The Renal Association
UK Renal Registry

Southmead Hospital
Southmead Road
Bristol, BS10 5NB, UK

Telephone
+ 44 (0) 117 323 5665

Fax
+ 44 (0) 117 323 5664

Email
renalregistry@renalregistry.nhs.uk

Web site
www.renalreg.org

Director
Ron Cullen

Medical Director
Fergus Caskey
Damian Fogarty

Medical Advisor
Terry Feest

Management Team
David Bull
Hilary Doxford
Retha Steenkamp

Project Management
Chrissie Jacobs
Sue Shaw

Clinical Informatics
Fiona Braddon
Shaun Mannings

Clinical Data Management
Fran Benoy-Deeney
Lynsey Billett
Paul Dawson
Jo Wilson

Programmers
Matthew Brealey
George Swinnerton

Business Support
Steph Shearn
Laura Woodward

Foreword

Welcome to the 2013 UK Renal Registry Report. It continues to be a tribute to the hard work of the renal community and to the Renal Registry itself. Last year, David Wheeler referred to the achievements of the Registry but cautioned against complacency. As the NHS in England goes through the biggest reorganisation since it's formation so too the Registry and the renal community need to consider and perhaps adjust and develop their remit. That is already apparent as this report is the first to be published in the calendar year following data collection. For the teams that supply the data to the Registry that does mean an increased responsibility in assuring data completeness and quality freeing the Registry to devote energies to analysis and publication.

The NHS reorganisation also provides the stimulus to consider the role of the Registry. It certainly provides the clinical teams with an insight into the quality of care delivered within renal units but as yet the message for commissioners, patients and carers is not clear. The Francis report not only highlighted safety but also patient experience as key areas to understand and monitor.

So it is important that the Registry understands the needs of commissioners to assure the quality of the service that they commission. Aspects of those quality measures may be found within this report but there is a need to consider system level measures that have a global reach to understand quality within provision. Safety clearly is a major element within that and there is a need to develop safety measures within the dataset. It is gratifying to see a continued and sustained fall in MRSA bacteraemia but there is a need to move beyond this single measure and document harm events in more depth.

The Registry is now working closely with NHS England on completing pilots around patient experience and outcome measures. These must be embedded into clinical practice in the way that systematic data collection has been achieved for laboratory data. These need to then develop into patient centred outcome measures that provide system level markers for both the users and the commissioners of the service to understand the quality of care.

Behind that, work continues to broaden data collection to include earlier stages of CKD into the remit of the Registry and consolidate RaDaR, the rare disease registry. The Registry is also a key partner in the newly established Acute Kidney Injury programme board, with the aim of significantly reducing the burden from AKI – a project set to run over 3 years.

It is also a time for wider collaboration. The Registry is also an important component of the **National cardiovascular intelligence network**, a far reaching project linking the cardiovascular disease headings into a health atlas for Public Health England.

Finally, there is the huge potential in the Registry to bridge the gap between randomised controlled trials and observation – (NEJM 369;17: 1579 Lauer et al.) and use the Registry as a registry based randomised trial. This may yield important benefit and be a valuable asset to the renal community.

Much has been delivered by the Registry over the twenty years since its inception. There is more to come and there is the challenge to widen the horizon.

Well done to everyone involved in the production of this report.

Richard Fluck
National Clinical Director (Renal), NHS England

Chapters and appendices

Contents

UK Renal Registry 16th Annual Report: Introduction

Damian Fogarty, Ron Cullen

UK Renal Registry, Bristol, UK

The UK Renal Registry (UKRR) continues to provide a national source of NHS healthcare data on patients dependent on renal replacement therapy (RRT) across the four nations. Using electronic reporting and substantial integration across the 71 adult and 13 paediatric renal centres independent audit and analysis of dialysis and transplant activity and care across the UK is provided. The UKRR is part of the UK Renal Association and is funded directly by participating renal centres through an annual capitation fee per patient per annum, currently £19 or ~0.01% of annual RRT running costs. The UKRR remains relatively unique amongst renal registries in publishing both centre-specific analyses of indicators of quality of care, such as haemoglobin and also age-adjusted survival statistics for each renal centre [1].

Incidence, prevalence and survival trends

This year 54,824 adult patients and 861 children and young people (<18 years) receiving RRT in the UK at the end of December 2012 were analysed. This represents an increase of 3.7% from the 2012 report. Incidence remains stable at 108 new patients per million population. The increase therefore in prevalence is attributable to increasing survival of our patients despite the overall group becoming older.

Elderly patients aged over 85 accepted onto RRT nearly doubled between 2006 and 2011. The percentage of RRT patients who are aged greater than 70 years has increased from 19.2% in 2000 to 24.9% in 2012. Greater recognition that older patients can and do tolerate dialysis and transplantation is accepted but there remains much variation in the prevalence and take on rates implying there is uncertainty about prognosis and perhaps quality of life with dialysis in particular. This merits discussion, wider data collection and further research.

Other notable points include the following:

- The number of patients receiving home haemodialysis (HD) increased by 19.3% from 905 patients in 2011 to 1,080 patients in 2012.
- The median age of prevalent patients was 58 years (HD 66 years, peritoneal dialysis (PD) 63 years, transplant 52 years). In 2000 the median age was 55 years (HD 63 years, PD 58 years, transplant 48 years).
- In 2012, 20.7% of the prevalent UK RRT population (with ethnicity assigned) were from ethnic minorities compared to 14.9% in 2007.
- There were national, regional and dialysis centre level variations in prevalence rates. A significant factor in this variation was the ethnic mix of local populations, but a large amount of the variation remains unexplained. Assessment of conservatively managed stage 5 CKD patients might explain more of this variation.
- Unadjusted 1 year after 90 day survival for patients starting RRT in 2011 increased to 87.5% from 87.3% for those starting in 2010.

- In all incident RRT patients aged ⩾65 years, unadjusted 1 year after 90 day survival increased from 63.9% in 1997 to 80.6% in the 2011 cohort.
- One year survival for prevalent diabetic patients increased from 81.6% in the 2002 cohort to 84.9% in the 2011 cohort.
- In the prevalent RRT dialysis population, cardiovascular disease accounted for 22% of deaths and treatment withdrawal 19%, whilst 21% were recorded as other cause of death.
- The median life years remaining for an incident patient aged 25–29 years was 18.5 years and approximately 2.4 years for a 75+ year old.
- There was a 5% increase in overall renal transplant numbers in 2012, with a significant rise in kidney donation from donors after circulatory death (19%).
- In 2012, approximately 1 in 50 transplant patients have graft failure per year and additionally about 1 in 50 transplanted patients die each year.

Completeness of data returns from UK renal centres

As stated in recent reports the UKRR continues to review the processes used for collection and validation of data and its communications with renal centres. It remains our intention to publish data following initial validation on the data portal section of the UKRR website (www.renalreg.com).

Data completeness (table 1) has improved dramatically over the last few years for returns on ethnic origin, primary renal diagnosis and date first seen by a nephrologist. Alas comorbidity at the start of RRT remains poorly returned overall with 55% of patients having comorbidity data. There are improvements at centre level: in the 2010 data there were ten centres with an average completeness of <50% across the indicator areas; this reduced to five centres with respect to 2011 data and two centres for the 2012 data. There are both in-centre process issues and also design issues with some of the electronic patient record systems. Clinical directors are encouraged to consider these aspects for their planning. These data deficiencies limit the UKRR's ability to perform fully adjusted analyses and have been highlighted in a publication this year [1]. Linked data between the UKRR and Hospital Episode Statistics enabled a dramatic reduction in missing data and showed that nearly all the variation between English renal centres in 3-year survival on RRT was explained by demographic factors and by comorbidity.

Interpretation of centre-specific clinical measures and survival comparisons

The UKRR continues to advise caution in the interpretation of the comparisons of centre-specific attainment of clinical performance measures provided in this report. In general terms, the UKRR has not tested for 'significant difference' between the highest achiever of a standard and the lowest achiever, as centres were not identified in advance of looking at the data and statistically this approach can be invalid. As in previous reports, the arbitrary 95% confidence interval is shown for compliance with a guideline. The calculation of this confidence interval (based on the binomial distribution) and the width of the confidence interval depends on the number of values falling within the standard and the number of patients with reported data. However for many of these analyses no adjustment can be made for the range of factors known to influence the measured variable as outlined above. Some of the clinical measures are summarised here:

- In 2012, 88% of prevalent HD patients achieved a URR >65%. The between centre range of prevalent patients achieving this target was wide (between 69.7% and 100%). The median URR in 2012 was 75%. The UK Renal Registry (UKRR) will explore a possible move to reporting Kt/V combined with residual renal function.
- There was substantial variation in the average dose of ESA prescription used (4,000 IU/week (Leeds, York) to 11,025 IU/week (Newcastle) with a median Hb for these centres of 110 g/L (Leeds, York) and 116 g/L (Newcastle) respectively). This may reflect the adoption of a well validated and researched protocol in the centres with lowest ESA requirements.
- There continues to be poor correlation between median Hb achieved to median ferritin and ESA usage across the UK centres.
- There was also a significant variation between the centres in the percentages of patients treated with an ESA and having Hb >120 g/L (HD: 7–39%, PD: 0–33%).
- ESA resistance is quite rare with a prevalence of patients receiving high doses of ESA (HD >450 IU/kg/week, PD >300 IU/kg/week) of 1.0% and 2.2% for HD and PD patients respectively. Of these half or less had failed to reach the target Hb >100 g/L and therefore have true ESA resistance.
- There continues to be significant variation in the achievement of BP standards between UK renal

Table 1. Percentage completeness of data returns for ethnicity, primary renal diagnosis, date first seen by a nephrologist, comorbidity at the start of RRT (incident patients 2012) and cause of death (for deaths in 2012 amongst incident or existing patients)

Centre	Ethnicity	Primary diagnosis	Date first seen	Comorbidity	Cause of death	Average completeness	Country
Ulster	100.0	100.0	100.0	100.0	100.0	100.0	N Ireland
Wrexm	100.0	100.0	97.1	100.0	100.0	99.4	Wales
Sthend	96.2	100.0	100.0	100.0	100.0	99.2	England
Antrim	100.0	100.0	100.0	96.2	100.0	99.2	N Ireland
L Kings	99.2	100.0	96.0	100.0	100.0	99.0	England
Nottm	100.0	100.0	97.9	97.0	99.0	98.8	England
York	100.0	98.1	100.0	94.3	100.0	98.5	England
Bradfd	100.0	98.6	97.1	98.6	97.7	98.4	England
Leeds	99.4	98.7	98.0	98.1	97.7	98.4	England
Swanse	100.0	100.0	99.1	95.6	97.1	98.4	Wales
Exeter	99.3	100.0	97.1	100.0	95.1	98.3	England
Oxford	100.0	100.0	98.2	99.4	92.7	98.1	England
Kent	94.8	100.0	100.0	100.0	94.9	97.9	England
Sund	98.6	100.0	98.6	94.4	97.4	97.8	England
Hull	95.9	100.0	97.9	96.9	96.9	97.5	England
Newry	100.0	100.0	100.0	88.9	96.7	97.1	N Ireland
Middlbr	99.2	98.3	97.5	90.0	94.9	96.0	England
Wolve	100.0	100.0	100.0	88.1	90.9	95.8	England
B Heart	100.0	93.1	96.0	92.1	96.6	95.6	England
Dorset	100.0	100.0	95.8	91.7	88.9	95.3	England
Truro	100.0	92.0	98.0	100.0	78.8	93.7	England
Derby	93.8	97.5	100.0	91.4	85.2	93.6	England
Donc	100.0	97.5	95.0	82.5	92.6	93.5	England
Clwyd	100.0	100.0	95.5	81.8	89.5	93.3	Wales
Bangor	100.0	100.0	90.5	76.2	100.0	93.3	Wales
Stevng	98.2	100.0	99.1	100.0	67.7	93.0	England
West NI	100.0	95.2	100.0	66.7	100.0	92.4	N Ireland
Basldn	100.0	88.7	96.2	84.9	88.9	91.7	England
Redng	80.8	97.3	97.3	84.9	91.2	90.3	England
Carlis	100.0	100.0	94.7	52.6	94.7	88.4	England
Leic	97.4	83.8	97.0	64.3	94.1	87.3	England
Glouc	100.0	100.0	94.5	37.8	91.5	84.8	England
Belfast	100.0	95.6	89.0	50.6	79.7	83.0	N Ireland
Bristol	95.9	84.5	94.6	54.7	82.2	82.4	England
Prestn	100.0	98.6	95.8	9.5	97.6	80.3	England
Colchr	100.0	100.0	100.0	0.0	100.0	80.0	England
Dudley	100.0	98.2	98.2	0.0	90.9	77.5	England
Chelms	80.0	97.8	97.8	11.1	100.0	77.3	England
Sheff	98.1	99.4	98.7	83.5	0.8	76.1	England
Newc	98.1	98.1	89.4	77.9	16.9	76.1	England
Stoke	96.1	93.5	98.7	0.0	89.6	75.6	England
Shrew	96.5	68.4	98.3	100.0	7.9	74.2	England
B QEH	100.0	99.5	99.5	66.7	2.1	73.6	England
Norwch	94.6	91.9	64.9	37.8	76.1	73.1	England
L Barts	100.0	93.5	1.5	72.6	79.9	69.5	England
Carsh	86.0	77.3	88.0	53.3	40.8	69.1	England
Ports	94.4	98.1	96.9	33.5	19.8	68.6	England
Covnt	99.1	98.2	98.2	9.8	33.3	67.7	England
Camb*	99.2	32.3	100.0	2.4	94.1	65.6	England
M RI	100.0	96.3	92.4	26.3	9.9	65.0	England
L Rfree	87.9	99.6	99.2	29.6	7.0	64.7	England
Cardff	100.0	99.4	98.8	21.8	0.6	64.1	Wales
L St.G	89.0	81.3	65.9	36.3	42.4	63.0	England
Ipswi*	90.7	34.9	97.7	2.3	77.4	60.6	England

Table 1. Continued

Centre	Ethnicity	Primary diagnosis	Date first seen	Comorbidity	Cause of death	Average completeness	Country
Liv Ain	100.0	100.0	100.0	0.0	0.0	60.0	England
Brightn	94.9	97.8	91.8	14.0	1.1	59.9	England
Plymth	97.9	72.3	31.9	55.3	41.2	59.7	England
L West	100.0	99.7	0.3	0.9	96.8	59.5	England
Liv RI	95.5	81.8	99.1	0.9	2.8	56.0	England
L Guys	96.9	86.6	22.4	1.6	58.8	53.2	England
Wirral	98.0	38.0	97.9	2.0	2.7	47.7	England
Salford	89.6	21.6	10.6	0.0	0.0	24.4	England
Abrdn		100.0			65.7		Scotland
Airdrie		100.0			93.9		Scotland
D & Gall		100.0			81.3		Scotland
Dundee		100.0			62.2		Scotland
Dunfn		100.0			87.5		Scotland
Edinb		100.0			100.0		Scotland
Glasgw		100.0			96.0		Scotland
Inverns		100.0			95.7		Scotland
Klmarnk		100.0			96.8		Scotland

*These centres have an unrealistically high percentage of people with diagnosis 'uncertain'. Therefore the primary diagnosis value given is the percentage with a specific diagnosis

centres. Only 26% of PD patients and 27% of transplant patients achieved the Renal Association guideline of SBP <130 mmHg and DBP <80 mmHg.
- There was marked variation (45–80%) between centres achieving their pre-dialysis SBP readings in the target range suggested by the RA guidelines of 120–160 mmHg.
- 56% of HD patients and 61% of PD patients achieved the audit measure for phosphate. 77% of HD and 78% of PD patients had adjusted calcium between 2.2–2.5 mmol/L.
- 58% of HD and 65% of PD patients had a serum PTH between 16–72 pmol/L.

For a number of years de-anonymised centre specific reports on survival of RRT patients have been published. This has taken on significant gravitas given the Francis, Keogh Enquiries and the ongoing CQC inspections of patient care and outcomes at a number of hospital trusts. In 2011 (2010 data) the UKRR sent letters to six centres with lower than expected survival at one year after 90 days for incident patients starting on RRT; in 2012 (2011 data) this was required for only three centres and for the 2012 data two centres were contacted. These centres are often managing cohorts of patients that may be sicker than some of their benchmarked peers but this can only be assessed if the data to support this contention is returned. As centres push the boundaries of their practice and perhaps offer RRT to sicker patients than in previous times it is important to ensure that these benchmarking activities do not create a negative pressure such that centres do not offer treatment to patients if a local clinical decision has deemed this appropriate. So such differences between centres' practices need to be interpreted in the light of measured and unmeasured variables that may account for these differences, the clinical impact of the differences and trend in these variables over time. For instance the one year survival of a centre may be in the lowest quartile of centres but be improving faster than others and may reflect excellent care given the case-mix and socio-demographic population base of the region. Furthermore the interpretation of survival in RRT patients needs to be seen in the context of the total population with advanced CKD (symptomatic stage 5 CKD) that may merit renal replacement therapy. Since conservative care is used for many patients in whom there is a choice not to start dialysis the selection of sicker (and/or) older patients in one centre versus the practice in another centre may result in unmeasured differences in survival due to this potential selection bias. For this important reason and the need to understand the quality of conservative care it is planned to expand the UKRR remit (technically and with appropriate information governance) to capture routine data on those patients with CKD stage 5. For the present centres are asked to report their outlying status internally at trust

level and follow up with robust mortality and morbidity meetings.

The UKRR has no statutory powers. However, the fact that the UKRR provides centre-specific de-anonymised analyses of important clinical outcomes, including survival, makes it important to define how the UKRR responds to apparent under-performance. The senior management team of the UKRR (Director, Medical Director and Head of Research and Audit) communicate survival outlier status with the renal centres in advance of publication of this finding. The centres are asked to provide evidence that the Clinical Governance department and Chief Executive of the Trust housing the service have been informed. In the event that no such evidence is provided, the Chair of the UKRR would inform the President of the Renal Association, who would then take action to ensure that the findings were properly investigated. These procedures are followed even if there is evidence that further adjustment, for instance for comorbidity, might explain outlier status. Coupled with open publication of the analyses this should by itself drive up the quality of care provided.

Information governance

At present the UKRR operates within a comprehensive governance framework which concerns data handling, reporting and research, including data linkages and sharing agreements. The Chair of the Renal Association Renal Information Governance Board is appointed as the Lead for Governance, with the UKRR Director responsible for day to day management of governance compliance and the Head of Operations is the operational information governance lead. The Framework is based on good practice, as described in the Information Governance Framework: (http://www.connectingforhealth.nhs.uk/systemsandservices/infogov/igap/igaf) and the Research Governance Framework for Health and Social Care (2005).

The UKRR has temporary exemption, granted by the Secretary of State under section 251 of The National Health Service Act (2006), to hold patient identifiable data. This exemption is reviewed annually. The UKRR has successfully completed the Connecting for Health information governance toolkit to a satisfactory standard.

Recently following a request from the Secretary of State for Health, Dame Fiona Caldicott carried out a new independent review of information sharing to ensure that there is an appropriate balance between the protection of patient information and the use and sharing of information to improve patient care. This review is available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/192572/2900774_InfoGovernance_accv2.pdf. This so called Caldicott 2 review is likely to shape data-sharing in many domains including healthcare registries.

Paediatric data and summary

The UKRR continues to provide a service for collecting paediatric data. It is hoped that this task is getting easier as the Hospital Trusts for those centres invest more resources into appropriate clinical information systems needed for day-to-day patient care and reporting structures. Notable aspects from the 2012 data are:

- A total of 861 children and young people under 18 years with ERF were receiving treatment at paediatric nephrology centres in 2012. 80.2% had a functioning kidney transplant, 10.6% were receiving haemodialysis (HD) and 9.2% were receiving peritoneal dialysis (PD).
- A third of children on RRT had one or more reported comorbidities.
- Median weight z-score for children on dialysis was −1.1 whereas children with a functioning transplant had a near normal weight (median z-score 0.1).
- Median height z-score for children on dialysis was −2.0 and for children with a functioning transplant −1.3.
- 76% of transplant patients, 57% of haemodialysis patients and 56% of peritoneal dialysis patients had a systolic blood pressure within the 90th percentile standard.
- 92% of transplant patients, 74% of HD patients and 83% of PD patients had a haemoglobin within or above the age appropriate standard.
- 50% of HD patients and 56% of PD patients achieved the audit standard for phosphate.
- Over the past 15 years for those referred early there has been a rise in pre-emptive transplantation rates, rising from 26.2% in 1998–2002 to 36.3% in 2008–2012.
- At transfer to adult services, 81.5% of patients had a functioning kidney transplant.

Vascular and peritoneal access and bacteraemia

The Vascular Access Audit was funded by the Healthcare Quality Improvement Partnership (HQIP) and run by the NHS Information Centre from 2009–2012. The expectation was that renal centres would have established systems and processes that record dialysis access data for all incident patients. The Renal Association and the UKRR always considered that this project should fall to its systems and processes. Although all UK renal centres have IT systems capable of collecting the ~400 item UKRR dataset the additional items required for paediatrics or detailed vascular access for instance are not uniformly entered for a variety of reasons. Each year the Renal Registry dataset is reviewed and the implications of any changes discussed with third party suppliers of IT systems. The following are some key points:

- In 2012, 51 centres in England, Wales and Northern Ireland (representing 82% of all centres) returned data on first access from incident haemodialysis (HD) patients ($n = 3{,}720$) and peritoneal dialysis (PD) patients ($n = 1{,}018$).
- For all incident HD patients, 38.3% started therapy on arterio-venous fistula (AVF), 36.9% on tunnelled line (TL), 23.5% on non-tunnelled line (NTL) and 1.2% by means of arterio-venous graft (AVG).
- Initial surgical assessment was a key determinant of the likelihood of AVF formation; 70.4% of patients assessed by a surgeon at least three months before commencing dialysis started on an AVF. Contrastingly, only 9.7% of patients not surgically assessed used an AVF as first dialysis access.
- Length of time known to nephrology services and likelihood of commencing dialysis using either an AVF or a PD catheter are strongly associated. For patients presenting late, 84.6% started on a line (TL/NTL). Amongst patients known to the unit for at least a year only 33.9% started via a line.
- For centres returning data on one year peritoneal dialysis outcomes, the majority of centres maintained >50% of patients on peritoneal dialysis at one year, however only five centres maintained >80% on PD at one year.
- From May 1st 2011 to April 30th 2012 there were 49 episodes of methicillin resistant Staphylococcus aureus (MRSA) bacteraemia in end stage renal failure patients on dialysis. This represents a further slight decline in MRSA bacteraemia rates which have been falling since data collection began in 2007.
- In the same period there were 138 Clostridium difficile infection episodes with a rate of 0.61 per 100 prevalent dialysis patients per year.
- Methicillin sensitive Staphylococcus aureus (MSSA) bacteraemia rates were 1.15 per 100 prevalent dialysis patients per year with 322 episodes of blood stream infection reported.
- Eschericia coli data were available from June 2011 and showed a reported rate of 0.92 per 100 prevalent dialysis patients per year.

Patient report

It has been the intention of the UKRR to produce a patient report based on the data analysed for the main annual report which is of particular interest and relevance to patients. A patient leaflet will initially be produced in conjunction with the National Kidney Federation early in 2013 based on 2012 data. This leaflet will be issued via patient groups and patient charities. Additional patient leaflets will be produced over time with the aim of producing an annual standalone patient focused chapter in the future.

Peer-reviewed publications since the last annual Report

The primary role of the UKRR is to use data to develop high-quality analyses to drive a cycle of continuous improvement in the care of patients with kidney disease in the UK. Research is an important part of improving the quality of existing analyses and developing new ones. Research from the Registry appears in peer-reviewed journals [2–11] in addition to articles published in collaboration with the EDTA-ERA Registry [12–15], other reports published by the Registry [16] and posters presented at renal conferences [17–24]. A list of publications involving analyses of UKRR data is available on the UKRR website at www.renalreg.com.

With the progressive improvement in survival of patients on RRT documented in this report it seems inevitable that the prevalence of RRT will continue to increase, even with continuing improvements in preventive care, earlier referral of patients with advanced CKD

and where appropriate, provision of supportive care in place of RRT for those who wish for it. RRT is a high cost therapy and this will pose a challenge to the NHS and to the UK renal community. This will make it more important than ever to submit high quality data on the outcomes of RRT and to develop reliable analyses of the epidemiology and outcomes of conservative management of advanced CKD.

Conflicts of interest: none

References

1 Nephrol. Dial. Transplant. (2013) doi: 10.1093/ndt/gft363
2 Bartlett C, Simpson K, Turner AN. Patient access to complex chronic disease records on the Internet. Bmc Medical Informatics and Decision Making. 2012 Aug 6;12
3 Castledine CI, Gilg JA, Rogers C, Ben-Shlomo Y, Caskey FJ. How much of the regional variation in RRT incidence rates within the UK is explained by the health needs of the general population? Nephrology, dialysis, transplantation: official publication of the European Dialysis and Transplant Association–European Renal Association. 2012 Oct; 27(10):3943–3950
4 Connor TMF, Oygar DD, Gale DP, Steenkamp R, Nitsch D, Neild GH, et al. Incidence of End-Stage Renal Disease in the Turkish-Cypriot Population of Northern Cyprus: A Population Based Study. PloS one. 2013 Jan 17;8(1)
5 Jones HE, Clothier JC, Casula A, Sinha MD, Hulton SA, Inward C. The UK experience of chronic dialysis in infants and children under two years of age: a post millennium perspective on behalf of the British association for paediatric nephrology. Pediatric Nephrology. 2012 Sep;27(9):1642–1643
6 Judge A, Caskey FJ, Welton NJ, Ansell D, Tomson CRV, Roderick PJ, et al. Inequalities in rates of renal replacement therapy in England: does it matter who you are or where you live? Nephrology Dialysis Transplantation. 2012 Apr;27(4):1598–1607
7 Schaefer F, Jager K, Reid C, Simpson K. The new ERA-EDTA coding system for coding causes of renal failure. Pediatric Nephrology. 2012 Sep;27(9):1788–1789
8 Sinha MD, Gilg JA, Kerecuk L, Reid CJD, British Assoc Paediat N. Progression to hypertension in non-hypertensive children following renal transplantation. Nephrology Dialysis Transplantation. 2012 Jul;27(7):2990–2996
9 Sinha MD, Kerecuk L, Gilg J, Reid CJD, British Assoc Paediat N. Systemic arterial hypertension in children following renal transplantation: prevalence and risk factors. Nephrology Dialysis Transplantation. 2012 Aug;27(8):3359–3368
10 Thomas HL, Banner NR, Murphy CL, Steenkamp R, Birch R, Fogarty DG, et al. Incidence, Determinants, and Outcome of Chronic Kidney Disease After Adult Heart Transplantation in the United Kingdom. Transplantation. 2012 Jun 15;93(11):1151–1157
11 Udayaraj U, Ben-Shlomo Y, Roderick P, Casula A, Dudley C, Collett D, et al. Social Deprivation, Ethnicity, and Uptake of Living Kidney Donor Transplantation in the United Kingdom. Transplantation. 2012 Mar 27;93(6):610–616
12 Couchoud C, Jager KJ, Tomson C, Cabanne J-F, Collart F, Finne P, et al. Assessment of urea removal in haemodialysis and the impact of the European Best Practice Guidelines. Nephrology Dialysis Transplantation. 2009 Apr;24(4):1267–1274
13 Jager KJ, Ocak G, Drechsler C, Caskey FJ, Evans M, Postorino M, et al. The EQUAL study: a European study in chronic kidney disease stage 4 patients. Nephrology Dialysis Transplantation. 2012 Oct;27:27–31
14 Kramer A, Stel VS, Caskey FJ, Stengel B, Elliott RF, Covic A, et al. Exploring the Association between Macroeconomic Indicators and Dialysis Mortality. Clinical journal of the American Society of Nephrology: CJASN. 2012 Oct;7(10):1655–1663
15 van de Luijtgaarden, M.W.M., et al., Factors Influencing the Decision to Start Renal Replacement Therapy: Results of a Survey Among European Nephrologists. American Journal of Kidney Diseases, 2012;60(6):940–948
16 Fluck R, Pitcher D, Steenkamp R, Vascular Access Audit Report 2012: UK Renal Registry and NHS Kidney Care 2012
17 Anwar S, Pruthi R, Kenchayikoppad S. Hypercalcemia a Risk Factor for Renal Transplant Dysfunction. Nephrology Dialysis Transplantation. 2012 May;27:156
18 Castledine C, Gilg J, Rogers C, Ben-Shlomo Y, Caskey F. Renal centre characteristics and practice patterns associated with RRT incidence in the UK. Nephrology Dialysis Transplantation. 2012 May;27:72
19 Castledine C, Gilg J, Rogers C, Ben-Shlomo Y, Caskey F. Factors affecting the number of patients treated with either peritoneal or home haemodialysis in the UK. Nephrology Dialysis Transplantation. 2012 May;27:274
20 Connor T, Oygar D, Nitsch D, Gale D, Steenkamp R, Neild GH, et al. High incidence of end-stage renal disease in the Turkish-Cypriot population of northern Cyprus: a population based study. Nephrology Dialysis Transplantation. 2012 May;27:384
21 Pruthi R, Ravanan R, Casula A, Roderick P. UK study of living kidney donor-recipient relationships: gender and ethnic variations. Nephrology Dialysis Transplantation. 2012 May;27:69
22 Webb L, Casula A, Ben-Shlomo Y, Tomson C. The clinical characteristics of patients starting dialysis after renal transplant failure in the UK 2000–2008: a UK Renal Registry analysis. Nephrology Dialysis Transplantation. 2012 May;27:305
23 Webb L, Casula A, Tomson C, Ben-Shlomo Y. Primary renal disease and survival after transplant failure–is there a relationship? An analysis of UK Renal Registry data. Nephrology Dialysis Transplantation. 2012 May;27:304
24 Webb L, Casula A, Tomson C, Ben-Shlomo Y. Survival after renal transplant failure: a UK Renal Registry analysis. Nephrology Dialysis Transplantation. 2012 May;27:312

UK Renal Registry 16th Annual Report: Chapter 1 UK Renal Replacement Therapy Incidence in 2012: National and Centre-specific Analyses

Julie Gilg[a], Anirudh Rao[a], Damian Fogarty[ab]

[a]UK Renal Registry, Bristol, UK; [b]Centre for Public Health, Queen's University Belfast and Belfast Health and Social Care Trust

Key Words

Acceptance rates · Comorbidity · Dialysis · End stage renal disease · End stage renal failure · Established renal failure · Haemodialysis · Incidence · Peritoneal dialysis · Registries · Renal replacement therapy · Transplantation · Treatment modality

Summary

- In 2012 the incidence rate in the UK was stable at 108 per million population (pmp) reflecting renal replacement therapy (RRT) initiation for 6,891 new patients.
- From 2006 to 2012 the incidence rate pmp was stable for England but had increased from 95 pmp in 2001.
- The median age of all incident patients was 64.6 years but this is highly dependant on race (66.1 for White incident patients; 57.8 for non-White patients).
- Diabetic renal disease remained the single most common cause of renal failure (26%).
- By 90 days, 66.9% of patients were on haemodialysis, 19.0% on peritoneal dialysis, 8.3% had had a transplant and 5.9% had died or stopped treatment.
- The mean eGFR at the start of RRT was 8.5 ml/min/1.73 m^2 similar to the previous four years.
- Late presentation (<90 days) fell from 23.9% in 2006 to 19.3% in 2012.

Introduction

This chapter contains analyses of adult patients starting renal replacement therapy (RRT) in the UK in 2012. It describes regional and national variations in incidence rates of RRT, the demographic and clinical characteristics of all patients starting RRT and analyses of late presentation and delayed referral. The methodology and results for these analyses are in three separate sections.

Definitions

The definition of incident patients is given in detail in appendix B: Definitions and Analysis Criteria (www.renalreg.com). In brief, it is all patients over 18 who commenced RRT in the UK in 2012 and who did not recover renal function within 90 days. Importantly this does not include those with a failed renal transplant who returned to dialysis as they had already started RRT.

Differences may be seen in the 2007 to 2011 numbers now quoted when compared with previous publications because of retrospective updating of data in collaboration with renal centres, in particular for patients who were initially thought to have acute renal failure. Where applicable and possible, pre-emptive transplant patients were allocated to their work up centre rather than their transplant centre. However, this was not possible for all such patients and consequently some patients probably remain incorrectly allocated to the transplanting centre. The term established renal failure (ERF) as used within this chapter is synonymous with the terms end stage renal failure/disease (ESRF or ESRD).

UK Renal Registry coverage

The UK Renal Registry (UKRR) received individual patient level data from all 71 adult renal centres in the UK (five renal centres in Wales, five in Northern Ireland, nine in Scotland, 52 in England). Data from centres in Scotland were obtained from the Scottish Renal Registry. Data on children and young adults can be found in chapter 7: Demography of the UK Paediatric Renal Replacement Therapy population in 2012.

1. Geographical variation in incidence rates

Over the years, there have been wide variations in incidence rates between renal centres. Equity of access to RRT is an important aim but hard to assess as the need for RRT depends on many variables including medical, social and demographic factors such as underlying conditions, age, gender, social deprivation and ethnicity. Thus, comparison of crude incidence rates by geographical area can be misleading. This year's report again uses age and gender standardisation of PCT/HB rates as well as showing crude rates. It also gives the ethnic minority percentage of each area as this influences incidence rates.

The UKRR investigated the effect of socio-demographic, population health status and access to care factors on RRT incidence. This work suggested that population age, socio-economic deprivation and the proportion of non-White residents were able to explain 22% of the observed variation in RRT incidence. The prevalence of diabetes in an area explained a further 4% of the variation and access to complex health procedures (CABG/coronary angioplasty) a further 6% [1]. Much of the observed variation (about 2/3rds) remains unexplained and may be due to unmeasured elements of the above factors or be due to differences in practice patterns at individual renal centres which have not yet been captured.

Methods

Crude incidence rates were calculated per million population (pmp) and age/gender standardised incidence ratios were calculated as detailed in appendix D: Methodology used for Analyses (www.renalreg.com).

Results

In 2012, the number of adult patients starting RRT in the UK was 6,891 equating to an incidence rate of 108 pmp (table 1.1), the same as in 2011. Wales remained the country with the highest incidence rate (figure 1.1). For England, incidence rates have been stable for the last seven years. There continued to be very marked gender differences in incidence rates which were 136 pmp (95% CI 132–140) in males and 80 pmp (95% CI 77–83) in females. When incident patients aged under 18 were included, the UK rate was 110 pmp.

Table 1.2 shows incidence rates and standardised incidence ratios for PCT/HBs. The ratios calculated using combined data from up to six years have been used to determine areas with significantly high or low incidence rates. Significantly high areas have been shaded with bold text and significantly low areas shaded a lighter grey with italicised text. There were wide variations between areas, with 49 being significantly high and 48 being significantly low out of a total of 177 areas. Last year these numbers were 53 and 48 areas respectively. The standardised incidence ratios ranged from 0.51 to 2.37 (IQR 0.84, 1.18).

Table 1.1. Number of new adult patients starting RRT in the UK in 2012

	England	N Ireland	Scotland	Wales	**UK**
Number starting RRT	5,826	186	519	360	**6,891**
Total estimated population mid-2012 (millions)*	53.5	1.8	5.3	3.1	**63.7**
Incidence rate (pmp)	109	102	98	117	**108**
(95% CI)	(106–112)	(87–117)	(89–106)	(105–129)	**(106–111)**

*Data from the Office for National Statistics, National Records of Scotland and the Northern Ireland Statistics and Research Agency – based on the 2011 census

As would be expected, urban areas with high percentages of non-White residents tended to have high incidence rates. Figure 1.2 shows the positive correlation ($r = 0.87$, $p < 0.001$) between the standardised incidence ratio and the percentage of the PCT/HB population that was non-White.

Confidence intervals are not presented for the crude rates per million population but figures D1 and D2 in appendix D can be used to determine if a PCT/HB falls within the 95% confidence interval around the national average rate.

The number of new patients starting RRT at each renal centre from 2007 to 2012 is shown in table 1.3. For most centres there was a lot of variability in the numbers of incident patients from one year to the next making it hard to see any underlying trend. Some centres have had an increase in new patients over time and others have fallen. The variation may reflect chance fluctuation, the introduction of new centres, changes in catchment populations or in completeness of reporting. Variation over time may also be due to changing incidence of established renal failure (increases in underlying disease prevalence, survival from comorbid conditions and recognition of ERF), changes to treatment thresholds or the introduction of conservative care programmes. Table 1.3 also shows centre level incidence rates (per million population). For the methodology used to estimate catchment populations in England and Wales see appendix E: Methodology for Estimating Catchment Populations (www.renalreg.com). For Scotland, mid-2011 populations of Health Boards (from the General Register Office for Scotland) were converted to centre level populations using an approximate mapping of renal centres to HBs supplied by the Scottish Renal Registry. Estimates of the catchment populations in Northern Ireland were supplied by personal communication from Dr D Fogarty.

There were falls of 8% and 17% respectively in the number of new patients for Scotland and Wales between 2007 and 2012. There was an increase of approximately 6% in new patients for England between 2007 and 2012. Across all four countries the change between 2007 and 2012 was an increase of 3.3%.

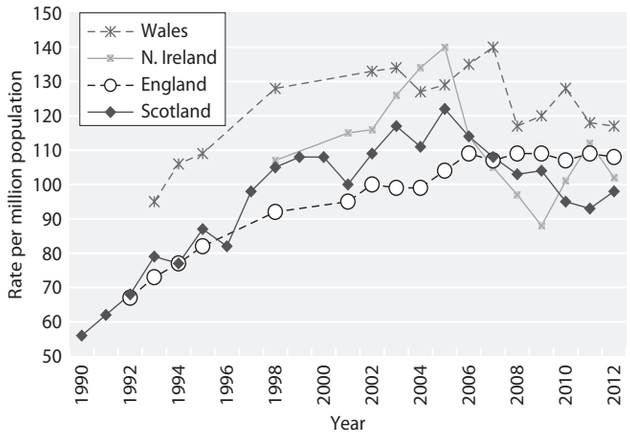

Fig. 1.1. RRT incidence rates in the countries of the UK 1990–2012

2. Demographics and clinical characteristics of patients starting RRT

Methods

Age, gender, primary renal disease, ethnic origin and treatment modality were examined for patients starting RRT. Centre level results are not shown for any centre with fewer than 10 incident patients in the year. Individual EDTA codes for primary diagnoses were grouped into eight categories, the details are given in appendix H: Ethnicity and ERA-EDTA Coding (www.renalreg.com).

Most centres electronically upload ethnicity coding to their renal information technology (IT) system from the hospital Patient Administration System (PAS). Ethnicity coding in these PAS systems is based on self-reported ethnicity. For the remaining centres, ethnicity coding is performed by clinical staff and recorded directly into the renal IT system (using a variety of coding systems). For all these analyses, data on ethnic origin were grouped into Whites, South Asians, Blacks, Chinese and

Table 1.2. Crude adult incidence rates (pmp) and age/gender standardised incidence ratios 2007–2012

PCT/HB – PCT in England, Health and Social Care Areas in Northern Ireland, Local Health Boards in Wales and Health Boards in Scotland
O/E – standardised incidence ratio
LCL – lower 95% confidence limit
UCL – upper 95% confidence limit
pmp – per million population
* – per year
Areas with significantly low incidence ratios over six years are italicised in greyed areas, those with significantly high incidence ratios over six years are bold in greyed areas
Blank cells – no data returned to the UKRR for that year. For the one area not covered by the Registry for the entire period 2007–2012, the combined years standardised incidence ratio and incidence rate are averages for the years covered by the Registry
Population data from the Office for National Statistics, National Records of Scotland and the Northern Ireland Statistics and Research Agency – based on the 2011 census
% non-White – percentage of the PCT/HB population that is non-White, from 2011 census for E, W & NI (2001 for Scotland)

								2012		2007–2012				
UK Area	PCT/HB	Tot pop (2011)	2007 O/E	2008 O/E	2009 O/E	2010 O/E	2011 O/E	O/E	Crude rate pmp	O/E	95% LCL	95% UCL	Crude rate pmp*	% non-White
North East	*County Durham*	*513,000*	*0.69*	*0.69*	*0.76*	*0.78*	*0.84*	*1.05*	*123*	*0.80*	*0.71*	*0.90*	*92*	*1.8*
	Darlington	105,600	1.13	1.04	0.94	0.96	0.93	1.26	142	1.04	0.83	1.31	115	3.8
	Gateshead	*200,300*	*0.81*	*0.54*	*0.80*	*0.77*	*0.75*	*0.88*	*100*	*0.76*	*0.62*	*0.92*	*85*	*3.7*
	Hartlepool	92,100	0.50	1.40	0.79	0.60	0.59	0.97	109	0.81	0.61	1.07	89	2.3
	Middlesbrough	138,400	1.31	1.31	0.64	1.46	0.71	1.06	108	1.08	0.88	1.33	108	11.8
	Newcastle	279,100	1.18	1.02	0.98	0.77	0.85	0.78	75	0.93	0.79	1.09	88	14.5
	North Tyneside	*201,200*	*0.76*	*0.54*	*0.92*	*0.99*	*0.61*	*0.87*	*99*	*0.78*	*0.65*	*0.95*	*88*	*3.4*
	Northumberland	*316,300*	*0.75*	*0.65*	*0.59*	*0.63*	*0.84*	*0.78*	*98*	*0.71*	*0.61*	*0.82*	*87*	*1.6*
	Redcar and Cleveland	135,200	0.95	0.76	0.87	0.76	1.05	0.86	104	0.88	0.71	1.09	104	1.5
	South Tyneside	148,200	1.20	0.54	1.42	0.72	1.00	0.52	61	0.90	0.73	1.10	102	4.1
	Stockton-on-Tees Teaching	191,800	0.75	0.85	0.69	0.91	1.12	1.07	115	0.90	0.74	1.08	95	5.4
	Sunderland Teaching	275,300	1.09	0.89	0.94	1.00	0.74	0.87	98	0.92	0.79	1.07	102	4.1
North West	*Ashton, Leigh and Wigan*	*318,100*	*0.56*	*0.85*	*0.55*	*0.74*	*0.92*	*0.77*	*85*	*0.73*	*0.62*	*0.86*	*79*	*2.7*
	Blackburn with Darwen Teaching	147,700	1.24	0.51	0.87	1.04	1.37	1.22	115	1.04	0.84	1.29	97	30.8
	Blackpool	142,100	0.98	0.92	1.03	0.55	0.78	1.43	169	0.95	0.78	1.16	110	3.3
	Bolton Teaching	277,300	0.89	0.92	0.80	1.43	0.94	0.90	94	0.98	0.84	1.14	100	18.1
	Bury	185,400	0.67	0.77	0.71	0.78	0.66	1.35	146	0.82	0.68	1.01	87	10.8
	Central and Eastern Cheshire	*462,800*	*0.66*	*0.67*	*0.68*	*0.75*	*0.77*	*0.74*	*89*	*0.71*	*0.63*	*0.81*	*83*	*3.1*
	Central Lancashire	*467,400*	*0.78*	*0.90*	*0.94*	*0.62*	*0.78*	*0.89*	*98*	*0.82*	*0.72*	*0.93*	*89*	*7.8*
	Cumbria Teaching	*499,800*	*0.64*	*0.74*	*0.61*	*0.69*	*0.59*	*0.60*	*76*	*0.64*	*0.57*	*0.73*	*80*	*1.5*
	East Lancashire Teaching	*382,500*	*0.76*	*0.66*	*0.82*	*0.71*	*0.88*	*0.52*	*58*	*0.73*	*0.63*	*0.84*	*78*	*11.6*
	Halton and St Helens	301,100	0.94	0.52	0.81	0.89	1.11	0.92	103	0.87	0.75	1.01	95	2.0
	Heywood, Middleton and Rochdale	211,900	0.90	0.90	1.13	0.77	1.26	1.25	127	1.04	0.88	1.23	104	18.3
	Knowsley	145,900	1.11	0.52	0.77	0.92	1.09	1.28	137	0.95	0.77	1.17	101	2.8
	Liverpool	465,700	1.08	1.15	1.16	0.87	1.08	1.30	129	1.10	0.99	1.24	108	11.1
	Manchester Teaching	**502,900**	**1.29**	**1.31**	**1.42**	**1.31**	**1.24**	**1.41**	**109**	**1.33**	**1.19**	**1.49**	**103**	**33.4**
	North Lancashire Teaching	*321,600*	*0.61*	*0.53*	*0.75*	*0.69*	*0.74*	*0.74*	*93*	*0.68*	*0.58*	*0.79*	*84*	*3.1*
	Oldham	225,200	0.91	1.09	0.90	0.97	0.98	0.71	71	0.93	0.78	1.11	91	22.5
	Salford	234,500	0.62	1.02	1.01	1.39	0.65	0.87	85	0.92	0.78	1.10	90	9.9
	Sefton	274,000	0.55	0.85	0.86	1.04	1.24	0.91	113	0.91	0.79	1.05	111	2.6
	Stockport	*283,300*	*0.82*	*0.79*	*0.62*	*0.89*	*0.83*	*0.64*	*74*	*0.76*	*0.65*	*0.90*	*86*	*7.9*
	Tameside and Glossop	252,900	1.33	0.76	0.90	0.96	0.93	0.59	63	0.91	0.77	1.07	96	8.2
	Trafford	227,100	1.05	0.59	1.00	1.32	0.54	1.15	123	0.94	0.79	1.11	99	14.5
	Warrington	*202,700*	*0.74*	*0.61*	*1.10*	*0.61*	*0.50*	*0.86*	*94*	*0.74*	*0.61*	*0.90*	*79*	*4.1*
	Western Cheshire	237,400	0.90	0.54	0.85	1.26	1.05	0.87	105	0.91	0.78	1.07	108	2.8
	Wirral	*319,800*	*0.74*	*0.74*	*0.81*	*0.93*	*0.93*	*0.66*	*78*	*0.80*	*0.69*	*0.93*	*93*	*3.0*

Table 1.2. Continued

UK Area	PCT/HB	Tot pop (2011)	2007 O/E	2008 O/E	2009 O/E	2010 O/E	2011 O/E	2012		2007–2012				% non-White
								O/E	Crude rate pmp	O/E	95% LCL	95% UCL	Crude rate pmp*	
Yorkshire and the Humber	Barnsley	231,900	0.86	1.13	0.89	1.18	0.80	1.03	116	0.98	0.84	1.15	109	2.1
	Bradford and Airedale Teaching	**523,100**	**1.43**	**1.08**	**0.96**	**1.32**	**1.04**	**1.30**	**122**	**1.19**	**1.07**	**1.32**	**110**	**32.6**
	Calderdale	*204,200*	*0.84*	*0.88*	*1.01*	*0.61*	*0.59*	*0.77*	*83*	*0.78*	*0.65*	*0.95*	*83*	*10.3*
	Doncaster	302,500	0.64	0.76	1.02	0.95	1.05	0.80	89	0.87	0.75	1.01	95	4.7
	East Riding of Yorkshire	*334,700*	*0.67*	*0.98*	*0.89*	*0.72*	*0.77*	*0.83*	*108*	*0.81*	*0.71*	*0.93*	*103*	*1.9*
	Hull Teaching	256,100	1.09	1.05	0.99	0.93	0.71	0.79	78	0.92	0.78	1.09	90	5.9
	Kirklees	423,000	0.72	0.74	1.03	0.94	1.05	0.86	90	0.89	0.78	1.02	91	20.9
	Leeds	*750,700*	*0.86*	*1.02*	*0.81*	*0.66*	*0.80*	*0.74*	*73*	*0.81*	*0.73*	*0.90*	*80*	*14.9*
	North East Lincolnshire	161,200	1.07	1.01	0.83	0.68	1.37	0.66	74	0.94	0.77	1.14	104	2.6
	North Lincolnshire	163,600	0.70	0.81	0.75	0.71	1.49	1.16	134	0.94	0.78	1.14	107	4.1
	North Yorkshire and York	*799,000*	*0.83*	*0.71*	*0.80*	*0.64*	*0.87*	*0.92*	*111*	*0.80*	*0.73*	*0.87*	*94*	*3.4*
	Rotherham	257,700	1.02	1.27	0.91	1.07	0.73	0.82	93	0.97	0.83	1.13	107	6.4
	Sheffield	**551,800**	**1.17**	**1.15**	**1.30**	**1.07**	**0.98**	**1.25**	**127**	**1.15**	**1.04**	**1.27**	**115**	**16.3**
	Wakefield District	*326,400*	*0.50*	*0.76*	*0.61*	*0.85*	*0.91*	*1.06*	*119*	*0.78*	*0.67*	*0.91*	*86*	*4.6*
East Midlands	Bassetlaw	113,000	1.68	0.61	0.68	0.84	0.82	1.04	124	0.94	0.75	1.18	111	2.6
	Derby City	**248,900**	**0.98**	**1.68**	**1.37**	**1.07**	**1.40**	**1.56**	**157**	**1.34**	**1.17**	**1.54**	**133**	**19.7**
	Derbyshire County	*737,500*	*0.82*	*1.04*	*0.78*	*0.73*	*0.90*	*0.83*	*99*	*0.85*	*0.78*	*0.94*	*100*	*2.5*
	Leicester City	**329,600**	**1.68**	**1.57**	**1.31**	**1.74**	**1.82**	**1.61**	**140**	**1.62**	**1.44**	**1.82**	**139**	**49.5**
	Leicestershire County and Rutland	*688,800*	*0.86*	*0.71*	*0.80*	*0.93*	*0.83*	*0.71*	*83*	*0.81*	*0.73*	*0.89*	*92*	*8.3*
	Lincolnshire Teaching	*717,200*	*0.79*	*0.69*	*0.71*	*0.85*	*0.89*	*0.69*	*86*	*0.77*	*0.70*	*0.85*	*95*	*2.4*
	Northamptonshire Teaching	694,000	0.99	1.19	0.81	0.80	0.90	1.12	120	0.97	0.88	1.07	101	8.5
	Nottingham City	**303,900**	**0.97**	**1.31**	**1.46**	**1.49**	**1.06**	**1.18**	**102**	**1.24**	**1.08**	**1.43**	**106**	**28.5**
	Nottinghamshire County Teaching	673,800	1.06	0.91	1.01	0.90	0.90	0.82	95	0.93	0.85	1.02	106	4.8
West Midlands	**Birmingham East and North**	**421,400**	**1.45**	**1.73**	**1.45**	**1.38**	**1.86**	**1.61**	**154**	**1.58**	**1.43**	**1.75**	**149**	**36.1**
	Coventry Teaching	**316,900**	**1.36**	**1.53**	**1.71**	**1.31**	**1.52**	**1.89**	**183**	**1.55**	**1.38**	**1.75**	**149**	**26.2**
	Dudley	313,300	0.96	0.82	1.40	0.80	0.80	1.19	137	1.00	0.87	1.14	113	10.0
	Heart of Birmingham Teaching	**299,200**	**2.47**	**2.83**	**2.68**	**2.19**	**1.89**	**2.14**	**160**	**2.37**	**2.12**	**2.64**	**177**	**70.5**
	Herefordshire	183,600	0.93	0.93	1.08	0.71	0.82	0.86	109	0.89	0.74	1.06	111	1.8
	North Staffordshire	212,900	0.56	0.84	1.30	0.69	1.18	0.62	75	0.87	0.73	1.03	103	3.5
	Sandwell	**309,000**	**1.55**	**2.15**	**1.76**	**1.84**	**1.65**	**1.39**	**139**	**1.72**	**1.54**	**1.92**	**170**	**30.1**
	Shropshire County	*307,100*	*0.78*	*1.00*	*0.71*	*0.92*	*0.92*	*0.73*	*91*	*0.84*	*0.73*	*0.97*	*103*	*2.0*
	Solihull	206,900	0.76	0.98	1.37	1.02	0.70	0.99	116	0.97	0.82	1.15	112	10.9
	South Birmingham	**353,700**	**1.26**	**1.53**	**1.39**	**1.09**	**1.26**	**1.09**	**105**	**1.27**	**1.12**	**1.43**	**121**	**25.3**
	South Staffordshire	*628,500*	*0.95*	*0.88*	*0.77*	*1.00*	*0.97*	*0.76*	*89*	*0.89*	*0.81*	*0.98*	*102*	*4.7*
	Stoke on Trent	256,900	1.24	1.01	1.33	1.32	0.99	0.88	93	1.13	0.98	1.30	118	11.0
	Telford and Wrekin	**166,800**	**1.61**	**1.08**	**1.24**	**1.51**	**1.06**	**1.23**	**126**	**1.29**	**1.08**	**1.53**	**130**	**7.3**
	Walsall Teaching	**269,500**	**1.13**	**1.37**	**1.01**	**1.84**	**1.10**	**1.34**	**145**	**1.30**	**1.14**	**1.48**	**138**	**21.1**
	Warwickshire	546,600	1.01	0.98	0.96	1.15	1.06	0.81	93	0.99	0.90	1.10	113	7.3
	Wolverhampton City	**249,900**	**1.01**	**1.44**	**1.11**	**1.45**	**1.18**	**1.41**	**148**	**1.27**	**1.10**	**1.46**	**131**	**32.0**
	Worcestershire	*566,600*	*0.83*	*0.94*	*1.05*	*0.77*	*0.81*	*0.98*	*118*	*0.90*	*0.81*	*1.00*	*106*	*4.3*
East of England	*Bedfordshire*	*413,500*	*0.60*	*0.76*	*0.81*	*0.90*	*0.74*	*1.00*	*109*	*0.80*	*0.70*	*0.92*	*85*	*11.2*
	Cambridgeshire	*622,300*	*0.82*	*0.73*	*1.02*	*0.80*	*0.95*	*0.65*	*71*	*0.83*	*0.74*	*0.92*	*88*	*7.4*
	Hertfordshire	*1,119,800*	*0.74*	*0.95*	*0.82*	*0.90*	*0.92*	*0.79*	*83*	*0.85*	*0.79*	*0.92*	*88*	*12.4*
	Great Yarmouth and Waveney	212,800	1.17	1.09	0.89	1.13	1.10	0.91	117	1.05	0.90	1.22	132	2.7
	Luton	**203,600**	**1.47**	**1.13**	**1.01**	**1.15**	**1.44**	**1.22**	**108**	**1.24**	**1.04**	**1.47**	**108**	**45.3**
	Mid Essex	375,200	0.92	0.84	0.93	0.90	0.94	0.75	85	0.88	0.77	1.00	98	4.4
	Norfolk	*762,000*	*1.07*	*0.88*	*0.69*	*0.81*	*0.81*	*0.77*	*97*	*0.84*	*0.76*	*0.91*	*104*	*3.5*

Table 1.2. Continued

UK Area	PCT/HB	Tot pop (2011)	2007 O/E	2008 O/E	2009 O/E	2010 O/E	2011 O/E	2012		2007–2012				
								O/E	Crude rate pmp	O/E	95% LCL	95% UCL	Crude rate pmp*	% non-White
East of England	North East Essex	311,700		1.57	0.82	0.98	1.27	0.98	119	1.12	0.98	1.29	135	5.5
	Peterborough	184,500	1.09	1.03	1.19	0.70	0.96	0.62	60	0.93	0.76	1.13	89	17.5
	South East Essex	*345,600*	*1.03*	*0.91*	*0.62*	*0.78*	*0.79*	*0.81*	*95*	*0.82*	*0.71*	*0.94*	*95*	*5.7*
	South West Essex	407,100	0.92	1.11	0.69	0.85	1.02	1.11	115	0.95	0.84	1.08	97	9.8
	Suffolk	*614,800*	*0.93*	*0.72*	*0.86*	*0.74*	*0.63*	*0.88*	*104*	*0.79*	*0.71*	*0.88*	*92*	*5.3*
	West Essex	*289,600*	*0.73*	*0.48*	*0.79*	*0.67*	*0.75*	*1.21*	*135*	*0.77*	*0.66*	*0.91*	*85*	*8.1*
London	**Barking and Dagenham**	**187,000**	**1.15**	**1.56**	**1.48**	**1.45**	**1.67**	**2.20**	**176**	**1.59**	**1.35**	**1.87**	**126**	**41.7**
	Barnet	**357,500**	**1.92**	**1.40**	**1.35**	**1.75**	**1.46**	**1.58**	**148**	**1.57**	**1.41**	**1.76**	**146**	**35.9**
	Bexley	232,800	1.09	1.17	1.28	1.39	1.19	0.86	90	1.16	1.00	1.35	120	18.1
	Brent Teaching	**312,200**	**1.99**	**1.92**	**2.17**	**2.72**	**2.19**	**2.49**	**215**	**2.25**	**2.03**	**2.49**	**192**	**63.7**
	Bromley	310,600	0.73	1.28	0.98	1.10	0.68	0.65	71	0.90	0.78	1.04	97	15.7
	Camden	**220,100**	**1.11**	**1.16**	**1.37**	**1.67**	**1.30**	**1.20**	**105**	**1.30**	**1.11**	**1.53**	**112**	**33.7**
	City and Hackney Teaching	**254,600**	**1.35**	**1.24**	**1.68**	**1.67**	**1.87**	**2.04**	**149**	**1.64**	**1.42**	**1.90**	**119**	**44.6**
	Croydon	**364,800**	**1.72**	**1.39**	**1.64**	**1.47**	**1.28**	**2.04**	**189**	**1.59**	**1.43**	**1.78**	**145**	**44.9**
	Ealing	**339,300**	**1.95**	**1.54**	**2.27**	**2.05**	**1.85**	**2.26**	**197**	**1.99**	**1.79**	**2.21**	**172**	**51.0**
	Enfield	**313,900**	**1.14**	**1.40**	**1.31**	**1.41**	**2.00**	**1.65**	**150**	**1.49**	**1.31**	**1.68**	**133**	**39.0**
	Greenwich Teaching	**255,500**	**1.47**	**1.66**	**1.23**	**2.08**	**1.08**	**1.36**	**114**	**1.48**	**1.28**	**1.71**	**122**	**37.5**
	Hammersmith and Fulham	**182,400**	**1.58**	**0.62**	**1.30**	**1.55**	**1.35**	**1.57**	**126**	**1.33**	**1.10**	**1.59**	**106**	**31.9**
	Haringey Teaching	**255,500**	**1.13**	**1.58**	**1.08**	**1.41**	**1.90**	**2.39**	**192**	**1.59**	**1.38**	**1.83**	**126**	**39.5**
	Harrow	**240,500**	**0.52**	**1.68**	**1.99**	**2.17**	**2.27**	**1.51**	**150**	**1.69**	**1.49**	**1.92**	**165**	**57.8**
	Havering	*237,900*	*0.69*	*0.81*	*0.61*	*0.39*	*1.21*	*1.05*	*118*	*0.80*	*0.67*	*0.95*	*88*	*12.3*
	Hillingdon	**275,500**	**0.91**	**1.46**	**1.33**	**1.40**	**1.59**	**1.47**	**138**	**1.36**	**1.19**	**1.56**	**126**	**39.4**
	Hounslow	**254,900**	**1.47**	**1.19**	**1.59**	**1.92**	**1.85**	**1.85**	**161**	**1.64**	**1.44**	**1.88**	**141**	**48.6**
	Islington	**206,300**	**1.22**	**0.92**	**1.59**	**1.50**	**1.63**	**2.31**	**184**	**1.53**	**1.30**	**1.79**	**121**	**31.8**
	Kensington and Chelsea	158,300	0.54	1.28	0.87	1.17	0.93	0.79	76	0.93	0.75	1.15	87	29.4
	Kingston	160,400	0.88	1.49	0.74	0.89	1.06	1.13	106	1.03	0.84	1.27	96	25.5
	Lambeth	**304,500**	**1.95**	**1.61**	**1.96**	**1.52**	**1.85**	**1.82**	**138**	**1.78**	**1.57**	**2.02**	**135**	**42.9**
	Lewisham	**276,900**	**1.83**	**1.61**	**2.31**	**1.46**	**1.90**	**1.99**	**162**	**1.85**	**1.64**	**2.10**	**150**	**46.5**
	Newham	**310,500**	**1.65**	**1.78**	**2.03**	**2.52**	**2.27**	**2.02**	**139**	**2.05**	**1.81**	**2.31**	**140**	**71.0**
	Redbridge	**281,400**	**1.38**	**1.54**	**1.81**	**1.56**	**1.39**	**2.15**	**192**	**1.64**	**1.45**	**1.86**	**145**	**57.5**
	Richmond and Twickenham	*187,500*	*0.77*	*0.77*	*0.81*	*0.89*	*0.70*	*0.81*	*80*	*0.79*	*0.64*	*0.98*	*77*	*14.0*
	Southwark	**288,700**	**2.33**	**2.10**	**1.51**	**1.87**	**2.03**	**1.86**	**142**	**1.95**	**1.72**	**2.20**	**148**	**45.8**
	Sutton and Merton	**391,700**	**1.23**	**1.47**	**1.27**	**1.36**	**1.45**	**1.63**	**156**	**1.40**	**1.25**	**1.57**	**132**	**28.4**
	Tower Hamlets	**256,000**	**1.77**	**2.00**	**1.90**	**1.46**	**1.81**	**2.02**	**133**	**1.83**	**1.58**	**2.11**	**120**	**54.8**
	Waltham Forest	**259,700**	**2.41**	**1.32**	**1.64**	**1.15**	**1.86**	**1.17**	**96**	**1.59**	**1.39**	**1.83**	**130**	**47.8**
	Wandsworth	**307,700**	**1.69**	**1.61**	**1.90**	**1.53**	**1.19**	**1.19**	**94**	**1.52**	**1.33**	**1.73**	**119**	**28.6**
	Westminster	**219,600**	**0.71**	**1.46**	**1.71**	**1.29**	**1.49**	**1.35**	**123**	**1.34**	**1.14**	**1.56**	**121**	**38.3**
South East Coast	Brighton and Hove City	273,000	0.82	1.06	1.12	0.83	0.92	1.12	106	0.98	0.84	1.15	92	10.9
	East Sussex Downs and Weald	*343,900*	*0.89*	*0.65*	*0.62*	*0.61*	*0.75*	*1.04*	*134*	*0.76*	*0.66*	*0.87*	*96*	*3.8*
	Eastern and Coastal Kent	759,600	1.31	1.19	1.04	1.04	0.90	0.88	103	1.06	0.97	1.15	121	5.0
	Hastings and Rother	*183,400*	*0.61*	*0.92*	*0.68*	*0.74*	*1.02*	*0.80*	*104*	*0.80*	*0.66*	*0.96*	*101*	*4.5*
	Medway	264,900	1.42	0.65	0.99	0.82	0.87	0.79	79	0.92	0.79	1.09	91	10.4
	Surrey	1,124,800	0.80	0.93	0.97	1.04	0.97	0.97	108	0.95	0.88	1.02	104	9.5
	West Kent	706,800	1.00	1.02	0.98	0.82	0.89	0.75	82	0.91	0.83	1.00	98	7.7
	West Sussex	*808,900*	*0.85*	*0.87*	*0.77*	*0.76*	*0.67*	*0.72*	*88*	*0.77*	*0.70*	*0.85*	*92*	*6.2*

Table 1.2. Continued

UK Area	PCT/HB	Tot pop (2011)	2007 O/E	2008 O/E	2009 O/E	2010 O/E	2011 O/E	2012		2007–2012				
								O/E	Crude rate pmp	O/E	95% LCL	95% UCL	Crude rate pmp*	% non-White
South Central	**Berkshire East**	**410,100**	**1.34**	**1.23**	**1.32**	**1.25**	**1.36**	**0.85**	**80**	**1.22**	**1.09**	**1.38**	**115**	**26.6**
	Berkshire West	464,400	0.89	1.11	0.84	0.75	1.05	0.76	78	0.90	0.79	1.02	90	14.0
	Buckinghamshire	*521,000*	*0.77*	*0.84*	*0.93*	*0.75*	*0.79*	*0.75*	*83*	*0.80*	*0.71*	*0.90*	*87*	*13.3*
	Hampshire	*1,322,100*	*0.77*	*0.83*	*0.83*	*0.76*	*0.74*	*0.69*	*81*	*0.77*	*0.71*	*0.83*	*88*	*5.0*
	Isle of Wight National Health Service	*138,400*	*0.22*	*0.34*	*0.16*	*0.62*	*0.82*	*0.87*	*116*	*0.51*	*0.39*	*0.66*	*66*	*2.7*
	Milton Keynes	255,400	1.18	1.00	1.00	1.11	0.99	1.19	110	1.08	0.92	1.27	97	19.6
	Oxfordshire	629,600	0.74	0.68	1.03	0.93	1.04	0.99	105	0.90	0.81	1.00	94	9.4
	Portsmouth City Teaching	205,400	0.80	0.90	0.74	0.59	1.30	1.10	102	0.91	0.75	1.10	84	11.6
	Southampton City	235,900	0.85	1.22	0.60	1.23	1.14	0.88	81	0.99	0.83	1.17	90	14.1
South West	Bath and North East Somerset	175,500	0.94	0.73	1.38	0.63	0.56	0.96	108	0.87	0.71	1.05	96	5.4
	Bournemouth and Poole Teaching	*331,500*	*0.68*	*0.84*	*0.53*	*0.54*	*0.74*	*0.79*	*90*	*0.69*	*0.59*	*0.81*	*77*	*6.3*
	Bristol	**428,100**	**1.05**	**1.56**	**1.19**	**1.45**	**1.38**	**1.26**	**117**	**1.31**	**1.18**	**1.47**	**121**	**16.0**
	Cornwall and Isles of Scilly	536,000	0.98	0.89	1.09	0.89	0.79	0.96	123	0.93	0.84	1.03	117	1.8
	Devon	747,700	1.07	1.13	1.01	0.93	0.89	0.99	128	1.00	0.92	1.09	128	2.5
	Dorset	*413,800*	*0.72*	*0.92*	*0.69*	*0.61*	*0.70*	*0.65*	*89*	*0.71*	*0.63*	*0.81*	*97*	*2.1*
	Gloucestershire	598,300	0.88	0.68	1.13	0.87	0.92	1.17	137	0.94	0.85	1.04	108	4.6
	North Somerset	203,100	0.82	1.19	0.88	0.99	0.84	0.99	123	0.95	0.81	1.12	116	2.7
	Plymouth Teaching	**256,600**	**1.73**	**1.05**	**1.15**	**1.29**	**1.10**	**0.95**	**101**	**1.21**	**1.05**	**1.39**	**127**	**3.9**
	Somerset	*531,600*	*0.73*	*0.75*	*1.11*	*1.07*	*0.85*	*0.69*	*87*	*0.87*	*0.78*	*0.96*	*106*	*2.0*
	South Gloucestershire	263,400	0.88	0.98	0.69	1.17	0.58	0.82	91	0.85	0.73	1.00	93	5.0
	Swindon	214,900	0.61	1.08	1.07	1.00	1.16	1.29	130	1.04	0.87	1.23	103	10.0
	Torbay	131,200	0.90	1.62	0.70	1.50	0.87	1.10	145	1.11	0.92	1.34	144	2.5
	Wiltshire	*474,300*	*0.62*	*0.85*	*0.74*	*0.83*	*0.63*	*0.49*	*57*	*0.69*	*0.61*	*0.79*	*78*	*3.4*
Wales	Betsi Cadwaladr University	688,700	1.11	0.93	0.94	1.00	0.81	0.99	121	0.96	0.88	1.05	115	2.5
	Powys Teaching	133,200	0.99	0.93	1.03	0.64	1.25	1.24	165	1.02	0.84	1.23	133	1.6
	Hywel Dda	381,900	1.10	1.27	0.80	1.12	1.20	0.86	107	1.06	0.94	1.18	130	2.2
	Abertawe Bro Morgannwg Univ.	**517,700**	**1.51**	**1.20**	**1.52**	**1.47**	**1.14**	**1.35**	**155**	**1.36**	**1.25**	**1.49**	**153**	**3.9**
	Cwm Taf	**293,500**	**1.61**	**1.07**	**1.31**	**0.99**	**1.45**	**0.86**	**95**	**1.21**	**1.07**	**1.38**	**132**	**2.6**
	Aneurin Bevan	**577,000**	**1.34**	**0.95**	**0.95**	**1.30**	**1.17**	**1.16**	**132**	**1.14**	**1.04**	**1.26**	**127**	**3.9**
	Cardiff and Vale University	**472,300**	**1.46**	**1.00**	**1.14**	**1.36**	**1.00**	**1.05**	**104**	**1.17**	**1.05**	**1.30**	**114**	**12.2**
Scotland	Ayrshire & Arran	373,800	0.85	0.82	0.88	1.08	0.81	0.89	107	0.89	0.78	1.01	105	0.7
	Borders	113,900	1.20	1.13	0.97	1.06	0.55	0.48	61	0.89	0.71	1.12	113	0.6
	Dumfries and Galloway	151,400	0.83	1.14	1.07	0.63	0.56	1.06	139	0.88	0.73	1.07	113	0.7
	Fife	365,300	1.00	0.96	1.21	1.19	1.15	0.86	99	1.06	0.94	1.20	120	1.3
	Forth Valley	298,100	1.33	0.77	1.07	1.03	0.79	0.84	94	0.97	0.84	1.12	106	1.1
	Grampian	*569,600*	*0.84*	*0.87*	*0.88*	*0.85*	*0.82*	*0.85*	*93*	*0.85*	*0.76*	*0.95*	*92*	*1.6*
	Greater Glasgow & Clyde	1,214,600	1.08	0.95	1.00	0.87	1.04	1.10	117	1.01	0.94	1.08	105	3.4
	Highland	*321,700*	*0.86*	*0.83*	*0.72*	*0.60*	*0.48*	*0.53*	*65*	*0.67*	*0.57*	*0.78*	*81*	*0.8*
	Lanarkshire	*572,400*	*0.80*	*0.77*	*0.84*	*0.96*	*0.84*	*1.15*	*126*	*0.89*	*0.80*	*1.00*	*96*	*1.2*
	Lothian	*836,600*	*0.88*	*0.97*	*0.85*	*0.62*	*0.72*	*0.73*	*75*	*0.79*	*0.72*	*0.87*	*81*	*2.8*
	Orkney	21,400	0.38	1.54	1.14	0.39	0.00	1.86	233	0.89	0.53	1.50	109	0.4
	Shetland	23,200	1.58	0.00	0.39	0.40	0.78	0.00	0	0.52	0.26	1.04	57	1.1
	Tayside	410,300	1.26	1.17	1.28	0.98	1.14	0.72	85	1.09	0.98	1.22	126	1.9
	Western Isles	27,700	1.72	0.29	0.85	1.73	0.00	0.00	0	0.76	0.46	1.24	96	0.6
N Ireland	**Belfast**	**348,300**	**1.27**	**1.01**	**0.76**	**1.25**	**1.10**	**1.68**	**167**	**1.18**	**1.04**	**1.34**	**115**	**3.2**
	Northern	**463,500**	**1.39**	**1.14**	**0.78**	**1.19**	**1.22**	**1.15**	**119**	**1.15**	**1.03**	**1.28**	**116**	**1.2**
	Southern	359,400	0.60	0.96	0.77	1.07	1.33	0.76	72	0.92	0.79	1.06	85	1.2
	South Eastern	*347,700*	*0.92*	*0.87*	*0.69*	*0.71*	*0.96*	*0.79*	*83*	*0.82*	*0.71*	*0.95*	*85*	*1.3*
	Western	295,300	1.04	0.90	1.21	0.84	1.10	0.56	54	0.94	0.81	1.10	89	1.0

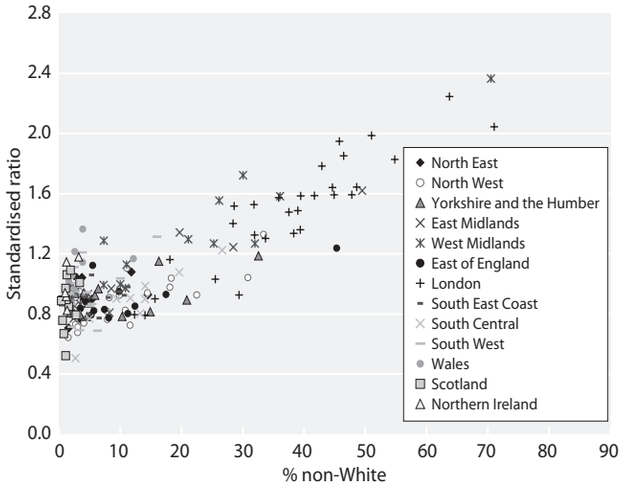

Fig. 1.2. Age/gender standardised incidence ratio (2007–2012) by percentage non-White

Others. The details of regrouping of the PAS codes into the above ethnic categories are provided in appendix H: Ethnicity and ERA-EDTA Coding (www.renalreg.com). Chi-squared, Fisher's exact, ANOVA and Kruskal Wallis tests were used as appropriate to test for significant differences.

Estimated glomerular filtration rate (eGFR) at the start of RRT was studied amongst patients with eGFR data within 14 days before the start of RRT. The eGFR was calculated using the abbreviated 4 variable MDRD study equation [2]. For the purpose of the eGFR calculation, patients who had missing ethnicity but a valid serum creatinine measurement were classed as Whites. The eGFR values were log transformed in order to normalise the data.

Results

Age

Overall, incidence rates have levelled off in the last seven years (figure 1.3). Figure 1.4 shows RRT incidence rates for 2012 by age group and gender. For women, the peak rate was in the 75–79 age group and in men in the 80–84 age group. Regarding numbers starting RRT (rather than rates), figure 1.5 shows that the 65–74 age group contained the most patients starting on both HD and PD. The pattern seen in this graph is very similar to the pattern for 2011.

In 2012, the median age of patients starting renal replacement therapy was 64.6 years (table 1.4) and this has changed little over the last six years (data not shown). The median age at start was 66.9 years for patients starting on HD, 60.5 for patients starting on PD and 48.6 for those having a pre-emptive transplant (table 1.5). The median age of non-White patients (57.8 years) was considerably lower than for White patients (66.1 years) reflecting the younger age distribution of ethnic minority populations in general compared with the White population (5.1% of ethnic minorities were over 65 years old compared to 16.9% of Whites) [3]. The median age of new patients with diabetes was similar to the overall median and has not varied greatly over the last five years.

There were large differences between centres in the median age of incident patients (figure 1.6) reflecting differences in the age and ethnic structure of the catchment populations and also, particularly in smaller centres, chance fluctuations. The median age of patients starting treatment at transplant centres was 63.1 years (IQR 49.8, 73.6) and at non-transplanting centres 65.9 years (IQR 52.7, 75.2) ($p < 0.0001$).

Averaged over 2007–2012, crude PCT/HB incidence rates in the over 75 years age group varied from 0 per million age related population (pmarp) (Shetland) to 904 pmarp (Heart of Birmingham) (data not shown). Excluding four areas which had much higher or lower rates than the rest, there was 5.4-fold variation (124 pmarp to 673 pmarp). The wide range of treatment rates suggests that there was geographical variation in the prevalence of comorbid and predisposing renal conditions as well as uncertainty within the renal community about the suitability of older patients for dialysis. The 5.4-fold variation between PCT/HBs seen in the over 75s was much greater than the 2.6-fold variation (66 pmp to 172 pmp) seen in the overall analysis although a proportion of this difference is likely to be due to the smaller numbers included in the over 75 analysis.

Gender

As in previous years, more men than women started RRT with 62.1% of new starters being male. This was a slight fall from the 63.0% seen for 2011 and negates some of the increase seen in 2010 and 2011. The male percentage was above 50 for all age groups and above 60 for over 55s (figure 1.7).

Ethnicity

As in previous reports, Scotland is not included in this section as ethnicity completeness was low. Across English, Welsh and Northern Irish centres the average completeness improved further this year up to 97.0% (vs 92.9% for 2011). A large part of the improvement was due to three centres (Brighton, Reading, Liverpool RI) which improved from having data for 3%, 30% and 40% of patients respectively to having data for 80% or more. Indeed, completeness was 80% or more for all centres for 2012 (table 1.6) and was over 90% for all

Table 1.3. Number of patients starting RRT by renal centre 2007–2012

Centre	Year						Catchment population (millions)	2012 crude rate pmp	(95% CI)
	2007	2008	2009	2010	2011	2012			
England									
B Heart	101	105	99	95	113	101	0.74	137	(110–164)
B QEH	222	268	255	197	215	216	1.70	127	(110–144)
Basldn	39	40	27	32	42	53	0.42	128	(93–162)
Bradfd	88	62	59	67	60	71	0.65	109	(84–134)
Brightn	120	119	117	106	119	136	1.30	105	(87–122)
Bristol	153	175	157	169	139	148	1.44	103	(86–119)
Camb	125	94	134	106	122	124	1.16	107	(88–126)
Carlis	26	30	28	22	28	19	0.32	59	(33–86)
Carsh	191	210	204	216	207	242	1.91	127	(111–142)
Chelms	51	36	51	45	47	45	0.51	88	(62–114)
Colchr	n/a	58	21	32	44	29	0.30	97	(62–132)
Covnt	110	113	116	114	111	112	0.89	126	(102–149)
Derby	62	97	77	79	80	81	0.70	115	(90–140)
Donc	20	26	40	45	43	40	0.41	98	(67–128)
Dorset	62	82	74	71	79	72	0.86	84	(64–103)
Dudley	40	46	69	43	43	56	0.44	127	(94–160)
Exeter	126	135	145	139	112	138	1.09	127	(106–148)
Glouc	59	46	79	61	58	74	0.59	126	(97–155)
Hull	99	110	99	87	109	97	1.02	95	(76–114)
Ipswi	40	38	38	33	29	43	0.40	108	(76–140)
Kent	171	139	128	134	122	115	1.22	94	(77–111)
L Barts	215	206	237	203	249	263	1.83	144	(126–161)
L Guys	167	161	172	143	120	127	1.08	117	(97–138)
L Kings	122	151	126	144	140	125	1.17	107	(88–125)
L Rfree	185	172	169	204	223	240	1.52	158	(138–178)
L St.G	90	99	110	86	74	91	0.80	114	(91–137)
L West	273	317	357	365	365	352	2.40	147	(131–162)
Leeds	124	158	153	126	158	154	1.67	92	(78–107)
Leic	244	242	228	246	267	235	2.44	96	(84–109)
Liv Ain	34	42	38	50	61	63	0.48	130	(98–162)
Liv RI	112	102	110	99	114	110	1.00	110	(89–131)
M RI	159	131	146	161	156	160	1.53	104	(88–121)
Middlbr	100	95	96	101	100	120	1.00	120	(98–141)
Newc	106	99	97	91	98	104	1.12	93	(75–111)
Norwch	111	84	72	86	87	74	0.79	94	(73–116)
Nottm	129	115	133	116	116	99	1.09	91	(73–109)
Oxford	143	148	174	165	177	171	1.69	101	(86–116)
Plymth[a]	76	69	57	56	60	75	0.47	160	(124–196)
Ports	157	170	149	149	187	161	2.02	80	(67–92)
Prestn	132	113	146	124	140	147	1.49	98	(83–114)
Redng	92	103	94	89	103	73	0.91	80	(62–99)
Salford	110	139	125	149	126	134	1.49	90	(75–105)
Sheff	165	180	149	143	135	158	1.37	115	(97–133)
Shrew	58	59	48	58	61	57	0.50	114	(84–143)
Stevng	88	102	98	107	110	110	1.20	91	(74–108)
Sthend	34	36	23	28	29	26	0.32	82	(51–114)
Stoke	87	80	110	95	93	77	0.89	87	(67–106)
Sund	62	45	64	54	57	71	0.62	115	(88–142)
Truro	45	41	58	46	38	50	0.41	121	(87–155)
Wirral	53	39	63	62	62	50	0.57	87	(63–112)
Wolve	68	89	65	106	76	84	0.67	126	(99–152)
York	37	36	44	38	52	53	0.49	108	(79–137)

Table 1.3. Continued

Centre	Year						Catchment population (millions)	2012 crude rate pmp	(95% CI)
	2007	2008	2009	2010	2011	2012			
N Ireland									
Antrim	37	41	21	41	30	26	0.30	87	(53–120)
Belfast	90	70	58	72	69	91	0.55	165	(131–199)
Newry	15	21	19	21	38	18	0.28	64	(35–94)
Ulster	18	14	13	20	35	30	0.30	100	(64–136)
West NI	29	31	37	26	38	21	0.35	60	(34–86)
Scotland									
Abrdn	56	56	55	51	50	54	0.60	90	(66–114)
Airdrie	48	39	48	56	48	61	0.56	109	(82–136)
D & Gall	17	19	17	10	10	19	0.15	127	(70–184)
Dundee	62	64	69	50	58	41	0.41	100	(69–131)
Dunfn	37	30	33	45	43	29	0.37	78	(50–107)
Edinb	95	103	98	68	75	76	0.96	79	(61–97)
Glasgw	187	159	174	153	177	186	1.51	123	(105–141)
Inverns	26	25	21	27	12	13	0.34	38	(17–59)
Klmarnk	36	33	39	43	33	40	0.37	108	(75–142)
Wales									
Bangor	36	40	30	26	20	21	0.22	96	(55–137)
Cardff	220	150	177	186	186	170	1.42	120	(102–138)
Clwyd	21	15	25	21	17	22	0.19	116	(68–164)
Swanse	128	125	116	135	118	113	0.89	128	(104–151)
Wrexm	27	21	19	25	26	34	0.24	142	(94–189)
							% change since 2007		
England	**5,483**	**5,652**	**5,728**	**5,583**	**5,756**	**5,826**	**6.3**		
N Ireland	**189**	**177**	**148**	**180**	**210**	**186**	**−1.6**		
Scotland	**564**	**528**	**554**	**503**	**506**	**519**	**−8.0**		
Wales	**432**	**351**	**367**	**393**	**367**	**360**	**−16.7**		
UK	**6,668**	**6,708**	**6,797**	**6,659**	**6,839**	**6,891**	**3.3**		

n/a – renal centre not yet operational
pmp – per million population
[a]Plymouth had 75 incident patients in 2012 but only 47 of these were included in the data extract. The extra 28 patients have been included in tables 1.1 and 1.3 but not in the remainder of this chapter. The estimated catchment population may be too low and hence the rate too high due to the missing patients (an incident cohort 2008–2012 was used for this work)

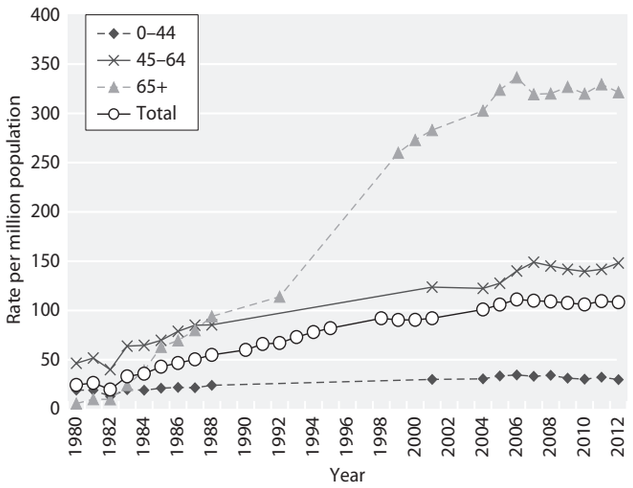

Fig. 1.3. RRT incidence rates between 1980 and 2012

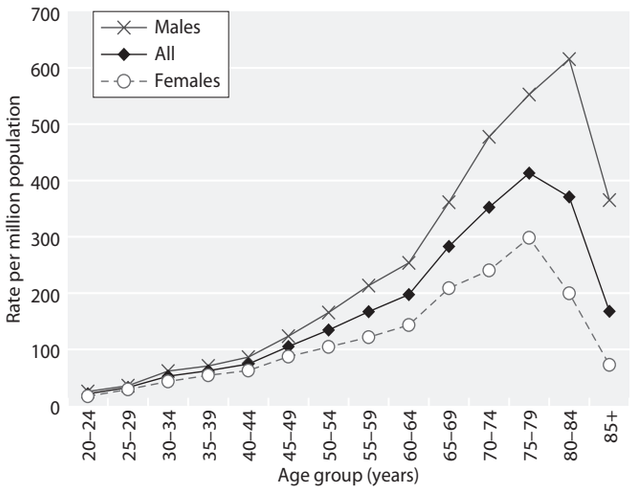

Fig. 1.4. RRT incidence rates in 2012 by age and gender

Table 1.4. Median, inter-quartile range and 90% range of the age of patients starting renal replacement therapy in 2012 by country

Country	Median	IQR	90% range
England	64.5	(51.0–74.6)	(31.2–83.7)
N Ireland	68.2	(52.0–76.0)	(33.3–85.4)
Scotland	63.9	(51.9–73.3)	(35.2–82.7)
Wales	67.1	(53.6–75.8)	(34.1–83.8)
UK	**64.6**	**(51.3–74.5)**	**(31.6–83.6)**

Table 1.5. Median, inter-quartile range and 90% range of the age of patients starting renal replacement therapy in 2012 by initial treatment modality

Treatment	Median	IQR	90% range
HD	66.9	(54.8–76.0)	(34.7–84.4)
PD	60.5	(47.0–71.2)	(29.1–82.0)
Transplant	48.6	(38.4–58.3)	(24.2–68.8)

but six centres. There was great variation between centres in the percentage of incident patients who were non-White ranging from zero in Antrim, Bangor, Colchester, Newry, Truro and Wrexham to over 50% in St Bartholomew's and London West.

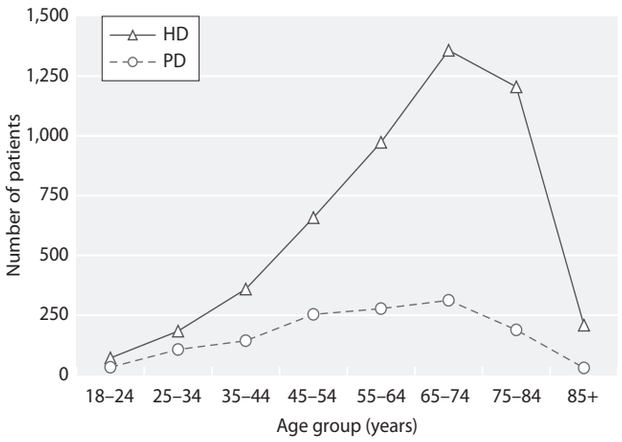

Fig. 1.5. Number of incident dialysis patients in 2012, by age group and initial dialysis modality

Primary renal diagnosis

The breakdown of primary renal disease (PRD) by centre is shown in table 1.7. The information was missing for 6.3% of patients. Sixty-one centres provided data on over 90% of incident patients and 33 of these centres had 100% completeness. There was only a small amount of missing data for Wales and none for Scotland, whilst England had 7.4% missing (down from 12.0% for 2011) and Northern Ireland, 2.7% missing. The overall percentage missing was down on 2011 (6.3% from 10.2%) and was slightly lower in under rather than over 65 year olds (5.3% and 7.3% respectively). As for 2011, four centres had missing PRD for more than 25% of incident patients and for these centres the percentages in the diagnostic categories are not shown in table 1.7.

The UKRR continues to be concerned about centres with apparently very high data completeness for PRD but also very high rates of 'uncertain' diagnoses (EDTA code 00: Chronic renal failure; aetiology uncertain). It is accepted that there will inevitably be a number of patients with uncertain aetiology and that the proportion of these patients will vary between clinicians and centres as the

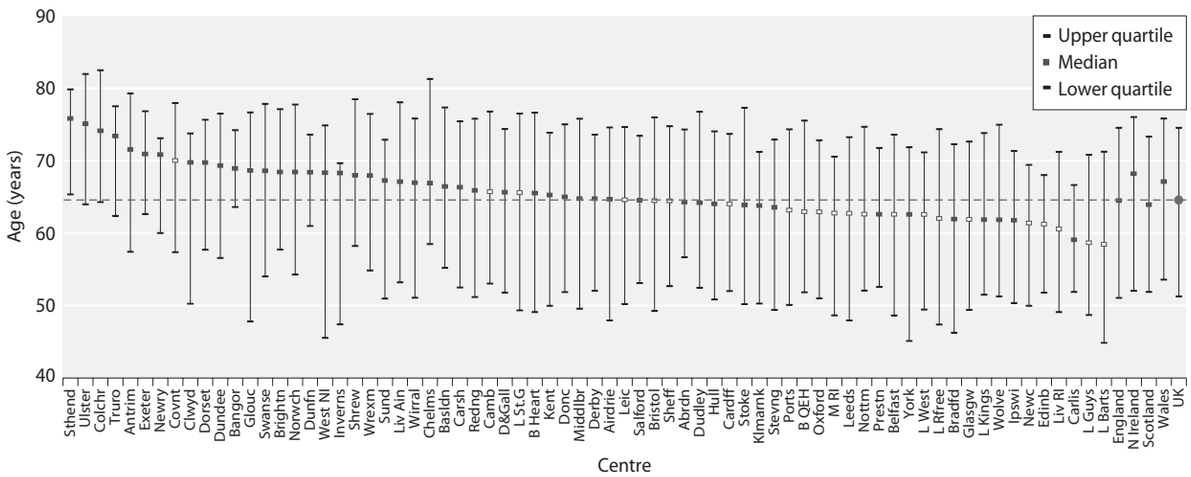

Fig. 1.6. Median age of incident RRT patients by centre in 2012
White points indicate transplant centres

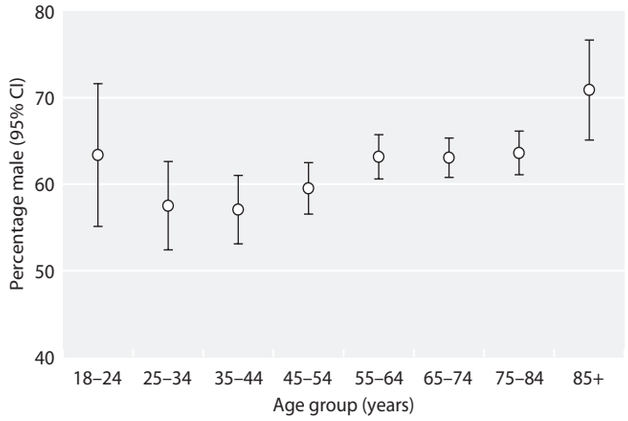

Fig. 1.7. Percentage of patients starting RRT in 2012 who were male, by age group

definitions of e.g. renal vascular disease and hypertensive renal disease remain relatively subjective. There was again a lot of variability between centres but, as in previous years, a small number of centres had far higher percentages with 'uncertain' diagnosis than other centres. This year, there were two centres with diagnosis 'uncertain' for over 50% of their incident patients – Cambridge (68%) and Ipswich (65%). As the numbers with the specific PRDs are likely to be falsely low in these centres, the breakdown into these categories has not been shown in table 1.7 or been used in the country and UK averages. These centres have also been excluded where PRD is used to stratify analyses.

As in previous years, there was a lot of variability between centres in the percentages with the specific diagnoses (partly due to the reasons mentioned above). For example, the percentage with diabetes as PRD varied from about 10% to 44% of incident patients. The overall percentage with uncertain aetiology was lower than last year (15.9% vs. 17.3%). There were increases in the percentages with diabetes, glomerulonephritis, hypertension and 'other' and decreases in the percentages with polycystic kidney disease, pyelonephritis and renal vascular disease.

The overall UK distribution of PRDs is shown in table 1.8. Diabetic nephropathy was the most common renal diagnosis in both the under and over 65 year age groups, accounting for 26% of all (non-missing) incident diagnoses. Glomerulonephritis and autosomal dominant polycystic kidney disease (ADPKD) made up higher proportions of the younger than the older incident cohorts (17% vs. 10% and 10% vs. 3% respectively), whilst patients with renal vascular disease comprised a much higher percentage of the older rather than the younger patients (11% vs. 2%). Uncertainty about the underlying diagnosis was also much more likely in the older rather than the younger cohort (20% vs. 12%).

For all primary renal diagnoses except ADPKD, the male to female ratio was 1.3 or greater. This gender difference may relate to factors such as smoking, hypertension, atheroma and renal vascular disease which are more common in males and may influence the rate of progression of renal failure.

Table 1.9 shows the incidence rates for each PRD per million population for the 2012 cohort. The incidence of RRT due to diabetes as PRD was somewhat higher in

Table 1.6. Percentage of incident RRT patients (2012) in different ethnic groups by centre

Centre	% data not available	*N* with data	Percentage in each ethnic group				
			White	South Asian	Black	Chinese	Other
England							
B Heart	0.0	101	70.3	24.8	5.0		
B QEH	0.0	216	70.8	22.7	5.1		1.4
Basldn	0.0	53	79.2	3.8	11.3	5.7	
Bradfd	0.0	71	57.7	42.3			
Brightn	5.1	129	91.5	3.1	3.9		1.6
Bristol	4.1	142	90.8	4.9	4.2		
Camb	0.8	123	96.7	0.8	0.8	0.8	0.8
Carlis	0.0	19	94.7			5.3	
Carsh	14.1	208	72.6	13.0	10.1	0.5	3.8
Chelms	20.0	36	97.2	2.8			
Colchr	0.0	29	100.0				
Covnt	0.9	111	83.8	12.6	2.7	0.9	
Derby	6.2	76	81.6	13.2	2.6	2.6	
Donc	0.0	40	95.0		5.0		
Dorset	0.0	72	98.6				1.4

Table 1.6. Continued

Centre	% data not available	*N* with data	Percentage in each ethnic group				
			White	South Asian	Black	Chinese	Other
Dudley	0.0	56	85.7	10.7	3.6		
Exeter	0.7	137	97.1	0.7			2.2
Glouc	0.0	74	95.9	2.7			1.4
Hull	4.1	93	96.8	3.2			
Ipswi	9.3	39	97.4		2.6		
Kent	5.2	109	95.4	1.8			2.8
L Barts	0.0	263	35.7	26.6	36.5	0.4	0.8
L Guys	3.2	123	62.6	6.5	23.6	0.8	6.5
L Kings	0.8	124	55.6	11.3	29.8		3.2
L Rfree	12.1	211	50.2	13.7	23.7	1.9	10.4
L St.G	11.0	81	56.8	19.8	16.0	1.2	6.2
L West	0.0	352	41.5	40.6	17.6	0.3	
Leeds	0.6	153	83.7	11.1	4.6	0.7	
Leic	2.6	229	79.5	16.6	2.2		1.7
Liv Ain	0.0	63	95.2	3.2		1.6	
Liv RI	4.5	105	94.3	1.9	1.9		1.9
M RI	0.0	160	75.6	10.6	10.0		3.8
Middlbr	0.8	119	95.0	5.0			
Newc	1.9	102	92.2	6.9			1.0
Norwch	5.4	70	87.1			12.9	
Nottm	0.0	99	83.8	10.1	4.0		2.0
Oxford	0.0	171	78.9	10.5	4.1		6.4
Plymth	2.1	46	97.8				2.2
Ports	5.6	152	94.1	3.3	1.3		1.3
Prestn	0.0	147	88.4	10.2	1.4		
Redng	19.2	59	72.9	16.9	6.8	1.7	1.7
Salford	10.4	120	82.5	15.8	0.8		0.8
Sheff	1.9	155	86.5	5.8	5.2	2.6	
Shrew	3.5	55	96.4	1.8	1.8		
Stevng	1.8	108	70.4	15.7	8.3	0.9	4.6
Sthend	3.8	25	96.0		4.0		
Stoke	3.9	74	93.2	2.7			4.1
Sund	1.4	70	95.7	4.3			
Truro	0.0	50	100.0				
Wirral	2.0	49	98.0			2.0	
Wolve	0.0	84	70.2	23.8	6.0		
York	0.0	53	96.2	1.9	1.9		
N Ireland				1.6			
Antrim	0.0	26	100.0				
Belfast	0.0	91	94.5	1.1		3.3	1.1
Newry	0.0	18	100.0				
Ulster	0.0	30	96.7	3.3			
West NI	0.0	21	95.2	4.8			
Wales				2.2	0.3		
Bangor	0.0	21	100.0				
Cardff	0.0	170	95.3	3.5	0.6	0.6	
Clwyd	0.0	22	90.9	9.1			
Swanse	0.0	113	99.1				0.9
Wrexm	0.0	34	100.0				
England	**3.3**	**5,606**	**77.8**	**12.2**	**7.6**	**0.6**	**1.8**
N Ireland	**0.0**	**186**	**96.2**	**1.6**		**1.6**	**0.5**
Wales	**0.0**	**360**	**96.9**	**2.2**	**0.3**	**0.3**	**0.3**
E, W & NI	**3.0**	**6,152**	**79.4**	**11.3**	**7.0**	**0.6**	**1.7**

Blank cells – no reported patients

Table 1.7. Distribution of primary renal diagnosis by centre in the 2012 incident RRT cohort

Centre	% data not available	*N* with data	Percentage							
			Uncertain aetiology	Diabetes	Glomerulo-nephritis	Hyper-tension	Other	Polycystic kidney	Pyelo-nephritis	Renal vascular disease
England										
B Heart	6.9	94	20.2	34.0	7.5	7.5	16.0	4.3	6.4	4.3
B QEH	0.5	215	10.7	20.9	14.0	3.7	23.3	5.6	8.4	13.5
Basldn	11.3	47	2.1	27.7	21.3	14.9	12.8	6.4	4.3	10.6
Bradfd	1.4	70	24.3	27.1	17.1	7.1	10.0	8.6	1.4	4.3
Brightn	2.2	133	24.8	18.1	12.0	1.5	19.6	9.0	10.5	4.5
Bristol	15.5	125	13.6	23.2	17.6	4.0	18.4	8.0	9.6	5.6
Camb[a]	0.0	124	67.7							
Carlis	0.0	19	5.3	15.8	42.1	5.3	0.0	10.5	15.8	5.3
Carsh	22.7	187	24.1	19.8	10.2	6.4	18.2	9.1	7.5	4.8
Chelms	2.2	44	25.0	34.1	13.6	6.8	11.4	2.3	2.3	4.6
Colchr	2.2	29	44.8	24.1	3.5	3.5	10.3	3.5	6.9	3.5
Covnt	1.8	110	12.7	21.8	10.0	11.8	18.2	4.6	7.3	13.6
Derby	2.5	79	12.7	31.7	17.7	1.3	15.2	7.6	6.3	7.6
Donc	2.5	39	28.2	23.1	10.3	10.3	18.0	2.6	0.0	7.7
Dorset	0.0	72	5.6	23.6	11.1	9.7	26.4	9.7	8.3	5.6
Dudley	1.8	55	25.5	14.6	3.6	5.5	38.2	9.1	0.0	3.6
Exeter	0.0	138	8.7	26.1	15.9	8.7	16.7	5.1	7.3	11.6
Glouc	0.0	74	27.0	16.2	14.9	2.7	16.2	5.4	13.5	4.1
Hull	0.0	97	23.7	23.7	14.4	7.2	14.4	11.3	5.2	0.0
Ipswi[a]	0.0	43	65.1							
Kent	0.0	115	25.2	17.4	15.7	3.5	15.7	2.6	15.7	4.4
L Barts	6.5	246	14.2	31.3	11.8	14.6	15.5	4.5	6.5	1.6
L Guys	13.4	110	14.6	28.2	12.7	5.5	12.7	11.8	11.8	2.7
L Kings	0.0	125	13.6	39.2	13.6	12.0	8.8	7.2	4.8	0.8
L Rfree	0.4	239	6.7	26.8	15.1	11.3	27.2	3.4	2.5	7.1
L St.G	18.7	74	28.4	21.6	13.5	9.5	17.6	4.1	4.1	1.4
L West	0.3	351	13.7	35.3	14.5	2.9	18.8	5.4	4.0	5.4
Leeds	1.3	152	10.5	16.5	15.1	11.8	21.7	9.2	8.6	6.6
Leic	16.2	197	21.8	19.3	13.2	6.6	14.7	11.2	7.6	5.6
Liv Ain	0.0	63	22.2	17.5	17.5	14.3	11.1	3.2	6.4	7.9
Liv RI	0.0	90	10.0	20.0	11.1	21.1	23.3	6.7	7.8	0.0
M RI	3.8	154	15.6	29.2	9.1	17.5	14.3	7.1	4.6	2.6
Middlbr	1.7	118	19.5	24.6	11.0	3.4	18.6	6.8	6.8	9.3
Newc	1.9	102	16.7	19.6	23.5	4.9	19.6	3.9	4.9	6.9
Norwch	8.1	68	29.4	17.7	16.2	5.9	17.7	5.9	7.4	0.0
Nottm	0.0	99	13.1	26.3	15.2	4.0	23.2	6.1	5.1	7.1
Oxford	0.0	171	15.8	31.0	14.6	7.6	11.1	5.9	7.0	7.0
Plymth[b]	27.7	34								
Ports	1.9	158	8.9	23.4	11.4	10.1	19.0	11.4	7.0	8.9
Prestn	1.4	145	13.1	28.3	13.1	11.0	13.8	6.2	7.6	6.9
Redng	2.7	71	11.3	33.8	12.7	5.6	18.3	4.2	8.5	5.6
Salford[b]	78.4	29								
Sheff	0.6	157	15.9	33.8	19.1	3.8	6.4	4.5	8.3	8.3
Shrew[b]	31.6	39								
Stevng	0.0	110	14.6	15.5	6.4	1.8	52.7	4.6	3.6	0.9
Sthend	0.0	26	3.9	15.4	23.1	0.0	23.1	7.7	3.9	23.1
Stoke	6.5	72	8.3	27.8	18.1	9.7	15.3	13.9	5.6	1.4
Sund	0.0	71	5.6	23.9	5.6	22.5	16.9	11.3	5.6	8.5
Truro	8.0	46	10.9	10.9	23.9	15.2	19.6	4.4	6.5	8.7
Wirral[b]	62.0	19								
Wolve	0.0	84	31.0	22.6	13.1	2.4	16.7	8.3	3.6	2.4
York	1.9	52	5.8	21.2	21.2	1.9	21.2	11.5	9.6	7.7

Table 1.7. Continued

Centre	% data not available	*N* with data	Percentage							
			Uncertain aetiology	Diabetes	Glomerulo-nephritis	Hyper-tension	Other	Polycystic kidney	Pyelo-nephritis	Renal vascular disease
N Ireland										
Antrim	0.0	26	42.3	30.8	7.7	3.9	11.5	0.0	3.9	0.0
Belfast	4.4	87	14.9	18.4	14.9	3.5	20.7	6.9	17.2	3.5
Newry	0.0	18	5.6	44.4	11.1	5.6	5.6	5.6	5.6	16.7
Ulster	0.0	30	10.0	20.0	10.0	30.0	10.0	3.3	3.3	13.3
West NI	4.8	20	5.0	15.0	20.0	15.0	30.0	0.0	10.0	5.0
Scotland										
Abrdn	0.0	54	9.3	25.9	13.0	11.1	20.4	7.4	7.4	5.6
Airdrie	0.0	61	23.0	29.5	18.0	1.6	4.9	6.6	8.2	8.2
D & Gall	0.0	19	10.5	42.1	10.5	5.3	15.8	5.3	5.3	5.3
Dundee	0.0	41	17.1	14.6	26.8	2.4	24.4	4.9	4.9	4.9
Dunfn	0.0	29	20.7	31.0	10.3	6.9	17.2	0.0	6.9	6.9
Edinb	0.0	76	15.8	30.3	13.2	2.6	19.7	9.2	5.3	4.0
Glasgw	0.0	186	14.5	28.5	18.3	2.2	13.4	9.1	7.5	6.5
Inverns	0.0	13	46.2	15.4	7.7	0.0	7.7	15.4	0.0	7.7
Klmarnk	0.0	40	0.0	37.5	15.0	12.5	17.5	5.0	7.5	5.0
Wales										
Bangor	0.0	21	9.5	38.1	19.1	9.5	14.3	0.0	0.0	9.5
Cardff	0.6	169	24.9	26.0	14.2	2.4	11.2	8.9	3.6	8.9
Clwyd	0.0	22	4.6	18.2	18.2	22.7	22.7	4.6	9.1	0.0
Swanse	0.0	113	15.9	29.2	14.2	4.4	18.6	2.7	3.5	11.5
Wrexm	0.0	34	11.8	26.5	14.7	0.0	20.6	8.8	5.9	11.8
England	**7.4**	**5,381**	**15.7**	**25.3**	**13.7**	**7.9**	**18.1**	**6.7**	**6.7**	**5.9**
N Ireland	**2.7**	**181**	**16.0**	**22.7**	**13.3**	**9.4**	**17.1**	**4.4**	**11.1**	**6.1**
Scotland	**0.0**	**519**	**15.2**	**28.5**	**16.4**	**4.2**	**15.4**	**7.5**	**6.7**	**6.0**
Wales	**0.3**	**359**	**18.7**	**27.3**	**14.8**	**4.5**	**15.3**	**6.1**	**3.9**	**9.5**
UK	**6.3**	**6,440**	**15.9**	**25.6**	**14.0**	**7.4**	**17.7**	**6.7**	**6.6**	**6.1**

The percentage in each category has been calculated after excluding those patients with data not available
[a]For those centres judged to have high % uncertain aetiology, the percentages in the other diagnostic categories have not been calculated and these centres have not been included in the country and UK averages
[b]For those centres with >25% missing primary diagnoses, the percentages in the diagnostic categories have not been calculated

Wales than in the other countries. As there were some missing data, the rates for at least some of the diagnoses will be underestimates.

First established treatment modality

In 2012, the first treatment recorded, irrespective of any later change, was haemodialysis in 73.0% of patients, peritoneal dialysis in 19.5% and pre-emptive transplant in 7.4%. The previous year on year fall in the proportion of patients starting on PD has now levelled off during the last six years (table 1.10). The percentage having a pre-emptive transplant has continued to rise. Table F.1.3 in appendix F: Additional Data Tables for 2012 New and Existing Patients gives the treatment breakdown at start of RRT by centre.

Table 1.8. Percentage distribution of primary renal diagnosis by age in the 2012 incident RRT cohort

Diagnosis	Percentage with diagnosis		
	Age <65	Age ⩾65	All patients
Diabetes	28.6	22.3	25.6
Glomerulonephritis	17.3	10.4	14.0
Pyelonephritis	6.8	6.4	6.6
Hypertension	6.2	8.8	7.4
Polycystic kidney	10.1	3.1	6.7
Renal vascular disease	1.7	10.9	6.1
Other	17.4	18.0	17.7
Uncertain aetiology	11.8	20.1	15.9

Percentages calculated after excluding those patients with data not available

Table 1.9. Primary renal diagnosis RRT incidence rates (2012) per million population (unadjusted)

Diagnosis	England	N Ireland	Scotland	Wales	UK
Diabetes	25.5	22.5	27.9	31.9	25.9
Glomerulonephritis	13.8	13.2	16.0	17.2	14.2
Pyelonephritis	6.7	11.0	6.6	4.6	6.7
Hypertension	8.0	9.3	4.1	5.2	7.5
Polycystic kidney	6.8	4.4	7.3	7.2	6.8
Renal vascular disease	6.0	6.0	5.8	11.1	6.2
Other	18.3	17.0	15.1	17.9	18.0
Uncertain aetiology	15.9	15.9	14.9	21.8	16.1
Data not available	8.1	2.7	0.0	0.3	6.8
All	**109**	**102**	**98**	**117**	**108**

The overall rates per country may be slightly different to those in table 1.1 as those centres whose PRD data has not been used have been excluded from both the numerator and the denominator here

Many patients undergo a brief period of HD before switches to other modalities are, or can be, considered. Therefore, the established modality at 90 days is more representative of the elective first modality and this modality was used for the remainder of this section. For these analyses, the incident cohort from 1st October 2011 to 30th September 2012 was used so that follow up to 90 days was possible for all patients. By 90 days, 5.5% of incident patients had died and a further 0.4% had stopped treatment, leaving 94.0% of the original cohort still on RRT. Table 1.11 shows the percentages on each treatment modality at 90 days both as percentages of all of those starting RRT and then of those still on treatment at 90 days. Expressed as percentages of the whole incident cohort, 66.9% were on HD at 90 days, 19.0% were on PD and 8.3% had received a transplant. Expressed as percentages of those still receiving RRT at 90 days, 71.0% were on HD, 20.2% on PD and 8.8% had received a transplant. This small decrease for PD as a modality at 90 days (22.7%–20.2%) is similar in size to the increase for transplant patients (5.7%–8.8%) over the last 6 years.

Table 1.10. Treatment at start and at 90 days by year of start

Start	HD (%)	PD (%)	Transplant (%)
Day 0 treatment			
2007	74.7	20.5	4.8
2008	75.2	19.3	5.5
2009	76.4	18.0	5.7
2010	74.7	18.5	6.7
2011	72.9	20.3	6.8
2012	73.1	19.5	7.4
Day 90 treatment			
Oct 2006 to end Sept 2007	71.7	22.7	5.7
Oct 2007 to end Sept 2008	72.0	21.5	6.5
Oct 2008 to end Sept 2009	73.9	19.1	7.0
Oct 2009 to end Sept 2010	72.7	19.4	7.9
Oct 2010 to end Sept 2011	71.0	20.5	8.5
Oct 2011 to end Sept 2012	71.0	20.2	8.8

Figure 1.8 shows the modality breakdown with the HD patients further subdivided. Of those still on RRT at 90 days, 43% were treated with hospital HD, 28% with satellite HD, and only 0.2% were receiving home HD at this early stage.

The percentage of incident patients who had died by 90 days varied considerably between centres (0% to 23% although, as last year, the percentage was 12.5% or less for all except one centre). Differences in the definition of whether patients have acute or chronic renal failure may be a factor in this apparent variation along with possible differences in clinical practice.

The percentage of patients still on RRT at 90 days who had a functioning transplant at 90 days varied between centres from 0% to 24%. The mean percentage of the incident cohort with a functioning transplant at 90 days was significantly greater in transplanting compared to non-transplanting centres (11.2% vs. 5.4%: $p < 0.0001$). One possible reason could be that some patients transplanted pre-emptively were attributed to the incident cohort of the transplanting centre rather than that of the referring centre (as mentioned earlier).

Table 1.12 gives the HD/PD breakdown for those incident patients on dialysis at 90 days. The breakdown is given by age group and overall. The percentage on PD at 90 days was about 65% higher in patients aged under 65 years than in older patients (27.6% vs. 16.7%). These percentages are similar to those for 2011. There was a lot of variability in the percentage on PD

Table 1.11. RRT modality at 90 days by centre (incident cohort 1/10/2011 to 30/09/2012)

		Status at 90 days of all patients who started RRT (%)					Status at 90 days of only those patients still on RRT (%)		
Centre	*N*	HD	PD	Tx	Stopped treatment	Died	HD	PD	Tx
England									
B Heart	105	78.1	17.1	1.0	0.0	3.8	81.2	17.8	1.0
B QEH	225	72.0	17.8	8.4	0.0	1.8	73.3	18.1	8.6
Basldn	51	72.6	19.6	3.9	0.0	3.9	75.5	20.4	4.1
Bradfd	73	74.0	11.0	9.6	0.0	5.5	78.3	11.6	10.1
Brightn	130	62.3	26.2	2.3	0.8	8.5	68.6	28.8	2.5
Bristol	140	72.1	16.4	5.7	0.0	5.7	76.5	17.4	6.1
Camb	125	62.4	10.4	20.8	0.0	6.4	66.7	11.1	22.2
Carlis	17	58.8	35.3	0.0	0.0	5.9	62.5	37.5	0.0
Carsh	228	70.2	15.4	8.8	0.4	5.3	74.4	16.3	9.3
Chelms	44	84.1	11.4	0.0	0.0	4.6	88.1	11.9	0.0
Colchr	36	91.7	2.8	0.0	0.0	5.6	97.1	2.9	0.0
Covnt	105	57.1	28.6	9.5	0.0	4.8	60.0	30.0	10.0
Derby	83	56.6	33.7	1.2	0.0	8.4	61.8	36.8	1.3
Donc	38	76.3	18.4	0.0	5.3	0.0	80.6	19.4	0.0
Dorset	76	60.5	27.6	4.0	5.3	2.6	65.7	30.0	4.3
Dudley	49	65.3	28.6	0.0	2.0	4.1	69.6	30.4	0.0
Exeter	126	72.2	19.1	4.0	0.8	4.0	75.8	20.0	4.2
Glouc	64	70.3	20.3	1.6	0.0	7.8	76.3	22.0	1.7
Hull	93	50.5	33.3	5.4	0.0	10.8	56.6	37.4	6.0
Ipswi	37	59.5	29.7	8.1	0.0	2.7	61.1	30.6	8.3
Kent	115	62.6	20.0	11.3	0.0	6.1	66.7	21.3	12.0
L Barts	274	63.9	24.8	6.2	0.0	5.1	67.3	26.2	6.5
L Guys	129	73.6	12.4	13.2	0.0	0.8	74.2	12.5	13.3
L Kings	130	69.2	26.9	2.3	0.0	1.5	70.3	27.3	2.3
L Rfree	240	63.3	19.6	12.9	0.4	3.8	66.1	20.4	13.5
L St.G	90	73.3	10.0	7.8	0.0	8.9	80.5	11.0	8.5
L West	365	78.6	5.2	12.6	0.0	3.6	81.5	5.4	13.1
Leeds	152	66.5	17.1	13.2	0.0	3.3	68.7	17.7	13.6
Leic	242	61.2	18.6	13.6	0.0	6.6	65.5	19.9	14.6
Liv Ain	69	72.5	18.8	1.5	0.0	7.3	78.1	20.3	1.6
Liv RI	111	53.2	25.2	10.8	0.9	9.9	59.6	28.3	12.1
M RI	170	52.4	25.9	20.0	0.0	1.8	53.3	26.4	20.4
Middlbr	127	74.8	3.2	12.6	0.0	9.5	82.6	3.5	13.9
Newc	107	60.8	15.9	12.2	0.0	11.2	68.4	17.9	13.7
Norwch	80	65.0	26.3	2.5	0.0	6.3	69.3	28.0	2.7
Nottm	98	43.9	38.8	7.1	0.0	10.2	48.9	43.2	8.0
Oxford	167	56.9	19.2	13.8	0.6	9.6	63.3	21.3	15.3
Plymth[a]	50								
Ports	175	66.9	16.6	10.3	0.0	6.3	71.3	17.7	11.0
Prestn	133	66.9	15.0	11.3	0.8	6.0	71.8	16.1	12.1
Redng	84	61.9	32.1	3.6	0.0	2.4	63.4	32.9	3.7
Salford	119	70.6	25.2	2.5	0.8	0.8	71.8	25.6	2.6
Sheff	153	69.3	15.7	9.2	0.7	5.2	73.6	16.7	9.7
Shrew	56	66.1	25.0	0.0	0.0	8.9	72.6	27.5	0.0
Stevng	101	69.3	14.9	10.9	0.0	5.0	72.9	15.6	11.5
Sthend	22	81.8	18.2	0.0	0.0	0.0	81.8	18.2	0.0
Stoke	89	68.5	18.0	4.5	0.0	9.0	75.3	19.8	4.9
Sund	74	81.1	10.8	4.1	0.0	4.1	84.5	11.3	4.2
Truro	41	58.5	22.0	7.3	0.0	12.2	66.7	25.0	8.3
Wirral	47	61.7	29.8	2.1	0.0	6.4	65.9	31.8	2.3
Wolve	87	41.4	48.3	1.2	0.0	9.2	45.6	53.2	1.3
York	55	54.6	25.5	14.6	0.0	5.5	57.7	26.9	15.4

Table 1.11. Continued

		Status at 90 days of all patients who started RRT (%)					Status at 90 days of only those patients still on RRT (%)		
Centre	*N*	HD	PD	Tx	Stopped treatment	Died	HD	PD	Tx
N Ireland									
Antrim	31	74.2	16.1	6.5	3.2	0.0	76.7	16.7	6.7
Belfast	92	59.8	9.8	21.7	1.1	7.6	65.5	10.7	23.8
Newry	26	65.4	30.8	0.0	0.0	3.9	68.0	32.0	0.0
Ulster	26	69.2	7.7	0.0	0.0	23.1	90.0	10.0	0.0
West NI	30	76.7	10.0	3.3	6.7	3.3	85.2	11.1	3.7
Scotland									
Abrdn	44	81.8	18.2	0.0	0.0	0.0	81.8	18.2	0.0
Airdrie	61	83.6	14.8	1.6	0.0	0.0	83.6	14.8	1.6
D & Gall	18	50.0	38.9	0.0	0.0	11.1	56.3	43.8	0.0
Dundee	41	75.6	19.5	0.0	0.0	4.9	79.5	20.5	0.0
Dunfn	31	80.7	12.9	0.0	0.0	6.5	86.2	13.8	0.0
Edinb	78	74.4	10.3	9.0	0.0	6.4	79.5	11.0	9.6
Glasgw	185	78.9	10.3	7.6	0.0	3.2	81.6	10.6	7.8
Inverns	12	75.0	25.0	0.0	0.0	0.0	75.0	25.0	0.0
Klmarnk	39	66.7	23.1	0.0	0.0	10.3	74.3	25.7	0.0
Wales									
Bangor	16	68.8	18.8	0.0	0.0	12.5	78.6	21.4	0.0
Cardff	180	67.2	14.4	12.8	0.6	5.0	71.2	15.3	13.5
Clwyd	21	71.4	9.5	4.8	4.8	9.5	83.3	11.1	5.6
Swanse	128	67.2	23.4	0.8	1.6	7.0	73.5	25.6	0.9
Wrexm	32	43.8	28.1	12.5	3.1	12.5	51.9	33.3	14.8
England	**5,797**	**66.1**	**19.6**	**8.6**	**0.3**	**5.5**	**70.1**	**20.8**	**9.1**
N Ireland	**205**	**66.3**	**13.2**	**11.2**	**2.0**	**7.3**	**73.1**	**14.5**	**12.4**
Scotland	**509**	**76.8**	**14.7**	**4.3**	**0.0**	**4.1**	**80.1**	**15.4**	**4.5**
Wales	**377**	**65.5**	**18.6**	**7.7**	**1.3**	**6.9**	**71.4**	**20.2**	**8.4**
UK	**6,888**	**66.9**	**19.0**	**8.3**	**0.4**	**5.5**	**71.0**	**20.2**	**8.8**

[a]Breakdown not shown for Plymouth as not all data was available (see table 1.3)

with some centres having over double the average percentage on PD for one or both of the age groups. Some centres had less than half the average percentage on PD.

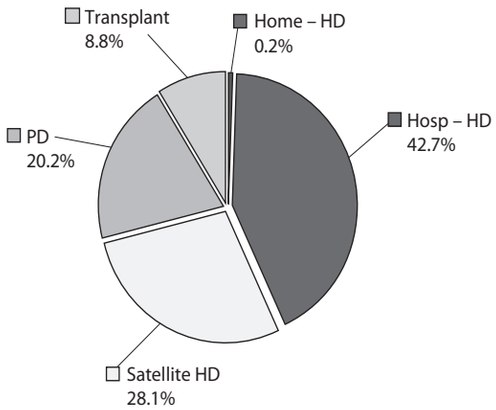

Fig. 1.8. RRT modality at 90 days (incident cohort 1/10/2011 to 30/09/2012)

The median age at start for those on HD at 90 days was 66.3 years compared with 59.8 years for PD. There were 10 centres where the percentage of patients treated with PD was the same as or higher in the over 65s than the under 65s (a similar number to the 11 centres for 2011).

Modality change over time

Table 1.13 gives the breakdown of status/treatment modality at four subsequent time points by initial treatment type for patients starting RRT in 2007. Fifty-three percent of patients who started on HD had died within five years of starting. This compared to 30% and 4% for those starting on PD or transplant respectively. Of those patients starting on PD, 92% were on PD at 90 days but this percentage dropped sharply at the later time points. As expected and in contrast, 89% of patients starting with a transplant were also transplant patients at the five year time point.

Table 1.12. Modality split of patients on dialysis at 90 days (incident cohort 1/10/2011 to 30/09/2012)

		Age <65 (%)		Age ⩾65 (%)		All patients (%)	
Centre	*N*	HD	PD	HD	PD	HD	PD
England							
B Heart	100	73.5	26.5	90.2	9.8	82.0	18.0
B QEH	202	73.0	27.0	89.7	10.3	80.2	19.8
Basldn	47	70.8	29.2	87.0	13.0	78.7	21.3
Bradfd	62	85.7	14.3	88.9	11.1	87.1	12.9
Brightn	115	60.8	39.2	78.1	21.9	70.4	29.6
Bristol	124	73.7	26.3	88.1	11.9	81.5	18.5
Camb	91	80.0	20.0	88.5	11.5	85.7	14.3
Carlis	16	54.5	45.5	80.0	20.0	62.5	37.5
Carsh	195	72.7	27.3	88.1	11.9	82.1	17.9
Chelms	42	81.0	19.0	95.2	4.8	88.1	11.9
Colchr	34	92.3	7.7	100.0	0.0	97.1	2.9
Covnt	90	56.4	43.6	74.5	25.5	66.7	33.3
Derby	75	60.5	39.5	64.9	35.1	62.7	37.3
Donc	36	81.3	18.8	80.0	20.0	80.6	19.4
Dorset	67	63.6	36.4	71.1	28.9	68.7	31.3
Dudley	46	54.2	45.8	86.4	13.6	69.6	30.4
Exeter	115	69.7	30.3	82.9	17.1	79.1	20.9
Glouc	58	79.3	20.7	75.9	24.1	77.6	22.4
Hull	78	50.0	50.0	75.0	25.0	60.3	39.7
Ipswi	33	70.6	29.4	62.5	37.5	66.7	33.3
Kent	95	68.6	31.4	80.0	20.0	75.8	24.2
L Barts	243	71.6	28.4	72.6	27.4	72.0	28.0
L Guys	111	80.3	19.7	93.3	6.7	85.6	14.4
L Kings	125	66.2	33.8	81.3	18.8	72.0	28.0
L Rfree	199	68.3	31.7	84.7	15.3	76.4	23.6
L St.G	75	84.6	15.4	91.7	8.3	88.0	12.0
L West	306	92.2	7.8	95.4	4.6	93.8	6.2
Leeds	127	69.6	30.4	91.4	8.6	79.5	20.5
Leic	193	74.7	25.3	78.4	21.6	76.7	23.3
Liv Ain	63	69.0	31.0	88.2	11.8	79.4	20.6
Liv RI	87	62.7	37.3	75.0	25.0	67.8	32.2
M RI	133	64.9	35.1	69.6	30.4	66.9	33.1
Middlbr	99	93.8	6.3	98.0	2.0	96.0	4.0
Newc	82	76.7	23.3	82.1	17.9	79.3	20.7
Norwch	73	58.1	41.9	81.0	19.0	71.2	28.8
Nottm	81	41.9	58.1	65.8	34.2	53.1	46.9
Oxford	127	77.0	23.0	71.7	28.3	74.8	25.2
Plymth[a]	44						
Ports	146	76.4	23.6	83.8	16.2	80.1	19.9
Prestn	109	81.0	19.0	82.4	17.6	81.7	18.3
Redng	79	61.8	38.2	68.9	31.1	65.8	34.2
Salford	114	64.4	35.6	83.6	16.4	73.7	26.3
Sheff	130	74.6	25.4	88.9	11.1	81.5	18.5
Shrew	51	57.7	42.3	88.0	12.0	72.5	27.5
Stevng	85	76.3	23.7	87.2	12.8	82.4	17.6
Sthend	22	70.0	30.0	91.7	8.3	81.8	18.2
Stoke	77	80.6	19.4	78.0	22.0	79.2	20.8
Sund	68	82.9	17.1	93.9	6.1	88.2	11.8
Truro	33	55.6	44.4	79.2	20.8	72.7	27.3
Wirral	43	60.0	40.0	73.9	26.1	67.4	32.6
Wolve	78	45.8	54.2	46.7	53.3	46.2	53.8
York	44	55.0	45.0	79.2	20.8	68.2	31.8

Table 1.12. Continued

		Age <65 (%)		Age ⩾65 (%)		All patients (%)	
Centre	*N*	HD	PD	HD	PD	HD	PD
N Ireland							
Antrim	28	64.3	35.7	100.0	0.0	82.1	17.9
Belfast	64	80.0	20.0	93.1	6.9	85.9	14.1
Newry	25	72.7	27.3	64.3	35.7	68.0	32.0
Ulster	20	85.7	14.3	92.3	7.7	90.0	10.0
West NI	26	83.3	16.7	92.9	7.1	88.5	11.5
Scotland							
Abrdn	44	68.2	31.8	95.5	4.5	81.8	18.2
Airdrie	60	82.9	17.1	88.0	12.0	85.0	15.0
D & Gall	16	57.1	42.9	55.6	44.4	56.3	43.8
Dundee	39	73.3	26.7	83.3	16.7	79.5	20.5
Dunfn	29	82.4	17.6	91.7	8.3	86.2	13.8
Edinb	66	94.6	5.4	79.3	20.7	87.9	12.1
Glasgw	165	82.4	17.6	95.0	5.0	88.5	11.5
Inverns	12	80.0	20.0	71.4	28.6	75.0	25.0
Klmarnk	35	66.7	33.3	85.7	14.3	74.3	25.7
Wales							
Bangor	14	80.0	20.0	77.8	22.2	78.6	21.4
Cardff	147	76.4	23.6	88.0	12.0	82.3	17.7
Clwyd	17	85.7	14.3	90.0	10.0	88.2	11.8
Swanse	116	59.1	40.9	83.3	16.7	74.1	25.9
Wrexm	23	44.4	55.6	71.4	28.6	60.9	39.1
England	**4,968**	**71.6**	**28.4**	**82.6**	**17.4**	**77.1**	**22.9**
N Ireland	**163**	**77.2**	**22.8**	**89.3**	**10.7**	**83.4**	**16.6**
Scotland	**466**	**80.3**	**19.7**	**87.8**	**12.2**	**83.9**	**16.1**
Wales	**317**	**69.3**	**30.7**	**84.4**	**15.6**	**77.9**	**22.1**
UK	**5,914**	**72.4**	**27.6**	**83.3**	**16.7**	**77.9**	**22.1**

[a]Breakdown not shown for Plymouth as not all data was available (see table 1.3) and more PD than HD starters were missing

Table 1.13. Initial and subsequent modalities for patients starting RRT in 2007

			Percentage			
First treatment	*N*	Later modality	90 days	1 year	3 years	5 years
HD	4,981	HD	88	72	47	30
		PD	3	3	2	1
		Transplant	1	3	10	15
		Other*	0	1	1	1
		Died	7	20	40	53
PD	1,365	HD	4	13	20	18
		PD	92	70	31	12
		Transplant	2	11	28	39
		Other*	0	1	1	1
		Died	1	5	19	30
Transplant	322	HD	1	1	3	5
		PD	0	0	0	2
		Transplant	98	96	92	89
		Died	1	2	3	4

*Other e.g. stopped treatment

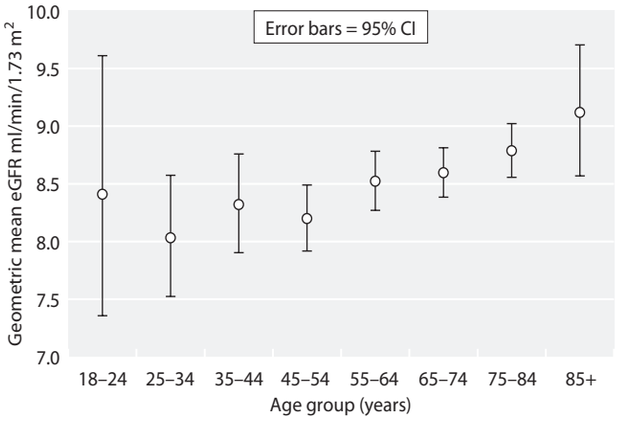

Fig. 1.9. Geometric mean eGFR at start of RRT (2012) by age group

Renal function at the time of starting RRT

The mean eGFR at initiation of RRT in 2012 was 8.5 ml/min/1.73 m^2. This increased with increasing age after the 45–54 age group and was highest in the 85+ age group at about 9.1 ml/min/1.73 m^2 (figure 1.9). By contrast, in the United States, 54% of patients starting RRT in 2009 had an eGFR greater than 10 ml/min/1.73 m^2 [4].

Figure 1.10 shows serial data from centres reporting annually to the UKRR since 2003. For both HD and PD patients, average eGFR at start of RRT in 2012 was slightly lower than for 2011. For the six years prior to 2011 there was higher average eGFR at start of RRT for PD than HD patients but the values were similar for 2011 and 2012.

Some caution should be applied to the analysis of eGFR at the start of RRT as a review of pre-RRT biochemistry in nine renal centres revealed that up to 18% of patients may have had an incorrect date of starting RRT allocated and thus, the eGFR used for analysis may have been taken whilst they were already receiving RRT. For details see the 12th Annual Report chapter 13: The UK Renal Registry Advanced CKD Study 2009 [5].

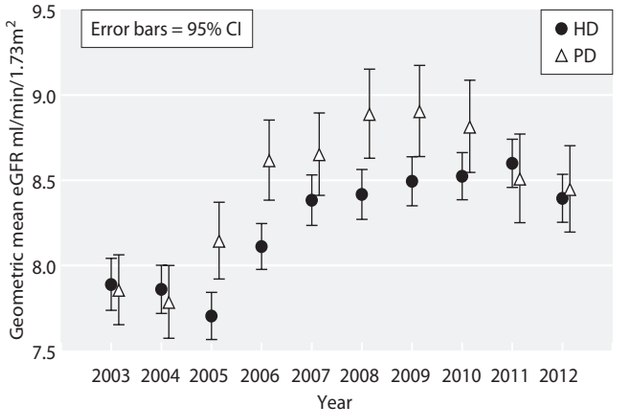

Fig. 1.10. eGFR on starting RRT 2003 to 2012, PD and HD (restricted to centres reporting since 2003)

3. Late presentation and delayed referral of incident patients

Introduction

Late presentation to a nephrologist is regarded as a negative aspect in renal care. It can be defined in a number of ways as it has a range of possible causes. There are many patients with chronic kidney disease who are regularly monitored in primary or secondary care and whose referral to nephrology services is delayed (delayed or late referral). In contrast, other patients present late to medical services due to no particular deficiency in the service; those with either such slowly progressive disease as to have remained asymptomatic for many years or the opposite with rapidly progressive glomerulonephritis. The main analyses presented here do not differentiate between these groups and include any patient first seen by renal services within 90 days of starting RRT as 'late presentation'.

One analysis attempts to capture 'late referrals': it shows the percentage presenting within 90 days of starting RRT after excluding an acute renal disease group. This group is made up of those people with conditions likely to present with rapidly deteriorating renal function: crescentic glomerulonephritis (type I, II, III), renal vascular disease due to malignant hypertension, renal vascular disease due to polyarteritis, nephropathy (interstitial) due to cis-platinum, Balkan nephropathy, Wegener's granulomatosis, cryoglobulinemic glomerulonephritis, myelomatosis/light chain deposit disease, Goodpasture's syndrome, systemic sclerosis, haemolytic ureaemic syndrome (including Moschcowitz syndrome), multi-system disease – other, tubular necrosis (irreversible) or cortical necrosis, kidney tumour(s) and surgical loss of kidney.

Methods

Date first seen by a nephrologist has not been collected from the Scottish Renal Registry and so Scottish centres were excluded from these analyses. Data were included from all incident patients in English, Welsh or Northern Irish centres in the years 2011 to 2012. This two year cohort is used for most of the analyses in order to make the late presentation percentages more reliably

estimated and to allow these to be shown for subgroups of patients. The date first seen in a renal centre and the date of starting RRT were used to define the late presenting cohort. A small amount of data were excluded because of actual or potential inconsistencies. Only data from those centres with 75% or more completeness for the relevant year were used. Some data were excluded if 10% or more of the patients were reported to have started RRT on the same date as the first presentation. This was because investigation has shown that this is likely due to misunderstanding on the part of the renal centres resulting in incorrect recording of data. After these exclusions, data on 9,937 patients were available for analysis. Presentation times of 90 days or more were defined as early presentation and times of less than 90 days were defined as late presentation.

Results

Table 1.14 shows the percentage completeness of data for 2011 and 2012. Average completeness for 2012 was similar to 2011 at just over 80%.

Late presentation by centre

Figure 1.11 shows that late presentation varied between centres from 7–32% in patients starting RRT in 2011 to 2012. The overall rate of late presentation was 19.5% and was 14.2% once those people with diseases likely to present acutely were excluded. Table 1.15 shows the overall percentage presenting late for the combined

Table 1.14. Percentage completeness of time of presentation data (2011 and 2012 incident RRT patients) by centre

	N		Percentage completeness	
Centre	2011	2012	2011	2012
England				
B Heart	113	101	97.3	96.0
B QEH	215	216	97.7	99.5
Basldn	42	53	100.0	96.2
Bradfd	60	71	98.3	97.1
Brightn	119	136	17.1	91.8
Bristol	139	148	88.2	94.6
Camb	122	124	98.4	100.0
Carlis	28	19	96.4	94.7
Carsh	207	242	94.2	88.0
Chelms	47	45	95.7	97.8
Colchr	44	29	86.4	100.0
Covnt	111	112	73.4	98.2
Derby	80	81	95.0	100.0
Donc	43	40	100.0	95.0
Dorset	79	72	100.0	95.8
Dudley	43	56	97.7	98.2
Exeter	112	138	99.1	97.1
Glouc	58	74	100.0	94.5
Hull	109	97	66.1	97.9
Ipswi	29	43	92.9	97.7
Kent	122	115	100.0	100.0
L Barts	249	263	2.0	1.5
L Guys	120	127	94.1	22.4
L Kings	140	125	96.4	96.0
L Rfree	223	240	91.9	99.2
L St.G	74	91	32.4	65.9
L West	365	352	93.1	0.3
Leeds	158	154	98.1	98.0
Leic	267	235	97.3	97.0
Liv Ain	61	63	58.3	100.0
Liv RI	114	110	7.1	99.1
M RI	156	160	81.2	92.4
Middlbr	100	120	98.0	97.5
Newc	98	104	95.9	89.4
Norwch	87	74	93.1	64.9
Nottm	116	99	97.4	97.9
Oxford	177	171	94.3	98.2
Plymth	60	47	31.7	31.9
Ports	187	161	97.8	96.9
Prestn	140	147	98.6	95.8
Redng	103	73	63.1	97.3
Salford	126	134	0.8	10.6
Sheff	135	158	100.0	98.7
Shrew	61	57	100.0	98.3
Stevng	110	110	97.3	99.1
Sthend	29	26	100.0	100.0
Stoke	93	77	100.0	98.7
Sund	57	71	94.7	98.6
Truro	38	50	97.4	98.0
Wirral[a]	62	50	[b]	97.9
Wolve	76	84	100.0	100.0
York	52	53	100.0	100.0
N Ireland				
Antrim	30	26	96.7	100.0
Belfast	69	91	95.7	89.0
Newry	38	18	100.0	100.0
Ulster	35	30	100.0	100.0
West NI	38	21	94.7	100.0
Wales				
Bangor	20	21	100.0	90.5
Cardff	186	170	97.3	98.8
Clwyd	17	22	[b]	95.5
Swanse	118	113	99.2	99.1
Wrexm	26	34	88.0	97.1
England	**5,756**	**5,798**	**81.8**	**81.6**
N Ireland	**210**	**186**	**97.1**	**94.6**
Wales	**367**	**360**	**92.9**	**98.0**
E, W & NI	**6,333**	**6,344**	**83.0**	**82.9**

[a]Although completeness was good for Wirral for 2012, the late presentation percentage was suspiciously high and is not shown in table 1.15 or figure 1.11 due to concerns about data accuracy

[b]Data not shown as >10% of patients reported as starting RRT on the same date as first presentation

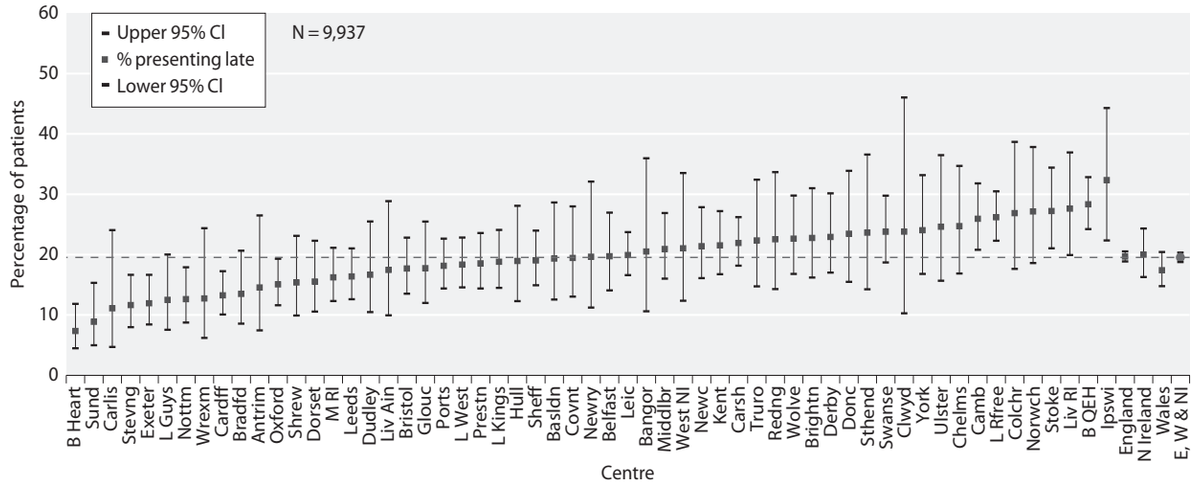

Fig. 1.11. Percentage presenting late (2011/2012)

2011–2012 incident cohort, the percentages presenting late amongst those patients defined as not having an 'acute diagnosis' and the percentages amongst non-diabetics (as PRD).

Late presentation in 2012 and the trend over time

There has been a steady decline nationally in the proportion of patients presenting late to renal services, with some centres achieving <10% late presentation rates. This may be a consequence of the National CKD guidelines published by the Medical and GP Royal Colleges [6], the Quality and Outcomes Framework (QOF) initiative (www.dh.gov.uk) raising awareness of CKD amongst non-nephrologists and the introduction of estimated GFR reporting.

In 2012, 66.8% of incident patients presented over a year before they needed to start RRT. There were 8.4% of patients presenting within 6–12 months, 5.5% within 3–6 months and 19.3% within three months. Figure 1.12 shows this breakdown by year for those 20 centres supplying data over 75% complete for each of the last six years. The figure shows an increase over time in the percentage of patients presenting 12 months or more before starting RRT. As shown in previous reports this

Table 1.15. Percentage of patients presenting to a nephrologist less than 90 days before RRT initiation (2011–2012 incident patients) by centre

		Percentage presenting late			
Centre	*N* with data	Overall	(95% CI)	Non-acute*	Non-diab PRD
England					
B Heart	204	7.4	(4.5–11.8)	4.5	10.5
B QEH	420	28.3	(24.2–32.8)	23.5	29.3
Basldn	93	19.4	(12.6–28.6)	12.2	23.2
Bradfd	126	13.5	(8.6–20.6)	11.9	15.6
Brightn	123	22.8	(16.2–31.0)	16.5	25.0
Bristol	260	17.7	(13.5–22.8)	11.4	20.4
Camb	243	25.9	(20.8–31.8)		
Carlis	45	11.1	(4.7–24.1)	11.9	11.4
Carsh	406	21.9	(18.2–26.2)	17.9	23.3
Chelms	89	24.7	(16.9–34.7)	19.0	28.8
Colchr	67	26.9	(17.6–38.7)	18.5	22.7
Covnt	108	19.4	(13.0–28.0)	14.6	20.2
Derby	157	22.9	(17.0–30.2)	16.8	29.7
Donc	81	23.5	(15.5–33.9)	18.6	28.1
Dorset	148	15.5	(10.6–22.3)	14.0	17.5
Dudley	96	16.7	(10.5–25.5)	12.5	20.3
Exeter	243	11.9	(8.4–16.7)	10.0	14.6

Table 1.15. Continued

		Percentage presenting late			
Centre	*N* with data	Overall	(95% CI)	Non-acute*	Non-diab PRD
Glouc	124	17.7	(12.0–25.5)	13.9	19.0
Hull	95	19.0	(12.3–28.1)	14.9	23.0
Ipswi	68	32.4	(22.4–44.3)	34.6	44.4
Kent	237	21.5	(16.8–27.2)	16.8	25.0
L Guys	112	12.5	(7.5–20.0)	10.2	12.8
L Kings	255	18.8	(14.5–24.1)	14.0	27.5
L Rfree	443	26.2	(22.3–30.5)	21.5	28.7
L West	338	18.3	(14.6–22.8)	14.9	21.9
Leeds	299	16.4	(12.6–21.0)	8.7	18.8
Leic	482	19.9	(16.6–23.7)	11.7	23.5
Liv Ain	63	17.5	(9.9–28.9)	16.7	21.2
Liv RI	105	27.6	(19.9–36.9)	11.3	32.2
M RI	271	16.2	(12.3–21.1)	14.3	18.5
Middlbr	215	20.9	(16.0–26.9)	18.8	26.1
Newc	187	21.4	(16.1–27.9)	11.8	24.2
Norwch	81	27.2	(18.6–37.8)	17.7	30.4
Nottm	206	12.6	(8.7–17.9)	11.3	14.8
Oxford	332	15.1	(11.6–19.3)	11.3	19.0
Ports	336	18.2	(14.4–22.6)	9.4	20.3
Prestn	275	18.6	(14.4–23.6)	13.1	20.1
Redng	71	22.5	(14.3–33.7)	19.1	31.3
Sheff	289	19.0	(14.9–24.0)	13.5	23.8
Shrew	117	15.4	(9.9–23.1)	11.1	11.1
Stevng	215	11.6	(8.0–16.6)	9.8	12.1
Sthend	55	23.6	(14.3–36.6)	18.8	28.9
Stoke	169	27.2	(21.0–34.4)	19.0	32.3
Sund	124	8.9	(5.0–15.3)	5.6	10.0
Truro	85	22.4	(14.7–32.4)	18.7	25.0
Wolve	159	22.6	(16.8–29.8)	20.5	25.6
York	104	24.0	(16.8–33.2)	17.4	27.4
N Ireland					
Antrim	55	14.6	(7.4–26.5)	13.2	18.4
Belfast	147	19.7	(14.1–27.0)	12.3	24.6
Newry	56	19.6	(11.2–32.1)	13.5	23.7
Ulster	65	24.6	(15.7–36.5)	21.0	22.5
West NI	57	21.1	(12.4–33.5)	16.3	22.9
Wales					
Bangor	39	20.5	(10.6–36.0)	21.1	25.0
Cardff	347	13.3	(10.1–17.3)	10.3	16.3
Clwyd	21	23.8	(10.3–46.0)	22.2	17.7
Swanse	227	23.8	(18.7–29.8)	16.2	30.7
Wrexm	55	12.7	(6.2–24.4)	11.1	18.4
England	**8,868**	**19.7**	**(18.9–20.5)**	**14.3**	**22.2**
N Ireland	**380**	**20.0**	**(16.3–24.3)**	**14.8**	**23.0**
Wales	**689**	**17.4**	**(14.8–20.4)**	**13.2**	**21.7**
E, W & NI	**9,937**	**19.5**	**(18.8–20.3)**	**14.2**	**22.2**
(min, max)		**(7.4–42.6)**		**(4.5–34.6)**	**(10.0–44.4)**
(IQR)		**(16.3–23.6)**		**(11.7–18.5)**	**(18.5–26.4)**

Blank cells – data for PRD not used due to high % with uncertain aetiology

*Non-acute group excludes crescentic (extracapillary) glomerulonephritis (type I, II, III), nephropathy (interstitial) due to cis-platinum, renal vascular disease due to malignant hypertension, renal vascular disease due to polyarteritis, Wegener's granulomatosis, cryoglobulinemic glomerulonephritis, myelomatosis/light chain deposit disease, Goodpasture's syndrome, systemic sclerosis (scleroderma), haemolytic ureaemic syndrome (including Moschcowitz syndrome), multi-system disease – other, tubular necrosis (irreversible) or cortical necrosis, Balkan nephropathy, kidney tumour(s), and traumatic or surgical loss of kidney

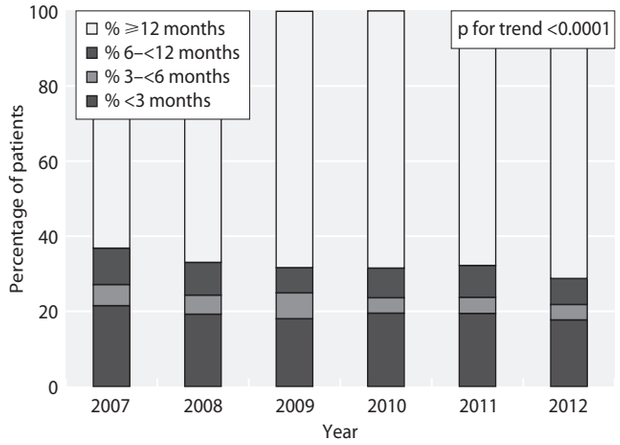

Fig. 1.12. Late presentation rate by year (2007–2012)
Restricted to centres reporting continuous data for 2007–2012

increase was most marked in the years just before those shown in the figure. In 2005, only 52.6% of incident patients presented over a year before they needed to start RRT compared with the 66.8% seen for 2012.

Age and late presentation

In the 2011 to 2012 cohort, patients who presented late were not significantly older or younger than patients who presented earlier (⩾90 days before RRT initiation) (median age 66.1 vs. 64.7 years: $p = 0.1$). Except for the two youngest age groups, the median duration of pre-RRT care did not vary greatly with age group (figure 1.13).

Gender and late presentation

In the 2011 and 2012 cohort, there was no significant difference in the ratio of males to females by time of presentation (male : female ratio 1.68 in early presentation, 1.84 in late presentation, $p = 0.08$).

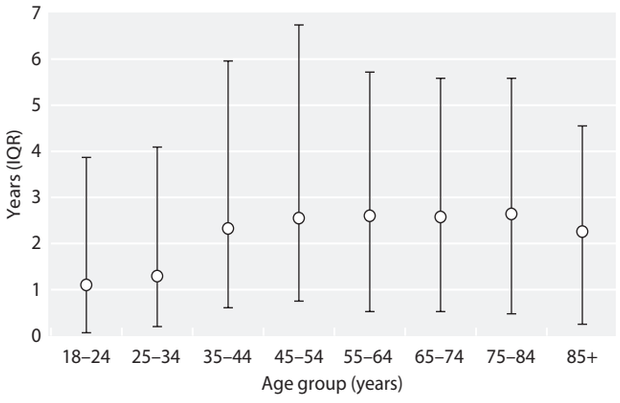

Fig. 1.13. Median duration of pre-RRT care by age group (incident patients 2011–2012)

Ethnicity and late presentation

In the 2011 to 2012 cohort, the percentage of South Asian and Black patients presenting late (<90 days) was significantly lower than in Whites (16.4% vs. 19.8%: $p = 0.002$). The high incidence of diabetes in non-Whites (as discussed below, patients with diabetes tended to present earlier) explains some of the difference in presentation time between the ethnic groups. When patients with diabetes were excluded, the percentages presenting late (<90 days) became 20.0% in South Asian and Black patients vs. 22.6% in Whites ($p = 0.1$).

Primary renal disease and late presentation

In the 2011 to 2012 cohort, late presentation differed significantly between primary renal diagnoses (Chi-squared test $p < 0.0001$) (table 1.16). Patients in the acute group or with data not available had high rates of late presentation. Those with diabetes and pyelonephritis or adult polycystic kidney disease had low rates. There was a notable decline in the proportion of diabetics presenting late up until 2007. Since then the proportion has been stable. The decline seen earlier likely reflects national initiatives to screen patients with diabetes for proteinuria and falling GFR.

Table 1.16. Late presentation by primary renal diagnosis (2011–2012 incident patients)

		Late presentation	
Diagnosis	*N*	*N*	%
Uncertain aetiology	1,407	294	20.9
Diabetes	2,251	204	9.1
Glomerulonephritis	1,160	179	15.4
Other identified category	893	167	18.7
Polycystic kidney or pyelonephritis	1,270	130	10.2
Renal vascular disease	1,140	179	15.7
Acute group	889	488	54.9
Data not available	296	127	42.9

Unlike elsewhere in the report, the RVD group includes hypertension
Polycystic and pyelonephritis are grouped together
Acute group includes crescentic (extracapillary) glomerulonephritis (type I, II, III), nephropathy (interstitial) due to cis-platinum, renal vascular disease due to malignant hypertension, renal vascular disease due to polyarteritis, Wegener's granulomatosis, cryoglobulinemic glomerulonephritis, myelomatosis/light chain deposit disease, Goodpasture's syndrome, systemic sclerosis (scleroderma), haemolytic ureaemic syndrome (including Moschcowitz syndrome), multi-system disease – other, tubular necrosis (irreversible) or cortical necrosis, Balkan nephropathy, kidney tumour(s), and traumatic or surgical loss of kidney

Table 1.17. Percentage prevalence of specific comorbidities amongst patients presenting late (<90 days) compared with those presenting early (⩾90 days) (2011–2012 incident patients)

Comorbidity	<90 days	⩾90 days	p-value
Ischaemic heart disease	16.3	19.5	0.02
Cerebrovascular disease	9.7	10.0	0.7
Peripheral vascular disease	8.8	12.7	0.0003
Diabetes (not a cause of ERF)	10.2	9.6	0.5
Liver disease	4.2	2.8	0.02
Malignancy	19.9	11.1	<0.0001
COPD	9.0	7.3	0.1
Smoking	15.4	14.2	0.3

Modality and late presentation

In the 2011 to 2012 cohort, late presentation was associated with initial modality. The percentage of patients whose first modality was PD was significantly lower in the late presentation group than in those presenting earlier (9.3% vs. 22.7%: $p < 0.0001$). By 90 days after RRT initiation this difference was reduced, although it was still highly significant (12.5% vs. 22.0%: $p < 0.0001$).

Comorbidity and late presentation

In the 2011 to 2012 cohort, the percentage of patients who were assessed as having no comorbidity was slightly lower in those who presented late than those presenting earlier (43.3% vs. 47.0%: $p = 0.03$). Ischaemic heart disease and peripheral vascular disease were significantly less common in the group presenting late (table 1.17). Liver disease was significantly more common in those presenting late as was malignancy; perhaps because of the potential for rapid decline in renal function in this group. The evidence in the literature is in keeping with these findings with subtle variation between the individual comorbidities [7–9].

Haemoglobin and late presentation

In the 2011 to 2012 cohort, patients presenting late had a significantly lower average haemoglobin concentration at RRT initiation than patients presenting earlier (92 vs. 102 g/L: $p < 0.0001$). This may reflect inadequate predialysis care with limited anaemia management, but alternatively those presenting late may be more likely to have anaemia because of multisystem disease or intercurrent illness. More detailed analyses of haemoglobin at start of RRT and late presentation can be found in chapter 10: Haemoglobin, Ferritin and Erythropoietin amongst UK Adult Dialysis Patients in 2012: National and Centre-specific Analyses.

eGFR at start of RRT and late presentation

In the 2011 to 2012 cohort, eGFR at start of RRT was significantly lower in patients presenting late than those presenting earlier (7.9 vs. 8.7 ml/min/1.73 m^2: $p < 0.0001$). These findings are in contrast to some of the studies in the literature which have found the opposite [7, 8].

Survival of incident patients

See chapter 8: Survival and Causes of Death of UK Adult Patients on Renal Replacement Therapy in 2012.

Summary

RRT incidence rates for 2012 were similar to 2011 for England and for the UK as a whole. At least partly because of the smaller numbers involved, rates have been more variable over the last few years for Northern Ireland, Scotland and Wales. Wales continues to have the highest incidence rate. There remain large centre variations in incidence rates for RRT. Significant numbers of patients continue to present late to renal centres.

Conflicts of interest: none

References

1 Castledine CI et al.: *How much of the regional variation in RRT incidence rates within the UK is explained by the health needs of the general population?* Nephrology Dialysis Transplantation 2012;27(10):3943/–3950

2 Kuan Y et al.: *GFR prediction using the MDRD and Cockcroft and Gault equations in patients with end-stage renal disease.* Nephrology Dialysis Transplantation 2005;20(11):2394–2401

3 http://www.ons.gov.uk/ons/rel/ethnicity/focus-on-ethnicity-and-identity/focus-on-ethnicity-and-identity-summary-report/focus-on—ethnicity-and-identity-summary-report.pdf.

4 US Renal Data System: USRDS 2011 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and

Digestive and Kidney Diseases, Bethesda, MD, 2011. Publications based upon USRDS data reported here or supplied upon request must include this citation and the following notice: The data reported here have been supplied by the United States Renal Data System (USRDS)

5 Ford DJ, Fogarty DG, Steenkamp R, Tomson CRV, Ben-Shlomo Y, Ansell D. Chapter 13: The UK Renal Registry Advanced CKD Study: frequency of incorrect reporting of date of start of RRT. Nephron Clinical Practice; 115(suppl 1):c271–c278

6 http://www.renal.org/CKDguide/full/UKCKDfull.pdf.

7 Kazmi WHet al.: *Late nephrology referral and mortality among patients with end-stage renal disease: a propensity score analysis.* Nephrology Dialysis Transplantation 2004;19(7):1808–1814

8 Roubicek C et al.: *Timing of nephrology referral: Influence on mortality and morbidity.* American journal of kidney diseases: the official journal of the National Kidney Foundation 2000;36(1):35–41

9 Winkelmayer WC et al.: *A Propensity Analysis of Late Versus Early Nephrologist Referral and Mortality on Dialysis.* Journal of the American Society of Nephrology 2003;14(2):486–492.

UK Renal Registry 16th Annual Report: Chapter 2 UK RRT Prevalence in 2012: National and Centre-specific Analyses

Catriona Shaw[a], David Pitcher[a], Rishi Pruthi[a], Damian Fogarty[ab]

[a]UK Renal Registry, Bristol, UK; [b]Belfast Health and Social Care Trust, Belfast, UK

Key Words

Chronic kidney disease · Comorbidity · Diabetes · Dialysis · End stage renal disease · Established renal failure · Ethnicity · Haemodialysis · Peritoneal dialysis · Prevalence · Primary Care Trust · Renal replacement therapy · Transplantation · Treatment modality

Summary

- There were 54,824 adult patients receiving renal replacement therapy (RRT) in the UK on 31st December 2012, an absolute increase of 3.7% from 2011. The actual number of patients increased across all modalities: 2.3% increase haemodialysis (HD), 0.3% peritoneal dialysis (PD) and 5.6% for those with a functioning transplant.
- The UK adult prevalence of RRT was 861 per million population (pmp). The reported prevalence in 2000 was 523 pmp.
- The number of patients receiving home HD increased by 19.3% from 905 patients in 2011 to 1,080 patients in 2012.
- The median age of prevalent patients was 58 years (HD 66 years, PD 63 years, transplant 52 years). In 2000 the median age was 55 years (HD 63 years, PD 58 years, transplant 48 years). The percentage of RRT patients aged greater than 70 years increased from 19.2% in 2000 to 24.9% in 2012.
- For all ages, the prevalence rate in men exceeded that in women, peaking in age group 80–84 years at 2,973 pmp and for females in age group 75–79 years at 1,528 pmp.
- The most common identifiable renal diagnosis was glomerulonephritis (18.8%), followed by uncertain aetiology (16.7%) and diabetes (15.5%).
- Transplantation continued as the most common treatment modality (50.4%), HD was used in 42.7% and PD in 6.9% of RRT patients.
- Prevalence rates in patients aged >85 years continued to increase between 2011 and 2012 (952 pmp to 983 pmp). There was 20 fold variation between PCT/HBs in prevalence rates in patients aged >80 years suggesting there was uncertainty regarding the risks and benefits of RRT in the elderly.
- In 2012, 20.7% of the prevalent UK RRT population (with ethnicity assigned) were from ethnic minorities compared to 14.9% in 2007.
- There were national, regional and dialysis centre level variations in prevalence rates. A significant factor in this variation was the ethnic mix of local populations, but a large amount of the variation remains unexplained. Assessment of conservatively managed stage 5 CKD patients might explain more of this variation.

Introduction

This chapter presents data on all adult patients on RRT in the UK at the end of 2012. The UK Renal Registry (UKRR) received data returns for 2012 from all five renal centres in Wales, all five in Northern Ireland and all 52 in England. Data from all nine centres in Scotland were obtained from the Scottish Renal Registry. Demographic data on children and young adults can be found in chapter 7.

These analyses of prevalent RRT patients are performed annually to aid clinicians and policy makers in planning future RRT requirements in the UK. It is important to understand national, regional and centre level variation in numbers of prevalent patients as part of the planning process. In addition, knowledge about variation in case mix is also reported to improve understanding of where resources should be focussed to improve equity of provision of RRT in the UK.

The term established renal failure (ERF) used within this chapter is synonymous with the terms end stage renal failure and end stage renal disease, which are in more widespread international usage. Patients have disliked the term 'end stage' which reflects the inevitable outcome of this disease.

Methods

These analyses relate to the prevalent RRT cohort in the UK in 2012. The cohort was defined as all adult patients receiving RRT on the UKRR database on 31st December 2012. Population estimates were obtained from the UK Office for National Statistics (ONS) [1], the National Records of Scotland (NRS) [2] and the Northern Ireland Statistic and Research Agency (NISRA) [3].

The number of adult prevalent RRT patients was calculated for the UK as a whole and for each UK country, using UKRR data from all renal centres. Crude prevalence rates were calculated per million population (pmp) and standardised prevalence ratios were calculated as detailed in appendix D: Methodology used for Analyses (www.renalreg.com) for Primary Care Trusts (PCTs) in England, Health & Social Care Areas in Northern Ireland, Local Health Boards in Wales and Health Boards in Scotland. These areas will be referred to in this report as 'PCT/HBs' reflecting the period of time before re-organisation of PCTs in England. Briefly, data from all areas were used to calculate overall age and gender specific prevalence rates. The age and gender breakdown of the population in each PCT/HB were obtained from the mid-2011 population estimate based on 2011 Census data from the ONS [1], the NRS [2] and the NISRA [3]. The population breakdown and the overall prevalence rates were used to calculate the expected age and gender specific prevalence numbers for each PCT/HB for each of the last six years. The age and gender standardised prevalence ratio was the observed prevalence number divided by the expected prevalence number. The expected number of prevalent patients in a specific age/sex group (e.g. females 70–74) for a PCT is found by multiplying the total number of people (from the census) in that age/sex group in that PCT by the overall rate in the whole of the UK for that same age/sex group. Summing together the expected numbers in each of the age/sex groups gives the overall expected number of prevalent patients for that PCT. A ratio below 1 indicates that the observed number was less than expected given the area's population structure. This was statistically significant at the 5% level if the upper confidence limit was less than 1. To enable assessment of whether a centre was an outlier in this regard, funnel plots for smaller and larger populations have been included (appendix D: figures D3, D4) which show the 95% confidence intervals around the national average prevalence. The proportion of non-Whites in each PCT/HB was obtained from the ONS [1], the NRS [2] and the NISRA [3].

The prevalence rate per million population for each centre was calculated using a derived catchment population. For a full description of the methodology used to estimate the catchment populations see appendix E: Methodology for Estimating Catchment Populations Analyses (www.renalreg.com). For Scotland, mid-2011 populations of Health Boards (from the General Register Office for Scotland) were converted to centre level populations using an approximate mapping of renal centres to HBs supplied by the Scottish Renal Registry. Estimates of the catchment populations in Northern Ireland were supplied by personal communication from Dr D Fogarty.

Throughout this chapter, haemodialysis refers to all modes of HD treatment, including haemodiafiltration (HDF). Several centres reported significant numbers of patients on HDF, but other centres did not differentiate this treatment type in their UKRR returns. Where joint care of renal transplant recipients between the referring centre and the transplant centre occurred, the patient was allocated to the centre which saw the patient most frequently, usually the referring centre. Thus the number of patients allocated to a transplant centre is often lower than that recorded by the centre itself and as a converse pre-emptively transplanted patients are sometimes allocated to the transplanting centre rather than the referring centre if no transfer out code had been sent through. Queries and updated information are welcomed by the UKRR at any point during the year if this has occurred.

Prevalent patients on RRT in 2012 were examined by time on RRT, age group, gender, ethnic origin, primary renal disease, presence of diabetes and treatment modality (see appendix H: Coding (www.renalreg.com)). In this year's analysis of prevalence, only adult patients on RRT contributed to the numerator. In previous years, children have also been included in the numerator. Data on the paediatric population are presented in chapter 7. Some centres electronically upload ethnicity coding to their renal information technology (IT) system from the hospital Patient Administration System (PAS). Ethnicity coding in these PAS systems is based on self-reported ethnicity and uses a different coding system to those centres not linked to PAS [4]. For the remaining centres, ethnicity coding is performed by clinical staff and recorded directly into the renal IT system (using a variety of coding systems). For all these analyses, data on ethnic origin were grouped into Whites, South Asians, Blacks, Chinese and

Table 2.1. Prevalence of adult RRT in the UK on 31/12/2012

	England	N Ireland	Scotland	Wales	UK
All UK centres	46,076	1,520	4,492	2,736	54,824
Total estimated population, mid-2012 (millions)*	53.5	1.8	5.3	3.1	63.7
Prevalence rate HD (pmp)	369	381	361	351	367
Prevalence rate PD (pmp)	61	46	44	65	60
Prevalence rate dialysis (pmp)	430	427	405	416	427
Prevalence rate transplant (pmp)	432	407	440	474	434
Prevalence rate total (pmp)	861	834	845	890	861
95% confidence intervals total (pmp)	853–869	792–875	821–870	857–923	853–868

*Data from the Office for National Statistics, National Records of Scotland and the Northern Ireland Statistics and Research Agency – based on the 2011 census

Others as described in appendix H: Coding (www.renalreg.com). Time on RRT was defined as median time on treatment and was calculated from the most recent start date. Patients without an accurate start date were excluded from this calculation. Analyses were done for the UK as a whole, by UK country, at centre level and split by treatment modality when appropriate.

Chi-squared test, Fisher's exact test, linear regression and Kruskal Wallis tests were used as appropriate to test for significant differences between groups. The data were analysed using SAS 9.3.

Results

Prevalent patient numbers and changes in prevalence

The number of patients for each country (table 2.1) was calculated by adding the patient numbers in each renal centre and these differ marginally from those quoted elsewhere when patients are allocated to geographical areas by their individual postcodes, as some centres treat patients across national boundaries.

There were 54,824 adult patients receiving RRT in the UK at the end of 2012, giving an adult UK population prevalence of 861 pmp (table 2.1) compared with 841 pmp in 2011. Prevalence rates increased in all of the UK countries in 2012. PD prevalence increased in Northern Ireland but remained static or decreased in the other three countries compared with 2011. The decline in PD prevalence in the UK overall noted since 1997 seems to have plateaud in 2011 and 2012 with a static overall prevalence of 60 pmp. Once more, the prevalence of transplanted patients increased in the UK. Northern Ireland had a higher RRT prevalence rate for patients aged 65 and older compared with the other UK countries (figure 2.1). In the UK, the RRT prevalence rate in patients aged 80–84 continued to rise over time from 1,824 per million age related population (pmarp) in 2011 to 1,896 pmarp in 2012 and in patients aged >85 years from 952 pmarp in 2011 to 983 pmarp in 2012. It is likely that this ageing of the prevalent population was due to an increasing number of older patients starting RRT, although improving patient survival will also contribute.

Prevalent patients by RRT modality and centre

The number of prevalent patients in each renal centre and the distribution of their treatment modalities varied widely (table 2.2). Many factors including geography, local population density, age distribution, ethnic composition, prevalence of diseases predisposing to kidney disease and the social deprivation index of that population may contribute to this.

Changes in prevalence

Overall growth in the prevalent UK RRT population from 2011 to 2012 was 3.7% (table 2.3), an annual growth rate which has been fairly consistent over the last 10–15 years (figure 2.2). Most of the growth in the prevalent RRT population was due to a continued increase in the size of the prevalent RRT population in England, Wales

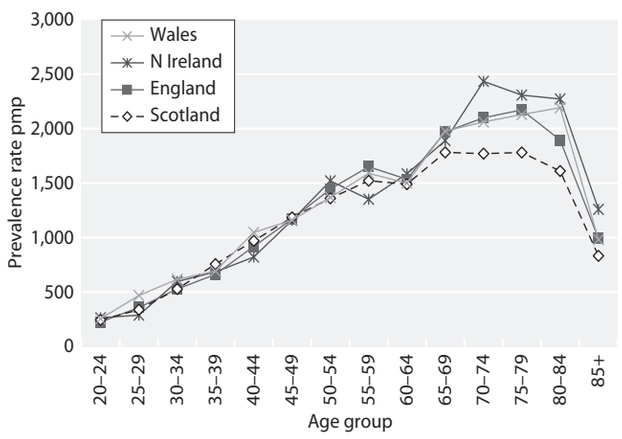

Fig. 2.1. Prevalence rates per million population by age group and UK country on 31/12/2012

Table 2.2. Number of prevalent RRT patients by treatment modality and centre on 31/12/2012

Centre	HD	PD	Dialysis	Transplant	RRT	Catchment population (millions)	2012 crude rate pmp	(95% CI)
England								
B Heart	435	47	482	188	670	0.74	908	(839–977)
B QEH[a]	926	159	1,085	886	1,971	1.70	1,160	(1,109–1,211)
Basldn	164	32	196	68	264	0.42	636	(559–713)
Bradfd	208	29	237	271	508	0.65	779	(711–847)
Brightn	371	85	456	375	831	1.30	641	(597–684)
Bristol[a]	494	66	560	777	1,337	1.44	929	(879–979)
Camb[a]	350	35	385	728	1,113	1.16	961	(905–1,018)
Carlis	61	27	88	128	216	0.32	673	(584–763)
Carsh	764	112	876	599	1,475	1.91	771	(732–811)
Chelms	129	26	155	69	224	0.51	439	(381–496)
Colchr	117		117		117	0.30	391	(320–462)
Covnt[a]	363	100	463	437	900	0.89	1,009	(943–1,075)
Derby	220	89	309	168	477	0.70	679	(618–740)
Donc	172	29	201	60	261	0.41	636	(559–714)
Dorset	260	48	308	302	610	0.86	708	(652–764)
Dudley	169	63	232	84	316	0.44	715	(636–794)
Exeter	397	77	474	372	846	1.09	777	(724–829)
Glouc	219	36	255	162	417	0.59	710	(642–778)
Hull	334	90	424	365	789	1.02	773	(719–827)
Ipswi	129	31	160	179	339	0.40	850	(759–940)
Kent	384	62	446	476	922	1.22	753	(704–802)
L Barts[a]	895	195	1,090	865	1,955	1.83	1,068	(1,021–1,116)
L Guys[a]	626	31	657	1,088	1,745	1.08	1,612	(1,537–1,688)
L Kings	492	86	578	340	918	1.17	784	(733–834)
L Rfree[a]	714	120	834	1,031	1,865	1.52	1,228	(1,173–1,284)
L St.G[a]	284	54	338	386	724	0.80	907	(841–974)
L West[a]	1,426	52	1,478	1,626	3,104	2.40	1,294	(1,248–1,340)
Leeds[a]	495	87	582	834	1,416	1.67	848	(804–892)
Leic[a]	872	160	1,032	950	1,982	2.44	814	(778–849)
Liv Ain	175	20	195		195	0.48	403	(346–459)
Liv RI[a]	366	63	429	812	1,241	1.00	1,241	(1,172–1,310)
M RI[a]	507	82	589	1,121	1,710	1.53	1,117	(1,064–1,170)
Middlbr	339	11	350	439	789	1.00	786	(731–841)
Newc[a]	285	47	332	614	946	1.12	844	(790–898)
Norwch	318	55	373	239	612	0.79	778	(716–840)
Nottm[a]	376	81	457	549	1,006	1.09	925	(868–982)
Oxford[a]	423	86	509	1,026	1,535	1.69	908	(863–953)
Plymth[ab]	131	35	166	293	459	0.47	977	(888–1,067)
Ports[a]	555	83	638	809	1,447	2.02	715	(678–752)
Prestn	536	69	605	476	1,081	1.49	724	(681–767)
Redng	271	72	343	328	671	0.91	737	(682–793)
Salford	380	104	484	398	882	1.49	592	(553–631)
Sheff[a]	588	69	657	650	1,307	1.37	953	(901–1,005)
Shrew	195	41	236	118	354	0.50	707	(633–781)
Stevng	409	32	441	224	665	1.20	552	(510–594)
Sthend	118	14	132	81	213	0.32	672	(582–763)
Stoke	305	79	384	311	695	0.89	781	(723–839)
Sund	198	22	220	201	421	0.62	681	(616–746)
Truro	154	23	177	200	377	0.41	913	(820–1,005)
Wirral	202	32	234		234	0.57	409	(357–462)
Wolve	285	92	377	151	528	0.67	790	(722–857)
York	135	32	167	229	396	0.49	805	(725–884)

Table 2.2. Continued

Centre	HD	PD	Dialysis	Transplant	RRT	Catchment population (millions)	2012 crude rate pmp	(95% CI)
Northern Ireland								
Antrim	132	13	145	80	225	0.30	750	(652–848)
Belfast[a]	228	28	256	445	701	0.55	1,275	(1,180–1,369)
Newry	91	16	107	81	188	0.28	671	(575–767)
Ulster	108	8	116	32	148	0.30	493	(414–573)
West NI	135	19	154	104	258	0.35	737	(647–827)
Scotland								
Abrdn	230	25	255	249	504	0.60	840	(767–913)
Airdrie	194	11	205	183	388	0.56	693	(624–762)
D & Gall	51	16	67	61	128	0.15	853	(706–1,001)
Dundee	181	21	202	201	403	0.41	983	(887–1,079)
Dunfn	147	20	167	111	278	0.37	751	(663–840)
Edinb[a]	265	37	302	420	722	0.96	752	(697–807)
Glasgw[a]	624	47	671	878	1,549	1.51	1,026	(975–1,077)
Inverns	74	18	92	126	218	0.34	641	(556–726)
Klmarnk	150	41	191	111	302	0.37	816	(724–908)
Wales								
Bangor	90	15	105		105	0.22	481	(389–573)
Cardff[a]	482	77	559	989	1,548	1.42	1,090	(1,036–1,144)
Clwyd	84	18	102	70	172	0.19	907	(771–1,042)
Swanse	328	68	396	266	662	0.89	748	(691–805)
Wrexm	96	22	118	131	249	0.24	1,036	(908–1,165)
England	**19,721**	**3,272**	**22,993**	**23,083**	**46,076**			
N Ireland	**694**	**84**	**778**	**742**	**1,520**			
Scotland	**1,916**	**236**	**2,152**	**2,340**	**4,492**			
Wales	**1,080**	**200**	**1,280**	**1,456**	**2,736**			
UK	**23,411**	**3,792**	**27,203**	**27,621**	**54,824**			

Blank cells indicate no patients on that treatment type attending that centre when data were collected
Centres prefixed 'L' are London centres
The numbers of patients calculated for each country quoted above differ marginally from those quoted elsewhere when patients are allocated to areas by their individual post codes, as some centres treat patients from across national boundaries
[a]Transplant centres
[b]The catchment population for Plymouth may be too low, see appendix E

and Scotland, with slower growth in the prevalent RRT population in Northern Ireland. The increases in prevalence across Scotland and England were similar at ~4%. The increase in prevalence in Wales was 2.4%. In Northern Ireland the increase in the prevalent RRT population was lower in magnitude at 1.5% between 2011 and 2012.

From 2011 to 2012, there was a 0.7% pmp growth in prevalent HD patients, a 4.3% pmp growth in those with a functioning transplant and a 1.5% pmp decline in patients on PD. Between 2007 and 2012 there was an average annual 2.6% pmp growth in HD, 4.8% pmp fall in PD, and 4.6% pmp growth in prevalent transplant patients in the UK (table 2.4). In the same period there was an average annual 16.8% pmp growth in the use of home haemodialysis (data not shown).

Prevalence rates between centres showed marked variation (table 2.2); the long-term (1997–2012) UK prevalence pattern by treatment modality is shown in figure 2.2. The steady growth in transplant numbers was maintained in 2012. The increase in haemodialysis patient numbers has been associated with an increase in home haemodialysis, from 2.0% of the dialysis population in 2007 to 4.0% in 2012. The slow contraction in PD observed in more recent years may have started to plateau in 2012, with only a small reduction in the prevalent PD population from 7.2% in 2011 to 6.9% in 2012.

Prevalence of RRT in Primary Care Trusts in England, Health and Social Care Areas in Northern Ireland (HBs), Local Health Boards in Wales (HBs) and Health Boards in Scotland (HBs)

The need for RRT depends on many factors such as predisposing conditions but also on social and

Table 2.3. Number of prevalent patients on RRT by centre at year end 2008–2012

Centre	Date					% change 2011–2012	% annual change 2008–2012
	31/12/2008	31/12/2009	31/12/2010	31/12/2011	31/12/2012		
England							
B Heart	598	624	633	664	670	0.9	2.9
B QEH	1,714	1,821	1,844	1,912	1,971	3.1	3.6
Basldn	217	214	214	233	264	13.3	5.0
Bradfd	414	422	455	467	508	8.8	5.2
Brightn	722	737	770	775	831	7.2	3.6
Bristol	1,247	1,232	1,261	1,315	1,337	1.7	1.8
Camb	927	940	1,004	1,074	1,113	3.6	4.7
Carlis	205	205	206	215	216	0.5	1.3
Carsh	1,249	1,302	1,377	1,380	1,475	6.9	4.2
Chelms	207	225	238	216	224	3.7	2.0
Colchr	118	116	120	119	117	−1.7	−0.2
Covnt	745	794	844	874	900	3.0	4.8
Derby	389	419	459	448	477	6.5	5.2
Donc	154	196	222	248	261	5.2	14.1
Dorset	515	553	585	586	610	4.1	4.3
Dudley	275	292	303	284	316	11.3	3.5
Exeter	708	731	785	796	846	6.3	4.6
Glouc	325	366	377	381	417	9.4	6.4
Hull	696	725	725	757	789	4.2	3.2
Ipswi	294	312	316	340	339	−0.3	3.6
Kent	714	744	797	864	922	6.7	6.6
L Barts	1,526	1,638	1,778	1,872	1,955	4.4	6.4
L Guys	1,447	1,613	1,625	1,681	1,745	3.8	4.8
L Kings	784	786	837	858	918	7.0	4.0
L Rfree	1,510	1,546	1,639	1,727	1,865	8.0	5.4
L St.G	624	663	684	716	724	1.1	3.8
L West	2,576	2,734	2,879	3,020	3,104	2.8	4.8
Leeds	1,342	1,348	1,383	1,425	1,416	−0.6	1.4
Leic	1,660	1,737	1,809	1,927	1,982	2.9	4.5
Liv Ain	130	147	159	189	195	3.2	10.7
Liv RI	1,200	1,223	1,238	1,250	1,241	−0.7	0.8
M RI	1,424	1,450	1,552	1,646	1,710	3.9	4.7
Middlbr	682	707	711	752	789	4.9	3.7
Newc	901	898	900	917	946	3.2	1.2
Norwch	567	591	615	611	612	0.2	1.9
Nottm	955	975	1,008	1,019	1,006	−1.3	1.3
Oxford	1,318	1,343	1,421	1,446	1,535	6.2	3.9
Plymth	443	456	461	465	459	−1.3	0.9
Ports	1,268	1,301	1,333	1,394	1,447	3.8	3.4
Prestn	876	940	970	1,011	1,081	6.9	5.4
Redng	578	618	636	688	671	−2.5	3.8
Salford	758	784	837	820	882	7.6	3.9
Sheff	1,216	1,216	1,254	1,260	1,307	3.7	1.8
Shrew	325	337	343	342	354	3.5	2.2
Stevng	580	582	606	639	665	4.1	3.5
Sthend	204	207	212	207	213	2.9	1.1
Stoke	603	643	658	696	695	−0.1	3.6
Sund	343	368	369	388	421	8.5	5.3
Truro	297	320	335	352	377	7.1	6.1
Wirral	216	223	223	234	234	0.0	2.0
Wolve	490	490	531	513	528	2.9	1.9
York	276	321	338	340	396	16.5	9.4

Table 2.3. Continued

Centre	Date					% change 2011–2012	% annual change 2008–2012
	31/12/2008	31/12/2009	31/12/2010	31/12/2011	31/12/2012		
N Ireland							
Antrim	220	215	217	220	225	2.3	0.6
Belfast	726	680	682	685	701	2.3	−0.9
Newry	163	170	177	190	188	−1.1	3.6
Ulster	97	114	115	137	148	8.0	11.1
West NI	236	258	256	266	258	−3.0	2.3
Scotland							
Abrdn	456	452	462	478	504	5.4	2.5
Airdrie	245	310	326	344	388	12.8	12.2
D & Gall	113	118	118	122	128	4.9	3.2
Dundee	370	395	385	400	403	0.8	2.2
Dunfn	220	241	263	278	278	0.0	6.0
Edinb	695	721	730	700	722	3.1	1.0
Glasgw	1,568	1,469	1,505	1,477	1,549	4.9	−0.3
Inverns	212	228	230	223	218	−2.2	0.7
Klmarnk	263	273	284	299	302	1.0	3.5
Wales							
Bangor	112	110	113	108	105	−2.8	−1.6
Cardff	1,374	1,426	1,517	1,534	1,548	0.9	3.0
Clwyd	146	144	142	136	172	26.5	4.2
Swanse	602	598	624	656	662	0.9	2.4
Wrexm	223	219	223	237	249	5.1	2.8
England	**39,552**	**41,175**	**42,879**	**44,353**	**46,076**	**3.9**	**3.9**
N Ireland	**1,442**	**1,437**	**1,447**	**1,498**	**1,520**	**1.5**	**1.3**
Scotland	**4,142**	**4,207**	**4,303**	**4,321**	**4,492**	**4.0**	**2.0**
Wales	**2,457**	**2,497**	**2,619**	**2,671**	**2,736**	**2.4**	**2.7**
UK	**47,593**	**49,316**	**51,248**	**52,843**	**54,824**	**3.7**	**3.6**

demographic factors such as age, gender, social deprivation and ethnicity. Hence, comparison of crude prevalence rates by geographical area can be misleading. This section, as in previous reports, uses age and gender standardisation to compare RRT prevalence rates. The ethnic minority profile is also provided to help understand the differences in standardised prevalence ratios (SPRs). The impact of social deprivation was reported in the 2003 UKRR Report [4].

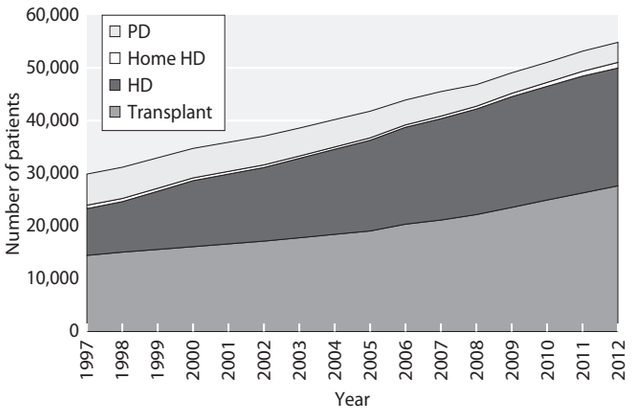

Fig. 2.2. Growth in prevalent patients by treatment modality at the end of each year 1997–2012

There were substantial variations in the crude PCT/HB prevalence rates pmp, from 430 pmp (Shetland, population 23,200) to 1,630 pmp (Brent, population 312,200). There were similar variations in the standardised prevalence ratios (ratio of observed:expected prevalence rate given the age/gender breakdown of the PCT/HB) from 0.48 (Shetland) to 2.23 (Brent) (table 2.5). Confidence intervals are not presented for the rates per million population for 2012 but figures D3 and D4 in appendix D (www.renalreg.com) can be used to determine if a PCT/HB falls within the range representing the 95% confidence limit of the national average prevalence rate. The annual standardised prevalence ratios were inherently more stable than the annual standardised incidence ratios (chapter 1).

Table 2.4. Change in RRT prevalence rates pmp 2007–2012 by modality*

	Prevalence					% growth in prevalence pmp				
Year	HD pmp	PD pmp	Dialysis pmp	Transplant pmp	RRT pmp	HD	PD	Dialysis	Tx	RRT
2007	323	76	399	346	746					
2008	342	69	411	363	774	5.8	−9.0	2.9	4.9	3.8
2009	354	64	417	377	794	3.5	−7.8	1.6	3.7	2.6
2010	359	62	421	397	818	1.5	−3.2	0.8	5.4	3.0
2011	365	60	426	416	841	1.7	−2.2	1.1	4.7	2.9
2012	367	60	427	434	861	0.7	−1.5	0.4	4.3	2.3
Average annual growth 2007–2012						2.6	−4.8	1.4	4.6	2.9

*Differences in the figures for dialysis and RRT prevalence and the sum of the separate modalities are due to rounding
pmp – per million population
Tx = transplant

Factors associated with variation in standardised prevalence ratios in Primary Care Trusts in England, Health and Social Care Areas in Northern Ireland, Local Health Boards in Wales and Health Boards in Scotland

In 2012, there were 57 PCT/HBs with a significantly low SPR, 73 with a 'normal' SPR and 47 with a significantly high SPR (table 2.5). The areas with high and low SPRs have been fairly consistent over the last few years. They tend to reflect the demographics of the regions in question such that urban, ethnically diverse populations in areas of high social deprivation have the highest prevalence rates of renal replacement therapy. Mean SPRs were significantly higher in the 75 PCT/HBs with an ethnic minority population greater than 10% than in those with lower ethnic minority populations ($p < 0.001$). The SPR was positively correlated with the percentage of the population that are non-White ($r = 0.69$ $p < 0.001$). In 2012 for each 10% increase in ethnic minority population, the standardised prevalence ratio increased by 0.16 (equates to ~16%). In figure 2.3, the relationship between the ethnic composition of a PCT/HB and its SPR is demonstrated.

Only five of the 102 PCT/HBs with ethnic minority populations of less than 10% had high SPRs: Abertawe Bro Morgannwg University, Aneurin Bevan, Belfast, Cwm Taf, and Greater Glasgow & Clyde. Forty-two (56%) of the 75 PCT/HBs with ethnic minority populations greater than 10% had high SPRs, whereas seven (9%) (Bedfordshire, Brighton and Hove City, Buckinghamshire, Hertfordshire, Leeds, Richmond & Twickenham and Trafford) had low SPRs. However, not all PCT/HBs with a high (>15%) ethnic minority population also had higher than expected RRT prevalence rates (e.g. Bromley, Oldham, Kensington). The age and gender standardised prevalence ratios in each region of England and in Wales, Northern Ireland and Scotland are presented in table 2.6. These calculations have not taken into account variation in ethnicity between areas. Wales and Northern Ireland previously had higher than expected prevalence rates but in more recent years were similar to their expected rates. Scotland had lower than expected prevalence rates of RRT. There was marked variation (20–fold) in prevalence rates in over 80 year olds between PCT/HBs (data not shown).

Case mix in prevalent RRT patients

Time on RRT (vintage)

Table 2.7 shows the median time, in years, since starting RRT of prevalent RRT patients on 31st December 2012. Median time on RRT for all prevalent patients remained fairly static at 5.9 years. Patients with functioning transplants had survived a median of 10.2 years on RRT whilst the median time on RRT of HD and PD patients was significantly less (3.4 and 1.7 years respectively, $p < 0.001$).

Age

The median age of prevalent UK patients on RRT at 31st December 2012 was static (58.3 years) compared with 2011 (58.2 years) (table 2.8) and significantly higher than in 2005 when it was 55 years. There were marked differences between modalities; the median age of HD patients (66.4 years) was greater than that of those on PD (63.4 years) and substantially higher than that of transplanted patients (52.3 years). Half of the UK prevalent RRT population was in the 40–64 years age group (table 2.9). The proportion of patients aged 75 years and older was 17.1% in Wales, 16.1% in Northern Ireland, 15.7% in England and 13.4% in Scotland

Table 2.5. Prevalence of RRT and standardised prevalence ratios in PCT/HB areas

PCT/HB – PCT in England, Health and Social Care Areas in Northern Ireland, Local Health Boards in Wales and Health Boards in Scotland
O/E – standardised prevalence ratio. Ratio of observed:expected rate of RRT given the age and gender breakdown of the area
LCL – lower 95% confidence limit
UCL – upper 95% confidence limit
pmp – per million population
Blank cells – no data returned to the UKRR for that year
Areas with significantly low prevalence ratios in 2012 are italicised in greyed areas, those with significantly high prevalence ratios in 2012 are bold in greyed areas
Population data from the Office for National Statistics, National Records of Scotland and the Northern Ireland Statistics and Research Agency – based on the 2011 Census
% non-White – percentage of the PCT/HB population that is non-White, from 2011 Census for E, W & NI (2001 for Scotland)
ONS specifies that the populations should be rounded to the nearest 100 when being presented

UK area	Name	Total population	2007 O/E	2008 O/E	2009 O/E	2010 O/E	2011 O/E	2012 O/E	2012 95% LCL	2012 95% UCL	2012 Crude rate pmp	% non-White
North East	*County Durham*	*513,000*	*0.90*	*0.87*	*0.86*	*0.85*	*0.87*	*0.87*	*0.79*	*0.96*	*801*	*1.8*
	Darlington	105,600	0.86	0.89	0.91	0.85	0.79	0.86	0.69	1.07	767	3.8
	Gateshead	*200,300*	*0.87*	*0.82*	*0.86*	*0.84*	*0.81*	*0.84*	*0.72*	*0.99*	*759*	*3.7*
	Hartlepool	92,100	0.88	0.94	0.92	0.86	0.85	0.91	0.72	1.14	804	2.3
	Middlesbrough	138,400	1.07	1.10	1.10	1.10	1.10	1.14	0.96	1.35	932	11.8
	Newcastle	279,100	1.00	1.01	0.97	0.91	0.90	0.89	0.77	1.02	692	14.5
	North Tyneside	201,200	0.98	0.93	0.95	0.97	0.91	0.92	0.79	1.07	835	3.4
	Northumberland	*316,300*	*0.85*	*0.82*	*0.77*	*0.74*	*0.75*	*0.74*	*0.65*	*0.84*	*724*	*1.6*
	Redcar and Cleveland	135,200	1.04	1.02	1.01	0.97	1.01	0.95	0.79	1.13	888	1.5
	South Tyneside	148,200	1.05	0.98	1.06	0.96	0.98	0.93	0.78	1.11	850	4.1
	Stockton-on-Tees Teaching	191,800	0.84	0.84	0.81	0.80	0.85	0.87	0.74	1.02	751	5.4
	Sunderland Teaching	275,300	0.96	0.99	0.97	0.97	0.93	0.93	0.82	1.06	839	4.1
North West	Ashton, Leigh and Wigan	318,100	0.86	0.80	0.80	0.81	0.86	0.91	0.81	1.03	811	2.7
	Blackburn with Darwen Teaching	**147,700**	**1.31**	**1.23**	**1.23**	**1.21**	**1.23**	**1.21**	**1.03**	**1.43**	**941**	**30.8**
	Blackpool	142,100	0.77	0.80	0.86	0.81	0.81	0.93	0.78	1.11	859	3.3
	Bolton Teaching	277,300	1.05	1.02	0.94	1.02	1.05	1.05	0.92	1.18	880	18.1
	Bury	185,400	0.88	0.85	0.92	0.89	0.90	0.92	0.78	1.08	793	10.8
	Central and Eastern Cheshire	*462,800*	*0.82*	*0.79*	*0.79*	*0.79*	*0.79*	*0.79*	*0.71*	*0.88*	*741*	*3.1*
	Central Lancashire	*467,400*	*0.80*	*0.83*	*0.86*	*0.85*	*0.85*	*0.88*	*0.79*	*0.97*	*774*	*7.8*
	Cumbria Teaching	*499,800*	*0.76*	*0.75*	*0.73*	*0.72*	*0.70*	*0.70*	*0.63*	*0.78*	*688*	*1.5*
	East Lancashire Teaching	382,500	1.09	1.04	0.99	0.97	0.97	0.92	0.82	1.03	810	11.6
	Halton and St Helens	301,100	0.93	0.86	0.88	0.90	0.94	0.94	0.83	1.06	837	2.0
	Heywood, Middleton and Rochdale	211,900	0.99	0.99	1.02	0.95	1.00	1.01	0.87	1.17	830	18.3
	Knowsley	145,900	1.14	1.08	1.05	0.96	0.96	0.97	0.81	1.16	836	2.8
	Liverpool	465,700	1.06	1.07	1.08	1.04	1.04	1.01	0.91	1.12	816	11.1
	Manchester Teaching	**502,900**	**1.05**	**1.12**	**1.15**	**1.18**	**1.16**	**1.21**	**1.09**	**1.33**	**799**	**33.4**
	North Lancashire Teaching	*321,600*	*0.78*	*0.75*	*0.76*	*0.74*	*0.75*	*0.76*	*0.67*	*0.86*	*731*	*3.1*
	Oldham	225,200	0.93	0.93	0.95	0.92	0.91	0.93	0.80	1.08	755	22.5
	Salford	234,500	0.79	0.84	0.83	0.84	0.84	0.87	0.75	1.01	695	9.9
	Sefton	274,000	0.87	0.83	0.83	0.86	0.92	0.89	0.78	1.01	850	2.6
	Stockport	*283,300*	*0.87*	*0.88*	*0.83*	*0.86*	*0.87*	*0.85*	*0.75*	*0.97*	*777*	*7.9*
	Tameside and Glossop	252,900	1.03	0.99	0.98	0.99	0.98	0.97	0.85	1.11	842	8.2
	Trafford	*227,100*	*0.76*	*0.72*	*0.75*	*0.86*	*0.82*	*0.85*	*0.73*	*0.99*	*735*	*14.5*
	Warrington	*202,700*	*0.91*	*0.88*	*0.96*	*0.87*	*0.85*	*0.84*	*0.71*	*0.98*	*735*	*4.1*
	Western Cheshire	237,400	0.93	0.92	0.95	0.97	0.99	0.96	0.84	1.10	906	2.8
	Wirral	*319,800*	*0.93*	*0.86*	*0.83*	*0.80*	*0.80*	*0.80*	*0.70*	*0.91*	*738*	*3.0*
Yorkshire and the Humber	Barnsley	231,900	1.05	1.06	1.08	1.12	1.10	1.06	0.93	1.21	957	2.1
	Bradford and Airedale Teaching	**523,100**	**1.13**	**1.12**	**1.10**	**1.17**	**1.16**	**1.22**	**1.12**	**1.34**	**941**	**32.6**
	Calderdale	204,200	1.08	1.06	1.07	1.09	1.02	0.96	0.82	1.11	838	10.3
	Doncaster	302,500	0.97	0.96	0.97	0.95	0.99	0.97	0.86	1.10	860	4.7
	East Riding of Yorkshire	*334,700*	*0.81*	*0.83*	*0.84*	*0.81*	*0.81*	*0.81*	*0.71*	*0.91*	*804*	*1.9*

Table 2.5. Continued

UK area	Name	Total population	2007 O/E	2008 O/E	2009 O/E	2010 O/E	2011 O/E	2012 O/E	2012 95% LCL	2012 95% UCL	Crude rate pmp	% non-White
Yorkshire and the Humber	Hull Teaching	256,100	1.08	1.00	1.05	1.03	0.99	0.96	0.84	1.11	777	5.9
	Kirklees	423,000	1.08	1.01	1.01	1.02	1.01	1.02	0.92	1.13	856	20.9
	Leeds	*750,700*	*0.98*	*0.93*	*0.91*	*0.91*	*0.90*	*0.87*	*0.80*	*0.95*	*701*	*14.9*
	North East Lincolnshire	161,200	0.99	1.00	0.98	0.97	1.03	1.01	0.86	1.18	900	2.6
	North Lincolnshire	163,600	0.88	0.85	0.75	0.71	0.80	0.85	0.72	1.01	783	4.1
	North Yorkshire and York	*799,000*	*0.80*	*0.79*	*0.81*	*0.81*	*0.81*	*0.84*	*0.78*	*0.91*	*794*	*3.4*
	Rotherham	257,700	1.11	1.13	1.10	1.13	1.06	1.05	0.92	1.19	939	6.4
	Sheffield	**551,800**	**1.11**	**1.10**	**1.10**	**1.13**	**1.10**	**1.11**	**1.02**	**1.21**	**901**	**16.3**
	Wakefield District	*326,400*	*0.84*	*0.81*	*0.81*	*0.81*	*0.84*	*0.86*	*0.76*	*0.97*	*772*	*4.6*
East Midlands	Bassetlaw	113,000	0.97	0.90	0.80	0.78	0.78	0.84	0.68	1.03	788	2.6
	Derby City	**248,900**	**0.99**	**1.05**	**1.14**	**1.11**	**1.10**	**1.15**	**1.01**	**1.31**	**928**	**19.7**
	Derbyshire County	*737,500*	*0.87*	*0.87*	*0.85*	*0.84*	*0.85*	*0.82*	*0.76*	*0.89*	*773*	*2.5*
	Leicester City	**329,600**	**1.66**	**1.68**	**1.69**	**1.73**	**1.75**	**1.76**	**1.60**	**1.93**	**1265**	**49.5**
	Leicestershire County and Rutland	*688,800*	*0.90*	*0.89*	*0.88*	*0.89*	*0.87*	*0.86*	*0.79*	*0.94*	*790*	*8.3*
	Lincolnshire Teaching	*717,200*	*0.78*	*0.77*	*0.76*	*0.77*	*0.80*	*0.79*	*0.73*	*0.86*	*761*	*2.4*
	Northamptonshire Teaching	*694,000*	*0.91*	*0.92*	*0.91*	*0.90*	*0.91*	*0.91*	*0.83*	*0.99*	*784*	*8.5*
	Nottingham City	**303,900**	**1.15**	**1.16**	**1.20**	**1.27**	**1.21**	**1.19**	**1.05**	**1.34**	**849**	**28.5**
	Nottinghamshire County Teaching	*673,800*	*1.00*	*0.99*	*0.96*	*0.95*	*0.95*	*0.91*	*0.84*	*0.99*	*842*	*4.8*
West Midlands	**Birmingham East and North**	**421,400**	**1.52**	**1.57**	**1.54**	**1.49**	**1.52**	**1.53**	**1.40**	**1.67**	**1179**	**36.1**
	Coventry Teaching	**316,900**	**1.19**	**1.21**	**1.25**	**1.30**	**1.33**	**1.38**	**1.24**	**1.54**	**1079**	**26.2**
	Dudley	313,300	0.91	0.88	0.92	0.90	0.84	0.91	0.81	1.03	827	10.0
	Heart of Birmingham Teaching	**299,200**	**2.25**	**2.28**	**2.30**	**2.28**	**2.18**	**2.18**	**1.98**	**2.40**	**1380**	**70.5**
	Herefordshire	*183,600*	*0.88*	*0.80*	*0.84*	*0.78*	*0.79*	*0.79*	*0.67*	*0.93*	*773*	*1.8*
	North Staffordshire	212,900	0.88	0.88	0.92	0.88	0.93	0.88	0.76	1.02	827	3.5
	Sandwell	**309,000**	**1.44**	**1.52**	**1.58**	**1.55**	**1.55**	**1.53**	**1.39**	**1.69**	**1233**	**30.1**
	Shropshire County	*307,100*	*0.90*	*0.93*	*0.90*	*0.87*	*0.85*	*0.84*	*0.74*	*0.95*	*808*	*2.0*
	Solihull	206,900	0.97	0.92	0.98	0.95	0.92	0.87	0.75	1.02	802	10.9
	South Birmingham	**353,700**	**1.31**	**1.32**	**1.34**	**1.30**	**1.30**	**1.28**	**1.16**	**1.42**	**1001**	**25.3**
	South Staffordshire	*628,500*	*0.91*	*0.91*	*0.87*	*0.87*	*0.90*	*0.84*	*0.77*	*0.92*	*781*	*4.7*
	Stoke on Trent	256,900	1.11	1.07	1.11	1.12	1.12	1.07	0.94	1.22	911	11.0
	Telford and Wrekin	166,800	1.01	1.02	1.07	1.06	1.05	1.01	0.86	1.19	845	7.3
	Walsall Teaching	**269,500**	**1.22**	**1.28**	**1.24**	**1.32**	**1.30**	**1.26**	**1.12**	**1.42**	**1076**	**21.1**
	Warwickshire	546,600	1.02	0.98	1.00	1.01	1.01	0.98	0.90	1.07	900	7.3
	Wolverhampton City	249,900	1.22	1.23	1.25	1.19	1.10	1.11	0.98	1.26	929	32.0
	Worcestershire	*566,600*	*0.84*	*0.84*	*0.85*	*0.85*	*0.86*	*0.87*	*0.79*	*0.95*	*819*	*4.3*
East of England	*Bedfordshire*	*413,500*	*0.85*	*0.87*	*0.86*	*0.88*	*0.86*	*0.88*	*0.79*	*0.99*	*771*	*11.2*
	Cambridgeshire	*622,300*	*0.87*	*0.83*	*0.85*	*0.88*	*0.91*	*0.87*	*0.80*	*0.96*	*758*	*7.4*
	Hertfordshire	*1,119,800*	*0.82*	*0.91*	*0.91*	*0.93*	*0.93*	*0.92*	*0.86*	*0.98*	*780*	*12.4*
	Great Yarmouth and Waveney	212,800	0.54	0.82	0.91	0.97	0.97	0.93	0.80	1.07	902	2.7
	Luton	**203,600**	**1.21**	**1.27**	**1.26**	**1.28**	**1.35**	**1.36**	**1.18**	**1.56**	**992**	**45.3**
	Mid Essex	*375,200*	*0.86*	*0.85*	*0.86*	*0.83*	*0.83*	*0.79*	*0.70*	*0.89*	*714*	*4.4*
	Norfolk	*762,000*	*0.94*	*0.92*	*0.89*	*0.85*	*0.82*	*0.79*	*0.73*	*0.85*	*761*	*3.5*
	North East Essex	*311,700*		*0.88*	*0.86*	*0.87*	*0.89*	*0.87*	*0.77*	*0.99*	*815*	*5.5*
	Peterborough	184,500	1.03	0.96	1.02	1.00	1.03	1.00	0.85	1.18	792	17.5
	South East Essex	*345,600*	*0.91*	*0.90*	*0.89*	*0.86*	*0.84*	*0.84*	*0.74*	*0.94*	*776*	*5.7*
	South West Essex	407,100	0.94	0.97	0.95	0.96	0.98	0.97	0.87	1.08	818	9.8
	Suffolk	*614,800*	*0.84*	*0.82*	*0.83*	*0.83*	*0.82*	*0.80*	*0.73*	*0.88*	*742*	*5.3*
	West Essex	*289,600*	*0.75*	*0.69*	*0.71*	*0.75*	*0.74*	*0.82*	*0.72*	*0.94*	*732*	*8.1*
London	**Barking and Dagenham**	**187,000**	**1.18**	**1.16**	**1.24**	**1.33**	**1.44**	**1.51**	**1.31**	**1.74**	**1027**	**41.7**
	Barnet	**357,500**	**1.40**	**1.45**	**1.41**	**1.48**	**1.47**	**1.51**	**1.38**	**1.67**	**1172**	**35.9**
	Bexley	**232,800**	**1.15**	**1.15**	**1.19**	**1.23**	**1.23**	**1.24**	**1.09**	**1.41**	**1044**	**18.1**
	Brent Teaching	**312,200**	**1.79**	**2.01**	**2.10**	**2.20**	**2.20**	**2.23**	**2.04**	**2.43**	**1630**	**63.7**

Table 2.5. Continued

UK area	Name	Total population	2007 O/E	2008 O/E	2009 O/E	2010 O/E	2011 O/E	2012 O/E	2012 95% LCL	2012 95% UCL	2012 Crude rate pmp	% non-White
London	Bromley	310,600	1.00	1.04	1.00	1.03	1.02	0.99	0.88	1.12	866	15.7
	Camden	**220,100**	**1.14**	**1.21**	**1.24**	**1.27**	**1.29**	**1.30**	**1.13**	**1.48**	**954**	**33.7**
	City and Hackney Teaching	**254,600**	**1.35**	**1.28**	**1.35**	**1.44**	**1.51**	**1.56**	**1.39**	**1.77**	**1017**	**44.6**
	Croydon	**364,800**	**1.31**	**1.31**	**1.38**	**1.37**	**1.42**	**1.45**	**1.31**	**1.59**	**1118**	**44.9**
	Ealing	**339,300**	**1.56**	**1.84**	**1.86**	**1.88**	**1.86**	**1.92**	**1.75**	**2.10**	**1426**	**51.0**
	Enfield	**313,900**	**1.40**	**1.41**	**1.39**	**1.40**	**1.51**	**1.52**	**1.37**	**1.68**	**1147**	**39.0**
	Greenwich Teaching	**255,500**	**1.06**	**1.15**	**1.18**	**1.30**	**1.34**	**1.34**	**1.19**	**1.52**	**959**	**37.5**
	Hammersmith and Fulham	**182,400**	**1.19**	**1.24**	**1.31**	**1.31**	**1.34**	**1.38**	**1.19**	**1.60**	**970**	**31.9**
	Haringey Teaching	**255,500**	**1.36**	**1.41**	**1.41**	**1.42**	**1.56**	**1.69**	**1.51**	**1.89**	**1186**	**39.5**
	Harrow	**240,500**	**1.45**	**1.67**	**1.76**	**1.82**	**1.87**	**1.86**	**1.67**	**2.06**	**1497**	**57.8**
	Havering	237,900	0.82	0.82	0.84	0.82	0.87	0.88	0.76	1.02	778	12.3
	Hillingdon	**275,500**	**0.92**	**1.31**	**1.32**	**1.33**	**1.41**	**1.44**	**1.29**	**1.61**	**1111**	**39.4**
	Hounslow	**254,900**	**1.20**	**1.41**	**1.44**	**1.51**	**1.58**	**1.62**	**1.44**	**1.81**	**1192**	**48.6**
	Islington	**206,300**	**1.35**	**1.27**	**1.29**	**1.37**	**1.42**	**1.58**	**1.38**	**1.79**	**1100**	**31.8**
	Kensington and Chelsea	158,300	0.88	1.09	1.08	1.12	1.11	1.08	0.91	1.27	872	29.4
	Kingston	160,400	1.08	1.19	1.16	1.14	1.16	1.17	1.00	1.38	916	25.5
	Lambeth	**304,500**	**1.56**	**1.55**	**1.61**	**1.58**	**1.67**	**1.73**	**1.56**	**1.92**	**1176**	**42.9**
	Lewisham	**276,900**	**1.65**	**1.62**	**1.71**	**1.65**	**1.71**	**1.75**	**1.58**	**1.95**	**1246**	**46.5**
	Newham	**310,500**	**1.48**	**1.52**	**1.57**	**1.77**	**1.87**	**1.90**	**1.72**	**2.11**	**1166**	**71.0**
	Redbridge	**281,400**	**1.22**	**1.34**	**1.39**	**1.47**	**1.43**	**1.50**	**1.34**	**1.67**	**1112**	**57.5**
	Richmond and Twickenham	*187,500*	*0.64*	*0.70*	*0.76*	*0.77*	*0.77*	*0.77*	*0.65*	*0.93*	*640*	*14.0*
	Southwark	**288,700**	**1.65**	**1.68**	**1.71**	**1.76**	**1.85**	**1.89**	**1.71**	**2.09**	**1288**	**45.8**
	Sutton and Merton	**391,700**	**1.17**	**1.20**	**1.24**	**1.26**	**1.27**	**1.33**	**1.21**	**1.46**	**1054**	**28.4**
	Tower Hamlets	**256,000**	**1.22**	**1.26**	**1.39**	**1.44**	**1.47**	**1.54**	**1.36**	**1.76**	**914**	**54.8**
	Waltham Forest	**259,700**	**1.44**	**1.42**	**1.40**	**1.46**	**1.56**	**1.52**	**1.35**	**1.71**	**1078**	**47.8**
	Wandsworth	**307,700**	**1.33**	**1.33**	**1.40**	**1.38**	**1.34**	**1.29**	**1.15**	**1.45**	**894**	**28.6**
	Westminster	**219,600**	**0.98**	**1.12**	**1.20**	**1.22**	**1.30**	**1.31**	**1.15**	**1.50**	**1016**	**38.3**
South East Coast	*Brighton and Hove City*	*273,000*	*0.83*	*0.84*	*0.83*	*0.81*	*0.81*	*0.83*	*0.72*	*0.96*	*656*	*10.9*
	East Sussex Downs and Weald	*343,900*	*0.80*	*0.75*	*0.71*	*0.71*	*0.69*	*0.76*	*0.67*	*0.85*	*739*	*3.8*
	Eastern and Coastal Kent	759,600	0.87	0.92	0.93	0.96	0.96	0.97	0.90	1.05	878	5.0
	Hastings and Rother	*183,400*	*0.76*	*0.79*	*0.74*	*0.78*	*0.76*	*0.74*	*0.62*	*0.88*	*725*	*4.5*
	Medway	264,900	0.86	0.90	0.90	0.90	0.91	0.92	0.80	1.05	751	10.4
	Surrey	*1,124,800*	*0.85*	*0.87*	*0.88*	*0.88*	*0.87*	*0.89*	*0.84*	*0.95*	*794*	*9.5*
	West Kent	*706,800*	*0.85*	*0.88*	*0.89*	*0.86*	*0.85*	*0.87*	*0.80*	*0.95*	*768*	*7.7*
	West Sussex	*808,900*	*0.82*	*0.83*	*0.83*	*0.84*	*0.82*	*0.80*	*0.74*	*0.87*	*753*	6.2
South Central	**Berkshire East**	**410,100**	**1.16**	**1.16**	**1.19**	**1.22**	**1.25**	**1.25**	**1.13**	**1.37**	**983**	**26.6**
	Berkshire West	464,400	1.11	1.10	1.11	1.04	1.05	1.00	0.91	1.11	835	14.0
	Buckinghamshire	*521,000*	*0.95*	*0.94*	*0.92*	*0.91*	*0.87*	*0.86*	*0.78*	*0.95*	*764*	*13.3*
	Hampshire	*1,322,100*	*0.77*	*0.79*	*0.81*	*0.80*	*0.79*	*0.78*	*0.73*	*0.83*	*719*	*5.0*
	Isle of Wight National Health Service	*138,400*	*0.59*	*0.59*	*0.55*	*0.56*	*0.60*	*0.64*	*0.52*	*0.79*	*650*	*2.7*
	Milton Keynes	255,400	0.93	0.95	0.93	0.95	0.96	0.97	0.84	1.11	752	19.6
	Oxfordshire	629,600	0.96	0.92	0.89	0.90	0.92	0.93	0.85	1.02	789	9.4
	Portsmouth City Teaching	205,400	0.97	0.97	0.93	0.91	0.97	0.99	0.84	1.15	755	11.6
	Southampton City	235,900	0.91	0.95	0.94	0.99	1.02	1.04	0.90	1.20	784	14.1
South West	*Bath and North East Somerset*	*175,500*	*0.92*	*0.84*	*0.87*	*0.85*	*0.79*	*0.79*	*0.66*	*0.94*	*695*	*5.4*
	Bournemouth and Poole Teaching	*331,500*	*0.86*	*0.84*	*0.81*	*0.79*	*0.79*	*0.77*	*0.68*	*0.88*	*688*	*6.3*
	Bristol	**428,100**	**1.25**	**1.30**	**1.26**	**1.22**	**1.23**	**1.27**	**1.16**	**1.40**	**972**	**16.0**
	Cornwall and Isles of Scilly	536,000	1.03	1.00	1.00	0.97	0.93	0.93	0.85	1.01	910	1.8
	Devon	*747,700*	*0.85*	*0.87*	*0.87*	*0.86*	*0.85*	*0.87*	*0.81*	*0.94*	*860*	*2.5*
	Dorset	*413,800*	*0.83*	*0.86*	*0.86*	*0.84*	*0.79*	*0.80*	*0.72*	*0.89*	*826*	*2.1*
	Gloucestershire	*598,300*	*0.88*	*0.82*	*0.85*	*0.85*	*0.86*	*0.88*	*0.80*	*0.96*	*807*	*4.6*
	North Somerset	203,100	0.96	0.97	0.90	0.88	0.89	0.91	0.79	1.06	876	2.7

Table 2.5. Continued

UK area	Name	Total population	2007 O/E	2008 O/E	2009 O/E	2010 O/E	2011 O/E	2012 O/E	2012 95% LCL	2012 95% UCL	2012 Crude rate pmp	% non-White
South West	Plymouth Teaching	256,600	1.14	1.12	1.11	1.15	1.15	1.12	0.99	1.27	951	3.9
	Somerset	*531,600*	*0.84*	*0.81*	*0.82*	*0.84*	*0.87*	*0.84*	*0.76*	*0.92*	*805*	*2.0*
	South Gloucestershire	263,400	1.01	1.00	0.94	1.00	0.97	0.95	0.83	1.08	839	5.0
	Swindon	214,900	0.86	0.85	0.87	0.90	0.94	0.96	0.82	1.11	796	10.0
	Torbay	131,200	0.84	0.94	0.88	0.93	0.96	0.98	0.82	1.16	976	2.5
	Wiltshire	*474,300*	*0.72*	*0.75*	*0.73*	*0.73*	*0.74*	*0.72*	*0.64*	*0.80*	*651*	*3.4*
Wales	*Betsi Cadwaladr University*	*688,700*	*0.96*	*0.94*	*0.91*	*0.89*	*0.84*	*0.86*	*0.79*	*0.93*	*807*	*2.5*
	Powys Teaching	133,200	0.89	0.89	0.94	0.88	0.86	0.87	0.73	1.05	886	1.6
	Hywel Dda	*381,900*	*0.96*	*1.00*	*0.96*	*0.91*	*0.94*	*0.88*	*0.79*	*0.98*	*843*	*2.2*
	Abertawe Bro Morgannwg University	**517,700**	**1.25**	**1.17**	**1.20**	**1.24**	**1.23**	**1.20**	**1.11**	**1.31**	**1084**	**3.9**
	Cwm Taf	**293,500**	**1.51**	**1.43**	**1.39**	**1.31**	**1.35**	**1.27**	**1.14**	**1.41**	**1118**	**2.6**
	Aneurin Bevan	**577,000**	**1.16**	**1.09**	**1.08**	**1.11**	**1.09**	**1.09**	**1.00**	**1.18**	**974**	**3.9**
	Cardiff and Vale University	472,300	1.16	1.06	1.07	1.06	1.05	1.02	0.93	1.13	822	12.2
Scotland	Ayrshire & Arran	373,800	1.13	1.14	1.08	1.07	1.01	0.99	0.89	1.10	939	0.7
	Borders	113,900	0.97	1.01	1.03	1.08	0.97	0.91	0.75	1.11	913	0.6
	Dumfries and Galloway	151,400	0.95	0.96	0.93	0.90	0.87	0.87	0.74	1.03	878	0.7
	Fife	365,300	0.97	0.96	0.95	0.95	0.99	0.97	0.87	1.08	881	1.3
	Forth Valley	*298,100*	*0.96*	*0.93*	*0.92*	*0.93*	*0.89*	*0.87*	*0.76*	*0.99*	*778*	*1.1*
	Grampian	569,600	1.01	0.98	0.95	0.95	0.94	0.96	0.88	1.05	853	1.6
	Greater Glasgow & Clyde	**1,214,600**	**1.17**	**1.13**	**1.09**	**1.06**	**1.06**	**1.08**	**1.02**	**1.14**	**925**	**3.4**
	Highland	*321,700*	*1.11*	*1.05*	*1.03*	*0.99*	*0.90*	*0.86*	*0.76*	*0.97*	*833*	*0.8*
	Lanarkshire	572,400	0.98	0.96	0.95	0.96	0.93	0.98	0.89	1.07	865	1.2
	Lothian	*836,600*	*0.96*	*0.93*	*0.90*	*0.86*	*0.82*	*0.82*	*0.76*	*0.89*	*694*	*2.8*
	Orkney	21,400	0.89	1.07	1.02	0.93	0.79	0.76	0.47	1.24	747	0.4
	Shetland	*23,200*	*0.71*	*0.50*	*0.54*	*0.57*	*0.49*	*0.48*	*0.26*	*0.89*	*430*	*1.1*
	Tayside	410,300	1.13	1.05	1.07	1.03	1.02	0.97	0.88	1.08	897	1.9
	Western Isles	*27,700*	*0.81*	*0.72*	*0.69*	*0.82*	*0.67*	*0.58*	*0.35*	*0.94*	*578*	*0.6*
Northern Ireland	**Belfast**	**348,300**	**1.34**	**1.28**	**1.18**	**1.18**	**1.15**	**1.16**	**1.04**	**1.30**	**933**	**3.2**
	Northern	463,500	1.14	1.10	1.05	1.01	1.05	1.05	0.96	1.16	878	1.2
	Southern	359,400	1.00	1.00	0.98	1.01	1.05	0.98	0.87	1.10	765	1.2
	South Eastern	347,700	1.00	0.99	0.96	0.89	0.92	0.89	0.79	1.01	759	1.3
	Western	295,300	1.15	1.12	1.15	1.14	1.08	1.00	0.88	1.13	792	1.0

(table 2.9). Furthermore, there existed a wide range between centres in the proportion of patients aged over 75 (9.2% in Liverpool RI to 36.8% in Colchester).

Colchester had the highest median age (70.4 years), whilst Belfast the lowest (53.8 years) (table 2.8). This could reflect either variation in the demography of the catchment populations or follow-up of younger transplant patients (as above in the case of Belfast). The median age of the non-White dialysis population was lower than the overall dialysis population (60.9 vs. 66.1 years, data not shown). The differing age distributions of the transplant and dialysis populations are illustrated in figure 2.4, demonstrating that the age peak for prevalent dialysis patients is 24 years later than for prevalent transplant patients.

In the UK on 31st December 2012, 63.5% of patients aged less than 65 years on RRT had a functioning transplant (table 2.15), compared with only 26.9% aged 65 years and over. There was a similar pattern in all four UK countries.

Gender

Standardising the age of the UK RRT prevalent patients, by using the age and gender distribution of the UK population by PCT/HB (from mid-2011 population estimates), allowed estimation of crude prevalence rates by age and gender (figure 2.5). This shows a progressive increase in prevalence rate with age, peaking at 2,138 pmp (a slight increase from 2,099 pmp in 2011) in the age group 75–79 years before showing a reducing prevalence rate in

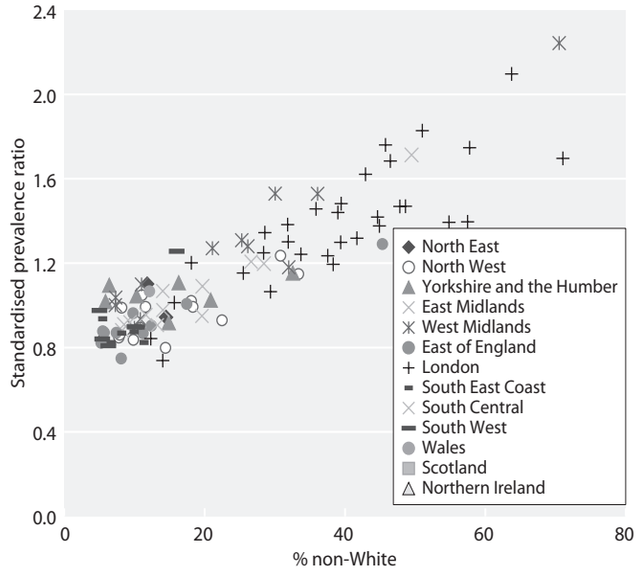

Fig. 2.3. Standardised prevalence ratios for all PCT/HB areas by percentage non-White on 31/12/2012 (excluding areas with <5% ethnic minorities)

age groups over 80 years. Crude prevalence rates in males exceeded those of females for all age groups, peaking in age group 80–84 years at 2,973 pmp and for females in age group 75–79 years at 1,528 pmp. Survival on RRT is described in chapter 8.

Ethnicity

Fifty-nine of the 71 centres (83.1%) provided ethnicity data that were at least 90% complete (table 2.10), an improvement compared with 51 of 71 (71.8%) in 2011 and 36 centres in 2006. Ethnicity completeness for prevalent RRT patients improved in the UK from 88.6% in 2011 to 92.0% in 2012, with 97.9% ethnicity completeness in England, 99.9% completeness in Wales and 100% in Northern Ireland. Completeness of ethnicity data was highest in prevalent transplant patients. This may relate to the fact that the intensive work-up for transplantation may increase the recording of data. Completeness of ethnicity data from Scotland was low at 33.6%.

In 2012, 20.7% of the prevalent UK RRT population (with ethnicity assigned) were from ethnic minorities (22.7% in England). The proportion of the prevalent UK RRT population (with ethnicity assigned) from ethnic minorities in Wales, Scotland and Northern Ire-

Table 2.7. Median time on RRT of prevalent patients on 31/12/2012

Modality	*N*	Median time treated (years)
Haemodialysis	23,034	3.4
Peritoneal dialysis	3,752	1.7
Transplant	26,365	10.2
All RRT	**53,151**	**5.9**

All patients without a treatment modality were excluded
Median time on RRT was calculated from the most recent start date. For patients who recovered for >90 days and then subsequently restarted RRT the median time from the start of RRT was calculated from the most recent start date
Patients with an initial treatment modality of transferred in or transferred out were excluded from the calculation of median time on RRT since their treatment start date was not accurately known

Table 2.6. Standardised prevalence rate ratio of RRT for each Strategic Health Authority in England and for Wales, Scotland and Northern Ireland in 2012

UK Area	Total population	O/E	95% LCL	95% UCL	Crude rate pmp
North East	2,596,400	0.88	0.85	0.92	792.6
North West	7,089,100	0.91	0.88	0.93	790.2
Yorkshire and the Humber	5,285,700	0.96	0.93	0.99	832.2
East Midlands	4,506,800	0.94	0.91	0.97	835.6
West Midlands	**5,608,700**	**1.10**	**1.07**	**1.13**	**948.9**
East of England	5,862,400	0.88	0.85	0.90	780.6
London	**8,204,400**	**1.49**	**1.46**	**1.52**	**1,101.8**
South East Coast	4,465,200	0.87	0.84	0.89	778.7
South Central	4,182,300	0.91	0.88	0.94	779.0
South West	5,306,100	0.89	0.87	0.92	829.4
Wales	3,064,300	1.02	0.99	1.06	925.2
Scotland	5,299,900	0.95	0.92	0.98	850.2
Northern Ireland	1,814,300	1.02	0.97	1.07	829.5

O/E – observed/expected prevalence rate ratio given the age/gender breakdown of each region
Bold – higher than expected prevalence rate ratio

Table 2.8. Median age of prevalent RRT patients by treatment modality in renal centres on 31/12/2012

	Median age			
Centre	HD	PD	Transplant	RRT
England				
B Heart	66.6	53.9	50.8	62.5
B QEH	64.7	58.0	51.3	57.1
Basldn	67.8	65.3	50.8	64.2
Bradfd	61.8	56.6	50.6	54.3
Brightn	69.2	66.8	53.8	62.3
Bristol	68.9	56.0	53.4	58.2
Camb	72.1	71.3	52.6	58.3
Carlis	67.2	62.7	52.7	58.4
Carsh	68.9	66.4	52.3	62.0
Chelms	68.0	65.8	59.3	65.3
Colchr	70.4			70.4
Covnt	68.0	66.6	50.9	58.8
Derby	66.9	64.3	54.2	61.7
Donc	66.3	62.6	56.1	64.0
Dorset	71.5	69.8	57.8	64.7
Dudley	69.0	61.9	56.9	63.0
Exeter	72.2	68.3	53.2	62.9
Glouc	71.5	68.5	55.5	64.5
Hull	66.9	62.1	51.5	58.8
Ipswi	66.3	66.3	54.0	59.3
Kent	69.6	64.5	53.4	60.4
L Barts	60.1	60.3	50.5	55.1
L Guys	62.6	58.8	49.8	54.0
L Kings	63.2	60.8	52.8	58.1
L Rfree	67.6	63.0	51.1	57.2
L St.G	66.7	62.2	53.9	59.9
L West	65.8	62.1	53.5	58.8
Leeds	66.8	55.1	52.0	56.8
Leic	66.2	66.0	52.4	59.5
Liv Ain	67.1	59.9		65.9
Liv RI	61.8	58.1	51.8	54.9
M RI	62.8	61.8	50.3	54.0
Middlbr	67.3	55.5	52.6	57.6
Newc	62.5	64.1	54.3	57.0
Norwch	71.7	65.1	53.9	63.4
Nottm	68.7	62.7	51.1	57.4
Oxford	66.3	64.6	51.1	55.7
Plymth	68.4	67.4	54.5	59.0
Ports	66.2	63.8	53.1	58.3
Prestn	63.9	65.9	52.7	58.5
Redng	69.4	62.4	56.5	60.3
Salford	64.2	59.7	51.2	57.7
Sheff	65.5	64.2	52.0	58.4
Shrew	67.6	61.9	53.9	62.2
Stevng	67.1	66.2	51.8	60.6
Sthend	72.1	65.1	54.9	65.6
Stoke	66.3	68.6	50.8	59.3
Sund	65.5	60.4	53.3	58.1
Truro	71.9	67.0	57.5	63.9
Wirral	65.0	60.2		64.9
Wolve	66.7	59.0	51.7	59.8
York	66.4	56.8	52.0	57.4
N Ireland				
Antrim	70.9	60.4	51.1	64.7
Belfast	64.5	60.8	50.8	53.8
Newry	65.3	69.7	52.5	60.4
Ulster	71.7	64.9	56.7	69.1
West NI	66.8	46.7	50.7	59.5
Scotland				
Abrdn	66.2	57.0	52.5	57.2
Airdrie	62.6	51.5	51.6	56.6
D & Gall	64.7	69.8	51.5	60.7
Dundee	69.7	65.5	52.7	61.3
Dunfn	66.5	62.0	51.3	60.0
Edinb	60.1	69.6	51.5	54.8
Glasgw	65.0	63.9	52.9	56.9
Inverns	68.9	65.2	47.9	54.8
Klmarnk	66.2	59.1	50.4	57.9
Wales				
Bangor	66.0	67.1		66.1
Cardff	68.3	68.1	52.1	57.1
Clwyd	65.5	71.0	57.0	62.2
Swanse	71.1	62.9	56.5	63.7
Wrexm	71.5	62.9	52.6	57.9
England	**66.5**	**63.3**	**52.3**	**58.4**
N Ireland	**67.8**	**64.1**	**51.1**	**58.2**
Scotland	**65.0**	**63.3**	**51.8**	**57.2**
Wales	**68.6**	**66.1**	**52.9**	**59.7**
UK	**66.4**	**63.4**	**52.3**	**58.3**

Blank cells indicate no patients on that treatment modality attending that centre when data were collected

land were very small, although it should be noted that there was a high level of missing ethnicity data in Scotland. The ONS estimates that approximately 14% of the UK general population are designated as belonging to an ethnic minority [1]. The relative proportion of patients reported to the UKRR as receiving RRT and belonging to an ethnic minority has increased from 14.9% in 2007 which may be due to improvements in coding and reporting of ethnicity data as well as an increasing incidence of ERF and increased referral rates in these populations.

Amongst the centres with more than 50% returns there was wide variation in the proportion of patients from ethnic minorities, ranging from 0.5% in two centres (Truro and Newry) to over 50% in 3 centres: London Barts (60.2%), London West (55.5%) and London Royal

Table 2.9. Percentage of prevalent RRT patients in each age group by centre on 31/12/2012

		Percentage of patients			
Centre	*N*	18–39 years	40–64 years	65–74 years	75+ years
England					
B Heart	670	14.0	42.8	22.8	20.3
B QEH	1,971	14.9	52.0	17.7	15.4
Basldn	264	12.5	39.4	22.0	26.1
Bradfd	508	20.7	48.8	19.1	11.4
Brightn	831	11.4	44.8	22.4	21.4
Bristol	1,337	16.1	47.9	20.0	15.9
Camb	1,113	14.0	50.7	20.0	15.3
Carlis	216	13.9	53.2	19.9	13.0
Carsh	1,475	10.6	45.9	22.6	20.8
Chelms	224	7.6	41.1	25.4	25.9
Colchr	117	5.1	27.4	30.8	36.8
Covnt	900	12.9	48.7	19.8	18.7
Derby	477	11.7	45.5	24.3	18.4
Donc	261	11.5	42.9	21.5	24.1
Dorset	610	9.8	41.1	28.7	20.3
Dudley	316	7.3	48.7	20.9	23.1
Exeter	846	10.0	44.4	23.6	21.9
Glouc	417	10.1	42.2	23.0	24.7
Hull	789	13.6	50.6	20.2	15.7
Ipswi	339	10.3	54.9	21.8	13.0
Kent	922	12.9	46.3	23.8	17.0
L Barts	1,955	17.3	55.1	16.6	11.0
L Guys	1,745	19.7	53.6	15.6	11.0
L Kings	918	12.3	51.7	20.4	15.6
L Rfree	1,865	17.8	48.3	18.4	15.5
L St.G	724	13.7	49.9	19.6	16.9
L West	3,104	12.0	52.8	21.3	13.8
Leeds	1,416	17.6	50.0	19.8	12.6
Leic	1,982	13.6	49.1	22.4	14.9
Liv Ain	195	8.7	38.5	24.1	28.7
Liv RI	1,241	16.0	57.7	17.2	9.2
M RI	1,710	18.4	55.6	16.4	9.6
Middlbr	789	13.7	50.4	19.0	16.9
Newc	946	14.4	53.7	21.5	10.5
Norwch	612	11.3	41.8	22.5	24.3
Nottm	1,006	16.3	48.8	19.1	15.8
Oxford	1,535	16.3	53.0	17.6	13.1
Plymth	459	13.5	49.5	24.4	12.6
Ports	1,447	14.0	50.9	20.6	14.5
Prestn	1,081	12.4	53.4	20.5	13.7
Redng	671	10.1	49.2	22.5	18.2
Salford	882	13.8	52.3	20.6	13.3
Sheff	1,307	13.8	51.6	19.2	15.3
Shrew	354	12.1	44.4	21.2	22.3
Stevng	665	12.2	46.6	20.5	20.8
Sthend	213	13.6	34.7	24.4	27.2
Stoke	695	14.8	46.5	20.0	18.7
Sund	421	12.8	52.7	21.6	12.8
Truro	377	12.2	40.3	24.4	23.1
Wirral	234	7.7	43.2	21.8	27.4
Wolve	528	10.8	49.8	20.8	18.6
York	396	19.2	46.2	21.7	12.9

Table 2.9. Continued

Centre	*N*	Percentage of patients			
		18–39 years	40–64 years	65–74 years	75+ years
N Ireland					
Antrim	225	10.2	40.4	25.3	24.0
Belfast	701	17.4	54.6	17.1	10.8
Newry	188	14.9	47.9	22.9	14.4
Ulster	148	9.5	33.1	26.4	31.1
West NI	258	17.1	45.3	21.7	15.9
Scotland					
Abrdn	504	19.0	50.2	17.5	13.3
Airdrie	388	15.5	52.1	18.0	14.4
D & Gall	128	12.5	47.7	22.7	17.2
Dundee	403	12.2	46.2	22.1	19.6
Dunfn	278	13.3	46.8	24.1	15.8
Edinb	722	15.5	56.6	18.1	9.7
Glasgw	1,549	13.6	55.5	18.7	12.2
Inverns	218	15.1	56.4	13.8	14.7
Klmarnk	302	10.6	52.6	21.9	14.9
Wales					
Bangor	105	8.6	37.1	30.5	23.8
Cardff	1,548	15.1	51.6	19.6	13.7
Clwyd	172	12.2	45.3	26.7	15.7
Swanse	662	10.7	42.6	24.0	22.7
Wrexm	249	16.5	44.6	17.7	21.3
England	**46,076**	**14.2**	**49.8**	**20.3**	**15.7**
N Ireland	**1,520**	**15.2**	**48.0**	**20.7**	**16.1**
Scotland	**4,492**	**14.4**	**53.0**	**19.1**	**13.4**
Wales	**2,736**	**13.7**	**47.8**	**21.4**	**17.1**
UK	**54,824**	**14.2**	**50.0**	**20.2**	**15.6**
(min : max)		**(5.1 : 20.7)**	**(27.4 : 57.7)**	**(13.8 : 30.8)**	**(9.2 : 36.8)**

Free (50.9%). Three additional centres had over 40% of prevalent patients from ethnic minorities: Bradford (42.3%), London Kings (48.5%) and London St Georges (44.6%).

Primary renal diagnosis

Data for primary renal diagnosis (PRD) were not complete for 3.6% of patients (table 2.11) and there remained a marked inter-centre difference in completeness of data

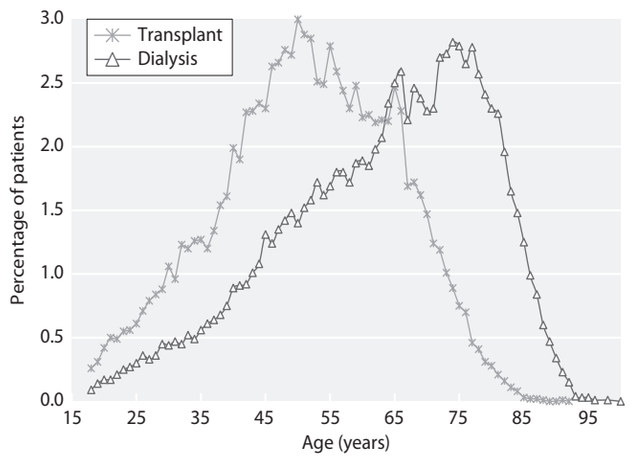

Fig. 2.4. Age profile of prevalent RRT patients by modality on 31/12/2012

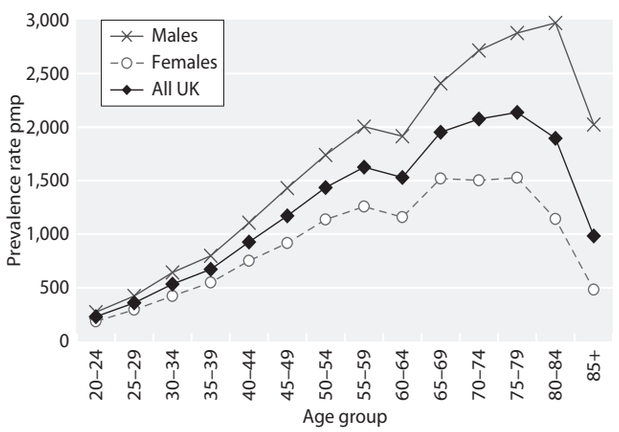

Fig. 2.5. Prevalence rate of RRT patients per million population by age and gender on 31/12/2012

Table 2.10. Ethnicity of prevalent RRT patients by centre on 31/12/2012

Centre	Data not available	*N* with data	Percentage in each ethnic group				
			White	Black	S Asian	Chinese	Other
England							
B Heart	0.0	670	61.9	7.2	29.6	0.6	0.7
B QEH	0.0	1,971	64.3	9.0	23.4	0.9	2.4
Basldn	0.0	264	85.2	8.3	4.2	0.8	1.5
Bradfd	1.4	501	57.7	1.8	39.7	0.0	0.8
Brightn	3.7	800	92.1	2.9	3.5	0.3	1.3
Bristol	0.4	1,331	89.9	5.0	3.6	0.4	1.1
Camb	1.2	1,100	93.1	1.9	4.0	0.2	0.8
Carlis	0.0	216	99.1	0.0	0.9	0.0	0.0
Carsh	6.8	1,374	72.9	9.6	12.7	1.5	3.3
Chelms	5.4	212	92.5	2.8	1.9	0.9	1.9
Colchr	0.0	117	95.7	0.9	0.9	0.9	1.7
Covnt	0.3	897	81.7	4.0	13.5	0.7	0.1
Derby	1.3	471	82.0	3.8	13.2	0.6	0.4
Donc	0.0	261	96.6	1.1	1.1	0.8	0.4
Dorset	0.0	610	97.5	0.2	0.7	0.5	1.1
Dudley	0.0	316	86.4	2.8	8.9	0.6	1.3
Exeter	0.2	844	98.3	0.6	0.4	0.2	0.5
Glouc	0.0	417	94.2	1.7	2.9	0.0	1.2
Hull	37.3	495	97.2	0.6	1.6	0.2	0.4
Ipswi	1.2	335	94.0	3.0	2.7	0.3	0.0
Kent	0.7	916	94.9	0.7	3.2	0.1	1.2
L Barts	0.0	1,955	39.8	32.4	25.8	1.5	0.4
L Guys	0.9	1,730	67.0	22.0	6.4	1.2	3.4
L Kings	1.9	901	51.5	34.4	11.0	1.7	1.4
L Rfree	3.1	1,807	49.1	21.7	19.0	1.6	8.5
L St.G	11.7	639	55.4	22.4	12.8	2.2	7.2
L West	0.0	3,104	44.5	17.9	33.5	1.0	3.1
Leeds	0.7	1,406	81.2	4.3	13.2	0.1	1.1
Leic	1.8	1,946	77.3	3.6	17.6	0.3	1.2
Liv Ain	2.1	191	95.8	0.5	2.1	1.0	0.5
Liv RI	1.4	1,224	93.5	2.0	1.6	1.4	1.6
M RI	0.6	1,699	79.1	6.2	11.8	0.9	2.0
Middlbr	0.3	787	94.0	0.6	5.0	0.3	0.1
Newc	0.1	945	93.4	0.7	4.2	0.7	0.8
Norwch	0.5	609	96.1	0.5	1.0	2.1	0.3
Nottm	0.0	1,006	87.0	5.1	6.5	0.0	1.5
Oxford	2.0	1,505	83.7	3.7	9.3	0.6	2.7
Plymth	0.0	459	97.4	0.7	0.4	0.7	0.9
Ports	1.1	1,431	94.3	0.9	3.1	0.0	1.7
Prestn	0.0	1,081	85.8	0.8	12.8	0.0	0.6
Redng	4.9	638	71.2	6.7	20.4	0.2	1.6
Salford	1.6	868	82.1	1.7	14.2	0.5	1.5
Sheff	0.5	1,301	91.8	2.2	3.8	0.7	1.5
Shrew	0.6	352	96.0	1.4	2.3	0.0	0.3
Stevng	0.3	663	69.4	9.5	17.6	0.6	2.9
Sthend	0.0	213	84.5	2.3	4.2	2.3	6.6
Stoke	15.5	587	93.4	0.3	4.3	0.3	1.7
Sund	0.2	420	96.9	0.7	2.1	0.2	0.0
Truro	0.0	377	99.5	0.0	0.3	0.0	0.3
Wirral	1.3	231	95.2	0.4	1.7	1.3	1.3
Wolve	0.0	528	71.4	9.1	19.3	0.2	0.0
York	3.3	383	97.4	0.5	1.6	0.0	0.5

Table 2.10. Continued

Centre	Data not available	*N* with data	Percentage in each ethnic group				
			White	Black	S Asian	Chinese	Other
N Ireland							
Antrim	0.0	225	99.1	0.0	0.9	0.0	0.0
Belfast	0.0	701	98.4	0.1	1.0	0.3	0.1
Newry	0.0	188	99.5	0.0	0.0	0.5	0.0
Ulster	0.0	148	97.3	0.0	2.0	0.7	0.0
West NI	0.0	258	98.4	0.4	0.8	0.4	0.0
Scotland							
Abrdn	60.7	198					
Airdrie	66.2	131					
D & Gall	88.3	15					
Dundee	55.8	178					
Dunfn	82.4	49					
Edinb	93.1	50					
Glasgw	92.5	116					
Inverns	14.7	186	98.9	0.0	1.1	0.0	0.0
Klmarnk	55.0	136					
Wales							
Bangor	0.0	105	96.2	1.0	1.0	0.0	1.9
Cardff	0.2	1,545	94.2	0.9	4.0	0.5	0.4
Clwyd	0.6	171	98.8	0.0	0.6	0.6	0.0
Swanse	0.0	662	97.9	0.3	1.5	0.0	0.3
Wrexm	0.0	249	99.2	0.4	0.4	0.0	0.0
England	**2.1**	**45,104**	**77.3**	**8.1**	**12.1**	**0.7**	**1.9**
N Ireland	**0.0**	**1,520**	**98.6**	**0.1**	**0.9**	**0.3**	**0.1**
Scotland	**76.4**	**1,059**					
Wales	**0.1**	**2,732**	**95.9**	**0.7**	**2.7**	**0.3**	**0.4**
UK	**8.0**	**50,415**	**79.3**	**7.3**	**11.0**	**0.7**	**1.7**

Percentage breakdown is not shown for centres with less than 50% data completeness, but these centres are included in national averages
Blank cells – less than 50% data completeness
Appendix H ethnicity coding

returns. Only one centre had ⩾40% primary renal diagnosis data coded as uncertain and has been excluded from the between centre analysis and other analyses where PRD is included in the case-mix adjustment (Colchester, 48% uncertain PRD); the UK and national totals have been appropriately adjusted. The range for the remaining 70 centres was between 5.0% and 34.5%, and has shown improvement over time. Completeness of

Table 2.11. Primary renal diagnosis in prevalent RRT patients by age and gender on 31/12/2012

Primary diagnosis*	*N*	% all patients	Inter-centre range %	Age <65		Age ⩾65		M:F ratio
				N	%	*N*	%	
Aetiology uncertain	9,154	16.7	5.0–34.5	5,092	14.5	4,062	20.7	1.6
Glomerulonephritis	10,289	18.8	8.5–28.6	7,523	21.4	2,766	14.1	2.1
Pyelonephritis	6,008	11.0	3.9–18.5	4,473	12.7	1,535	7.8	1.1
Diabetes	8,456	15.5	9.6–24.9	5,064	14.4	3,392	17.3	1.6
Polycystic kidney	5,286	9.7	4.1–16.7	3,510	10.0	1,776	9.1	1.1
Hypertension	3,249	5.9	1.5–15.4	1,773	5.0	1,476	7.5	2.4
Renal vascular disease	1,743	3.2	0.6–9.1	354	1.0	1,389	7.1	2.0
Other	8,568	15.7	9.5–25.3	6,071	17.3	2,497	12.8	1.3
Not sent	1,954	3.6	0.2–37.5	1,266	3.6	688	3.5	1.6

*Appendix H: ERA-EDTA coding
Excluded centre: ⩾40% primary renal diagnosis aetiology uncertain (Colchr)

PRD data has also continued to improve and no centres had >50% missing data in 2012.

Glomerulonephritis (GN) remained the most common primary renal diagnosis in the 2012 prevalent cohort at 18.8% (table 2.11). Diabetes accounted for 15.5% of renal disease in prevalent patients on RRT, although it was more common in the ⩾65 year age group compared to the younger group (17.3% vs. 14.4%). This contrasted with incident patients where diabetes was the predominant diagnostic code in 25.6% of new RRT patients. Younger patients (age <65 years) are more likely to have GN or pyelonephritis and less likely to have renal vascular disease or hypertension as the cause of their renal failure.

As described before, the male:female ratio was greater than unity for all primary renal diagnoses (table 2.11).

In individuals aged less than 65 years, renal transplantation to dialysis ratio was greater than 1 in all PRD groups except diabetes and renovascular disease. In those aged >65 years, dialysis was more prevalent than renal transplantation in all PRD groups except polycystic kidney disease (PKD) (table 2.12).

Diabetes

Diabetes included all prevalent patients with type 1 or type 2 diabetes as the primary renal diagnosis (ERA-EDTA coding) and did not include patients with diabetes as a comorbidity. This analysis did not differentiate between type 1 and type 2 diabetes as this distinction was not made in the data submitted by most centres.

The number of prevalent patients with diabetes as a primary renal diagnosis increased 8.4% to 8,456 in 2012, from 7,798 in 2011, representing 15.5% of all prevalent patients (compared with 13.5% in 2006) (table 2.13). The median age at start of RRT for patients with diabetes (56 years) was nine years higher compared with patients without diabetes (47 years), although the median age at the end of 2012 for prevalent diabetic patients was only three years higher than for individuals without diabetes. This reflects reduced survival for patients with diabetes compared with patients without diabetes on RRT. Median time on RRT for patients with diabetes was less when compared with patients without diabetes (3.5 years vs. 6.7 years) and this difference in survival has not changed over the last five years. Patients with diabetes starting RRT in Scotland were three years younger and in Northern Ireland three years older compared with the UK average age of patients with diabetes starting RRT (data not shown).

Sixty percent of patients with diabetes as primary renal diagnosis were undergoing HD. In patients with a different primary renal diagnosis 39% were undergoing HD (table 2.13). The percentage of patients with a functioning transplant was much lower in prevalent patients with diabetes than in prevalent patients without diabetes (32% vs. 54%). However, the proportion of patients with diabetes as PRD with a functioning transplant has

Table 2.12. Transplant : dialysis ratios by age and primary renal disease in the prevalent RRT population on 31/12/2012

	Transplant : dialysis ratio	
Primary diagnosis*	<65	⩾65
Aetiology uncertain	1.8	0.3
Glomerulonephritis	2.2	0.7
Pyelonephritis	2.5	0.4
Diabetes	0.8	0.1
Polycystic kidney	2.3	1.4
Hypertension	1.1	0.3
Renal vascular disease	0.9	0.1
Other	1.9	0.3
Not sent	2.1	0.3

*Appendix H ERA-EDTA coding
Excluded centre: ⩾40% primary renal diagnosis aetiology uncertain (Colchr)

Table 2.13. Age relationships in patients with diabetes and patients without diabetes and modality in prevalent RRT patients on 31/12/2012

	Patients with diabetes[a]	Patients without diabetes[b]
N	8,456	44,297
M : F ratio	1.59	1.54
Median age on 31/12/12	61	58
Median age at start of RRT[cd]	56	47
Median years on RRT[d]	3.5	6.7
% HD[e]	60	39
% PD[e]	9	6
% transplant[e]	32	54

Excluded centre: ⩾40% primary renal diagnosis aetiology uncertain (Colchr)
[a]Patients with diabetes: patients with a primary renal disease code of diabetes
[b]Patients without diabetes: all patients excluding patients with diabetes and patients with a missing primary renal disease code
[c]Median age at start of RRT was calculated from the most recent RRT start date
[d]Patients with an initial treatment modality of transferred in or transferred out were excluded from the calculation of median age at start of RRT and median years on RRT, since their treatment start date was not accurately known
[e]Patients without a treatment modality code were excluded from calculating the % per treatment modality

Table 2.14. Treatment modalities by age and diabetes status on 31/12/2012

	<65 years		⩾65 years	
	Diabetes[a]	All other causes[b]	Diabetes[a]	All other causes[b]
N	5,064	28,796	3,392	15,501
% HD	46.8	28.0	78.9	60.7
% PD	8.2	5.3	9.7	8.6
% transplant	45.0	66.7	11.4	30.6

Excludes all patients without a treatment modality code
Excluded centre with ⩾40% PRD aetiology uncertain (Colchr)
[a]Patients with diabetes are patients with a primary renal disease code of diabetes
[b]Patients without diabetes are calculated as all patients excluding patients with diabetes and patients with a missing primary renal disease code

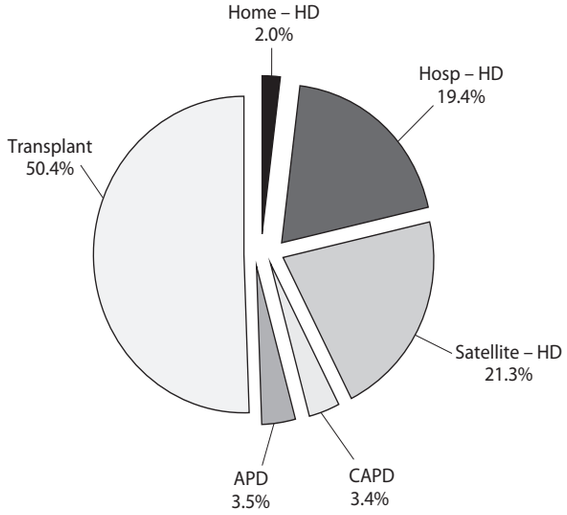

Fig. 2.6. Treatment modality in prevalent RRT patients on 31/12/2012

increased since 2004 when only 26% of patients with diabetes had a functioning transplant. For older patients with diabetes (age ⩾65 years), 11.4% had a functioning transplant compared with 30.6% of their peers without diabetes (table 2.14). In Northern Ireland, 23.6% of prevalent patients with diabetes had a functioning transplant compared with the UK average of 31.5% although on average the Northern Ireland patients with diabetes were older by three years (data not shown). A higher proportion of prevalent patients without diabetes (18.7%) were on home dialysis therapies (home HD and PD) compared with prevalent patients with diabetes (14.8%).

Modalities of treatment

Transplantation was the most common treatment modality (50.4%) for prevalent RRT patients in 2012, followed closely by centre-based HD (40.7%) in either hospital centre (19.4%) or satellite unit (21.3%) (figure 2.6). Satellite based haemodialysis was more prevalent than hospital centre haemodialysis for the first time in 2012. Home therapies made up the remaining 8.9% of treatment therapies, largely PD in its different formats (6.9%) which was similar to 2011. The proportion on continuous ambulatory peritoneal dialysis (CAPD) and automated PD (APD) was 3.4% and 3.5% respectively, although the proportion on APD may be an underestimate due to centre level coding issues which mean the UKRR cannot always distinguish between these therapies. The term CAPD has been used for patients receiving non-disconnect as well as disconnect CAPD systems, because the proportion of patients using non-disconnect systems was very small.

As mentioned earlier, treatment modality was related to patient age. Younger patients (age <65 years), were more likely to have a functioning transplant (63.5%) when compared with patients aged over 65 years (26.9%) (table 2.15). HD was the principal modality in the older patients (64.1%). However, in the elderly, interpreting the proportion of patients on renal replacement therapy who are transplanted is not straight forward as this depends on approaches to dialysis and conservative care in this age group.

Figure 2.7 shows the association between age and RRT modality. Beyond 54 years of age, transplant prevalence declined, whilst HD prevalence increased. The proportion of each age group treated by PD remained more stable across the age spectrum.

The proportion of prevalent dialysis patients receiving HD, ranged from 69.3% in Carlisle to 100% in Colchester (table 2.16).

Overall, the proportion of dialysis patients treated in a satellite haemodialysis unit has increased to 42.9% this year compared to 41.5% in 2011, and 39.9% in 2010. Although there are satellite units in Scotland, the data provided for 2012 did not distinguish between main centre and satellite unit haemodialysis. In 2012, the number of centres that had more than 50% of their haemodialysis activity taking place in satellite units was 28, an increase from 2011 (table 2.16 and figure 2.8). There was also wide variation between centres in the proportion of dialysis patients on APD treatment, ranging from 0% to 19.4% (table 2.16). Twelve of the 70 centres with a PD programme did not report having any patients

Table 2.15. Percentage of prevalent RRT patients by dialysis and transplant modality by UK country on 31/12/2012

	<65 years				⩾65 years			
UK country	*N*	% HD	% PD	% transplant	*N*	% HD	% PD	% transplant
England	29,491	30.9	6.0	63.1	16,585	64.0	9.1	26.9
N Ireland	961	30.6	4.5	64.9	559	71.6	7.3	21.1
Scotland	3,028	31.6	4.2	64.3	1,464	65.6	7.5	26.9
Wales	1,684	26.5	5.6	67.9	1,052	60.2	10.1	29.8
UK	**35,164**	**30.7**	**5.8**	**63.5**	**19,660**	**64.1**	**9.0**	**26.9**

All patients without a treatment modality code were excluded

on APD, whilst in the Northern Ireland centres almost all PD patients were on this form of the modality.

Home haemodialysis

The use of home HD as a RRT peaked in 1982 when almost 2,200 patients were estimated to be on this modality, representing 61% of HD patients reported to the ERA-EDTA Registry at that time. The fall in the use of this modality to just 445 patients (2.4% of HD patients) in 2006 was probably due to an increase in availability and uptake of renal transplantation, and also the similar expansion of hospital HD provision with the introduction of satellite units. In the last seven years there has been renewed interest in home HD and a target of 15% of HD patients on this modality has been suggested [6]. Equipment changes and patient choice has helped drive this change. Since 2006 there has been a gradual increase in the proportion of prevalent patients receiving haemodialysis in their own homes so that in 2012 it reached 4.6% of HD patients ($n = 1{,}080$, figure 2.2). These numbers may be an underestimate as some centres have been unable to submit data for patients coded as home HD and work is ongoing to address this.

In 2012, the percentage of dialysis patients receiving home HD varied from 0% in eight centres, to greater than 5% in 23 centres (table 2.16). In the UK, the overall percentage of dialysis patients receiving home haemodialysis has increased from 3.4% in 2011 to 4.0% in 2012.

The proportion of dialysis patients receiving home haemodialysis was greatest in Wales at 5.9%, compared with 4.9% in Northern Ireland, 3.9% in England and 2.9% in Scotland (figure 2.8, table 2.16). The proportion on home haemodialysis has increased in each of the four countries since 2011. Forty-seven renal centres across the UK had an increase in the proportion of individuals on home haemodialysis compared with 2011. In 2007, for comparison, the proportion of patients receiving home haemodialysis was 2% in each of the four UK countries.

Change in modality

The relative proportion of RRT modalities in prevalent patients has changed dramatically over the past decade. The main features are depicted in figure 2.9, which describes a decline in the proportion of patients treated by PD after 2000. This may however have started to

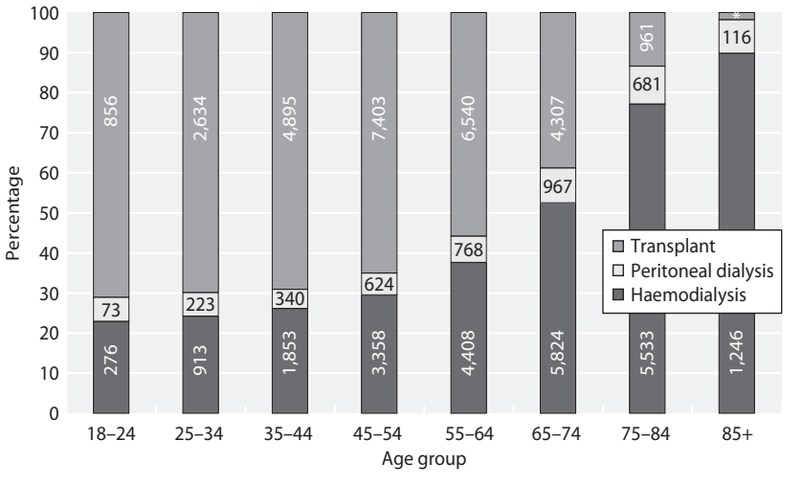

Fig. 2.7. Treatment modality distribution by age in prevalent RRT patients on 31/12/2012
*$N = 25$

Table 2.16. Percentage of prevalent dialysis patients by dialysis modality by centre on 31/12/2012

		Haemodialysis				Peritoneal dialysis	
Centre	*N*	Total	Home	Hospital	Satellite	CAPD	APD
England							
B Heart	482	90.3	3.7	79.9	6.6	7.3	2.5
B QEH	1,085	85.3	4.9	10.5	70.0	5.5	9.1
Basldn	196	83.7	0.0	83.2	0.5	8.2	7.7
Bradfd	237	87.8	0.8	71.7	15.2	1.7	10.6
Brightn	456	81.4	7.9	43.0	30.5	11.8	6.6
Bristol	560	88.2	5.5	15.4	67.3	5.7	6.1
Camb	385	90.9	3.4	37.4	50.1	0.0	0.0
Carlis	88	69.3	0.0	51.1	18.2	12.5	18.2
Carsh	876	87.2	2.5	19.1	65.6	3.7	9.1
Chelms	155	83.2	0.0	83.2	0.0	11.0	5.8
Colchr	117	100.0	0.0	100.0	0.0	0.0	0.0
Covnt	463	78.4	4.3	74.1	0.0	21.6	0.0
Derby	309	71.2	8.1	63.1	0.0	18.8	10.0
Donc	201	85.6	0.0	45.3	40.3	1.5	12.9
Dorset	308	84.4	0.7	20.8	63.0	6.5	8.4
Dudley	232	72.8	5.2	50.9	16.8	16.0	11.2
Exeter	474	83.8	0.6	12.5	70.7	7.8	8.4
Glouc	255	85.9	1.2	76.1	8.6	2.8	11.4
Hull	424	78.8	2.4	36.6	39.9	10.4	10.4
Ipswi	160	80.6	3.1	66.3	11.3	10.0	9.4
Kent	446	86.1	4.0	22.9	59.2	13.9	0.0
L Barts	1,090	82.1	1.7	35.1	45.4	5.6	12.3
L Guys	657	95.3	6.1	16.7	72.5	2.0	2.7
L Kings	578	85.1	1.2	20.6	63.3	6.8	8.1
L Rfree	834	85.6	2.3	3.7	79.6	3.8	10.4
L St.G	338	84.0	1.5	41.7	40.8	4.1	11.8
L West	1,478	96.5	1.0	22.2	73.3	1.6	2.0
Leeds	582	85.1	2.1	19.1	63.9	3.6	11.3
Leic	1,032	84.5	6.0	16.6	61.9	4.6	11.0
Liv Ain	195	89.7	2.6	9.2	78.0	2.6	7.7
Liv RI	429	85.3	8.2	37.1	40.1	9.8	4.9
M RI	589	86.1	11.5	30.9	43.6	2.6	11.4
Middlbr	350	96.9	3.4	30.9	62.6	3.1	0.0
Newc	332	85.8	7.5	78.3	0.0	1.5	12.7
Norwch	373	85.3	5.1	49.3	30.8	11.3	3.5
Nottm	457	82.3	7.7	39.0	35.7	8.1	9.6
Oxford	509	83.1	3.9	32.4	46.8	4.3	12.6
Plymth	166	78.9	4.2	74.7	0.0	17.5	3.6
Ports	638	87.0	1.4	18.7	66.9	13.0	0.0
Prestn	605	88.6	6.6	19.2	62.8	2.6	8.8
Redng	343	79.0	1.8	34.4	42.9	13.7	7.3
Salford	484	78.5	4.6	33.5	40.5	10.7	9.5
Sheff	657	89.5	6.1	39.0	44.4	10.5	0.0
Shrew	236	82.6	6.8	45.8	30.1	17.4	0.0
Stevng	441	92.8	6.4	33.1	53.3	7.3	0.0
Sthend	132	89.4	2.3	87.1	0.0	10.6	0.0
Stoke	384	79.4	6.8	46.9	25.8	3.7	16.9
Sund	220	90.0	1.4	54.6	34.1	6.4	3.6
Truro	177	87.0	2.8	45.2	39.0	6.2	6.8
Wirral	234	86.3	1.7	42.3	42.3	3.0	10.7
Wolve	377	75.6	3.7	23.6	48.3	24.4	0.0
York	167	80.9	7.2	31.7	41.9	18.6	0.6

Table 2.16. Continued

		Haemodialysis				Peritoneal dialysis	
Centre	*N*	Total	Home	Hospital	Satellite	CAPD	APD
N Ireland							
Antrim	145	91.0	2.8	88.3	0.0	1.4	7.6
Belfast	256	89.1	8.2	80.9	0.0	0.8	9.8
Newry	107	85.0	2.8	82.2	0.0	0.0	15.0
Ulster	116	93.1	3.5	89.7	0.0	0.0	6.9
West NI	154	87.7	3.9	83.8	0.0	0.0	12.3
Scotland							
Abrdn	255	90.2	2.0	88.2	0.0	5.5	4.3
Airdrie	205	94.6	0.0	94.6	0.0	3.4	2.0
D & Gall	67	76.1	1.5	74.6	0.0	11.9	11.9
Dundee	202	89.6	0.0	89.6	0.0	2.5	7.9
Dunfn	167	88.0	0.0	88.0	0.0	0.0	12.0
Edinb	302	87.8	2.0	85.8	0.0	4.0	8.3
Glasgw	671	93.0	5.2	87.8	0.0	2.4	4.6
Inverns	92	80.4	7.6	72.8	0.0	7.6	12.0
Klmarnk	191	78.5	4.2	74.4	0.0	2.1	19.4
Wales							
Bangor	105	85.7	13.3	54.3	18.1	5.7	8.6
Cardff	559	86.2	5.4	12.7	68.2	9.3	4.5
Clwyd	102	82.4	2.9	79.4	0.0	6.9	0.0
Swanse	396	82.8	7.1	47.5	28.3	14.1	3.0
Wrexm	118	81.4	0.9	67.0	13.6	18.6	0.0
England	**22,993**	**85.8**	**3.9**	**33.4**	**48.5**	**7.1**	**7.0**
N Ireland[a]	**778**	**89.2**	**4.9**	**84.3**	**0.0**	**0.5**	**10.2**
Scotland[b]	**2,152**	**89.0**	**2.9**	**86.2**	**0.0**	**3.4**	**7.6**
Wales	**1,280**	**84.4**	**5.9**	**37.2**	**41.3**	**11.2**	**3.6**
UK	**27,203**	**86.1**	**4.0**	**39.2**	**42.9**	**6.8**	**6.9**

[a]There are no satellite units in Northern Ireland
[b]All haemodialysis patients in Scotland are shown as receiving treatment at home or in centre as no data is available regarding satellite dialysis

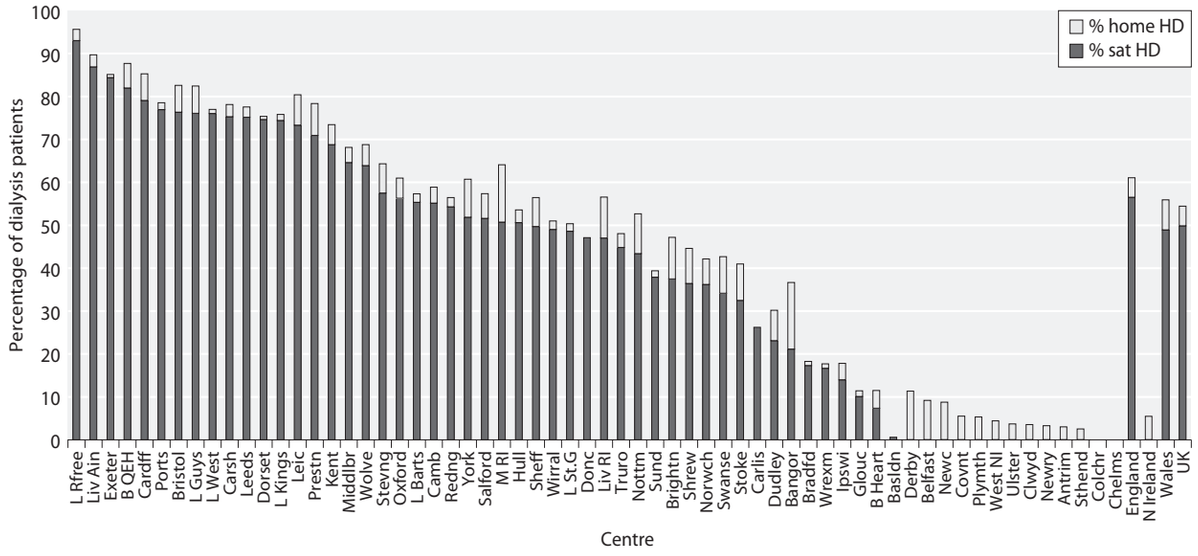

Fig. 2.8. Percentage of prevalent haemodialysis patients treated with satellite or home haemodialysis by centre on 31/12/2012
*Scottish centres excluded as information on satellite HD was not available. No centres in Northern Ireland have satellite dialysis units

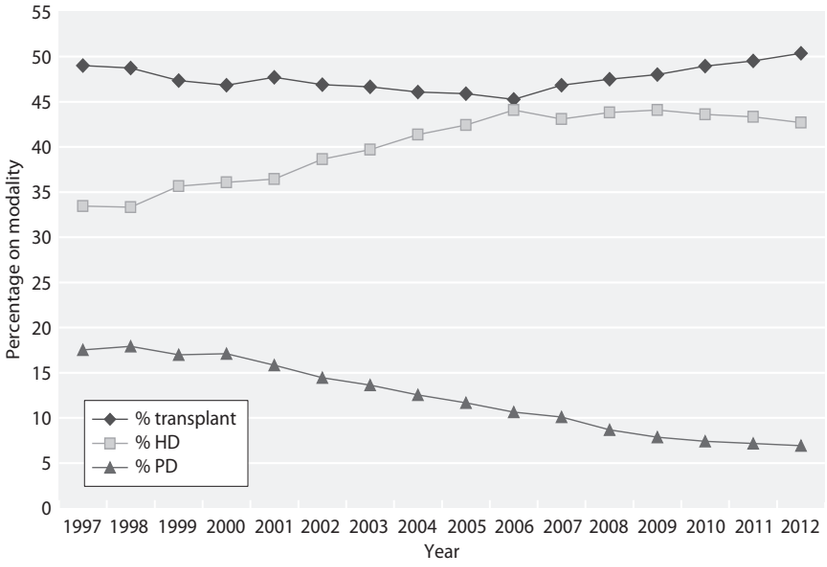

Fig. 2.9. Modality changes in prevalent RRT patients from 1997–2012

plateau, with only a minor reduction from 7.2% of the RRT population in 2011 to 6.9% in 2012. For the first time since 2007, the absolute number of patients on PD increased from 3,780 patients in 2011 to 3,792 patients in 2012. Time on PD has decreased marginally over that last six years, from a median of 2.0 years in 2007 to 1.7 years in 2012 probably reflecting increased transplantation rates in this largely younger patient group.

Since 2009 there have been small increases in the size of the incident population commencing PD as the first established modality. The determinants of this are likely to be multi-factorial and include the effect of patient or physician choice regarding the treatment modality at start of RRT, the general health and fitness of patients starting RRT, organisational level flexibility around PD tube insertion and acute PD. The introduction of dialysis best practice tariffs in England may result in further changes to the types of treatment patients receive in England.

The proportion of patients treated with HD has stabilised in the last three years. The proportion of patients with a functioning transplant which had been on a slight downward trend has reversed since 2007, probably due to continued increases in living organ and non-heart beating donation [7].

Figure 2.10 depicts in more detail the modality changes in the prevalent dialysis population during this time and highlights a sustained reduction in the proportion of patients treated by CAPD. There was a sustained increase in the proportion of prevalent HD

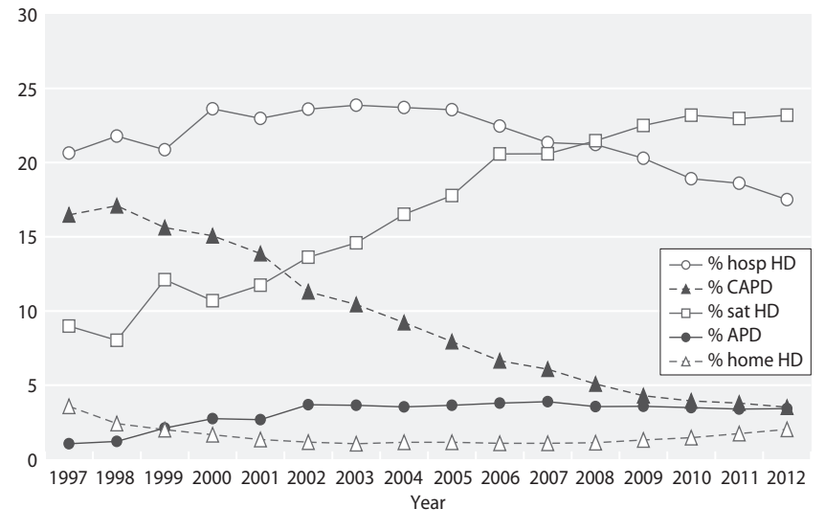

Fig. 2.10. Detailed dialysis modality changes in prevalent RRT patients from 1997–2012
*Scottish centres excluded as information on satellite HD was not available

patients treated at satellite units with a steady decline in hospital centre haemodialysis since 2004.

International comparisons

At the time of writing this report, prevalence rate data were not yet available for 2012 from other countries. Therefore international comparisons of prevalence rates are not presented. This data will be added to the UKRR data portal when it is available.

Summary

There continues to be growth across the UK in prevalent patients on RRT with regional and centre level variation. There was no real difference in prevalence rates between the four nations of the UK once adjusted for background population characteristics. In general, areas with large ethnic minority populations had higher standardised prevalence ratios. There were increasing numbers of patients on HD and those with a functioning transplant. There was an absolute increase in patient numbers on PD in 2012, with only a minor reduction in the relative proportion on PD between 2011 and 2012. The prevalence rate in the over 80 year age group continues to increase. There have been substantial increases in home HD use in some areas although several centres are still unable to offer this modality.

Conflicts of interest: none

References

1 Office for National Statistics. www.statistics.gov.uk
2 National Records of Scotland. http://www.nrscotland.gov.uk/
3 Northern Ireland Statistics and Research Agency. http://www.nisra.gov.uk/
4 Office for National Statistics. The classification of ethnic groups. (www.statistics.gov.uk)
5 Ansell D, Feest T: The sixth annual report. Chapter 17: Social deprivation on renal replacement therapy. Bristol, UK Renal Registry, 2003
6 NICE 2002. Technology appraisal No 48. National Institute Clinical Excellence. www.nice.org.uk
7 NHS Blood and Transplant activity report 2009/2010. Transplant activity in the UK. http://www.organdonation.nhs.uk/ukt/statistics/transplant_activity_report/current_activity_reports/ukt/activity_report_2009_10.pdf

UK Renal Registry 16th Annual Report: Chapter 3 Demographic and Biochemistry Profile of Kidney Transplant Recipients in the UK in 2012: National and Centre-specific Analyses

Rishi Pruthi[a], Anna Casula[a], Iain MacPhee[b]

[a]UK Renal Registry, Bristol, UK; [b]St George's, University of London, UK

Key Words

Blood pressure · Bone metabolism · Chronic kidney disease · Deceased donor · eGFR · Epidemiology · Ethnicity · Graft function · Haemoglobin · Live donor · Outcomes · Renal transplantation · Survival

Summary

- There was a 5% increase in overall renal transplant numbers in 2012, with a significant rise in kidney donation from donors after circulatory death (19%).
- In 2012, death-censored renal transplant failure rates in prevalent patients were similar to previous years at 2.2% per annum. Transplant patient death rates remained stable at 2.3 per 100 patient years.
- The median age of incident and prevalent renal transplant patients in the UK was 50.5 and 52.2 years respectively.
- The median eGFR of prevalent renal transplant recipients was 51.3 ml/min/1.73 m^2.
- The median eGFR of patients one year after transplantation was 56.4 ml/min/1.73 m^2 post live transplant, 52.7 ml/min/1.73 m^2 post brainstem death transplant and 49.4 ml/min/1.73 m^2 post circulatory death transplant.
- 13.7% of prevalent transplant patients had eGFR $<$30 ml/min/1.73 m^2.
- The median decline in eGFR slope beyond the first year after transplantation was $-$0.53 ml/min/1.73 m^2/year.
- In 2012, infection (23%) and malignancy (20%) remained amongst the commonest causes of death in patients with a functioning renal transplant.

Introduction

This chapter includes independent analyses regarding renal transplant activity and survival data from the UK Transplant Registry, held by the Organ Donation and Transplantation Directorate (ODT) of NHS Blood and Transplant (NHSBT). The UK Renal Registry (UKRR) has performed additional analyses of renal transplant recipient follow-up data examining demographics, clinical and biochemical variables. NHSBT records all the information regarding the episode of transplantation (donor and recipient details) and the UKRR holds additional information on key clinical and biochemical variables in renal transplant recipients. The co-operation between these two organisations results in a comprehensive database describing the clinical care delivered to renal transplant patients within the UK. This further allows for the comparison of key outcomes between centres and provides insight into the processes involved in the care of such patients in the UK.

This chapter is divided into six sections: (1) transplant activity, waiting list and survival data; (2) transplant demographics; (3) clinical and laboratory outcomes; (4) analysis of prevalent patients by chronic kidney disease (CKD) stage; (5) eGFR slope analysis; and (6) causes of death in transplant recipients. Methodology, results and conclusions of these analyses are discussed in detail for all six sections separately.

The UK Renal Registry methodology is described elsewhere [1]. The UKRR collects quarterly clinical data via an electronic data extraction process from hospital based renal IT systems on all patients receiving renal replacement therapy. Throughout the chapter, the number preceding the centre name in each figure indicates the percentage of missing data for that centre for that variable.

Unless otherwise specified, prevalent transplant patients were defined as patients with a functioning renal transplant on the 31st December 2012.

Transplant activity, waiting list activity and survival data

Introduction

NHSBT prospectively collects donor and recipient data around the episode of transplantation. They also request that transplant centres provide an annual paper based data return on the status of the recipient's graft function. This enables ODT to generate comprehensive analyses of renal transplant activity and graft survival statistics.

NHSBT attributes a patient to the centre that performed the transplant operation irrespective of where the patient was cared for before or after the procedure and hence only reports on transplant centre performance.

Methods

In 2012, there were 23 UK adult renal transplant centres, 19 in England, 2 in Scotland and 1 each in Northern Ireland and Wales.

Comprehensive information from 1999 onwards concerning the number of patients on the transplant waiting list, the number of transplants performed, the number of deceased kidney donors (donor after brainstem death and donor after circulatory death), living kidney donors, patient survival and graft survival is available on the NHSBT website (http://www.organdonation.nhs.uk/ukt/statistics/statistics.asp).

Results

During 2012, 2,901 kidney or kidney plus other organ transplants were performed. The absolute number of living kidney donors showed a 1% rise in 2012 representing 35.6% of all transplants performed whilst donor after circulatory death transplants continued to increase and comprised 24.4% of all kidney transplants performed. A small rise in the number of transplants from donors after brainstem death was also noted in 2012 partially reversing the small decline noted in 2011 (table 3.1).

There were small differences in one and five year risk-adjusted patient and graft survival rates amongst UK renal transplant centres (table 3.2). These graft survival rates include grafts with primary non-function (which are excluded from analysis by some countries).

Table 3.1. Kidney and kidney plus other organ transplant numbers in the UK, 1/1/2010–31/12/2012

Organ	2010	2011	2012	% change 2011–2012
Donor after brainstem death[a]	989	951	967	2
Donor after circulatory death[b]	549	594	708	19
Living donor kidney	1,027	1,026	1,034	1
Kidney and liver	9	16	17	6
Kidney and heart	0	0	3	
Kidney and pancreas[c]	150	163	172	6
Small bowel (inc kidney)	1	2	0	
Total kidney transplants	**2,725**	**2,752**	**2,901**	**5**

[a]Includes en bloc kidney transplants (7 in 2010, 7 in 2011, 4 in 2012) and double kidney transplants (6 in 2010, 5 in 2011, 7 in 2012)
[b]Includes en bloc kidney transplants (2 in 2010, 2 in 2011, 4 in 2012) and double kidney transplants (16 in 2010, 32 in 2011, 52 in 2012)
[c]Includes DCD transplants (29 in 2010, 28 in 2011, 35 in 2012)

Table 3.2. Risk-adjusted first adult kidney transplant only, graft and patient survival percentage rates for UK centres*

	Deceased donor 1 year survival		Deceased donor 5 year survival		Living kidney donor 1 year survival		Living kidney donor 5 year survival	
Centre	Graft	Patient	Graft	Patient	Graft	Patient	Graft	Patient
B QEH	88	96	83	89	96	99	88	96
Belfast	93	95	91	92	94	100	92	93
Bristol	94	96	84	85	98	99	95	98
Camb	92	97	85	90	99	99	96	100
Cardff	96	98	85	88	95	98	88	96
Covnt	88	94	89	91	96	100	88	96
Edin	90	95	83	85	95	98	91	97
Glasgw	93	97	84	84	96	96	96	97
L Barts	91	91	88	90	95	98	92	93
L Guys	93	96	81	90	97	98	92	95
L Rfree	94	97	88	93	98	100	93	95
L St.G	96	99	85	92	99	100	92	95
L West	94	98	88	92	96	99	83	95
Leeds	92	95	86	90	95	100	92	98
Leic	92	93	82	79	96	98	91	93
Liv RI	93	95	81	94	95	100	92	92
M RI	94	96	84	88	98	98	93	98
Newc	93	95	83	89	99	99	93	98
Nottm	94	95	80	86	95	99	91	94
Oxford	94	96	89	87	96	96	98	94
Plymth	88	97	86	89	95	99	88	93
Ports	95	95	80	88	94	99	82	91
Sheff	91	98	81	92	98	100	89	100
All centres	**93**	**96**	**84**	**88**	**96**	**96**	**96**	**96**

*Information courtesy of NHSBT; statistical methodology for computing risk-adjusted estimates can be obtained from the NHSBT website (see http://www.organdonation.nhs.uk/ukt/statistics/statistics.asp)
Cohorts for survival rate estimation: 1 year survival: 1/1/2007–31/12/2011; 5 year survival: 1/1/2003–31/12/2007; first grafts only – re-grafts excluded for patient survival estimation. Since the cohorts to estimate 1- and 5-year survival are different, some centres may appear to have 5 year survival better than 1 year survival

Using data from the UKRR on prevalent renal only transplant patients on 1st January 2012, the death rate during 2012 was 2.3/100 patient years (CI 2.1–2.5) when censored for return to dialysis and 2.4/100 patient years (CI 2.2–2.6) without censoring for dialysis. These death rates are similar to those observed over the last few years.

During 2012, 2.2% of prevalent transplant patients experienced graft failure (excluding death as a cause of graft failure) maintaining the fall in graft failure rates noted over the last couple of years. Whilst it might be premature to assume that graft failure rates are falling in the UK the 0.5% fall noted in the last five years is certainly encouraging.

Conclusions

In 2012, the increased number of kidney transplants performed was mostly due to the growing use of organs from donors after circulatory death. The graft failure rate of 2.2% per annum and patient death rate of 2.3 per 100 patient years were similar to those noted in 2011.

Transplant demographics

Introduction

Since 2008, all UK renal centres have established electronic linkage to the UKRR or Scottish Renal Registry, giving the UKRR complete coverage of individual patient level data across the UK.

The following sections need to be interpreted in the context of variable repatriation policies; some transplant centres continue to follow up and report on all patients they transplant, whereas others refer patients back to non-transplant centres for most or all ongoing post-transplant care. Some transplant centres only refer back patients when their graft is failing. The time

post-transplantation that a patient is referred back to their local centre varies between transplant centres. The UKRR is able to detect duplicate patients (being reported from both transplant and referring centres) and in such situations care is attributed to the referring centre. This process may result in some discrepancies in transplant numbers particularly in Oxford/Reading and Clywd/Liverpool RI.

Methods

Four centres (Bangor, Colchester, Liverpool Aintree and Wirral) did not have any transplant patients and were excluded from some of the analyses. Their dialysis patients were included in the relevant dialysis population denominators.

For the analysis of primary renal diagnosis (PRD) in transplant recipients, a few centres were excluded from some of the take-on years because of concerns relating to the reliability of PRD coding (with these centres submitting a high percentage of uncertain or missing aetiology codes).

Information on patient demographics (age, gender, ethnicity and PRD) for patients in a given renal centre was obtained from UKRR patient registration data fields. Individual patients were assigned to the centre that returned data for them during 2012. The prevalence of transplant patients in areas covered by individual primary care trusts (PCT) or Health Boards/Social Care Areas (HB) was estimated based on the post code of the registered address for patients on renal replacement therapy (RRT). Data on ethnic origin, supplied as Patient Administration System (PAS) codes, were retrieved from fields within renal centre IT systems. For the purpose of this analysis, patients were grouped into Whites, South Asians, Blacks, Others and Unknown. The details of ethnicity regrouping into the above categories are provided in appendix H: Coding http://www.renalreg.com.

Results and discussion

Prevalent transplant numbers across the UK are described in table 3.3.

The prevalence of renal transplant recipients in each PCT/HB in England, Northern Ireland (Health and Social Care Trust Areas), Scotland (Health Boards) and Wales (Local Health Boards) and the proportion of prevalent patients according to modality in the renal centres across the UK is described in tables 3.4 and 3.5 respectively. After standardisation for age and gender, unexplained variability was evident in the prevalence of renal transplant recipients, with some areas having higher than the predicted number of prevalent transplant patients per million population and others lower. There are a number of potential explanations for these inconsistencies, including geographical differences in access to renal transplantation in the UK. This has previously been analysed in detail by the UKRR [2] and is currently the focus of a large national study (access to Transplant and Transplant Outcome Measures (ATTOM)).

The proportion of prevalent RRT patients with a transplant relative to the number on dialysis has been relatively stable over the last decade.

Age and gender

The gender ratio amongst incident and prevalent transplant patients has remained stable for at least the last ten years (table 3.6, figure 3.1). Note absolute patient numbers differ from those published in previous reports as a result of additional data validation and reallocation of patients. The average age of incident transplant patients has steadily increased during the same time period. There has also been a gradual increase in the average age of prevalent transplant patients, which could reflect the increasing age at which patients are transplanted and/or improved survival after renal transplantation over the last few years. The prevalent transplant patient workload across the UK increased to 27,621 patients at the end of 2012. The continued expansion of this patient group means there is a need for careful planning by renal centres for future service provision and resource allocation.

Primary renal diagnosis

The primary renal diagnosis of patients receiving kidney transplants in the UK has remained relatively stable over the last five years (table 3.7).

Ethnicity

It was difficult to compare the proportion of patients within each ethnic group receiving a transplant to those commencing dialysis from the same group because data on ethnicity were missing in a considerable number of

Table 3.3. The prevalence per million population (pmp) of renal transplants in adults in the UK on 31/12/2012

	England	N Ireland	Scotland	Wales	UK
All UK centres	23,083	742	2,340	1,456	27,621
Total population, mid-2012 estimates from ONS* (millions)	53.5	1.8	5.3	3.1	63.7
Prevalence pmp transplant	432	407	440	474	434

*Office of National Statistics, UK

Table 3.4. The prevalence per million population (pmp) of patients with a renal transplant and standardised rate ratio in the UK, as on 31st December 2008–2012

[a]PCT/HB – Primary Care Trust (England); Health and Social Care Trust Areas (Northern Ireland); Health Board (Scotland) and Local Health Board (Wales)
[b]Population numbers based on the 2011 mid-year estimates by age group and gender (data obtained from the Office of National Statistics)
[c]O/E – age and gender standardised prevalence rate ratio
PCTs with significantly high average rate ratios are bold in greyed areas
PCTs with significantly low average rate ratios are italicised in greyed areas
LCL – lower 95% confidence limit
UCL – upper 95% confidence limit

UK Area	PCT/HB[a]	Population covered[b]	Rate pmp					Age and gender standardised rate ratio 2012		
			2008	2009	2010	2011	2012	O/E[c]	LCL	UCL
North East	County Durham	513,000	390	398	411	433	439	0.96	0.84	1.09
	Darlington	105,600	369	331	360	407	407	0.92	0.68	1.24
	Gateshead	200,300	374	389	389	404	449	1.00	0.82	1.24
	Hartlepool	92,100	369	358	402	413	456	1.03	0.76	1.40
	Middlesbrough	**138,400**	**434**	**470**	**477**	**520**	**549**	**1.32**	**1.06**	**1.66**
	Newcastle	279,100	373	376	380	408	398	0.99	0.82	1.20
	North Tyneside	**201,200**	**482**	**507**	**557**	**577**	**581**	**1.28**	**1.07**	**1.53**
	Northumberland	316,300	398	398	383	436	436	0.92	0.77	1.08
	Redcar and Cleveland	135,200	525	540	547	562	570	1.25	1.00	1.56
	South Tyneside	148,200	439	445	432	472	479	1.06	0.84	1.33
	Stockton-on-Tees Teaching	191,800	391	401	391	381	407	0.93	0.74	1.16
	Sunderland Teaching	275,300	418	403	421	469	487	1.08	0.91	1.28
North West	Ashton, Leigh and Wigan	318,100	358	339	387	446	490	1.08	0.92	1.270
	Blackburn with Darwen Teaching	147,700	305	312	312	339	379	0.93	0.72	1.21
	Blackpool	142,100	338	345	345	338	408	0.90	0.70	1.16
	Bolton Teaching	**277,300**	**408**	**418**	**433**	**483**	**516**	**1.20**	**1.02**	**1.41**
	Bury	185,400	351	410	410	421	448	1.02	0.82	1.26
	Central and Eastern Cheshire	*462,800*	*302*	*305*	*341*	*359*	*378*	*0.82*	*0.70*	*0.95*
	Central Lancashire	467,400	300	312	347	370	396	0.89	0.77	1.03
	Cumbria Teaching	*499,800*	*330*	*370*	*390*	*394*	*412*	*0.87*	*0.76*	*0.99*
	East Lancashire Teaching	382,500	405	405	403	429	437	0.99	0.85	1.15
	Halton and St Helens	301,100	299	312	345	365	385	0.85	0.71	1.02
	Heywood, Middleton and Rochdale	211,900	382	396	406	439	453	1.07	0.87	1.30
	Knowsley	145,900	329	363	377	377	398	0.91	0.71	1.18
	Liverpool	465,700	305	320	344	376	391	0.94	0.81	1.09
	Manchester Teaching	502,900	247	251	296	328	364	1.00	0.87	1.16
	North Lancashire Teaching	*321,600*	*320*	*317*	*311*	*320*	*342*	*0.75*	*0.62*	*0.90*
	Oldham	225,200	351	378	395	409	426	1.03	0.84	1.25
	Salford	234,500	290	316	345	371	426	1.03	0.85	1.26
	Sefton	*274,000*	*296*	*310*	*347*	*361*	*376*	*0.82*	*0.68*	*1.00*
	Stockport	283,300	342	371	395	413	431	0.96	0.80	1.14
	Tameside and Glossop	252,900	411	419	455	490	498	1.12	0.94	1.33
	Trafford	227,100	282	277	317	343	374	0.86	0.69	1.06
	Warrington	202,700	385	419	390	405	439	0.98	0.79	1.20
	Western Cheshire	237,400	320	358	379	400	425	0.92	0.76	1.12
	Wirral	*319,800*	*313*	*331*	*338*	*353*	*356*	*0.79*	*0.66*	*0.95*
Yorkshire and the Humber	Barnsley	231,900	367	371	392	405	423	0.93	0.76	1.13
	Bradford and Airedale Teaching	**523,100**	**390**	**419**	**447**	**449**	**499**	**1.25**	**1.11**	**1.42**
	Calderdale	**204,200**	**431**	**441**	**475**	**509**	**544**	**1.21**	**1.01**	**1.46**
	Doncaster	302,500	321	344	350	380	410	0.93	0.78	1.10
	East Riding of Yorkshire	334,700	338	362	371	382	412	0.86	0.73	1.02
	Hull Teaching	256,100	351	375	387	398	429	1.03	0.86	1.24

Table 3.4. Continued

UK Area	PCT/HB[a]	Population covered[b]	Rate pmp					Age and gender standardised rate ratio 2012		
			2008	2009	2010	2011	2012	O/E[c]	LCL	UCL
Yorkshire and the Humber	Kirklees	423,000	390	400	416	437	454	1.06	0.92	1.22
	Leeds	750,700	320	338	360	384	412	1.00	0.90	1.12
	North East Lincolnshire	161,200	323	347	366	409	434	0.98	0.78	1.24
	North Lincolnshire	*163,600*	*269*	*251*	*257*	*263*	*275*	*0.60*	*0.45*	*0.81*
	North Yorkshire and York	799,000	362	388	412	439	469	1.02	0.93	1.13
	Rotherham	257,700	357	376	415	450	466	1.04	0.87	1.24
	Sheffield	551,800	301	321	359	382	391	0.95	0.84	1.09
	Wakefield District	326,400	319	316	343	361	386	0.85	0.71	1.01
East Midlands	*Bassetlaw*	*113,000*	*283*	*274*	*301*	*301*	*327*	*0.70*	*0.51*	*0.97*
	Derby City	248,900	257	309	362	370	418	1.02	0.84	1.24
	Derbyshire County	*737,500*	*290*	*294*	*315*	*347*	*370*	*0.79*	*0.70*	*0.89*
	Leicester City	**329,600**	**458**	**525**	**525**	**561**	**586**	**1.53**	**1.33**	**1.76**
	Leicestershire County and Rutland	688,800	382	389	417	433	457	1.00	0.90	1.12
	Lincolnshire Teaching	*717,200*	*283*	*289*	*303*	*322*	*343*	*0.74*	*0.65*	*0.84*
	Northamptonshire Teaching	694,000	346	362	386	406	406	0.92	0.82	1.03
	Nottingham City	303,900	230	244	319	339	362	0.96	0.80	1.16
	Nottinghamshire County Teaching	673,800	327	346	389	420	453	0.99	0.88	1.11
West Midlands	Birmingham East and North	421,400	344	356	373	399	420	1.08	0.93	1.25
	Coventry Teaching	316,900	350	363	385	410	429	1.08	0.91	1.28
	Dudley	*313,300*	*271*	*287*	*300*	*310*	*290*	*0.65*	*0.53*	*0.80*
	Heart of Birmingham Teaching	**299,200**	**381**	**384**	**398**	**398**	**414**	**1.21**	**1.01**	**1.44**
	Herefordshire	*183,600*	*278*	*300*	*300*	*310*	*332*	*0.71*	*0.55*	*0.91*
	North Staffordshire	212,900	319	343	348	371	399	0.86	0.70	1.06
	Sandwell	309,000	337	353	353	359	398	0.97	0.82	1.16
	Shropshire County	*307,100*	*293*	*329*	*339*	*355*	*342*	*0.73*	*0.60*	*0.89*
	Solihull	206,900	285	290	305	319	358	0.80	0.63	1.00
	South Birmingham	353,700	328	328	362	373	382	0.95	0.81	1.13
	South Staffordshire	*628,500*	*309*	*318*	*333*	*344*	*344*	*0.74*	*0.65*	*0.85*
	Stoke on Trent	256,900	362	389	417	413	440	1.02	0.85	1.23
	Telford and Wrekin	*166,800*	*234*	*276*	*288*	*294*	*282*	*0.65*	*0.49*	*0.86*
	Walsall Teaching	269,500	338	360	378	401	416	0.98	0.81	1.18
	Warwickshire	546,600	353	373	412	443	468	1.03	0.91	1.16
	Wolverhampton City	*249,900*	*284*	*304*	*300*	*300*	*308*	*0.74*	*0.59*	*0.92*
	Worcestershire	*566,600*	*286*	*312*	*337*	*344*	*365*	*0.79*	*0.69*	*0.91*
East of England	Bedfordshire	413,500	343	370	387	397	450	1.01	0.88	1.17
	Cambridgeshire	622,300	320	358	394	407	423	0.96	0.85	1.08
	Hertfordshire	1,119,800	328	346	391	412	438	1.01	0.93	1.10
	Great Yarmouth and Waveney	*212,800*	*230*	*291*	*301*	*315*	*334*	*0.73*	*0.58*	*0.92*
	Luton	**203,600**	**344**	**354**	**388**	**437**	**481**	**1.25**	**1.03**	**1.53**
	Mid Essex	375,200	320	360	376	424	410	0.90	0.77	1.06
	Norfolk	*762,000*	*310*	*329*	*339*	*349*	*349*	*0.76*	*0.68*	*0.86*
	North East Essex	311,700	308	321	343	372	395	0.89	0.74	1.06
	Peterborough	184,500	249	287	298	347	352	0.86	0.68	1.10
	South East Essex	*345,600*	*298*	*330*	*336*	*339*	*368*	*0.81*	*0.68*	*0.97*
	South West Essex	407,100	290	317	341	366	383	0.89	0.76	1.04
	Suffolk	*614,800*	*290*	*320*	*342*	*372*	*386*	*0.86*	*0.75*	*0.97*
	West Essex	289,600	273	321	363	363	390	0.88	0.73	1.05
London	Barking and Dagenham	187,000	267	326	348	412	428	1.17	0.94	1.46
	Barnet	**357,500**	**406**	**467**	**503**	**559**	**632**	**1.57**	**1.37**	**1.78**
	Bexley	**232,800**	**438**	**455**	**498**	**511**	**524**	**1.24**	**1.04**	**1.48**
	Brent Teaching	**312,200**	**522**	**573**	**605**	**612**	**657**	**1.65**	**1.44**	**1.89**

Table 3.4. Continued

UK Area	PCT/HB[a]	Population covered[b]	Rate pmp					Age and gender standardised rate ratio 2012		
			2008	2009	2010	2011	2012	O/E[c]	LCL	UCL
London	**Bromley**	**310,600**	**441**	**454**	**483**	**493**	**512**	**1.17**	**1.00**	**1.37**
	Camden	**220,100**	**363**	**404**	**427**	**477**	**504**	**1.26**	**1.05**	**1.52**
	City and Hackney Teaching	254,600	275	299	322	322	342	0.92	0.74	1.13
	Croydon	364,800	310	345	356	386	395	0.96	0.82	1.13
	Ealing	**339,300**	**525**	**545**	**584**	**598**	**634**	**1.57**	**1.37**	**1.79**
	Enfield	**313,900**	**433**	**440**	**468**	**535**	**583**	**1.46**	**1.27**	**1.69**
	Greenwich Teaching	255,500	305	360	391	423	458	1.17	0.98	1.41
	Hammersmith and Fulham	182,400	323	400	438	444	477	1.21	0.98	1.49
	Haringey Teaching	**255,500**	**352**	**399**	**438**	**470**	**520**	**1.32**	**1.12**	**1.57**
	Harrow	**240,500**	**570**	**640**	**690**	**699**	**723**	**1.74**	**1.50**	**2.02**
	Havering	*237,900*	*282*	*303*	*315*	*336*	*336*	*0.77*	*0.62*	*0.96*
	Hillingdon	**275,500**	**417**	**468**	**512**	**563**	**592**	**1.47**	**1.26**	**1.71**
	Hounslow	**254,900**	**408**	**475**	**526**	**537**	**557**	**1.39**	**1.18**	**1.63**
	Islington	**206,300**	**431**	**475**	**499**	**528**	**572**	**1.46**	**1.22**	**1.74**
	Kensington and Chelsea	158,300	367	385	461	474	474	1.09	0.87	1.36
	Kingston	160,400	380	393	399	418	461	1.12	0.89	1.40
	Lambeth	304,500	292	325	325	365	414	1.06	0.89	1.27
	Lewisham	276,900	368	394	412	426	455	1.15	0.97	1.37
	Newham	310,500	232	293	332	354	396	1.12	0.94	1.34
	Redbridge	**281,400**	**355**	**380**	**455**	**476**	**526**	**1.34**	**1.14**	**1.57**
	Richmond and Twickenham	187,500	261	299	315	347	379	0.87	0.69	1.10
	Southwark	**288,700**	**405**	**461**	**492**	**526**	**571**	**1.46**	**1.26**	**1.71**
	Sutton and Merton	**391,700**	**378**	**411**	**431**	**452**	**500**	**1.20**	**1.04**	**1.38**
	Tower Hamlets	256,000	223	258	309	316	355	1.03	0.84	1.27
	Waltham Forest	259,700	354	377	412	439	450	1.16	0.96	1.39
	Wandsworth	307,700	338	338	357	390	435	1.12	0.94	1.32
	Westminster	219,600	355	437	483	474	501	1.19	0.99	1.44
South East Coast	*Brighton and Hove City*	*273,000*	*275*	*289*	*319*	*333*	*337*	*0.81*	*0.66*	*0.99*
	East Sussex Downs and Weald	*343,900*	*294*	*311*	*320*	*334*	*372*	*0.81*	*0.68*	*0.97*
	Eastern and Coastal Kent	759,600	340	374	404	440	483	1.09	0.99	1.21
	Hastings and Rother	*183,400*	*305*	*305*	*322*	*349*	*338*	*0.74*	*0.57*	*0.94*
	Medway	264,900	366	393	415	415	442	1.03	0.86	1.24
	Surrey	1,124,800	351	369	380	386	413	0.93	0.85	1.02
	West Kent	706,800	364	386	390	399	426	0.97	0.86	1.08
	West Sussex	*808,900*	*344*	*352*	*368*	*386*	*383*	*0.85*	*0.76*	*0.95*
South Central	**Berkshire East**	**410,100**	**407**	**444**	**502**	**527**	**568**	**1.37**	**1.20**	**1.56**
	Berkshire West	**464,400**	**418**	**450**	**459**	**484**	**493**	**1.14**	**1.00**	**1.30**
	Buckinghamshire	521,000	407	415	441	453	489	1.10	0.97	1.24
	Hampshire	*1,322,100*	*348*	*364*	*382*	*396*	*414*	*0.91*	*0.84*	*0.99*
	Isle of Wight National Health Service	*138,400*	*303*	*318*	*332*	*332*	*347*	*0.73*	*0.55*	*0.97*
	Milton Keynes	255,400	329	352	392	423	458	1.09	0.91	1.31
	Oxfordshire	629,600	405	410	429	442	480	1.12	1.00	1.25
	Portsmouth City Teaching	205,400	355	355	399	399	419	1.05	0.85	1.30
	Southampton City	235,900	343	356	352	399	428	1.09	0.90	1.33
South West	*Bath and North East Somerset*	*175,500*	*291*	*325*	*308*	*302*	*308*	*0.71*	*0.55*	*0.93*
	Bournemouth and Poole Teaching	*331,500*	*335*	*332*	*341*	*365*	*353*	*0.81*	*0.68*	*0.97*
	Bristol	**428,100**	**432**	**446**	**474**	**488**	**516**	**1.30**	**1.14**	**1.48**
	Cornwall and Isles of Scilly	536,000	416	437	446	465	511	1.09	0.97	1.23
	Devon	747,700	354	388	399	400	419	0.90	0.81	1.01
	Dorset	413,800	418	428	445	442	442	0.94	0.81	1.08
	Gloucestershire	*598,300*	*328*	*329*	*341*	*374*	*371*	*0.82*	*0.72*	*0.93*

Table 3.4. Continued

UK Area	PCT/HB[a]	Population covered[b]	Rate pmp					Age and gender standardised rate ratio 2012		
			2008	2009	2010	2011	2012	O/E[c]	LCL	UCL
South West	North Somerset	203,100	384	409	433	443	483	1.05	0.86	1.28
	Plymouth Teaching	**256,600**	**468**	**503**	**511**	**546**	**573**	**1.35**	**1.14**	**1.58**
	Somerset	531,600	348	367	386	420	421	0.92	0.80	1.04
	South Gloucestershire	263,400	444	448	475	490	509	1.14	0.96	1.35
	Swindon	214,900	335	349	409	428	437	1.01	0.82	1.23
	Torbay	131,200	404	450	473	495	495	1.07	0.84	1.36
	Wiltshire	*474,300*	*310*	*314*	*346*	*371*	*386*	*0.86*	*0.74*	*0.99*
Wales	*Betsi Cadwaladr University*	*688,700*	*327*	*338*	*354*	*351*	*348*	*0.77*	*0.67*	*0.87*
	Powys Teaching	133,200	360	375	413	405	375	0.78	0.59	1.04
	Hywel Dda	381,900	380	401	398	424	424	0.93	0.79	1.08
	Abertawe Bro Morgannwg University	**517,700**	**433**	**454**	**487**	**547**	**579**	**1.30**	**1.16**	**1.46**
	Cwm Taf	**293,500**	**535**	**569**	**630**	**664**	**685**	**1.55**	**1.35**	**1.78**
	Aneurin Bevan	**577,000**	**437**	**458**	**501**	**520**	**584**	**1.31**	**1.18**	**1.46**
	Cardiff and Vale University	**472,300**	**394**	**404**	**436**	**464**	**502**	**1.22**	**1.07**	**1.39**
Scotland	Ayrshire & Arran	373,800	399	396	393	388	415	0.89	0.76	1.04
	Borders	113,900	378	386	448	448	509	1.05	0.81	1.36
	Dumfries and Galloway	151,400	363	383	390	409	409	0.85	0.66	1.09
	Fife	365,300	315	323	342	367	389	0.85	0.72	1.00
	Forth Valley	*298,100*	*295*	*295*	*315*	*339*	*369*	*0.81*	*0.67*	*0.98*
	Grampian	569,600	348	377	393	404	421	0.93	0.82	1.06
	Greater Glasgow & Clyde	**1,214,600**	**424**	**431**	**444**	**460**	**510**	**1.16**	**1.07**	**1.25**
	Highland	321,700	423	476	504	494	497	1.04	0.89	1.22
	Lanarkshire	572,400	383	404	416	440	479	1.05	0.94	1.19
	Lothian	*836,600*	*326*	*339*	*357*	*377*	*390*	*0.89*	*0.80*	*1.00*
	Orkney	21,400	514	420	373	373	373	0.77	0.39	1.54
	Shetland	23,200	215	258	258	215	258	0.56	0.25	1.25
	Tayside	410,300	422	417	419	429	441	0.98	0.84	1.13
	Western Isles	27,700	289	289	289	325	325	0.67	0.35	1.29
Northern Ireland	Belfast	348,300	362	379	422	431	459	1.12	0.96	1.31
	Northern	463,500	339	356	371	390	406	0.95	0.82	1.10
	Southern	359,400	298	300	320	359	403	0.99	0.84	1.16
	South Eastern	347,700	348	359	359	394	403	0.93	0.78	1.09
	Western	295,300	305	322	342	359	369	0.89	0.73	1.07

patients who were classified as ethnicity 'unknown' (table 3.8). The percentages of patients with unknown ethnicity between 2007 and 2012 provided in this year's chapter are different from those in last year's chapter [3]; this reflects retrospective input of ethnicity data, improving data completeness.

Clinical and laboratory outcomes

Introduction

There continued to be marked variation in the completeness of data (tables 3.9a, 3.9b) reported by each renal centre, particularly for blood pressure. Better data records (or possibly better extraction of data held within renal IT systems) would facilitate more meaningful comparisons between centres and help to determine the causes of inter-centre differences in outcomes. For this reason, along with differences in repatriation policies of prevalent transplant patients between centres as highlighted previously, caution needs to be exercised when comparing centre performance.

The 71 renal centres in the UK comprise 52 centres in England, five in Wales, five in Northern Ireland and nine in Scotland. Four centres (Bangor, Colchester, Liverpool Aintree and Wirral) were reported as having no transplanted patients and were therefore excluded. After

Table 3.5. Distribution of prevalent patients on RRT by centre and modality on 31/12/2012

Centre	Total	% HD	% PD	% Transplant
Transplant centres				
B QEH	1,971	47	8	45
Belfast	701	33	4	63
Bristol	1,337	37	5	58
Camb	1,113	31	3	65
Cardff	1,548	31	5	64
Covnt	900	40	11	49
Edinb	722	37	5	58
Glasgw	1,549	40	3	57
L Barts	1,955	46	10	44
L Guys	1,745	36	2	62
L Rfree	1,865	38	6	55
L St George's	724	39	7	53
L West	3,104	46	2	52
Leeds	1,416	35	6	59
Leic	1,982	44	8	48
Livrpl RI	1,241	29	5	65
Man RI	1,710	30	5	66
Newc	946	30	5	65
Nottm	1,006	37	8	55
Oxford	1,535	28	6	67
Plymth	459	29	8	64
Ports	1,447	38	6	56
Sheff	1,307	45	5	50
Dialysis centres				
Abrdn	504	46	5	49
Airdrie	388	50	3	47
Antrim	225	59	6	36
B Heart	670	65	7	28
Bangor	105	86	14	
Basldn	264	62	12	26
Bradfd	508	41	6	53
Brightn	831	45	10	45
Carlis	216	28	13	59
Carsh	1,475	52	8	41
Chelms	224	58	12	31
Clwyd	172	49	10	41
Colchester	117	100		
D & Gall	128	40	13	48
Derby	477	46	19	35
Doncaster	261	66	11	23
Dorset	610	43	8	50
Dudley	316	53	20	27
Dundee	403	45	5	50
Dunfn	278	53	7	40
Exeter	846	47	9	44
Glouc	417	53	9	39
Hull	789	42	11	46
Inverns	218	34	8	58
Ipswi	339	38	9	53
Kent & Canterbury	922	42	7	52
Klmarnk	302	50	14	37
L Kings	918	54	9	37
Livrpl Ain	195	90	10	
Middlbr	789	43	1	56
Newry	188	48	9	43

Table 3.5. Continued

Centre	Total	% HD	% PD	% Transplant
Norwch	612	52	9	39
Prestn	1,081	50	6	44
Redng	671	40	11	49
Salford	882	43	12	45
Shrew	354	55	12	33
Stevng	665	62	5	34
Sthend	213	55	7	38
Stoke	695	44	11	45
Sund	421	47	5	48
Swanse	662	50	10	40
Truro	377	41	6	53
Ulster	148	73	5	22
West NI	258	52	7	40
Wirral	234	86	14	
Wolve	528	54	17	29
Wrexm	249	39	9	53
York	396	34	8	58
England	**46,076**	**43**	**7**	**50**
Northern Ireland	**1,520**	**46**	**6**	**49**
Scotland	**4,492**	**43**	**5**	**52**
Wales	**2,736**	**39**	**7**	**53**
UK	**54,824**	**43**	**7**	**50**

Blank cells denote no patients on that modality

Table 3.6. Median age and gender ratio of incident and prevalent transplant patients 2007–2012

	Incident transplants			Prevalent transplants*		
Year	*N*	Median age	M : F ratio	*N*	Median age	M : F ratio
2007	2,133	45.6	1.6	20,744	50.2	1.5
2008	2,343	46.4	1.5	22,229	50.4	1.5
2009	2,493	48.3	1.6	23,480	50.8	1.5
2010	2,581	49.6	1.7	24,876	51.2	1.6
2011	2,625	49.1	1.7	26,168	51.7	1.6
2012	2,782	50.5	1.6	27,621	52.2	1.6

*As on 31st December for given year

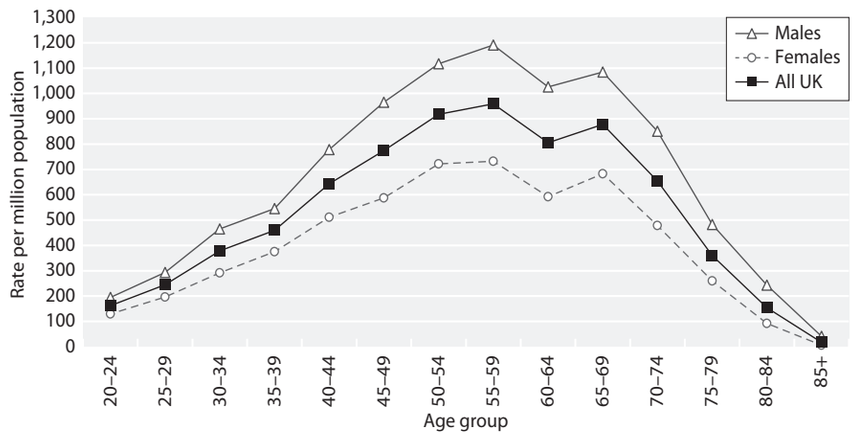

Fig. 3.1. Transplant prevalence rate per million population by age and gender on 31/12/2012

Table 3.7. Primary renal diagnosis in renal transplant recipients 2007–2012

	New transplants by year							Established transplants on 01/01/2012	
	2007	2008	2009	2010	2011	2012			
Primary diagnosis	%	%	%	%	%	%	*N*	%	*N*
Aetiology uncertain	15.2	14.5	14.0	13.8	14.4	11.9	322	15.8	4,140
Diabetes	14.9	12.9	12.8	11.8	12.5	14.8	399	9.3	2,428
Glomerulonephritis	23.2	21.9	23.3	19.4	22.6	22.5	609	23.1	6,050
Polycystic kidney disease	13.4	13.4	13.1	13.3	12.3	13.3	359	12.6	3,294
Pyelonephritis	11.7	12.1	11.2	9.3	10.1	9.8	265	13.6	3,555
Reno-vascular disease	5.4	6.7	5.9	6.8	6.5	6.8	184	5.6	1,471
Other	15.0	16.5	15.2	15.6	16.4	17.4	470	16.5	4,311
Not available	1.0	1.9	4.5	10.1	5.3	3.5	95	3.5	919

exclusion of these four centres, prevalent patient data from 67 renal centres across the UK were analysed.

For the one year post-transplant analyses, in which patients were assigned to the centre that performed their transplant, all 23 transplant centres across the UK were included in the analysis for the first time this year.

Methods

Data for key laboratory variables are reported for all prevalent patients with valid data returns for a given renal centre (both transplanting and non-transplanting centres) and for one year post-transplant results for patients transplanted 2005–2011, with patients attributed to the transplant centre that performed the procedure.

Time since transplantation may have a significant effect on key biochemical and clinical variables and this is likely to be independent of a centre's clinical practices. Therefore, inter-centre comparison of data on prevalent transplant patients is open to bias. To minimise bias relating to fluctuations in biochemical and clinical parameters occurring in the initial post-transplant period, one year post-transplantation outcomes are also reported. It is presumed that patient selection policies and local clinical practices are more likely to be relevant in influencing outcomes 12 months post-transplant and therefore comparison of outcomes between centres is more robust. However, even the 12 months post-transplant comparisons could be biased by the fact that in some centres, repatriation of patients only occurs if the graft is failing whereas in others it only occurs if the graft function is stable.

Centres with <20 patients or <50% data completeness have been excluded from the figures. Scottish centres were also excluded from blood pressure analyses as data not provided.

Prevalent patient data

Biochemical and clinical data for patients with a functioning transplant followed in either a transplanting or non-transplanting centre were included in the analyses. The cohort consisted of prevalent patients as on 31st December 2012. Patients were considered as having a functioning transplant if 'transplant' was listed as the last mode of RRT in the last quarter of 2012. Patients were assigned to the renal centre that sent the data to the UKRR but some patients will have received care in more than one centre. If data for the same transplant patient were received from both the transplant centre and non-transplant centre, care was allocated to the non-transplant centre. Patients with a functioning transplant of less than three months duration were excluded from analyses. For haemoglobin, estimated glomerular filtration rate (eGFR), corrected calcium, phosphate and blood pressure (BP), the latest value in quarter 3 or quarter 4 of 2012 was used.

Estimated glomerular filtration rate (eGFR)

For the purpose of eGFR calculation, the original 4–variable MDRD formula was used (with a constant of 186) to calculate eGFR from the serum creatinine concentration as reported by the centre (unless otherwise stated). A wide variety of creatinine assays are in use in clinical biochemistry laboratories in the UK, and it is not possible to ensure that all measurements of creatinine concentration collected by the UKRR are harmonised. Although many laboratories are now reporting assay

Table 3.8. Ethnicity of patients who received a transplant in the years 2007–2012

Year	% White	% S Asian	% Black	% Other	% Unknown
2007	76.9	8.2	5.5	2.1	7.3
2008	74.8	8.9	6.3	1.8	8.2
2009	73.5	10.3	6.7	2.4	7.1
2010	74.4	10.4	5.9	2.3	6.9
2011	74.1	9.5	6.2	2.5	7.7
2012	71.8	9.8	7.2	2.9	8.2

Table 3.9a. Percentage completeness by centre for prevalent transplant patients on 31/12/2012[a]

Centre	*N*	Ethnicity	eGFR[b]	Blood pressure
England				
B Heart	181	100	97	3
B QEH	858	100	94	93
Basldn	66	100	100	2
Bradfd	261	98	86	69
Brightn	363	97	88	0
Bristol	755	100	99	72
Camb	686	98	99	97
Carlis	123	100	96	0
Carsh	565	97	90	0
Chelms	67	97	96	94
Covnt	423	100	95	81
Derby	159	100	96	83
Donc	59	100	100	100
Dorset	293	100	89	81
Dudley	83	100	96	16
Exeter	365	100	99	92
Glouc	156	100	100	89
Hull	348	61	97	25
Ipswi	178	100	98	0
Kent	454	100	59	85
L Barts	836	100	99	0
L Guys	1,054	99	94	0
L Kings	329	98	99	0
L RFree	1,002	98	98	77
L St.G	378	88	96	0
L West	1,590	100	96	0
Leeds	810	99	97	96
Leic	930	97	97	48
Liv RI	794	100	89	2
M RI	1,080	99	98	0
Middlbr	423	100	96	46
Newc	603	100	99	0
Norwch	232	100	97	41
Nottm	535	100	100	87
Oxford	978	97	99	16
Plymth	280	100	97	85
Ports	784	100	95	19
Prestn	466	100	98	0
Redng[c]	326	100	98	0
Salford	384	100	97	0
Sheff	627	100	99	97
Shrew	116	100	63	1
Stevng	216	100	67	23
Sthend	79	100	99	61
Stoke	309	65	98	0
Sund	194	100	100	0
Truro	191	100	98	19
Wolve	146	100	98	95
York	221	95	99	53
N Ireland				
Antrim	79	100	99	65
Belfast	432	100	98	45
Newry	78	100	100	86
Ulster	31	100	97	90
West NI	101	100	98	93
Scotland				
Abrdn	245	62	98	n/a
Airdrie	178	41	63	n/a
D & Gall	61	13	95	n/a
Dundee	196	72	98	n/a
Dunfn	107	28	96	n/a
Edinb	401	10	96	n/a
Glasgw	841	10	82	n/a
Inverns	121	94	13	n/a
Klmarnk	110	76	65	n/a
Wales				
Cardff	964	100	99	98
Clwyd	68	99	0	0
Swanse	251	100	100	100
Wrexm	129	100	78	0
England	**22,356**	**98**	**95**	**37**
N Ireland	**721**	**100**	**98**	**60**
Scotland	**2,260**	**32**	**83**	**n/a**
Wales	**1,412**	**100**	**92**	**84**
UK	**26,749**	**93**	**94**	**41**

[a]Scottish centres excluded from blood pressure analysis as data not provided by the Scottish Renal Registry
[b]Patients with missing ethnicity were classed as White for eGFR calculation
[c]Data relating to blood pressure could not be extracted from this centre due to technical problems

results that have been aligned to the isotope dilution-mass spectrometry standard (which would necessitate use of the modified MDRD formula), this was not the case at the end of 2012. Patients with valid serum creatinine results but no ethnicity data were classed as White for the purpose of the eGFR calculation.

One year post-transplant data

Patients who received a renal transplant between 1st January 2005 and 31st December 2011 were assigned according to the renal centre in which they were transplanted. In a small number of instances, the first documented evidence of transplantation in a patient's record is from a timeline entry in data returned from a non-transplant centre, in these instances the patient was re-assigned to the nearest transplant centre (table 3.10).

Patients who had died or experienced graft failure within 12 months of transplantation were excluded from the analyses. Patients with more than one transplant during 2005–2011 were included as separate episodes provided each of the transplants functioned for a year.

For each patient, the most recent laboratory or blood pressure result for the relevant 4th/5th quarter (10–15 months) after renal transplantation was taken to be representative of the one year post-transplant outcome. Again, for the purpose of the eGFR

Table 3.9b. Percentage completeness by centre for prevalent transplant patients on 31/12/2012[a]

Centre	*N*	Haemoglobin	Total serum cholesterol	Adjusted serum calcium[b]	Serum phosphate	Serum PTH
England						
B Heart	181	95	41	92	92	2
B QEH	858	94	73	94	93	0
Basldn	66	98	47	98	62	32
Bradfd	261	82	47	83	75	55
Brightn	363	88	20	79	79	20
Bristol	755	99	70	99	99	98
Camb	686	99	77	99	99	93
Carlis	123	94	65	93	88	19
Carsh	565	90	47	88	88	0
Chelms	67	94	66	96	81	25
Covnt	423	95	0	92	75	38
Derby	159	94	75	92	89	79
Donc	59	100	86	100	100	22
Dorset	293	89	55	85	60	20
Dudley	83	96	63	98	98	41
Exeter	365	99	71	98	97	21
Glouc	156	100	43	97	97	40
Hull	348	97	21	97	97	18
Ipswi	178	98	38	98	98	62
Kent	454	95	45	93	93	0
L Barts	836	98	98	99	99	67
L Guys	1,054	94	33	89	89	33
L Kings	329	99	41	99	99	22
L RFree	1,002	98	67	97	97	71
L St.G	378	96	16	96	96	16
L West	1,590	96	20	96	96	17
Leeds	810	97	85	97	97	49
Leic	930	96	88	96	96	56
Liv RI	794	89	57	85	87	68
M RI	1,080	99	43	98	98	59
Middlbr	423	95	31	92	91	12
Newc	603	98	69	98	98	45
Norwch	232	98	93	94	94	24
Nottm	535	100	55	97	92	78
Oxford	978	99	55	98	98	29
Plymth	280	97	41	95	94	42
Ports	784	94	35	92	88	17
Prestn	466	98	41	95	92	2
Redng	326	98	76	97	80	40
Salford	384	91	76	94	94	82
Sheff	627	99	41	99	99	25
Shrew	116	91	67	77	78	7
Stevng	216	96	70	91	88	54
Sthend	79	99	29	96	96	13
Stoke	309	98	98	98	98	39
Sund	194	100	85	100	100	88
Truro	191	98	60	96	96	57
Wolve	146	97	60	94	82	37
York	221	85	55	98	95	21

Table 3.9b. Continued

Centre	*N*	Haemoglobin	Total serum cholesterol	Adjusted serum calcium[b]	Serum phosphate	Serum PTH
N Ireland						
Antrim	79	96	99	96	99	97
Belfast	432	97	97	97	97	24
Newry	78	99	99	99	99	83
Ulster	31	97	97	97	97	55
West NI	101	97	96	92	93	60
Scotland						
Abrdn	245	98	n/a	n/a	96	n/a
Airdrie	178	98	n/a	n/a	98	n/a
D & Gall	61	100	n/a	n/a	95	n/a
Dundee	196	98	n/a	n/a	97	n/a
Dunfn	107	96	n/a	n/a	95	n/a
Edinb	401	95	n/a	n/a	94	n/a
Glasgw	841	99	n/a	n/a	98	n/a
Inverns	121	4	n/a	n/a	2	n/a
Klmarnk	110	96	n/a	n/a	95	n/a
Wales						
Cardff	964	99	74	99	98	12
Clwyd	68	94	94	94	94	59
Swanse	251	98	68	98	98	57
Wrexm	129	97	89	97	97	95
England	**22,356**	**96**	**55**	**95**	**93**	**40**
N Ireland	**721**	**97**	**97**	**97**	**97**	**45**
Scotland[a]	**2,260**	**93**	**n/a**	**n/a**	**91**	**n/a**
Wales	**1,412**	**98**	**75**	**98**	**98**	**30**
UK	**26,749**	**96**	**57**[c]	**95**[c]	**93**	**40**[c]

[a]Limited dataset provided by the Scottish Renal Registry for Scottish centres shown and included in corresponding UK analyses
[b]Serum calcium corrected for serum albumin
[c]Excluding Scotland

calculation patients with valid serum creatinine results but missing ethnicity data were classed as White.

Results and discussion

Post-transplant eGFR in prevalent transplant patients

When interpreting eGFR post-transplantation, it is important to remember that estimated GFR formulae only have a modest predictive performance in the transplant population [4]. Median eGFR in each centre and percentage of patients with eGFR <30 ml/min/1.73 m^2 are shown in figures 3.2 and 3.3. The median eGFR was 51.3 ml/min/1.73 m^2, with 13.7% of prevalent transplant recipients having an eGFR <30 ml/min/1.73 m^2. Table 3.11 summarises the proportion of transplant patients with an eGFR <30 ml/min/1.73 m^2 by centre. Whilst local repatriation policies on timing of transfer of care for patients with failing transplants from transplant centres to referring centres might explain some of the differences, it is notable that both transplanting and non-transplanting centres feature at both ends of the scale. The accuracy of the 4–variable MDRD equation in estimating GFR $\geqslant 60$ ml/min/1.73 m^2 is questionable [5], therefore a figure describing this is not included in this chapter.

Figure 3.4 shows the percentage of prevalent patients by centre with eGFR <30 ml/min/1.73 m^2 as a funnel plot, enabling a more reliable comparison of outcomes between centres across the UK. The solid lines show the 2 standard deviation limits (95%) and the dotted lines the limits for 3 standard deviations (99.9%). With 65 centres included and a normal distribution, 3–4 centres would be expected to fall between the 95–99% CI (1 in 20) and no centres should fall outside the 99.9% limits.

There continued to be variation between centres; these data show over-dispersion with 17 centres falling outside the 95% CI of which eight centres were outside the 99.9% CI. Four centres (Newry, London St Georges, London West, Nottingham) fell outside the lower 99.9% CI suggesting a lower than expected proportion of patients with eGFR <30 ml/min/1.73 m^2. Liverpool RI, Portsmouth, Manchester RI and London Barts fell outside the upper 99.9% CI suggesting a higher than

Table 3.10. Number of patients per transplant centre after allocation of patients in non-transplant centres (transplanted between 2005–2011)

Transplant centre	Total patients per transplant centre *N*	Non-transplant centre	Patients reallocated to a transplant centre *N*
B QEH	877	Stoke	2
Belfast	331	Antrim	2
		Newry	7
		Ulster	1
		West NI	7
Bristol	687	Dorset	2
Camb	1,029	Stevng	1
Cardff	731	Swansea	2
Covnt	357		n/a
Edinb	606	Abrdn	5
		Dundee	8
		Inverns	2
Glasgw	570	Airdrie	1
L Barts	678		n/a
L Guys	1,156	Basldn	1
		Kent	1
		L Kings	2
L Rfree	578		n/a
L St.G	455	Carsh	2
L West	1,075		n/a
Leeds	903		n/a
Leic	526		n/a
Liv RI	559	Prestn	1
M RI	866	Salford	2
Newc	778	Middlbr	2
Nottm	377		n/a
Oxford	1,063		n/a
Plymth	416		n/a
Ports	424		n/a
Sheff	377		n/a
Total	**15,419**		**51**

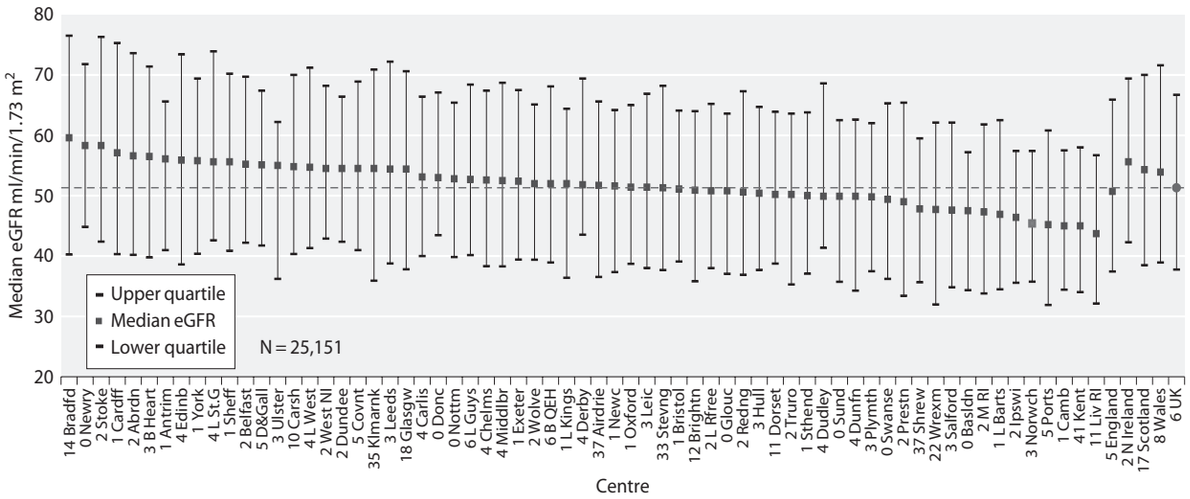

Fig. 3.2. Median eGFR in prevalent transplant patients by centre on 31/12/2012

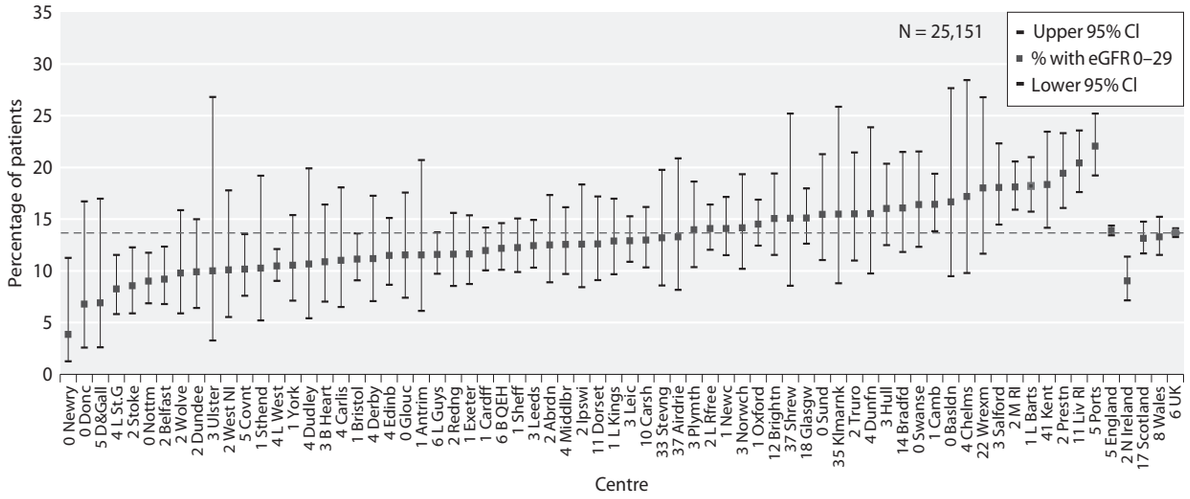

Fig. 3.3. Percentage of prevalent transplant patients by centre on 31/12/2012 with eGFR <30 ml/min/1.73 m^2

Table 3.11. Proportion of prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 on 31/12/2012

Centre	Patients with eGFR data *N*	Percentage with eGFR <30	Centre	Patients with eGFR data *N*	Percentage with eGFR <30
Ulster	30	10.0	Stoke	304	8.6
D & Gall	58	6.9	Brightn	319	15.0
Donc	59	6.8	Redng	319	11.6
Chelms	64	17.2	L Kings	326	12.9
Basldn	66	16.7	Hull	337	16.0
Klmarnk	71	15.5	Exeter	361	11.6
Shrew	73	15.1	L St.G	364	8.2
Dudley	75	10.7	Salford	371	18.1
Antrim	78	11.5	Edinb	383	11.5
Newry	78	3.8	Covnt	403	10.2
Sthend	78	10.3	Middlbr	406	12.6
West NI	99	10.1	Belfast	424	9.2
Wrexm	100	18.0	Prestn	458	19.4
Dunfn	103	15.5	Carsh	509	13.0
Airdrie	113	13.3	Nottm	533	9.0
Carlis	118	11.0	Newc	596	14.1
Wolve	143	9.8	Sheff	621	12.2
Stevng	144	13.2	Camb	682	16.4
Derby	152	11.2	Glasgw	689	15.1
Glouc	156	11.5	Liv RI	705	20.4
Ipswi	175	12.6	Ports	739	22.1
B Heart	175	10.9	Bristol	745	11.1
Truro	187	15.5	Leeds	789	12.4
Dundee	192	9.9	B QEH	806	12.2
Sund	194	15.5	L Barts	824	18.2
York	218	10.6	Leic	899	12.9
Bradfd	224	16.1	Cardff	954	11.9
Norwch	226	14.2	Oxford	965	14.5
Abrdn	240	12.5	L Rfree	980	14.1
Swanse	250	16.4	L Guys	994	11.6
Dorset	262	12.6	M RI	1,060	18.1
Kent	267	18.4	L West	1,530	10.5
Plymth	272	14.0			

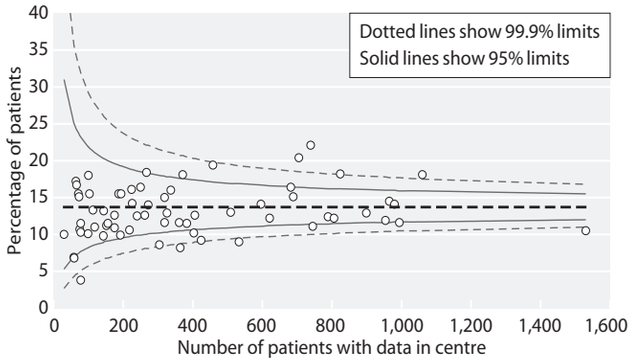

Fig. 3.4. Funnel plot of percentage of prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 by centre size on 31/12/2012

expected proportion of patients with eGFR <30 ml/min/1.73 m^2.

eGFR in patients one year after transplantation

Graft function at one year post-transplantation may predict subsequent long term graft outcome [6]. Figures 3.5a, 3.5b, and 3.5c show the median one year post-transplant eGFR for patients transplanted between 2005–2011, by transplant type. Living kidney donation had the highest median eGFR at one year (56.4 ml/min/1.73 m^2), followed by donation after brainstem death (52.7 ml/min/1.73 m^2) and donation after circulatory death (49.4 ml/min/1.73 m^2).

Figures 3.6a, 3.6b and 3.6c show one year post-transplant eGFR by donor type and year of transplantation. An upward trend in eGFR ($p < 0.001$) over the time period was noticed with both live and donation after brainstem death transplant, but not with donation after circulatory death ($p = 0.5$).

Haemoglobin in prevalent transplant patients

Transplant patients have previously fallen under the remit of the UK Renal Association Complications of Chronic Kidney Disease (CKD) guidelines. Updated guidelines regarding the management of anaemia in CKD were published by the association in November 2010 [7] which have now been adopted for this report. These guidelines recommend *achieving a population distribution centred on a mean of 11 g/dl with a range of 10–12 g/dl [8]* (equivalent to 110 g/L, range 100–120 g/L). However, many transplant patients with good transplant function will have haemoglobin concentrations >120 g/L without the use of erythopoiesis stimulating agents, and so it is inappropriate to audit performance using the higher limit.

A number of factors including comorbidity, immunosuppressive medication, graft function, ACE inhibitor use, erythropoietin (EPO) use, intravenous or oral iron use, as well as centre practices and protocols for management of anaemia, affect haemoglobin concentrations in transplant patients. Most of these data are not collected by the UKRR and therefore caution must be used when interpreting analyses of haemoglobin attainment. Figures 3.7a and 3.7b report centre results stratified according to graft function as estimated by eGFR. The percentage of prevalent transplant patients achieving Hb ⩾100 g/L in each centre, stratified by eGFR, is displayed in figures 3.8a and 3.8b.

Figure 3.9 describes the percentage of prevalent patients by centre with haemoglobin <100 g/L as a funnel plot enabling more reliable comparison of outcomes between centres across the UK. With 65 centres included and a normal distribution, 3–4 centres would be expected to fall between the 95%–99.9% CI (1 in 20) and no centres should fall outside the 99.9% CI purely as a chance event.

One centre (London Barts) fell outside the upper 99.9% CI and three further centres (London Royal Free, Norwich and Oxford) fell outside the upper 95% CI indicating a higher than predicted proportion of transplant patients not achieving the haemoglobin target. Six centres fell outside the lower 99.9% CI, indicating they performed better than expected with fewer than predicted patients having a haemoglobin <100 g/L.

Blood pressure in prevalent transplant patients

In the absence of controlled trial data, the opinion based recommendation of the UK Renal Association (RA) published in the 2010 guideline for the care of kidney transplant recipients is that '***Blood pressure should be <130/80 mmHg (or <125/75 mmHg if proteinuria)'*** [9]. This blood pressure target is the same as that used in previous annual reports [10].

As indicated in table 3.9a, completeness for blood pressure data returns was variable and only centres with >50% data returns were included for consideration. Despite this restriction, caution needs to be exercised in interpretation of these results because of the volume of missing data and potential bias, (e.g. a centre may be more likely to record and report blood pressure data electronically in patients with poor BP control). Figures 3.10a and 3.10b show the percentage of patients with a blood pressure of <130/80 mmHg, by eGFR. The percentage of patients with BP <130/80 (systolic BP <130 **and** diastolic BP <80 mmHg) was higher (27.6% vs. 24.4%) in those with better renal function (eGFR ⩾30 ml/min/1.73 m^2).

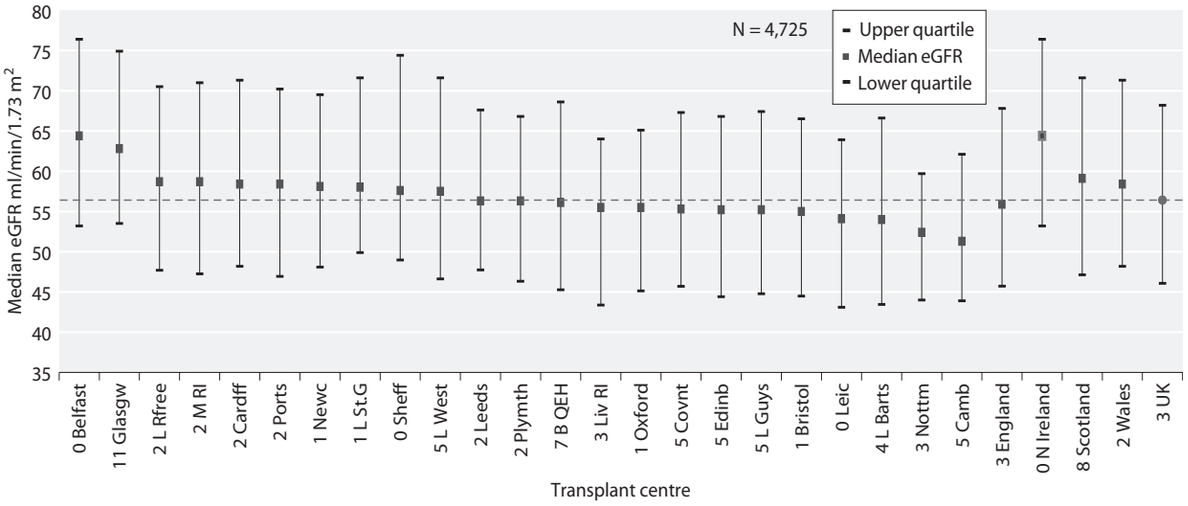

Fig. 3.5a. Median eGFR one year post-live donor transplant by transplant centre 2005–2011

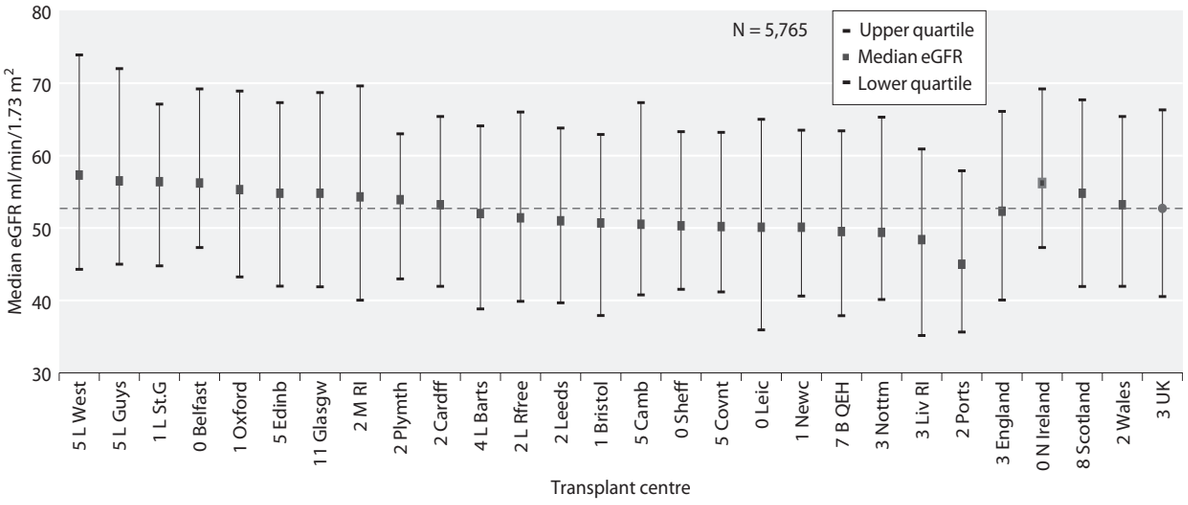

Fig. 3.5b. Median eGFR one year post-brainstem death donor transplant by transplant centre 2005–2011

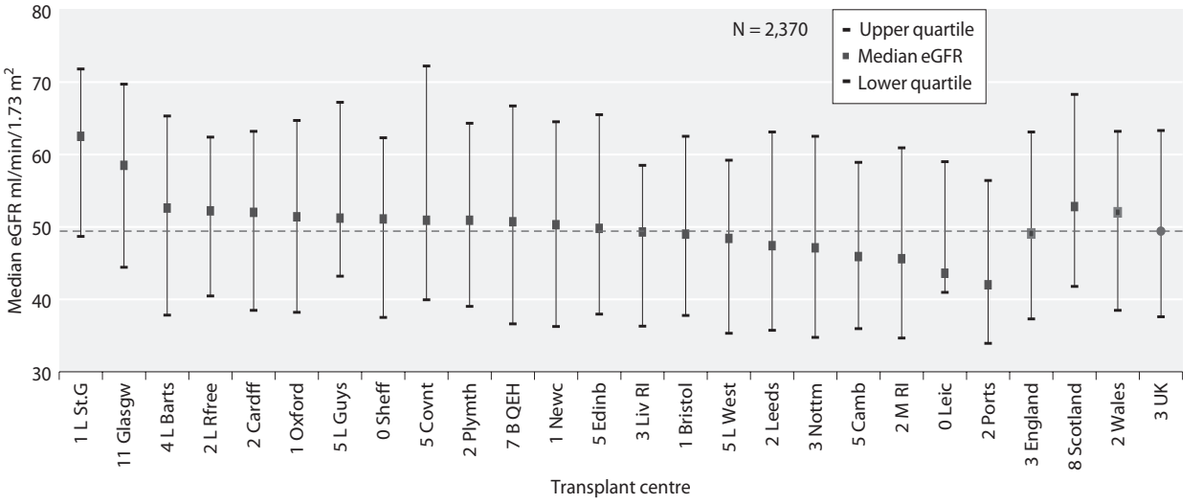

Fig. 3.5c. Median eGFR one year post-circulatory death donor transplant by transplant centre 2005–2011

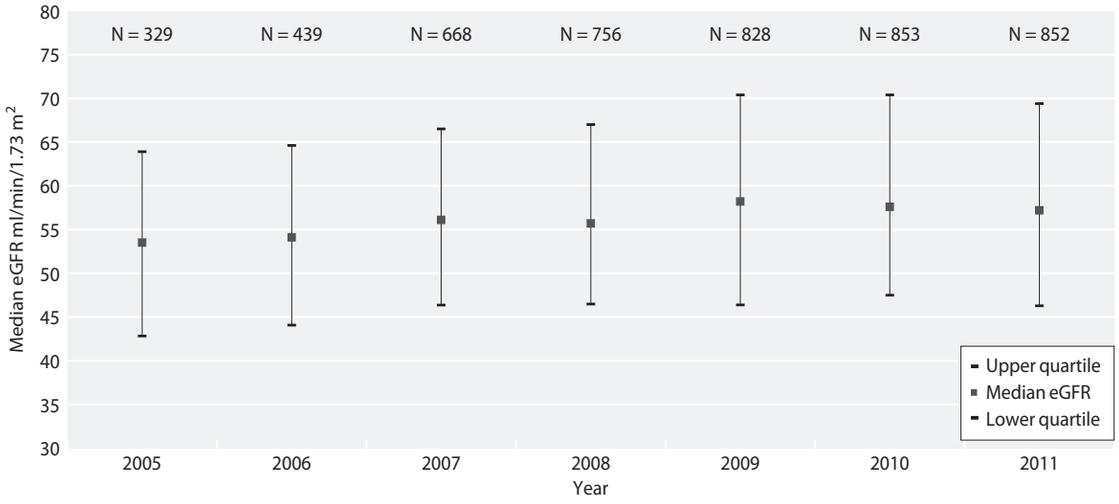

Fig. 3.6a. Median eGFR one year post-live donor transplant by year of transplantation 2005–2011

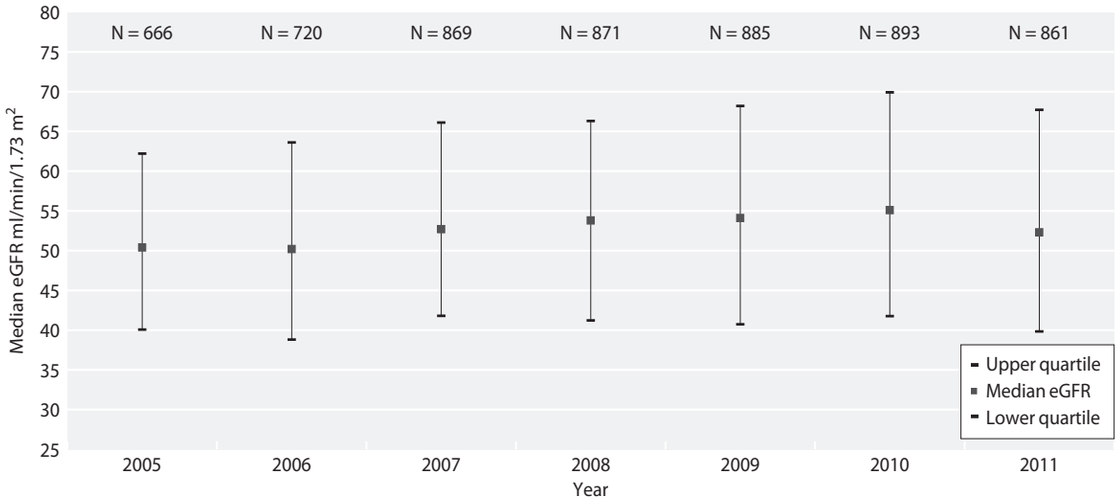

Fig. 3.6b. Median eGFR one year post-brainstem death donor transplant by year of transplantation 2005–2011

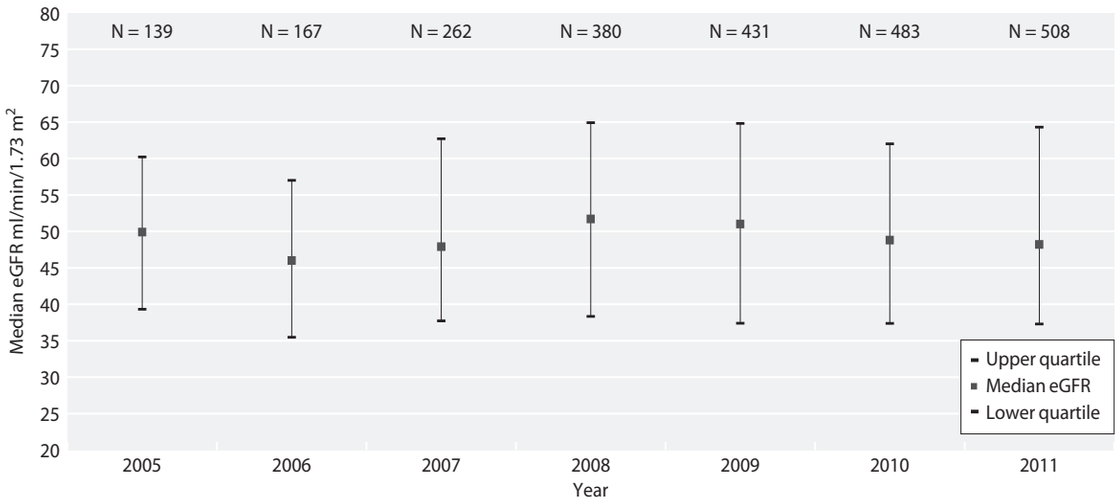

Fig. 3.6c. Median eGFR one year post-circulatory death donor transplant by year of transplantation 2005–2011

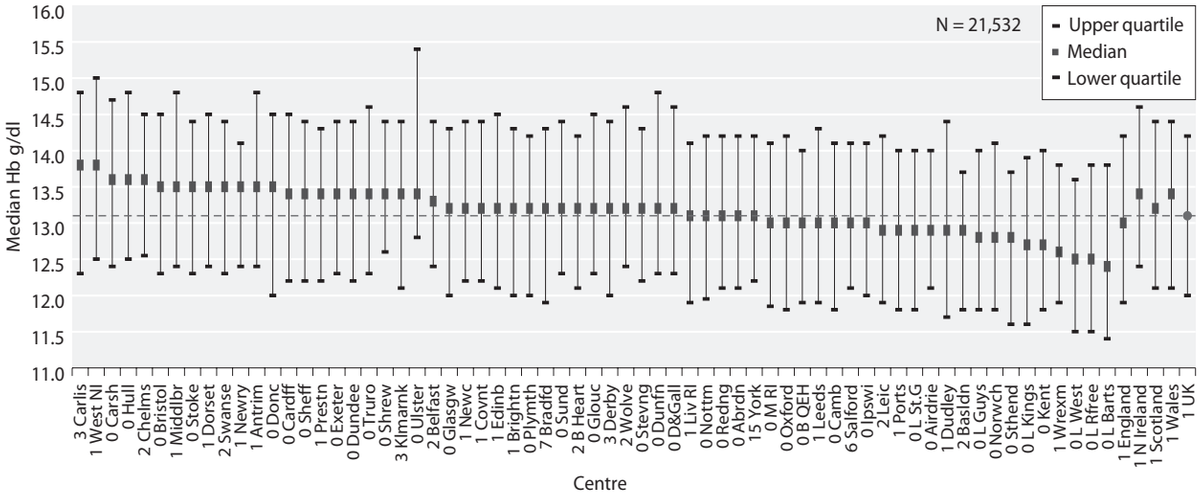

Fig. 3.7a. Median haemoglobin for prevalent transplant patients with eGFR ⩾30 ml/min/1.73 m^2 by centre on 31/12/2012

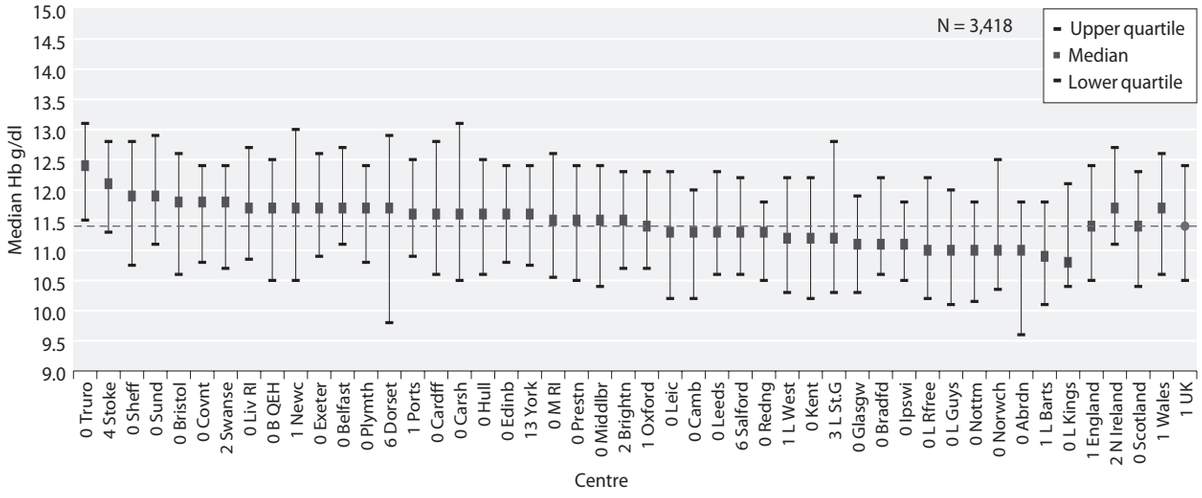

Fig. 3.7b. Median haemoglobin for prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 by centre on 31/12/2012

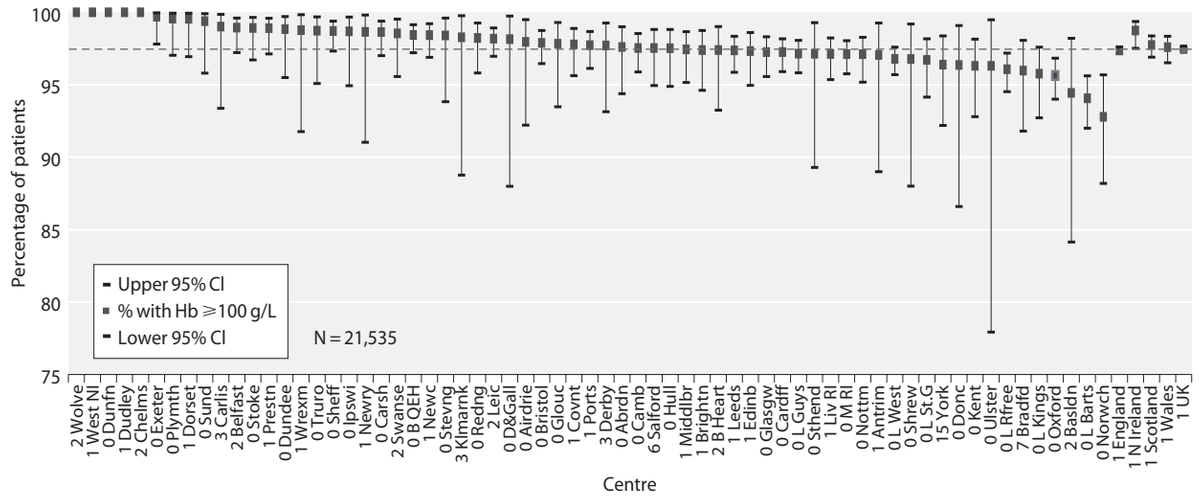

Fig. 3.8a. Percentage of prevalent transplant patients with eGFR ⩾30 ml/min/1.73 m^2 achieving haemoglobin ⩾100 g/L by centre on 31/12/2012

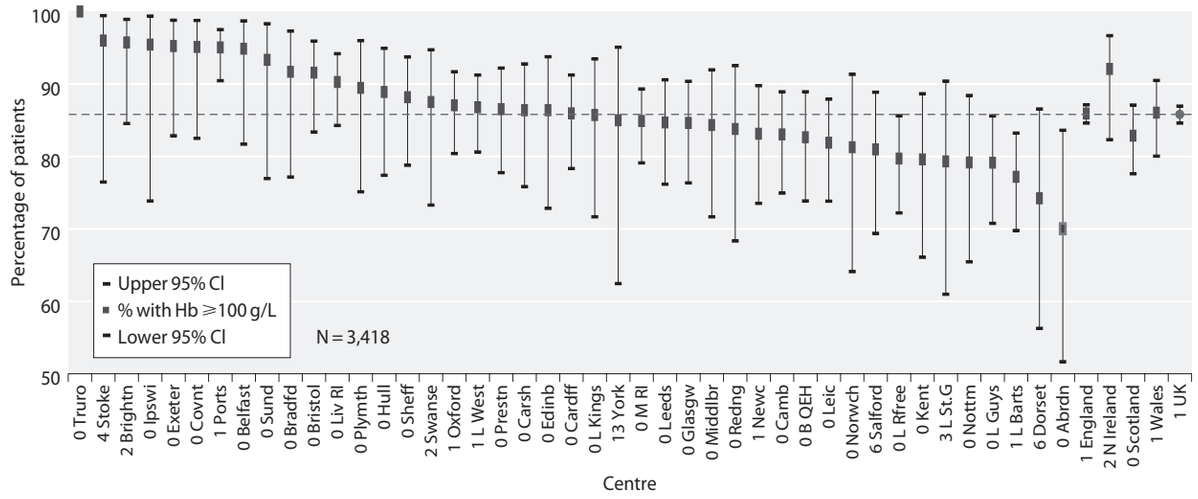

Fig. 3.8b. Percentage of prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 achieving haemoglobin ⩾100 g/L by centre on 31/12/2012

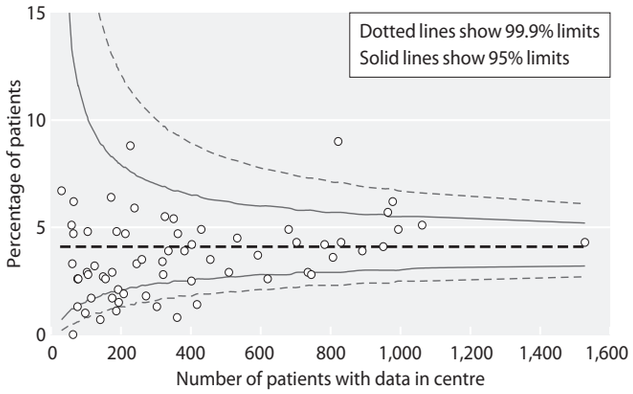

Fig. 3.9. Funnel plot of percentage of prevalent transplant patients with haemoglobin <100 g/L by centre size on 31/12/2012

Analysis of prevalent patients by CKD stage

Introduction

Approximately 2.2% of prevalent transplant patients returned to dialysis in 2012, a similar percentage to that seen over the last few years. Amongst patients with native chronic kidney disease, late presentation is associated with poor outcomes, largely attributable to lack of specialist management of anaemia, acidosis, hyperphosphataemia and to inadequate advance preparation for dialysis. Transplant recipients on the other hand, are almost always followed up regularly in specialist transplant or renal clinics and it would be reasonable to expect patients with

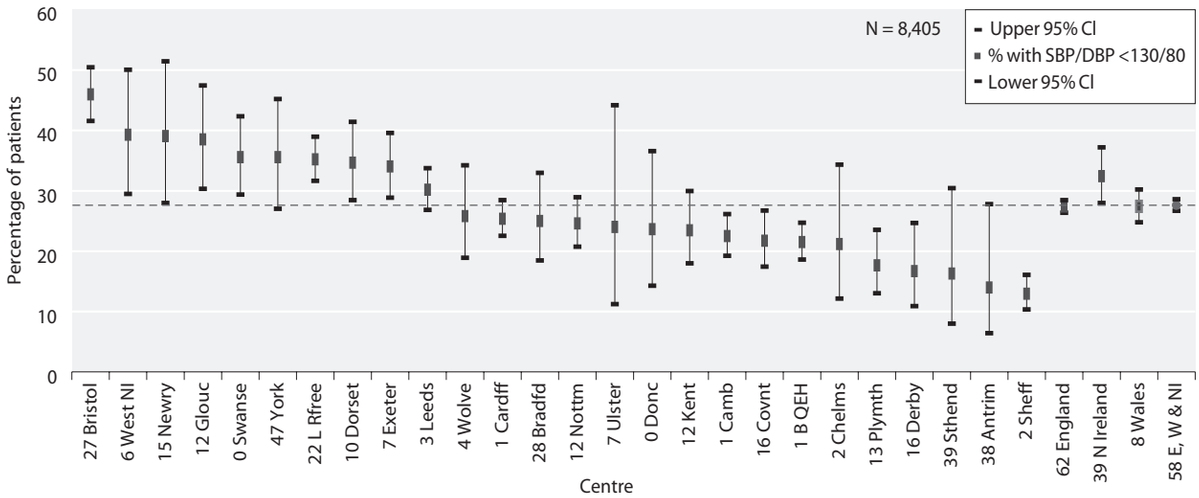

Fig. 3.10a. Percentage of prevalent transplant patients with eGFR ⩾30 ml/min/1.73 m^2 achieving blood pressure of <130/80 mmHg by centre on 31/12/2012

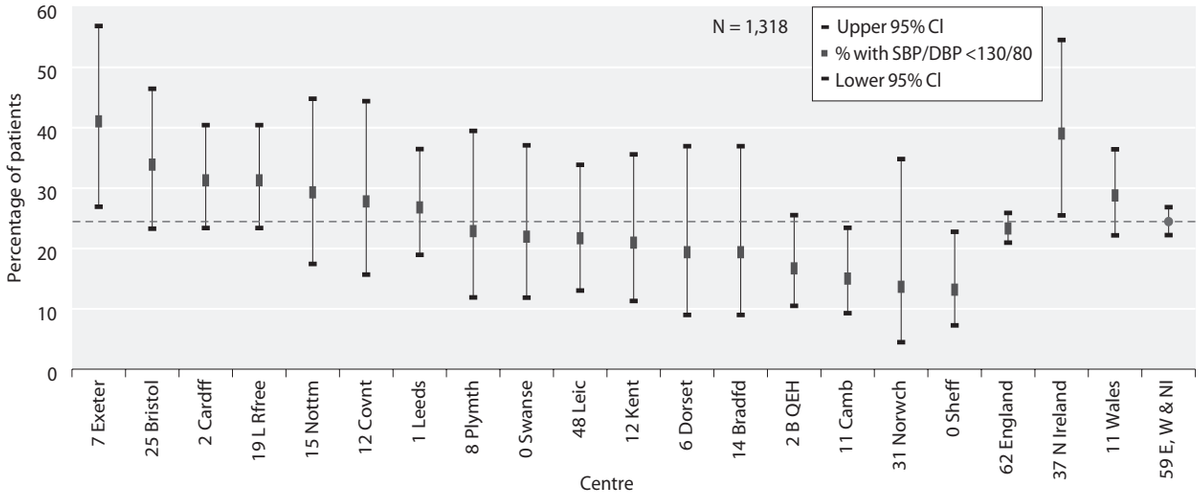

Fig. 3.10b. Percentage of prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 achieving blood pressure of <130/80 mmHg by centre on 31/12/2012

failing grafts to receive appropriate care and therefore have many of their modifiable risk factors addressed before complete graft failure and return to dialysis.

Methods

The transplant cohort consisted of prevalent transplant recipients as on 31st December 2012 ($N = 25{,}166$) and were classified according to the KDIGO staging criteria with the suffix of 'T' to represent their transplant status. Patients with missing ethnicity information were classified as White for the purpose of calculating eGFR. Prevalent dialysis patients, except those who commenced dialysis in 2012, comprised the comparison dialysis cohort ($N = 21{,}242$) including 2,467 peritoneal dialysis patients. Only patients on peritoneal dialysis were considered when examining differences in serum phosphate between transplant recipients and dialysis patients. For both the transplant and dialysis cohorts, the analysis used the most recent available value from the last two quarters of the 2012 laboratory data. Scottish centres were excluded from blood pressure, calcium, cholesterol and PTH analyses as corresponding data was not provided.

Results and discussion

Table 3.12 shows that 13.7% of the prevalent transplant population (3,442 patients), had moderate to advanced renal impairment of eGFR <30 ml/min/1.73 m^2. The table also demonstrates that patients with failing grafts achieved UK Renal Association standards for some key biochemical and clinical outcome variables less often than dialysis patients. This substantial group of patients represents a considerable challenge, as resources need to be channelled to improve key outcome variables and achieve a safe and timely modality switch to another form of renal replacement therapy.

eGFR slope analysis

Introduction

The gradient of deterioration in eGFR (slope) may predict patients likely to have early graft failure. The eGFR slope and its relationship to specific patient characteristics are presented here.

Methods

All UK patients aged ⩾18 years receiving a renal transplant between 1st January 2001 and 31st December 2010, were considered for inclusion. A minimum duration of 18 months graft function was required and three or more creatinine measurements from the second year of graft function onwards were used to plot eGFR slope. If a transplant failed but there were at least three creatinine measurements between 18 months post-transplant and graft failure, the patient was included but no creatinine measurements after the quarter preceding the recorded date of transplant failure were analysed.

Slopes were calculated using linear regression, assuming linearity, and the effect of age, ethnicity, gender, diabetes, donor type, year of transplant and current transplant status were analysed. P values were calculated using the Kruskal-Wallis test. eGFR was calculated using the CKD-EPI equation and results expressed as ml/min/1.73 m^2/year. The CKD-EPI equation was used in preference to the MDRD formula as it is thought to have a greater degree of accuracy at higher levels of eGFR [11].

Results and discussion

The study cohort consisted of 14,783 patients. The median GFR slope was −0.53 ml/min/1.73 m^2/year (table 3.13). The gradient was steeper for Black recipients (−1.23 ml/min/1.73 m^2/year), in keeping with previously

Table 3.12. Analysis by CKD stage for prevalent transplant patients compared with prevalent dialysis patients on 31/12/2012

	Stage 1–2T (⩾60)	Stage 3T (30–59)	Stage 4T (15–29)	Stage 5T (<15)	Stage 5D
Patients *N*	8,713	13,011	3,020	422	21,242
% of patients	34.6	51.7	12.0	1.7	
eGFR ml/min/1.73 m^2[a]					
mean ± SD	77.1 ± 15.0	45.5 ± 8.3	23.8 ± 4.1	11.8 ± 2.4	
median	73.1	45.6	24.3	12.1	
Systolic BP mmHg					
mean ± SD	133.7 ± 17.1	136.1 ± 17.9	139.5 ± 20.2	143.1 ± 22.6	130.9 ± 25.1
% ⩾130	58.7	63.6	69.1	72.6	49.3
Diastolic BP mmHg					
mean ± SD	78.2 ± 10.0	78.0 ± 10.4	78.0 ± 11.6	79.4 ± 11.8	68.4 ± 14.6
% ⩾80	46.8	46.9	46.7	49.0	21.6
Cholesterol mmol/L					
mean ± SD	4.5 ± 1.0	4.6 ± 1.1	4.7 ± 1.2	4.8 ± 1.3	4.0 ± 1.1
% ⩾4	70.0	72.7	72.7	72.6	46.0
Haemoglobin g/L					
mean ± SD	136 ± 16	128 ± 16	116 ± 15	106 ± 15	112 ± 14
% <100	1.3	3.4	11.6	33.3	16.7
Phosphate mmol/L[b]					
mean ± SD	0.9 ± 0.2	1.0 ± 0.2	1.1 ± 0.3	1.5 ± 0.4	1.6 ± 0.4
% >1.7	0.2	0.4	2.0	27.6	35.6
Corrected calcium mmol/L					
mean ± SD	2.4 ± 0.2	2.4 ± 0.2	2.4 ± 0.2	2.4 ± 0.2	2.4 ± 0.2
% >2.5	27.9	27.4	20.2	20.5	18.4
% <2.2	5.3	6.2	9.8	15.7	16.2
PTH pmol/L					
median	8.5	9.5	16.3	32.1	30.0
% >72	0.4	1.0	3.2	17.9	16.2

[a]Prevalent transplant patients with no ethnicity data were classed as White
[b]Only PD patients included in stage 5D, $N = 2,467$

published data suggesting poorer outcomes for this group [12, 13]. There was no statistically significant difference in eGFR slope in recipients of deceased donor kidneys (−0.56 ml/min/1.73 m^2/year) compared to patients who received organs from live donors (−0.48 ml/min/1.73 m^2/year). Female patients had a steeper slope (−0.82 ml/min/1.73 m^2/year) than males (−0.36 ml/min/1.73 m^2/year), as did diabetic patients (−1.02 ml/min/1.73 m^2/year) compared to non-diabetic patients (−0.45 ml/min/1.73 m^2/year). The slope was steeper in younger recipients, possibly reflecting increased risk of immunological damage. As might be expected, the steepest slope was in patients where the transplant subsequently failed. This analysis has assumed linearity of progression of fall in GFR and further work is underway to characterise the patterns of progression more precisely.

The findings in this study differ slightly from previous UKRR work exploring eGFR changes in transplant recipients [14]. This identified that male donor to female recipient transplantation, younger recipients, diabetes, white ethnicity, and human leukocyte antigen (HLA) mismatch were associated with faster decline in eGFR. These differences may be explained by patients with eGFR >60 ml/min/1.73 m^2 at one year post-transplantation being excluded and the more complex multivariable model used in the previous work. Udayaraj and colleagues [14] also adjusted for factors such as HLA mismatch and donor age, which were not available for the patients studied in this chapter.

Table 3.13. Differences in median eGFR slope between prevalent transplant patients

Patient characteristic		*N*	Median slope	Lower quartile	Upper quartile	p-value
Age at transplant	<40	4,808	−0.93	−3.89	1.14	<0.0001
	40–55	5,795	−0.38	−2.64	1.58	
	>55	4,180	−0.34	−2.60	1.57	
Ethnicity	S Asian	1,236	−1.01	−3.78	1.53	<0.0001
	Black	783	−1.23	−4.43	1.02	
	Other	271	−1.26	−4.61	1.53	
	White	11,495	−0.47	−2.84	1.41	
Gender	Male	9,024	−0.36	−2.69	1.56	<0.0001
	Female	5,759	−0.82	−3.56	1.30	
Diabetes	Non-diabetic	12,531	−0.45	−2.88	1.49	<0.0001
	Diabetic	1,816	−1.02	−3.75	1.17	
Donor	Deceased	9,855	−0.56	−2.99	1.39	n.s.
	Live	4,928	−0.48	−3.10	1.60	
Year of transplant	2001	942	−0.54	−2.22	0.68	0.0003
	2002	896	−0.58	−2.30	0.64	
	2003	1,103	−0.54	−2.26	0.89	
	2004	1,281	−0.36	−2.14	1.20	
	2005	1,253	−0.14	−2.10	1.50	
	2006	1,610	−0.50	−2.72	1.29	
	2007	1,750	−0.57	−2.72	1.50	
	2008	1,951	−0.53	−3.17	1.81	
	2009	2,011	−0.90	−4.43	1.95	
	2010	1,986	−0.86	−5.62	3.24	
Status of transplant at end of follow-up	Died	955	−0.94	−3.95	1.74	<0.0001
	Failed	1,048	−5.88	−10.75	−2.83	
	Re-transplanted	65	−4.20	−6.69	−1.62	
	Functioning	12,715	−0.24	−2.36	1.63	
All		**14,783**	**−0.53**	**−3.02**	**1.46**	

n.s. – not significant

Causes of death in transplant recipients

Introduction

Differences in causes of death between dialysis and transplant patients may be expected due to selection for transplantation and use of immunosuppression. Chapter 8 includes a more detailed discussion on causes of death in dialysis patients.

Methods

The cause of death is sent by renal centres as an ERA-EDTA registry code. These have been grouped into the following categories: cardiac disease, cerebrovascular disease, infection, malignancy, treatment withdrawal, other and uncertain.

Some centres have high data returns to the UKRR regarding cause of death, whilst others return no information. Provision of this information is not mandatory.

Analysis of prevalent patients included all those aged over 18 years and receiving RRT on 31st December 2012.

Results and discussion

Tables 3.14, 3.15 and figure 3.11 show the differences in the causes of death between prevalent dialysis and transplant patients. Death due to cardiovascular disease was less common in transplanted patients than in dialysis patients, perhaps reflecting the cardiovascular screening undertaken during transplant work-up; transplant recipients are a pre-selected lower risk group of patients. The leading causes of death amongst transplant patients were infection (23%), other (23%) and malignancy (20%). There has been a reduction over time in the proportion of deaths in transplant patients attributed to cardiovascular or stroke disease (43% in 2003 compared

Table 3.14. Cause of death by modality in prevalent RRT patients on 1/1/2012

	All modalities		Dialysis		Transplant	
Cause of death	*N*	%	*N*	%	*N*	%
Cardiac disease	647	22	575	22	72	18
Cerebrovascular disease	135	5	118	5	17	4
Infection	532	18	437	17	95	23
Malignancy	292	10	208	8	84	20
Treatment withdrawal	511	17	498	19	13	3
Other	624	21	528	20	96	23
Uncertain	245	8	212	8	33	8
Total	**2,986**		**2,576**		**410**	
No cause of death data	1,414	32	1,160	31	254	38

Table 3.15. Cause of death in prevalent transplant patients on 1/1/2012 by age

	All age groups		<65 years		⩾65 years	
Cause of death	*N*	%	*N*	%	*N*	%
Cardiac disease	72	18	36	18	36	17
Cerebrovascular disease	17	4	8	4	9	4
Infection	95	23	48	24	47	22
Malignancy	84	20	42	21	42	20
Treatment withdrawal	13	3	5	3	8	4
Other	96	23	43	22	53	25
Uncertain	33	8	16	8	17	8
Total	**410**		**198**		**212**	
No cause of death data	254	38	126	39	128	38

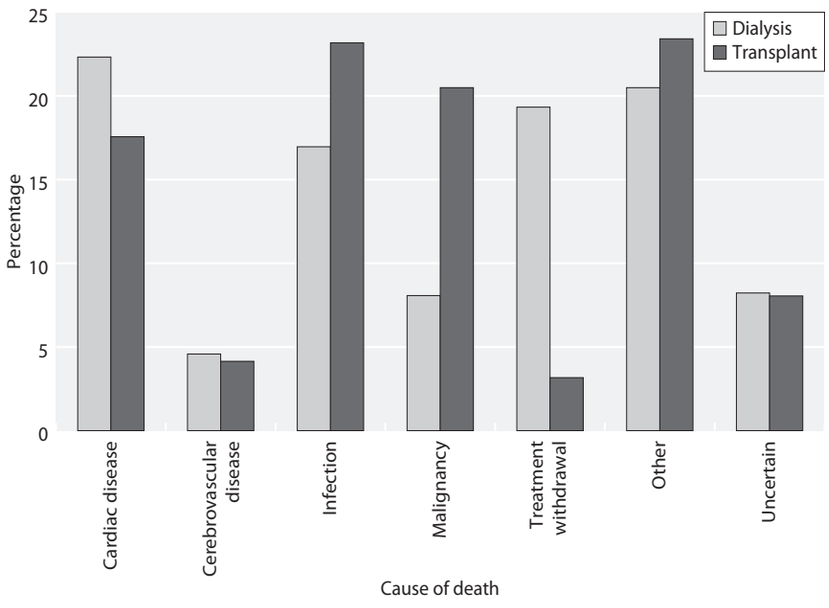

Fig. 3.11. Cause of death by modality for prevalent patients on 1/1/2012

to 22% in 2012) with an increase in the proportion ascribed to infection or malignancy (30% in 2003 compared to 43% in 2011). This change has also been reported in other registries, e.g. ANZDATA (http://www.anzdata.org.au) and may reflect better management of cardiovascular risk (although table 3.12 shows BP management remained suboptimal). Explanations for the rising death rate secondary to malignancy may include the increasing age of transplant recipients and the increased intensity of immunosuppressive regimens leading to complications of over-immunosuppression.

Conflicts of interest: Dr I MacPhee has received research funding and speaker honoraria from Astellas.

References

1 Ansell D, Tomson CRV: UK Renal Registry 11th Annual Report (December 2008) Chapter 15 The UK Renal Registry, UKRR database, validation and methodology. Nephron Clin Pract 2009;111(suppl 1): c277–c285

2 Pruthi R, Ravanan R, O'Neill J, Roderick P, Pankhurst L, Udayaraj U: 15th annual report: Chapter 9 centre variation in access to renal transplantation in the UK (2006–2008). Nephron Clin Pract. 2013; 123(suppl 1):183–93. doi: 10.1159/000353328

3 Pruthi R, Casula A, MacPhee I: UK Renal Registry 15th annual report: Chapter 3 demographic and biochemistry profile of kidney transplant recipients in the UK in 2011: national and centre-specific analyses. Nephron Clin Pract. 2013;123(suppl 1):55–80. doi: 10.1159/000353322

4 Bosma RJ, Doorenbos CRC, Stegeman CA, Homan van der Heide JJ, Navis G: Predictive Performance of Renal Function Equations in Renal Transplant Recipients: An analysis of Patient Factors in Bias. Am J Transplant 2005;5:2183–2203

5 Froissart M, Rossert J, Jacquot C, Paillard M, Houillier P: Predictive Performance of the Modification of Diet in Renal Disease and Cockcroft-Gault Equations for Estimating Renal Function. J Am Soc Nephrol. 2005;16:763–773

6 Hariharan, S, McBride MA, Cherikh WS, Tolleris CB, Bresnahan BA, Johnson CP: Post-transplant renal function in the first year predicts long-term kidney transplant survival. Kidney Int 2002;62:1:311–318

7 UK Renal Association Clinical Practice Guidelines Committee: Anaemia of CKD, 5th Edition. 2010. http://www.renal.org/clinical/GuidelinesSection/AnaemiaInCKD.aspx

8 UK Renal Association Clinical Practice Guidelines Committee: Guideline 3.7: Target haemoglobin. 2007 RA Guidelines – Complications of CKD, 4th Edition. 2007. http://www.renal.org/Clinical/GuidelinesSection/ComplicationsofCKD.aspx

9 UK Renal Association Clinical Practice Guidelines Committee: Guideline: Post-operative Care of the Kidney Transplant Recipient, 5th Edition. 2011. http://www.renal.org/Clinical/GuidelinesSection/Post-operative-Care-Kidney-Transplant-Recipient.aspx

10 UK Renal Association Clinical Practice Guidelines Committee: Guideline 2.1: Treatment of patients with CKD. 2007 RA Guidelines – CKD, 4th Edition. 2007. http://www.renal.org/Clinical/GuidelinesSection/CKD.aspx

11 White CA, Akbari A, Doucette S, Fergusson D, Knoll GA: Estimating Glomerular Filtration Rate in Kidney Transplantation: Is the New Chronic Kidney Disease Epidemiology Collaboration Equation Any Better? Clin Chem 2010;56:3:474–477

12 Ng FL, Holt DW, Chang RWS, MacPhee IAM: Black renal transplant recipients have poorer long-term graft survival than CYP3A5 expressers from other ethnic groups. Nephrol Dial Transplant 2010;25:628–634

13 Isaacs RB, Nock SL, Spencer CE, Connors AF Jr, Wang XQ, Sawyer R, Lobo PI: Racial disparities in renal transplant outcomes. Am J Kidney Dis 1999;34:4:706–712

14 Udayaraj U, Casula A, Ansell D, Dudley CRK, Ravanan R: Chronic Kidney Disease in Transplant Recipients – Is It Different From Chronic Native Kidney Disease? Transplantation 2010;90:7:765–770

UK Renal Registry 16th Annual Report: Chapter 4 Demography of Patients Wait-listed for Renal Transplantation in the UK: National and Centre-specific Analyses

Rishi Pruthi[a], Rachel Hilton[b], Laura Pankhurst[c], Nizam Mamode[b], Alex Hudson[c], Paul Roderick[d], Rommel Ravanan[e]

[a]UK Renal Registry, Bristol, UK; [b]Guys & St Thomas' Hospital, London, UK; [c]Organ Donation and Transplantation Directorate, NHS Blood and Transplant, Bristol, UK; [d]Southampton University, Southampton, UK; [e]Southmead Hospital, Bristol, UK

Key Words
Blood group · Calculated reaction frequency · Demography · End stage renal disease · Established renal failure · Ethnicity · Kidney allocation · Match grade · Prevalence · Renal replacement therapy · Transplantation · Transplant waiting list · Wait listing times

Summary

- There were 6,699 patients registered on the active transplant list for kidney only transplantation at the beginning of 2011.
- The UK population prevalence rate for listing for kidney transplantation was 107 pmp compared with a dialysis prevalence rate of 424 pmp, with wide inter-centre variation.
- A quarter of the patients listed (25%) were from ethnic minority groups (Black or South Asian). Only 10% (61/593) of Black patients were pre-emptively listed compared to 16% of Asian and 17% of White patients.
- The median age of prevalent listed patients on dialysis was 53 years, which was significantly lower than the median age of the prevalent haemodialysis (HD) patients (66.3 years) and those on peritoneal dialysis (PD) (61.7 years), $p < 0.0001$.
- The proportion of patients listed aged 70 or more was 8% in England, 11% in Wales, 7% in Northern Ireland and 6% in Scotland, with wide variation between centres.
- Of patients listed, 50% had blood group type O, whilst blood group AB was the least common accounting for just 3% of listed patients. The percentage of patients listed with blood group B showed inter-centre variation with some centres having more than a quarter of patients listed with blood group B.
- Of all patients listed for kidney transplantation, 43% were sensitised (cRF $\geqslant$10), with nearly a quarter (23%) of all patients listed being highly sensitised (cRF $\geqslant$85). Patients listed on haemodialysis had the largest proportion of highly sensitised patients with 30% having a cRF $\geqslant$85, whilst only 8% of patients listed pre-emptively were highly sensitised.
- Adult White patients had significantly shorter waiting times (1098 days, CI: 1071–1125) as compared to Black patients (1,396 days, CI: 1,301–1,491) or Asian patients (1411 days, CI: 1,334–1,488).
- Median waiting times in highly sensitised patients (2,218 days CI: 1,958–2,478) was more than twice that seen in patients who were not sensitised (1,063 days CI: 1,039–1,087).

Introduction

For suitable patients with established renal failure (ERF), renal transplantation is accepted as the optimal modality of renal replacement therapy, conferring both better quality of life and better life expectancy than dialysis. In the UK, after completing necessary medical and surgical assessment (guided by national guidelines [1]), 'suitable' patients are listed for transplantation on the UK Transplant Registry at NHSBT (National Health Service Blood and Transplant). The number of people registered on this database however are far greater than the number of donor organs available in the UK which has led to the development and implementation of an allocation policy for deceased donor kidneys. This policy aims to ensure equity of allocation whilst taking into account the importance of achieving a good match between donor and recipient.

Allocation policy

All kidneys from deceased donors whose death has been defined by brain-stem death criteria are allocated through the national allocation scheme managed by NHSBT. The current scheme was implemented in 2006 to meet agreed objectives and address issues of inequity of access to transplantation and utilises an evidence-based computer algorithm [2, 3]. This is based on a tier system, with all patients listed for kidney transplantation being allocated into one of five tiers (figure 4.1). Paediatric patients are prioritised within Tiers A and B according to waiting time, whilst within tiers C, D and E patients are prioritised according to a points based system (highest score first), based on seven elements. These are: waiting time, HLA match and age combined, donor-recipient age difference, geographical location of patient relative to donor, HLA-DR homozygosity, HLA-B homozygosity and blood group match (figure 4.1). Full details of the allocation policy can be accessed at: http://www.odt.nhs.uk/pdf/kidney_allocation_policy.pdf.

Whilst the analysis of these variables at a centre level is beyond the scope of a UK Renal Registry (UKRR) report, this report aims to provide clinicians with a better understanding of the 'make-up' of the UK Transplant Registry by:

(i) Defining the prevalence rates of listing, for individual UK countries and by age group
(ii) Providing centre level analysis of listing patterns by age group, ethnicity, gender, calculated HLA antibody reaction frequency (cRF), matchability score, blood group and primary renal disease (PRD)
(iii) Providing median waiting times by ethnicity, blood group and calculated HLA antibody reaction frequency (cRF).

Clinicians may find these analyses provide a better understanding of their practice patterns and service needs.

Methods

These analyses relate to the prevalent patients active on the transplant waiting list in the UK at the beginning of 2011. The cohort was defined as all patients listed for renal transplantation

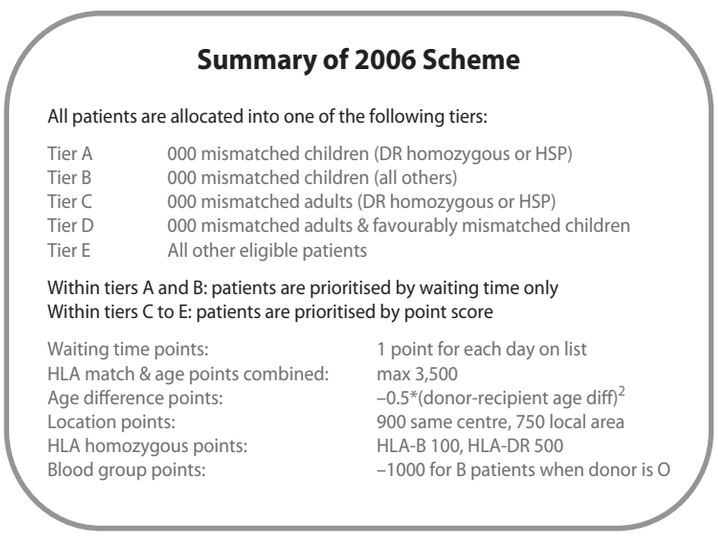

Fig. 4.1. Summary of national allocation scheme

Table 4.1. Prevalence of registration for kidney transplantation and dialysis in the UK on 01/01/2011 (including children <18 years)

	England	N Ireland	Scotland	Wales	**UK**
Total estimated population, mid-2010 (millions)*	52.2	1.8	5.2	3.0	62.3
Total number registered for transplantation	5,748	178	533	240	6,699
Prevalence rate registration for transplantation (pmp)	110	98	102	79	107
Prevalence rate dialysis (pmp)	424	440	415	436	424

*Data from the Office for National Statistics, National Records of Scotland and the Northern Ireland Statistics and Research Agency
pmp = per million population

on the UK Transplant Registry at NHSBT on 1st January 2011. Prevalent listed patients were extracted from the NHSBT database. Patients that had commenced dialysis were matched to the UKRR database. Patients were allocated to renal centres based on the origin of their data returns to the UKRR as opposed to their post-code. Population estimates were obtained from the UK Office of National Statistics (ONS) [4], the National Records of Scotland (NRS) [5] and the Northern Ireland Statistic and Research Agency (NISRA) [6]. Crude prevalence rates were calculated per million population (pmp) and centre level analyses were performed following a merge of data between NHSBT and the UKRR allowing listed patients to be re-allocated to their main renal centre.

The prevalence rate per million population for each centre was calculated using a derived catchment population. For a full description of the methodology used to estimate the catchment populations see appendix E: Methodology for Estimating Catchment Populations (www.renalreg.com). For Scotland, mid-2010 populations of Health Boards (HBs) (from the General Register Office for Scotland) were converted to centre level populations using an approximate mapping of renal centres to HBs supplied by the Scottish Renal Registry. Estimates of the catchment populations in Northern Ireland were supplied by personal communication from Dr D Fogarty.

Throughout this chapter, haemodialysis refers to all modes of HD treatment, including haemodiafiltration (HDF). Several centres reported significant numbers of patients on HDF, but other centres did not differentiate this treatment type in their UKRR returns. Prevalent patients listed for transplantation were examined by gender, ethnicity, age group, primary renal disease, blood group, match grade and calculated HLA antibody reaction frequency (Report appendix H: Coding (www.renalreg.com). Analyses were done for the UK as a whole, by UK country, at centre level and split by treatment modality as appropriate.

Match grade was calculated for each listed patient by NHSBT using a pool of 10,000 donors that were blood group identical, HLA compatible and 000 or favourably (100, 010, 110) HLA mismatched. The match count was then converted into a standardised score, and categorised as: easy to match (1–3), moderate to match (4–7) and difficult to match (8–10). UK and centre analyses were performed using the three generated categories.

Calculated HLA antibody reaction frequency (cRF) for each patient was determined by NHS Blood & Transplant-Organ Donation and Transplantation Directorate (NHSBT–ODT) from the unacceptable HLA specificities reported for each patient. The unacceptable specificities were compared with the HLA types of blood group identical donors from a pool of 10,000 UK donors and the resulting HLA antibody reaction frequency (cRF) was expressed as a percentage of HLA incompatible donors. These were then categorised into five groups: '0–9%', '10–29%', '30–84%', and '⩾85%'; '0–9%' was classed as being un-sensitised, and '⩾85%' was classed as being highly sensitised.

Chi-squared test, Fisher's exact test and Kruskal Wallis tests were used as appropriate to test for significant differences between groups. The data were analysed using SAS 9.3.

Results

Prevalent patient numbers listed for transplantation

There were 6,699 patients registered on the active transplant list for kidney only transplantation at the beginning of 2011, giving a UK population prevalence rate for listing for kidney transplantation of 107 pmp compared with a dialysis prevalence rate of 424 pmp (table 4.1). There were no significant differences in prevalence rates for dialysis in all four of the UK countries; however prevalence rates for listing were significantly lower in Wales at 79 pmp. This may be explained by the higher prevalence rate of dialysis for patients aged >80 seen in Wales who are less likely to be listed. Figure 4.2 shows that Northern Ireland had a higher prevalence rate for listing patients aged 65+ compared with the other UK countries, mirroring the trend seen in prevalence of dialysis patients in UK countries (chapter 2).

Prevalent patients listed for transplantation by RRT modality and centre

The number of prevalent patients listed for transplantation in each renal centre and the distribution of their treatment modalities varied widely (table 4.2). Many factors including geography, local population density, age distribution, ethnic composition, prevalence of diseases predisposing to kidney disease and the social deprivation index of that population may contribute to

Table 4.2. Number of prevalent listed patients by treatment modality and centre on 01/01/2011

Centre	HD	PD	Total number listed on dialysis	Catchment population (millions)	Rate of patients listed on dialysis	
					pmp	95% CI
England						
B Heart	94	13	107	0.74	145	(118–172)
B QEH[a]	208	72	280	1.70	165	(145–184)
Basldn	12	3	15	0.42	36	(18–54)
Bradfd	30	17	47	0.65	72	(51–93)
Brightn	45	21	66	1.30	51	(39–63)
Bristol[a]	83	26	109	1.44	76	(62–90)
Camb[a]	45	6	51	1.16	44	(32–56)
Carlis	13	4	17	0.32	53	(28–78)
Carsh	93	31	124	1.91	65	(53–76)
Chelms	15	13	28	0.51	55	(35–75)
Colchr	14	0	14	0.30	47	(22–71)
Covnt[a]	64	18	82	0.89	92	(72–112)
Derby	36	26	62	0.70	88	(66–110)
Donc	34	9	43	0.41	105	(74–136)
Dorset	59	19	78	0.86	91	(70–111)
Dudley	25	23	48	0.44	109	(78–139)
Exeter	38	22	60	1.09	55	(41–69)
Glouc	23	15	38	0.59	65	(44–85)
Hull	45	17	62	1.02	61	(46–76)
Ipswi	8	10	18	0.40	45	(24–66)
Kent	60	25	85	1.22	69	(55–84)
L Barts[a]	134	61	195	1.83	107	(92–122)
L Guys[a]	100	16	116	1.08	107	(88–127)
L Kings	72	30	102	1.17	87	(70–104)
L Rfree[a]	166	26	192	1.52	126	(109–144)
L St.G[a]	48	13	61	0.80	76	(57–96)
L West[a]	330	14	344	2.40	143	(128–159)
Leeds[a]	111	41	152	1.67	91	(77–105)
Leic[a]	235	71	306	2.44	126	(112–140)
Liv Ain	19	1	20	0.48	41	(23–59)
Liv RI[a]	82	25	107	1.00	107	(87–127)
M RI[a]	115	35	150	1.53	98	(82–114)
Middlbr	58	9	67	1.00	67	(51–83)
Newc[a]	41	25	66	1.12	59	(45–73)
Norwch	40	13	53	0.79	67	(49–86)
Nottm[a]	80	48	128	1.09	118	(97–138)
Oxford[a]	81	43	124	1.69	73	(60–86)
Plymth[ab]	20	13	33	0.47	70	(46–94)
Ports[a]	143	44	187	2.02	92	(79–106)
Prestn	94	30	124	1.49	83	(68–98)
Redng	64	37	101	0.91	111	(89–133)
Salford	99	49	148	1.49	99	(83–115)
Sheff[a]	114	19	133	1.37	97	(80–113)
Shrew	26	8	34	0.50	68	(45–91)
Stevng	83	14	97	1.20	81	(65–97)
Sthend	11	8	19	0.32	60	(33–87)
Stoke	54	20	74	0.89	83	(64–102)
Sund	34	11	45	0.62	73	(52–94)
Truro	28	8	36	0.41	87	(59–116)
Wirral	29	10	39	0.57	68	(47–90)
Wolve	36	19	55	0.67	82	(61–104)
York	28	5	33	0.49	67	(44–90)

Table 4.2. Continued

Centre	HD	PD	Total number listed on dialysis	Catchment population (millions)	Rate of patients listed on dialysis	
					pmp	95% CI
Northern Ireland						
Antrim	11	3	14	0.30	47	(22–71)
Belfast[a]	50	12	62	0.55	113	(85–141)
Newry	20	3	23	0.28	82	(49–116)
Ulster	11	0	11	0.30	37	(15–58)
West NI	36	5	41	0.35	117	(81–153)
Scotland						
Abrdn	37	11	48	0.60	80	(57–103)
Airdrie	27	3	30	0.56	54	(34–73)
D & Gall	10	2	12	0.15	80	(35–125)
Dundee	16	7	23	0.41	56	(33–79)
Dunfn	19	7	26	0.37	70	(43–97)
Edinb[a]	69	22	91	0.96	95	(75–114)
Glasgw[a]	186	24	210	1.51	139	(120–158)
Inverns	14	7	21	0.34	62	(35–88)
Klmarnk	24	11	35	0.37	95	(63–126)
Wales						
Bangor	14	4	18	0.22	83	(44–121)
Cardff[a]	64	29	93	1.42	65	(52–79)
Clwyd	11	2	13	0.19	69	(31–106)
Swanse	45	12	57	0.89	64	(48–81)
Wrexm	8	6	14	0.24	58	(28–89)
England	**3,619**	**1,156**	**4,775**			
N Ireland	**128**	**23**	**151**			
Scotland	**402**	**94**	**496**			
Wales	**142**	**53**	**195**			
UK	**4,291**	**1,326**	**5,617**			

Centres prefixed 'L' are London centres
The numbers of patients calculated for each country quoted above differ marginally from those quoted elsewhere when patients are allocated to areas by their individual postcodes, as some centres treat patients from across national boundaries
[a]Transplant centres
[b]The catchment population for Plymouth may be too low, see appendix E

this. Many of these factors are also likely to be the cause behind the wide inter-centre variation seen in listing patients pre-emptively between transplant centres with a range of 11 to 125 patients listed across 24 transplanting centres (table 4.3).

Case mix in prevalent wait-listed patients

Gender

Table 4.4 shows that the gender distribution of patients listed for transplantation was similar to that seen in the prevalent dialysis population with 59% of patients listed

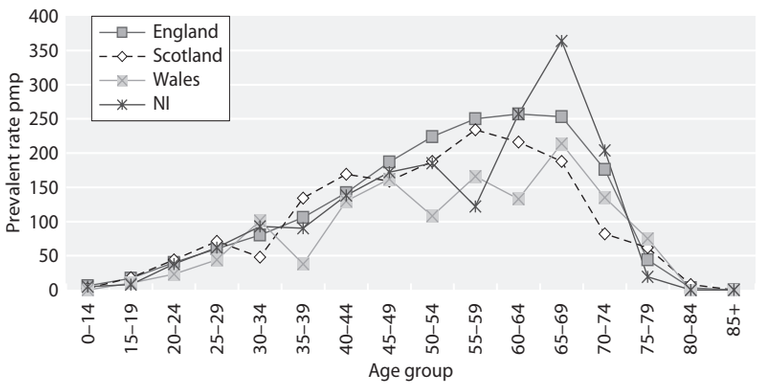

Fig. 4.2. Prevalence rates of registration for kidney transplantation in the UK per million population by age group and UK country on 01/01/2011

Table 4.3. Number of prevalent listed patients pre-emptively listed by transplant centre on 01/01/2011

Transplant centre	Number of pre-emptive listed patients
M RI	125
B QEH	112
Leic	97
L Guys	71
Bristol	67
L Rfree	61
L St.G	56
L West	56
Leeds	50
Oxford	49
Camb	34
Liv RI	33
Nottm	31
Newc	30
Sheff	30
Ports	30
Cardiff	29
Belfast	27
Glasgw	19
L Barts	18
Edin	16
Plymth	15
L GOSH	15
Covnt	11
UK	**1,082**

being male. There was wide inter-centre variation with a range of 37–91%, and only 11 centres had a preponderance of women listed (figure 4.3). Sub-analysis by modality did not show any significant gender differences.

Ethnicity

Ethnicity completeness for prevalent listed patients in the UK was 100% at the beginning of 2011 across all UK countries. Table 4.4 shows that a quarter of the patients listed (25%) were from ethnic minority groups (Black or South Asian) which compared to 12% of the UK general population who were designated as belonging to an ethnic minority. Whilst there was little difference across modalities, Black patients were seen to have the lowest proportion of pre-emptively listed patients, with only 10% (61/593) of listed Black patients being pre-emptively listed compared to 17% (817/4,835) and 16% (175/1,089) of White and South Asian listed patients respectively. Amongst renal centres there was wide variation between centres with respect to the proportion of patients listed from ethnic minorities (table 4.5, figure 4.4), ranging from zero percent (0%) in 12 centres to over 50% in London Barts (72%), London West (70%), London St Georges (69%), London Kings (69%), London Royal Free (65%), Birmingham Heartlands (61%) and London Guys (53%).

Age

The median age of prevalent listed patients on dialysis at 1st January 2011 was 53 years, which was significantly lower than the median age of the prevalent HD patients (66.3 years) and those on PD (61.7 years), $p < 0.0001$. As for those listed pre-emptively the median age was slightly lower than those on dialysis at 52 years. Table 4.4 shows that 79% of the UK prevalent listed

Table 4.4. Number and percentage of prevalent listed patients and their modalities by gender, ethnicity and age group on 01/01/2011

		Modality							
		HD		PD		Pre-emptive		Total	
		N	%	*N*	%	*N*	%	*N*	%
Gender	Male	2,595	60	724	55	614	57	3,933	59
	Female	1,696	40	602	45	468	43	2,766	41
Ethnicity	White	2,968	69	1,050	79	817	76	4,835	72
	Asian	738	17	176	13	175	16	1,089	16
	Black	461	11	71	5	61	6	593	9
	Other	124	3	29	2	29	3	182	3
Age group	0–17	20	0	24	2	52	5	96	1
	18–34	511	12	148	11	111	10	770	11
	35–49	1,265	29	380	29	303	28	1,948	29
	50–59	1,098	26	356	27	261	24	1,715	26
	60–69	1,024	24	334	25	300	28	1,658	25
	70+	373	9	84	6	55	5	512	8

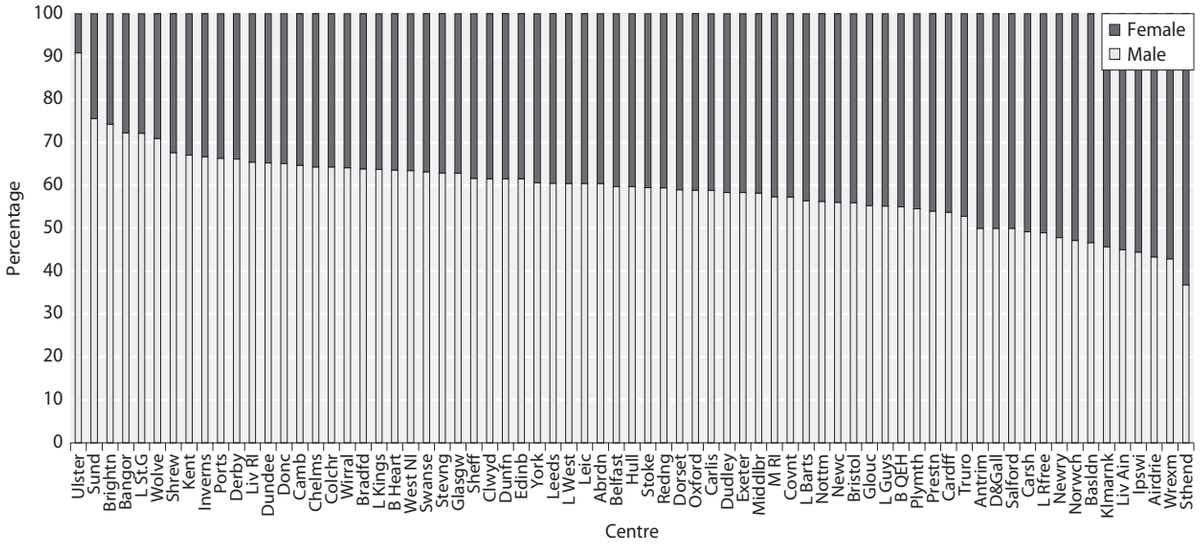

Fig. 4.3. Percentage of prevalent listed patients by gender and centre on 01/01/2011

Table 4.5. Ethnicity of prevalent listed patients by centre on 01/01/2011

		Ethnicity							
		White		Asian		Black		Other	
Centre	*N*	*N*	%	*N*	%	*N*	%	*N*	%
England									
Basldn	15	13	87	1	7	1	7	0	0
B Heart	107	42	39	54	50	10	9	1	1
B QEH	280	151	54	91	33	30	11	8	3
Bradfd	47	25	53	21	45	1	2	0	0
Brightn	66	54	82	4	6	4	6	4	6
Bristol	109	86	79	6	6	8	7	9	8
Camb	51	44	86	4	8	2	4	1	2
Carlis	17	17	100	0	0	0	0	0	0
Carsh	124	74	60	18	15	18	15	14	11
Chelms	28	23	82	1	4	1	4	3	11
Colchr	14	13	93	0	0	0	0	1	7
Covnt	82	52	63	22	27	5	6	3	4
Derby	62	48	77	11	18	3	5	0	0
Donc	43	42	98	1	2	0	0	0	0
Dorset	78	76	97	2	3	0	0	0	0
Dudley	48	38	79	7	15	3	6	0	0
Exeter	60	60	100	0	0	0	0	0	0
Glouc	38	35	92	2	5	1	3	0	0
Hull	62	56	90	2	3	2	3	2	3
Ipswi	18	16	89	0	0	1	6	1	6
Kent	85	84	99	0	0	1	1	0	0
Leeds	152	97	64	38	25	9	6	8	5
Leic	306	209	68	79	26	16	5	2	1
Liv Ain	20	19	95	1	5	0	0	0	0
Liv RI	107	95	89	1	1	5	5	6	6
L Barts	195	55	28	78	40	54	28	8	4
L Guys	116	55	47	4	3	52	45	5	4
L Kings	102	32	31	14	14	51	50	5	5
L Rfree	192	68	35	48	25	70	36	6	3

Table 4.5. Continued

		Ethnicity							
		White		Asian		Black		Other	
Centre	*N*	*N*	%	*N*	%	*N*	%	*N*	%
L St.G	61	19	31	18	30	18	30	6	10
L West	344	104	30	143	42	77	22	20	6
M RI	150	103	69	33	22	11	7	3	2
Middlbr	67	64	96	2	3	1	1	0	0
Newc	66	61	92	4	6	0	0	1	2
Norwch	53	50	94	2	4	0	0	1	2
Nottm	128	106	83	7	5	12	9	3	2
Oxford	124	89	72	21	17	10	8	4	3
Plymth	33	32	97	0	0	0	0	1	3
Ports	187	161	86	10	5	10	5	6	3
Prestn	124	100	81	21	17	2	2	1	1
Redng	101	60	59	32	32	8	8	1	1
Salford	148	111	75	31	21	4	3	2	1
Sheff	133	119	89	8	6	5	4	1	1
Shrew	34	31	91	1	3	2	6	0	0
Sthend	19	15	79	1	5	2	11	1	5
Stevng	97	69	71	16	16	10	10	2	2
Stoke	74	65	88	6	8	2	3	1	1
Sund	45	43	96	1	2	0	0	1	2
Truro	36	35	97	0	0	0	0	1	3
Wirral	39	33	85	3	8	1	3	2	5
Wolve	55	37	67	16	29	2	4	0	0
York	33	32	97	0	0	0	0	1	3
N Ireland									
Antrim	14	14	100	0	0	0	0	0	0
Belfast	62	60	97	1	2	0	0	1	2
Newry	23	22	96	0	0	0	0	1	4
Ulster	11	11	100	0	0	0	0	0	0
West NI	41	41	100	0	0	0	0	0	0
Scotland									
Abrdn	48	45	94	2	4	1	2	0	0
Airdrie	30	30	100	0	0	0	0	0	0
D & Gall	12	12	100	0	0	0	0	0	0
Dundee	23	22	96	1	4	0	0	0	0
Dunfn	26	26	100	0	0	0	0	0	0
Edinb	91	88	97	2	2	0	0	1	1
Glasgw	210	193	92	12	6	4	2	1	0
Inverns	21	21	100	0	0	0	0	0	0
Klmarnk	35	33	94	1	3	0	0	1	3
Wales									
Bangor	18	18	100	0	0	0	0	0	0
Cardff	93	83	89	7	8	1	1	2	2
Clwyd	13	13	100	0	0	0	0	0	0
Swanse	57	54	95	2	4	1	2	0	0
Wrexm	14	14	100	0	0	0	0	0	0
England	**4,775**	**3,218**	**67**	**886**	**19**	**525**	**11**	**146**	**3**
Northern Ireland	**151**	**148**	**98**	**1**	**1**	**0**	**0**	**2**	**1**
Scotland	**496**	**470**	**95**	**18**	**4**	**5**	**1**	**3**	**1**
Wales	**195**	**182**	**93**	**9**	**5**	**2**	**1**	**2**	**1**
UK	**5,617**	**4,018**	**72**	**914**	**16**	**532**	**9**	**153**	**3**

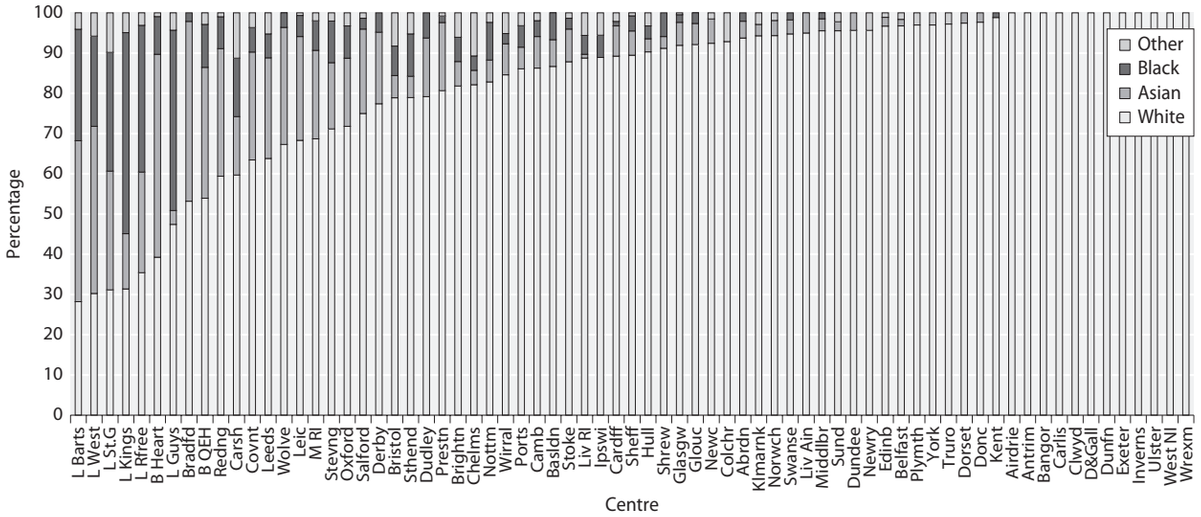

Fig. 4.4. Ethnicity of prevalent listed patients by centre on 01/01/2011

population was aged between 35–69 years, with only 8% of patients aged 70 or above. The proportion of patients listed aged 70 or more was 8% in England, 11% in Wales, 7% in Northern Ireland and 6% in Scotland (table 4.6). Analysis by centre (table 4.6) showed wide variation in the proportion of patients listed aged 70 or above by centre with four centres (Basildon, Colchester, Ipswich and London Barts) listing no patients, compared

Table 4.6. Number and percentage of prevalent listed patients in each age group by centre on 01/01/2011

	Age group (years)											
	0–17		18–34		35–49		50–59		60–69		70+	
Centre	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
England												
Basldn			1	7	5	33	6	40	3	20		
B Heart			17	16	27	25	27	25	24	22	12	11
B QEH	4	1	38	14	73	26	90	32	60	21	15	5
Bradfd			11	23	15	32	10	21	8	17	3	6
Brightn	1	2	7	11	16	24	16	24	17	26	9	14
Bristol	3	3	12	11	35	32	23	21	29	27	7	6
Camb			5	10	17	33	16	31	8	16	5	10
Carlis			2	12	5	29	4	24	5	29	1	6
Carsh			12	10	37	30	28	23	37	30	10	8
Chelms			3	11	8	29	9	32	7	25	1	4
Colchr					3	21	2	14	9	64		
Covnt			6	7	24	29	27	33	19	23	6	7
Derby			8	13	15	24	15	24	20	32	4	6
Donc			6	14	10	23	10	23	13	30	4	9
Dorset			7	9	17	22	12	15	26	33	16	21
Dudley			5	10	15	31	15	31	11	23	2	4
Exeter			4	7	16	27	15	25	22	37	3	5
Glouc			5	13	10	26	9	24	9	24	5	13
Hull			8	13	21	34	16	26	15	24	2	3
Ipswi			4	22	8	44	5	28	1	6		
Kent			8	9	17	20	23	27	31	36	6	7
Leeds	10	7	22	14	47	31	36	24	26	17	11	7
Leic			31	10	71	23	67	22	95	31	42	14
Liv Ain			4	20	5	25	4	20	4	20	3	15
Liv RI			14	13	39	36	30	28	19	18	5	5
L Barts			30	15	63	32	71	36	31	16		

Table 4.6. Continued

	Age group (years)											
	0–17		18–34		35–49		50–59		60–69		70+	
Centre	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
L Guys	1	1	14	12	42	36	32	28	19	16	8	7
L Kings			11	11	37	36	30	29	22	22	2	2
L Rfree			20	10	68	35	44	23	40	21	20	10
L St.G			7	11	19	31	9	15	17	28	9	15
L West	2	1	25	7	86	25	102	30	82	24	47	14
M RI			13	9	57	38	43	29	26	17	11	7
Middlbr			10	15	19	28	18	27	14	21	6	9
Newc	2	3	9	14	8	12	19	29	23	35	5	8
Norwch			7	13	13	25	12	23	18	34	3	6
Nottm	14	11	16	13	38	30	26	20	28	22	6	5
Oxford			12	10	36	29	39	31	30	24	7	6
Plymth			6	18	5	15	9	27	12	36	1	3
Ports			18	10	43	23	38	20	54	29	34	18
Prestn			18	15	34	27	38	31	29	23	5	4
Redng			8	8	35	35	28	28	23	23	7	7
Salford	1	1	19	13	42	28	40	27	38	26	8	5
Sheff			18	14	42	32	39	29	27	20	7	5
Shrew	1	3	7	21	13	38	5	15	7	21	1	3
Sthend			1	5	10	53	3	16	4	21	1	5
Stevng			12	12	35	36	20	21	20	21	10	10
Stoke			10	14	21	28	21	28	16	22	6	8
Sund			7	16	19	42	8	18	6	13	5	11
Truro			2	6	6	17	8	22	14	39	6	17
Wirral			6	15	9	23	14	36	7	18	3	8
Wolve			6	11	16	29	14	25	16	29	3	5
York			2	6	12	36	10	30	5	15	4	12
Northern Ireland												
Antrim					3	21	1	7	8	57	2	14
Belfast			12	19	19	31	12	19	18	29	1	2
Newry			5	22	6	26	2	9	9	39	1	4
Ulster			2	18	3	27	2	18	3	27	1	9
West NI			5	12	10	24	8	20	13	32	5	12
Scotland												
Abrdn			8	17	15	31	14	29	8	17	3	6
Airdrie			4	13	11	37	7	23	6	20	2	7
D & Gall					5	42	3	25	3	25	1	8
Dundee			1	4	9	39	5	22	5	22	3	13
Dunfn			2	8	6	23	10	38	6	23	2	8
Edinb	1	1	9	10	34	37	20	22	21	23	6	7
Glasgw	3	1	26	12	71	34	62	30	38	18	10	5
Inverns			3	14	3	14	6	29	8	38	1	5
Klmarnk			6	17	8	23	6	17	14	40	1	3
Wales												
Bangor			2	11	6	33	1	6	6	33	3	17
Cardff	1	1	12	13	31	33	21	23	20	22	8	9
Clwyd			2	15	5	38	2	15	3	23	1	8
Swanse			5	9	12	21	13	23	19	33	8	14
Wrexm			1	7	4	29	4	29	4	29	1	7
England	**39**	**1**	**554**	**12**	**1,384**	**29**	**1,255**	**26**	**1,146**	**24**	**397**	**8**
N Ireland	**0**	**0**	**24**	**16**	**41**	**27**	**25**	**17**	**51**	**34**	**10**	**7**
Scotland	**4**	**1**	**59**	**12**	**162**	**33**	**133**	**27**	**109**	**22**	**29**	**6**
Wales	**1**	**1**	**22**	**11**	**58**	**30**	**41**	**21**	**52**	**27**	**21**	**11**
UK	**44**	**1**	**659**	**12**	**1,645**	**29**	**1,454**	**26**	**1,358**	**24**	**457**	**8**

The numbers of patients calculated for each country quoted above differ marginally from those quoted elsewhere when patients are allocated to areas by their individual postcodes, as some centres treat patients from across national boundaries
Blank cells denote no patients listed for that age group within corresponding centre

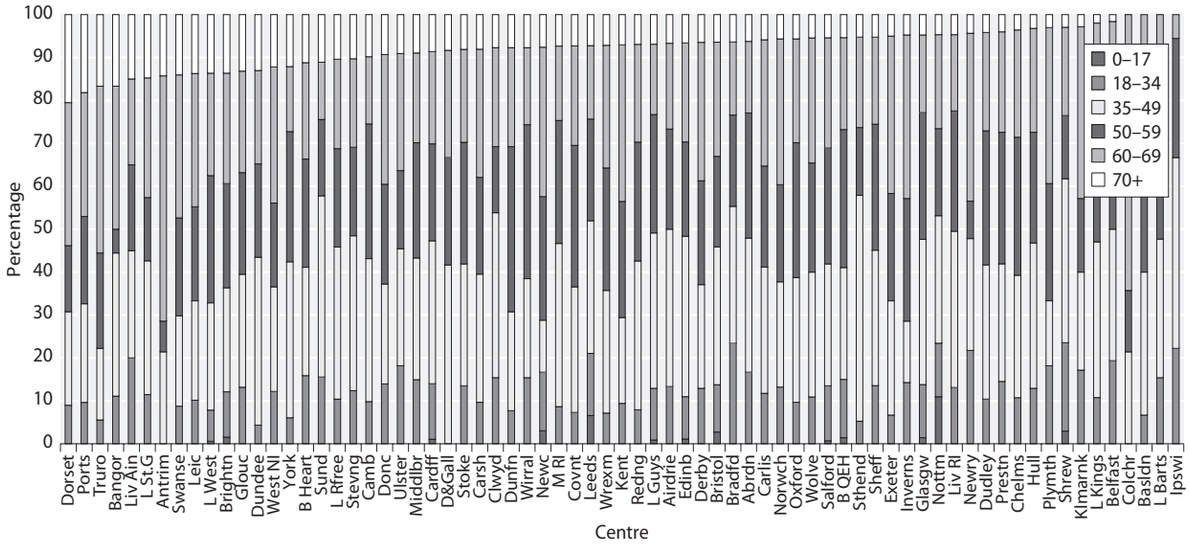

Fig. 4.5. Percentage of listed patients in each age group on 01/01/2011 by centre

to Dorset, Portsmouth, Truro and Bangor, where more than a sixth of their listed patients were aged 70 or more (figure 4.5). These differences may be due to variation in local listing practices, although could also reflect variation in the ethnic make-up of the catchment population and the social deprivation index of the local population.

Primary renal diagnosis

Data for primary renal diagnosis (PRD) were not complete for 3% of patients (table 4.7) and there remained a marked inter-centre difference in completeness of data returns for PRD to the UKRR. Glomerulonephritis (GN) was the most common PRD amongst patients listed for transplantation on 1st January 2011 at 22% (table 4.7), whilst hypertension only accounted for 7% and renovascular disease only 2%. This may be explained by the fact that younger patients (age <65 years) who are more likely to be listed are more likely to have GN or pyelonephritis and less likely to have renovascular disease or hypertension as the cause of their renal failure which are more prominent in older age.

Diabetes accounted for just 10% of listed patients, lower than the 15% seen in prevalent patients.

Amongst patients pre-emptively listed the most common diagnosis was polycystic kidney disease (PKD), which is probably a reflection of the fact that these patients are often known to renal services for many

Table 4.7. Number and percentage of prevalent listed patients and their modalities by primary renal diagnosis on 01/01/2011

	Modality							
	HD		PD		Pre-emptive		Total	
Primary renal diagnosis	*N*	%	*N*	%	*N*	%	*N*	%
Diabetes	463	11	114	9	41	6	618	10
Glomerulonephritis	926	22	323	24	124	20	1,373	22
Hypertension	311	7	83	6	26	4	420	7
Missing	127	3	40	3	47	7	214	3
Other	709	17	212	16	84	13	1,005	16
Polycystic kidney disease	493	11	189	14	131	21	813	13
Pyelonephritis	489	11	126	10	72	11	687	11
Renovascular	89	2	21	2	8	1	118	2
Uncertain	684	16	218	16	103	16	1,005	16

Table 4.8. Number and percentage of prevalent listed patients and their modalities by blood group, match grade and cRF group on 01/01/2011

		Modality							
		HD		PD		Pre-emptive		Total	
		N	%	*N*	%	*N*	%	*N*	%
Blood group	O	2,189	51	639	48	517	48	3,345	50
	A	1,290	30	475	36	373	35	2,138	32
	B	684	16	181	14	154	14	1,019	15
	AB	128	3	31	2	37	3	196	3
Match grade	Easy	1,175	27	482	36	422	39	2,079	31
	Moderate	1,684	39	601	45	492	46	2,777	41
	Difficult	1,432	33	243	18	167	15	1,842	28
cRF group	0 to <10	2,191	51	833	63	767	71	3,791	57
	10 to <30	172	4	75	6	57	5	304	5
	30 to <85	644	15	229	17	174	16	1,047	16
	85 to 100	1,284	30	189	14	83	8	1,556	23

years prior to starting dialysis allowing their timely work up to be pre-emptively listed.

Blood group

Table 4.8 shows that 50% of patients listed had blood group type O, whilst blood group AB was the least common accounting for just 3% of listed patients. The percentage of patients listed with blood group B (who are known to have the longest median waiting times) showed inter-centre variation (see table 4.9, figure 4.6) with some centres having more than a quarter of patients listed with blood group B (London St George's 31% and London West 26%) whilst four centres had none (Antrim, Basildon, Colchester, Truro). This may partly be due to the ethnic make-up of the catchment population with both London West and St George's having a large non-White prevalent dialysis population. Additionally the actual number of patients listed in Antrim, Basildon, Colchester and Truro were quite small, which may explain why all blood groups were not represented in their listed patients.

Calculated HLA antibody reaction frequency (cRF) and match grade

Table 4.8 shows that 43% of all patients listed for kidney transplantation on the 1st January 2011 were sensitised (cRF $\geqslant$10). Patients on haemodialysis had the largest proportion of sensitised patients with 49% having a cRF $\geqslant$10, whilst only 29% of patients listed pre-emptively were sensitised. This is likely a reflection of haemodialysis patients having an increased risk of exposure to sensitising events (e.g. blood transfusions) relating to dialysis complications and access procedures as compared to those listed pre-emptively and also selective enrichment of the HD population with patients with previous failed transplants (due to longer RRT vintage). Similar reasons are also likely to account for the disparity seen in distribution of highly sensitised patients (cRF $\geqslant$85) which constitute nearly a quarter (23%) of all patients listed for transplantation. Patients listed on haemodialysis had the largest proportion of highly sensitised patients with 30% having a cRF $\geqslant$85, whilst only 8% of patients listed pre-emptively were highly sensitised.

Centre analysis highlighted wide variation in the proportion of highly sensitised patients listed (table 4.10, figure 4.7) ranging from 50% of patients or more in Ipswich and Liverpool Aintree, to only 9% in Wolverhampton.

Similar trends were also noted when analysing match scores by modality (table 4.8) with those listed on haemodialysis having the greatest proportion of patients that were difficult to match (33%) as compared to those who were pre-emptively listed (15%). Centre variation was also seen in the proportion of patients that were difficult to match ranging from 48% of patients at London Royal Free, to only 13% at Wolverhampton (table 4.10, figure 4.8).

Table 4.9. Number and percentage of prevalent listed patients in each blood group by centre on 01/01/2011

	Blood group							
	O		A		B		AB	
Centre	*N*	%	*N*	%	*N*	%	*N*	%
England								
Basldn	9	60	6	40				
B Heart	44	41	33	31	24	22	6	6
B QEH	116	41	94	34	63	23	7	3
Bradfd	26	55	11	23	10	21		
Brightn	31	47	24	36	9	14	2	3
Bristol	54	50	37	34	16	15	2	2
Camb	29	57	16	31	4	8	2	4
Carlis	11	65	3	18	3	18		
Carsh	73	59	31	25	18	15	2	2
Chelms	13	46	13	46	2	7		
Colchr	7	50	7	50				
Covnt	36	44	28	34	13	16	5	6
Derby	29	47	20	32	13	21		
Donc	22	51	17	40	4	9		
Dorset	48	62	27	35	2	3	1	1
Dudley	25	52	15	31	8	17		
Exeter	27	45	28	47	4	7	1	2
Glouc	18	47	18	47	2	5		
Hull	30	48	23	37	3	5	6	10
Ipswi	11	61	5	28	2	11		
Kent	47	55	25	29	12	14	1	1
Leeds	82	54	42	28	23	15	5	3
Leic	148	48	89	29	53	17	16	5
Liv Ain	13	65	5	25	1	5	1	5
Liv RI	55	51	40	37	8	7	4	4
L Barts	90	46	58	30	44	23	3	2
L Guys	58	50	40	34	13	11	5	4
L Kings	48	47	30	29	17	17	7	7
L Rfree	92	48	49	26	46	24	5	3
L St.G	23	38	17	28	19	31	2	3
L West	171	50	71	21	89	26	13	4
M RI	80	53	46	31	21	14	3	2
Middlbr	39	58	23	34	2	3	3	4
Newc	32	48	18	27	15	23	1	2
Norwch	28	53	22	42	3	6		
Nottm	80	63	38	30	10	8		
Oxford	54	44	47	38	19	15	4	3
Plymth	21	64	10	30	2	6		
Ports	80	43	79	42	20	11	8	4
Prestn	67	54	28	23	23	19	6	5
Redng	49	49	36	36	13	13	3	3
Salford	71	48	49	33	25	17	3	2
Sheff	60	45	59	44	10	8	4	3
Shrew	17	50	13	38	3	9	1	3
Sthend	11	58	4	21	4	21		
Stevng	50	52	29	30	16	16	2	2
Stoke	34	46	29	39	8	11	3	4
Sund	31	69	10	22	4	9		
Truro	17	47	19	53				
Wirral	16	41	16	41	7	18		
Wolve	31	56	17	31	7	13		
York	17	52	9	27	5	15	2	6

Table 4.9. Continued

	Blood group							
	O		A		B		AB	
Centre	*N*	%	*N*	%	*N*	%	*N*	%
N Ireland								
Antrim	6	43	8	57				
Belfast	34	55	17	27	10	16	1	2
Newry	15	65	4	17	2	9	2	9
Ulster	5	45	5	45	1	9		
West NI	23	56	15	37	3	7		
Scotland								
Abrdn	29	60	12	25	7	15		
Airdrie	17	57	8	27	5	17		
D&Gall	6	50	2	17	3	25	1	8
Dundee	11	48	7	30	4	17	1	4
Dunfn	21	81	4	15	1	4		
Edinb	51	56	23	25	16	18	1	1
Glasgw	116	55	48	23	39	19	7	3
Inverns	15	71	4	19	2	10		
Klmarnk	19	54	10	29	4	11	2	6
Wales								
Bangor	10	56	7	39	1	6		
Cardff	38	41	38	41	13	14	4	4
Clwyd	6	46	4	31	3	23		
Swanse	28	49	20	35	8	14	1	2
Wrexm	7	50	6	43	1	7		
England	**2,371**	**50**	**1,523**	**32**	**742**	**16**	**139**	**3**
Northern Ireland	**83**	**55**	**49**	**32**	**16**	**11**	**3**	**2**
Scotland	**285**	**57**	**118**	**24**	**81**	**16**	**12**	**2**
Wales	**89**	**46**	**75**	**38**	**26**	**13**	**5**	**3**
UK	**2,828**	**50**	**1,765**	**31**	**865**	**15**	**159**	**3**

Blank cells denote no patients listed for that blood group within corresponding centre

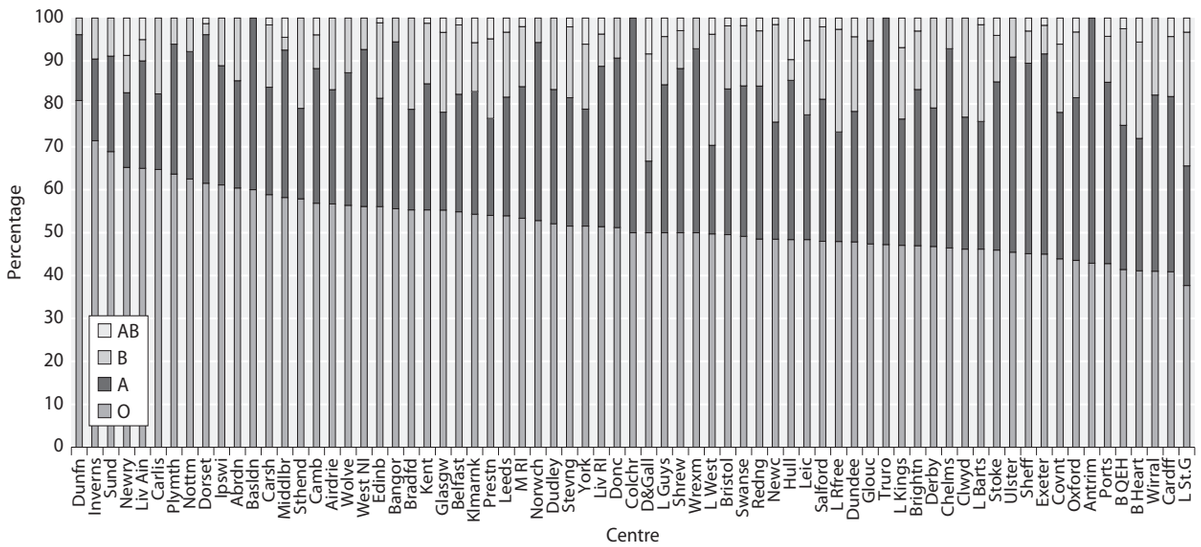

Fig. 4.6. Percentage of listed patients by blood group on 01/01/2011 by centre

Table 4.10. Centre analysis of number and percentage of prevalent listed patients by cRF and match score on 01/01/2011

	cRF Group								Match score					
	0 to <10		10 to <30		30 to <85		85 to 100		Easy		Moderate		Difficult	
Centre	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
England														
Basldn	9	60			4	27	2	13	5	33	7	47	3	20
B Heart	63	59	8	7	13	12	23	22	23	22	54	50	30	28
B QEH	137	49	12	4	46	16	85	30	70	25	119	43	91	33
Bradfd	23	49	2	4	10	21	12	26	11	23	23	49	13	28
Brightn	47	71	2	3	9	14	8	12	24	36	27	41	15	23
Bristol	66	61	3	3	14	13	26	24	29	27	50	46	30	28
Camb	20	39	7	14	7	14	17	33	12	24	20	39	19	37
Carlis	7	41			7	41	3	18	7	41	5	29	5	29
Carsh	60	48	6	5	20	16	38	31	32	26	46	37	46	37
Chelms	14	50	2	7	6	21	6	21	7	25	13	46	8	29
Colchr	8	57			4	29	2	14	4	29	6	43	4	29
Covnt	41	50	2	2	15	18	24	29	28	34	23	28	31	38
Derby	33	53	7	11	10	16	12	19	18	29	29	47	15	24
Donc	27	63	3	7	4	9	9	21	18	42	16	37	9	21
Dorset	40	51	6	8	10	13	22	28	36	46	22	28	20	26
Dudley	25	52	2	4	8	17	13	27	16	33	19	40	13	27
Exeter	30	50	1	2	11	18	18	30	20	33	22	37	18	30
Glouc	23	61	1	3	6	16	8	21	16	42	16	42	6	16
Hull	33	53	2	3	11	18	16	26	20	32	20	32	22	35
Ipswi	5	28	2	11	2	11	9	50	6	33	6	33	6	33
Kent	53	62	3	4	13	15	16	19	31	36	37	44	17	20
Leeds	66	43	6	4	23	15	57	38	42	28	58	38	52	34
Leic	201	66	2	1	66	22	37	12	102	33	136	44	68	22
Liv Ain	7	35	1	5	1	5	11	55	7	35	5	25	8	40
Liv RI	52	49	3	3	22	21	30	28	38	36	37	35	32	30
L Barts	122	63	7	4	30	15	36	18	36	18	105	54	54	28
L Guys	57	49	10	9	14	12	35	30	19	16	53	46	44	38
L Kings	61	60	2	2	19	19	20	20	22	22	49	48	31	30
L Rfree	80	42	12	6	33	17	67	35	25	13	75	39	92	48
L St.G	35	57	6	10	7	11	13	21	10	16	24	39	27	44
L West	264	77	5	1	28	8	47	14	83	24	172	50	89	26
M RI	63	42	5	3	32	21	50	33	33	22	61	41	56	37
Middlbr	30	45	6	9	11	16	20	30	17	25	26	39	24	36
Newc	31	47	4	6	5	8	26	39	23	35	20	30	23	35
Norwch	23	43	6	11	9	17	15	28	22	42	12	23	19	36
Nottm	68	53	5	4	25	20	30	23	40	31	61	48	27	21
Oxford	58	47	8	6	14	11	44	35	32	26	50	40	42	34
Plymth	17	52	1	3	6	18	9	27	15	45	10	30	8	24
Ports	109	58	2	1	29	16	47	25	64	34	64	34	59	32
Prestn	52	42	7	6	29	23	36	29	40	32	41	33	43	35
Redng	53	52	7	7	12	12	29	29	29	29	40	40	32	32
Salford	59	40	3	2	39	26	47	32	42	28	56	38	50	34
Sheff	58	44	9	7	24	18	42	32	41	31	54	41	38	29
Shrew	16	47			7	21	11	32	10	29	13	38	11	32
Sthend	12	63			2	11	5	26	6	32	8	42	5	26
Stevng	54	56	4	4	12	12	27	28	29	30	40	41	28	29
Stoke	36	49	8	11	10	14	20	27	27	36	25	34	22	30
Sund	20	44	2	4	10	22	13	29	15	33	17	38	13	29
Truro	16	44	1	3	6	17	13	36	13	36	10	28	13	36
Wirral	20	51	4	10	4	10	11	28	10	26	17	44	12	31
Wolve	37	67	6	11	7	13	5	9	27	49	21	38	7	13
York	15	45	2	6	3	9	13	39	7	21	16	48	10	30

Table 4.10. Continued

	cRF Group								Match score					
	0 to <10		10 to <30		30 to <85		85 to 100		Easy		Moderate		Difficult	
Centre	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
N Ireland														
Antrim	9	64			1	7	4	29	6	43	5	36	3	21
Belfast	28	45			11	18	23	37	23	37	18	29	21	34
Newry	11	48			5	22	7	30	4	17	13	57	6	26
Ulster	7	64	2	18			2	18	6	55	3	27	2	18
West NI	25	61	3	7	8	20	5	12	13	32	21	51	7	17
Scotland														
Abrdn	33	69	2	4	3	6	10	21	15	31	21	44	12	25
Airdrie	20	67	1	3	4	13	5	17	10	33	12	40	8	27
D&Gall	6	50			1	8	5	42	4	33	4	33	4	33
Dundee	15	65	2	9			6	26	8	35	11	48	4	17
Dunfn	16	62			3	12	7	27	12	46	6	23	8	31
Edinb	46	51	5	5	9	10	31	34	33	36	31	34	27	30
Glasgw	112	53	6	3	27	13	65	31	71	34	86	41	53	25
Inverns	13	62			2	10	6	29	8	38	9	43	4	19
Klmarnk	15	43	2	6	2	6	16	46	9	26	12	34	14	40
Wales														
Bangor	9	50	2	11	4	22	3	17	8	44	7	39	3	17
Cardff	53	57	3	3	13	14	24	26	35	38	38	41	20	22
Clwyd	4	31			4	31	5	38	4	31	4	31	5	38
Swanse	41	72	2	4	5	9	9	16	26	46	23	40	8	14
Wrexm	5	36	2	14	2	14	5	36	3	21	5	36	6	43
England	**2,556**	**54**	**215**	**5**	**769**	**16**	**1,235**	**26**	**1,359**	**28**	**1,956**	**41**	**1,460**	**31**
Northern Ireland	**80**	**53**	**5**	**3**	**25**	**17**	**41**	**27**	**52**	**34**	**60**	**40**	**39**	**26**
Scotland	**276**	**56**	**18**	**4**	**51**	**10**	**151**	**30**	**170**	**34**	**192**	**39**	**134**	**27**
Wales	**112**	**57**	**9**	**5**	**28**	**14**	**46**	**24**	**76**	**39**	**77**	**39**	**42**	**22**
UK	**3,024**	**54**	**247**	**4**	**873**	**16**	**1,473**	**26**	**1,657**	**29**	**2,285**	**41**	**1,675**	**30**

Blank cells denote no patients listed for that category within corresponding centre

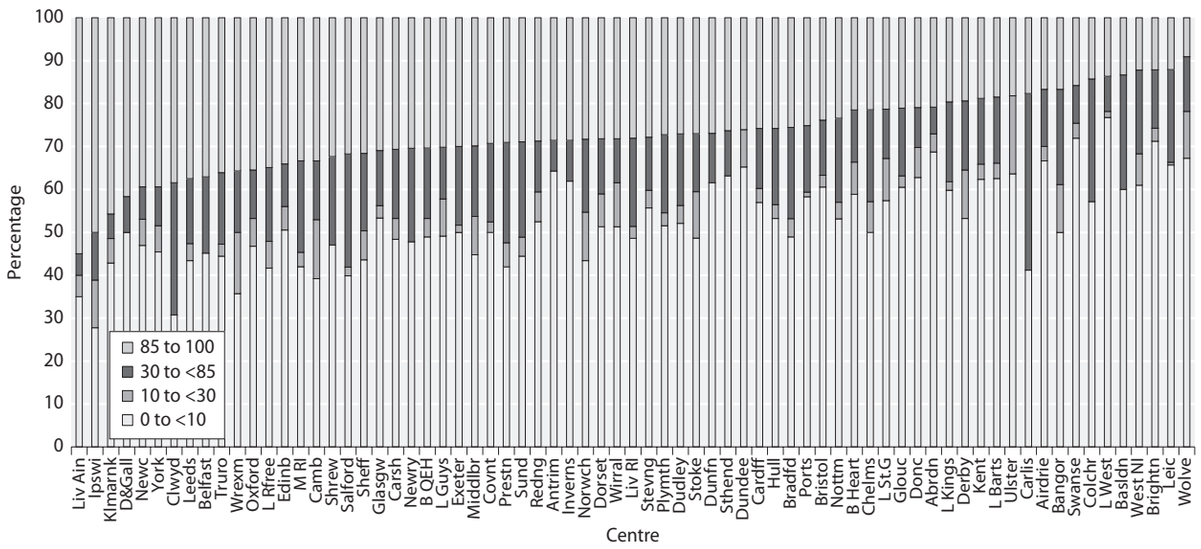

Fig. 4.7. Centre analysis of the percentage of patients listed by calculated reaction frequency group (cRF) on 01/01/2011

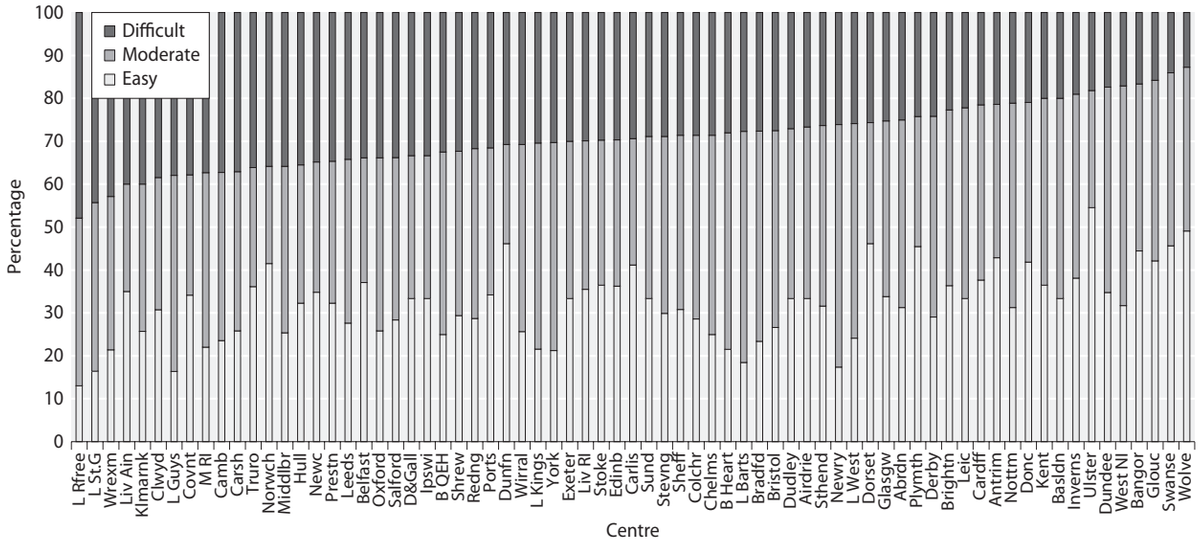

Fig. 4.8. Centre analysis of the percentage of patients listed by match score on 01/01/2011

Median waiting times

The median waiting times for receiving a deceased DBD kidney via the national allocation scheme are shown by ethnicity, blood group and cRF in tables 4.11, 4.12 and 4.13 respectively. These times were calculated using patients registered for kidney only transplants in the UK between 1st January 2006 and 31st December 2009. The overall median waiting time was 1,160 days for an adult (aged $\geqslant$18 years at time of registration) and 339 days for a paediatric patient (aged $<$18 years at time of registration). Due to the allocation algorithm stratifying patients on level of sensitisation and the need to match donor and recipient blood groups waiting times are seen to differ across ethnicity, blood groups and level of sensitisation. Adult White patients were seen to have significantly shorter waiting times (1,098 days, CI: 1,071–1,125) as compared to Black patients (1,396 days, CI: 1,301–1,491) or Asian patients (1,411 days, CI: 1,334–1,488) with similar trends seen across paediatric ethnic groups (table 4.11).

Across blood groups, adult patients with blood group O (1,373 days) and B (1,343 days) were seen to have significantly longer waiting times than those with blood group A (931 days) or AB (607 days). These differences were not seen to be significant across paediatric patients (table 4.12).

Table 4.11. Median waiting time to kidney only transplant in the UK by ethnicity, for patients registered 1st January 2006 to 31st December 2009

Ethnicity	Patients registered *N*	Waiting time (days) Median	95% CI
Adult			
White	6,899	1,098	(1,071–1,125)
South Asian	1,252	1,411	(1,334–1,488)
Black	667	1,396	(1,301–1,491)
Other	236	1,209	(1,046–1,372)
Total	**9,054**	**1,160**	**(1,136–1,184)**
Paediatric			
White	248	266	(212–320)
South Asian	73	542	(458–626)
Black	18	623	(361–885)
Other	11	276	(33–519)
Total	**350**	**339**	**(263–415)**

Table 4.12. Median waiting time to kidney only transplant in the UK by blood group, for patients registered 1st January 2006 to 31st December 2009

Blood group	Patients registered *N*	Waiting time (days) Median	95% CI
Adult			
O	4,066	1,373	(1,335–1,411)
A	3,364	931	(899–963)
B	1,259	1,343	(1,287–1,399)
AB	365	607	(521–693)
Total	**9,054**	**1,160**	**(1,136–1,184)**
Paediatric			
O	168	410	(294–526)
A	121	269	(161–377)
B	48	241	(128–354)
AB	13	504	(0–1,101)
Total	**350**	**339**	**(263–415)**

Table 4.13. Median waiting time to kidney only transplant in the UK by sensitisation at registration, for patients registered 1st January 2006 to 31st December 2009

Level of sensitisation	Patients registered *N*	Waiting time (days)	
		Median	95% CI
Adult			
0–9	6,731	1,063	(1,039–1,087)
10–29	308	1,148	(1,014–1,282)
30–84	1,297	1,475	(1,400–1,550)
85+	718	2,218	(1,958–2,478)
Total	**9,054**	**1,160**	**(1,136–1,184)**
Paediatric			
0–9	217	299	(212–386)
10–29	15	138	(2–274)
30–84	91	312	(215–409)
85+	27	1,241	(836–1,646)
Total	**350**	**339**	**(263–415)**

Table 4.13 shows that the level of sensitisation also has an impact on median waiting times with waiting times in highly sensitised patients (2,218 days CI: 1,958–2,478) being more than twice that seen in patients who were not sensitised (1,063 days CI: 1,039–1,087), which was highly significant $p \leqslant 0.0001$. This trend was also seen in paediatric listed patients with highly sensitised paediatric patients having a significantly longer median waiting time of 1,241 days as compared to 299 days in paediatric patients who were not sensitised.

Summary

Inter-centre variation exists in the number of patients wait-listed (both pre-emptively and after commencing dialysis) and in the proportion listed across different ethnic groups, age and blood groups. This may reflect differences in geography, local population density, age distribution, ethnic composition, prevalence of diseases predisposing to kidney disease and the social deprivation index of that population as well as individual centre practice patterns. Significant unexplained inter-centre variation was also seen in the proportion of patients listed that were highly sensitised.

Median waiting times are seen to differ significantly across blood groups, degree of sensitisation and ethnic groups, with differences in blood group being one probable factor in explaining the differences in median waiting times seen amongst the major ethnic groups.

Conflicts of interest: none

References

1 Renal Association Clinical Practice Guidelines Committee: Assessment of the Potential Kidney Transplant Recipient, 5th Edition. 2011. http://www.renal.org/Clinical/GuidelinesSection/AssessmentforRenalTransplantation.aspx
2 UK Kidney Transplantation: organ allocation policy. http://www.odt.nhs.uk/pdf/kidney_allocation_policy.pdf
3 http://www.odt.nhs.uk/pdf/kidney_allocation_policy.pdf
4 Office for National Statistics. www.statistics.gov.uk
5 National Records of Scotland. http://www.nrscotland.gov.uk/
6 Northern Ireland Statistics and Research Agency. http://www.nisra.gov.uk/

UK Renal Registry 16th Annual Report: Chapter 5 Comorbidities and Current Smoking Status amongst Patients starting Renal Replacement Therapy in England, Wales and Northern Ireland from 2011 to 2012

Anirudh Rao[a], Retha Steenkamp[a], Fergus Caskey[abc]

[a]UK Renal Registry, Bristol, UK; [b]Southmead Hospital, Bristol, UK; [c]School of Social and Community Medicine, University of Bristol, UK

Key Words
Comorbidity · Diabetes · Dialysis · eGFR · Ethnicity · Haemoglobin · Mortality · Renal replacement therapy · Smoking · Survival analysis

Summary

- Data on comorbidity at the time of start of renal replacement therapy (RRT) were submitted for only 7,085 (55.9%) of the incident adult (⩾18 years) RRT patients reported to the UK Renal Registry (UKRR) between 2011 and 2012. In 2012, nine centres provided data on 100% of new patients and 11 centres provided data for less than 5% of new patients.
- In patients with comorbidity data, more than half had one or more comorbidities (52.9%). In the subgroup of patients aged ⩾65 years, 64% had one or more comorbidities.
- Diabetes mellitus (primary renal disease and comorbidity) and ischaemic heart disease were the most common conditions, observed in 35% and 19% of patients respectively. Ischaemic heart disease, cerebrovascular disease, chronic obstructive pulmonary disease (COPD), claudication and malignancy were more prevalent in patients aged >65 years.
- In 2011–2012, 14% of incident RRT patients were recorded as being smokers at the initiation of dialysis.
- There was a higher prevalence of ischaemic heart disease ($p < 0.02$) and peripheral vascular disease ($p < 0.0003$) in patients presenting early to a nephrologist than amongst those referred late. Malignancy ($p < 0.0001$) was more common in patients who were referred late.
- In the multivariable survival analysis (incident patients in 2007–2012), malignancy (hazard ratio (HR) 2.9) and liver disease (HR 2.2) were strongly associated with reduced survival at 1-year in individuals aged <65 years at start of RRT who survived more than 90 days.

Introduction

The number and extent of comorbid illnesses in patients initiating dialysis is increasing [1–3]. These comorbidities are significant predictors of mortality and other adverse outcomes [4]. It is therefore imperative to account for differences in the comorbid illness burden amongst the groups of dialysis patients being compared. The importance of adjusting for comorbidity when undertaking centre [5–7] and international survival comparisons [8] is well recognised. This also allows for fair comparisons to be made between treatment modalities and costs.

However, an important consideration in applying case-mix adjustment to analyses is data completeness. If individuals with comorbidity data differ systematically from those without data, entering variables into statistical models can further bias outcome measures and provide invalid associations [9, 10].

The aim of this work is to describe the completeness of comorbidity data submitted to the UK Renal Registry (UKRR), the prevalence of comorbid conditions and current smoking status in incident renal replacement therapy (RRT) patients and to examine the association between these comorbidities and early mortality.

Methods

Study population

Incident adult ($\geqslant$18 years) RRT patients during 2011 and 2012 in the centres submitting data to the UKRR were considered. Of these, patients who had data recorded on comorbid conditions were included in statistical analyses. Data on completeness of comorbidity returns from each centre and overall may differ from those in previous UKRR reports due to some centres retrospectively entering previously missing comorbidity data.

Centre exclusions

The nine centres in Scotland do not provide comorbidity data to the UKRR and are not included in these analyses. There was concern that data extraction in four centres was inaccurate and these centres were excluded from this year's comorbidity analyses.

Definition of comorbidity and method of data collection

Clinical staff in each centre are responsible for recording in yes/no format the presence or absence of 13 comorbid conditions and information on current tobacco smoking (table 5.1) for each patient at the time of starting RRT on their renal information technology (IT) system. Definitions of each of these conditions are given in appendix B (www.renalreg.com).

Patients were classified as having complete comorbidity data if there was at least one entry (yes/no) for any one or more of the comorbid conditions. Comorbidities were grouped into broader categories for some analyses:

- 'Ischaemic heart disease' was defined as the presence of one or more of the following conditions: angina, myocardial infarction (MI) in the three months prior to starting RRT, MI more than three months prior to starting RRT or coronary artery bypass grafting (CABG)/angioplasty.
- 'Peripheral vascular disease' was defined as the presence of one or more of the following conditions: claudication, ischaemic or neuropathic ulcers, non-coronary angioplasty, vascular graft, aneurysm or amputation for peripheral vascular disease.
- 'Non-coronary vascular disease' was defined as the presence of cerebrovascular disease or any of the data items that comprise 'peripheral vascular disease'.

Table 5.1. Comorbid conditions listed in the UKRR dataset

- Angina
- Previous myocardial infarction (MI) within 3 months prior to start of RRT
- Previous MI more than 3 months prior to start of RRT
- Previous coronary artery bypass graft (CABG) or coronary angioplasty
  (in some analyses the above four variables are combined under the term 'ischaemic heart disease')
- Cerebrovascular disease
- Diabetes (when not listed as the primary renal disease)
- Chronic obstructive pulmonary disease (COPD)
- Liver disease
- Claudication
- Ischaemic or neuropathic ulcers
- Non-coronary angioplasty, vascular graft, or aneurysm
- Amputation for peripheral vascular disease
  (in some analyses these four variables are combined under the term 'peripheral vascular disease')
- Smoking
- Malignancy

Specific consideration needs to be made regarding diabetes coding. The UKRR also collect data on primary renal disease (PRD), and have used these data alongside the comorbidity data to determine which people had diabetes mellitus. The comorbidity screen is intended to capture those patients who have diabetes only when it is not the PRD, however some clinicians do enter 'yes' in the comorbidity field in such cases. Prior to statistical analyses, these fields were examined together to identify these cases and ensure diabetes is only counted as either the PRD or a comorbid condition for a certain individual.

Ethnicity data reporting

Some centres electronically upload ethnicity coding to their renal IT system from the hospital Patient Administration System (PAS) [11]. Ethnicity coding in PAS is based on self-reported ethnicity and uses a different system [11] to the remaining centres where coding of ethnicity is performed by clinical staff and recorded directly into the renal IT system (using a variety of coding systems). For all these analyses, data on ethnic origin

were grouped into Whites, South Asians, Blacks and Others. Appendix H (www.renalreg.com) details the regrouping of the PAS codes into the above ethnic categories.

Statistical methods

The statistical methods for the three individual sections of this chapter are described separately.

1) Patient demographics

The proportion of patients starting RRT with various co-morbidities was examined by age group (18–34, 35–44, 45–54, 55–64, 65–74 and ⩾75 years), primary renal disease, ethnic origin and first modality of RRT. Chi-squared, Fischer's exact and Kruskal-Wallis tests were used as appropriate to test for statistically significant differences between groups.

2) Late presentation (referral) and start of RRT

Referral time was defined as the number of days between the date first seen by a nephrologist and the date of starting RRT. Referral times of 90 or more days and less than 90 days define early and late presentation, respectively. Data on referral time were incomplete and therefore only patients with data on co-morbidity and referral time from centres with >75% data completeness for referral time were included in this analysis. Many UKRR analyses, including those presented here, rely on the accuracy of the date of start of RRT. A discussion of the issues around definition of the start date is included in chapter 13 of the 2009 Report [12].

3) Patient survival

The UKRR collected data with a 'timeline' entry on all patients who had started RRT for established renal failure (ERF). Patients presenting acutely and initially classified as acute renal failure requiring dialysis who continued to require long-term dialysis, can subsequently be re-classified by clinicians as having had ERF from the date of their first RRT. The death rate is high in the first 90 days of commencing RRT with variability observed between centres. This between centre variation may in part be due to clinician variation in the classification of patients who present acutely requiring RRT and who may be deemed from the start to be unlikely to recover renal function. As mortality rate varies with time on RRT and to remove the influence of between centre variation in the classification of patients, the survival analysis was stratified into two time frames. This also enables comparison with results from other national registries. The association of comorbid conditions and survival within the first 90 days was analysed and subsequently the association of comorbid conditions and 1-year survival in the cohort who survived after 90 days from the start of RRT was also analysed.

For each of the follow up periods, the association of baseline comorbidity with survival was analysed using univariable and multivariable Cox regression models. For analyses of survival within the first 90 days, the cohort included patients starting RRT between 1st January 2007 and 30th September 2012 to allow a minimum of three months follow-up from the start of RRT. For the 1-year survival analyses on individual patients who survived at least 90 days after the start of RRT, the cohort included data on individuals who started RRT between 1st January 2007 and 30th September 2011.

For each variable, the models were used to estimate the hazard ratio of death, comparing the survival experience of patients with a particular comorbidity with those who did not have the co-morbidity (reference group). For both the univariable and multi-variable Cox models, patients were first stratified by age group (<65 years and ⩾65 years) to account for the increasing incidence of certain comorbidities with age, which may otherwise confound the analyses. The multivariable models used an automatic selection procedure to identify the variables most strongly related to survival. The potential variables to be included were: age (per 10 year increase), smoking status, diabetes (listed as PRD or not listed as PRD) and the other 12 comorbidities listed in table 5.1. The automatic procedure starts by including only the variable most strongly related to survival. Then, with that variable included, it fits models adding each of the remaining variables in turn (singly) and chooses the variable that adds most to the model (in addition to the contribution made by the first variable included). The process continues in this way, adding variables that make a further significant contribution to the model, and removing any whose contribution becomes non-significant once other variables have been added. The final model only includes those variables selected by the process. These automatic methods have been used to give an indication of the variables most strongly related to survival but caution is needed in interpreting these because, amongst other factors, when using correlated variables, a slight difference in the data (or in the algorithm chosen) could result in different variables being included in the final models. A more robust analysis would make a considered judgement of which variables should be included (rather than an automatic one) and may require additional interaction terms.

For each model, a R^2 value was calculated using the Royston and Sauerbrei method [13]. The R^2 value is the percentage of the variation in mortality which is explained by the variables included in the final model.

All statistical analyses were performed using SAS version 9.3.

Results

Completeness of comorbidity returns from each participating centre

The number of patients with data on comorbidity and other variables included in the analyses are summarised in figure 5.1.

Of the 37,285 incident RRT patients starting RRT between 2007–2012, only 20,916 individuals had comorbidity reported to the UKRR. Of 12,677 incident RRT patients in 2011 and 2012, 7,085 individuals (55.8%) from 58 centres had data on comorbidity reported. In 2012, 6,344 patients commenced RRT in centres in England, Wales and Northern Ireland. Comorbidity data were provided for 3,479 (54.8%) of those patients (tables 5.2, 5.3). Table 5.2 highlights the continued wide variation in the completeness of data returns with nine centres providing data on 100% of patients, but 11 centres providing data for less than 5% of new patients in 2012.

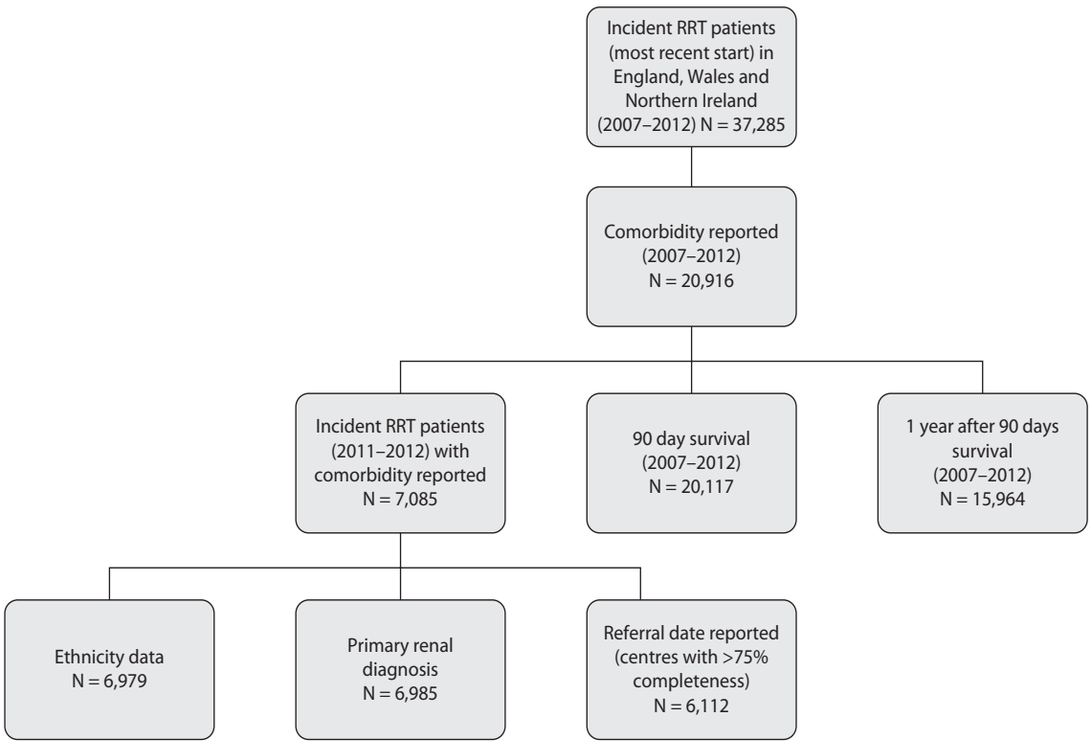

Fig. 5.1. Flow chart showing number of patients included in the various analyses

Limiting the comparison to the centres that reported in 2007, data completeness for comorbidity has dropped slightly. Completeness was 56.4% in 2007 and 55.1% in 2012 (table 5.3). When centres with 0% completeness for comorbidity were excluded, the median percentage of comorbidity returns in 2012 was 81.8%. For centres returning comorbidity data there has been an annual improvement in completeness since 2007 of 10% (table 5.3), albeit with a small decline in the most recent year.

Prevalence of multiple comorbidity

Including all incident patients from the years 2011–2012 ($n = 12{,}677$), comorbidity data were available for 7,085 (55.8%). More than half of these patients had one or more comorbidities (52.9%) (table 5.4), but in the subgroup of patients aged $\geqslant 65$ years, this increased to 64% for patients with one or more comorbidities recorded (table 5.5).

Frequency of each comorbid condition

Table 5.5 lists the prevalence of specific comorbidities and the percentage of the total number of incident patients for whom data were available for that item. Diabetes mellitus (either listed as the cause of PRD or as a comorbidity) was present in 35% of all patients. This is different to the sum of diabetes (not listed as PRD) and diabetes listed as PRD in table 5.5 and reflects some patients having both an entry in the comorbidity field for diabetes and having it recorded as their PRD as described in the methods section.

Prevalence of comorbidity by age group

Ischaemic heart disease, cerebrovascular disease, COPD, claudication, malignancy and non-coronary angioplasty were more prevalent in patients 65 years and over. Liver disease, ischaemic/neuropathic ulcers and prior amputation were more frequently observed in younger patients; actual percentages, nevertheless, were quite small (table 5.5). Smoking was also more common amongst patients under 65 years. With age categorised in 10 year age groups, prevalence of most comorbidities was seen to increase markedly from 18–65 years with some appearing to plateau beyond this (figures 5.2, 5.3). In those patients aged >75 years there was a slight reduction in several reported comorbidities apart from ischaemic heart disease (angina, MI, CABG), non-coronary angioplasty and cerebrovascular accidents.

Table 5.2. Percentage completeness of comorbidity data returns on incident patients from individual renal centres 2007–2012

	Percentage completeness of comorbidity data					
Centre	2007	2008	2009	2010	2011	2012
England						
B Heart	34.7	37.1	61.6	75.8	94.7	92.1
B QEH	33.3	32.8	39.6	39.1	50.7	66.7
Basldn	76.9	87.5	88.9	90.6	95.2	84.9
Bradfd	100.0	91.9	93.2	91.0	100.0	98.6
Brightn	36.7	34.5	12.0	6.6	9.2	14.0
Bristol	85.6	77.1	86.6	96.5	89.2	54.7
Camb	2.4	0.0	3.7	0.0	0.8	2.4
Carlis	92.3	96.7	85.7	63.6	67.9	52.6
Carsh	77.0	83.3	77.9	72.7	80.7	53.3
Chelms	54.9	36.1	35.3	26.7	19.2	11.1
Colchr		0.0	0.0	0.0	0.0	0.0
Covnt	0.0	0.9	0.9	3.5	2.7	9.8
Derby	85.5	91.8	93.5	84.8	82.5	91.4
Donc	90.0	26.9	42.5	60.0	62.8	82.5
Dorset	91.9	84.2	90.5	95.8	100.0	91.7
Dudley	0.0	2.2	4.4	0.0	2.3	0.0
Exeter	32.5	29.6	48.3	69.8	88.4	100.0
Glouc	94.9	89.1	67.1	44.3	51.7	37.8
Hull	98.0	92.7	84.9	87.4	97.3	96.9
Ipswi	50.0	34.2	10.5	12.1	0.0	2.3
Kent	76.0	81.3	89.1	100.0	100.0	100.0
L Barts	85.1	84.0	86.1	76.4	74.7	72.6
L Guys	7.2	3.1	3.5	2.8	5.0	1.6
L Kings	100.0	99.3	98.4	100.0	98.6	100.0
L Rfree	11.4	14.5	11.2	19.1	28.7	29.6
L St.G	68.9	70.7	60.0	59.3	51.4	36.3
L West	53.5	45.4	2.8	1.9	2.2	0.9
Leeds	82.3	79.1	90.2	91.3	98.1	98.1
Leic	77.1	76.9	69.7	65.5	49.1	64.3
Liv Ain	47.1	66.7	71.1	0.0	0.0	0.0
Liv RI	72.3	66.7	71.8	2.0	0.0	0.9
M RI	35.9	41.2	64.4	41.6	37.8	26.3
Middlbr	79.0	90.5	91.7	94.1	97.0	90.0
Newc	23.6	34.3	35.1	69.2	84.7	77.9
Norwch	18.0	21.4	23.6	41.9	46.0	37.8
Nottm	93.8	88.7	97.7	96.6	98.3	97.0
Oxford	86.7	82.4	92.5	96.4	98.9	99.4
Plymth	79.0	75.4	84.2	76.8	70.0	55.3
Ports	70.1	61.8	67.1	53.7	41.2	33.5
Prestn	43.9	42.5	50.0	44.4	20.0	9.5
Redng	57.6	66.0	66.0	66.3	78.6	84.9
Salford	10.9	2.2	0.8	0.7	0.0	0.0
Sheff	58.2	51.7	55.0	78.3	77.8	83.5
Shrew	67.2	88.1	85.4	100.0	100.0	100.0
Stevng	73.9	78.4	94.9	98.1	100.0	100.0
Sthend	88.2	80.6	95.7	75.0	86.2	100.0
Stoke	0.0	0.0	0.0	0.0	0.0	0.0
Sund	100.0	97.8	98.4	92.6	100.0	94.4
Truro	95.6	73.2	87.9	84.8	92.1	100.0
Wirral	15.1	15.4	17.5	11.3	6.5	2.0
Wolve	92.7	96.6	100.0	99.1	94.7	88.1
York	86.5	80.6	75.0	97.4	98.1	94.3

Table 5.2. Continued

Centre	Percentage completeness of comorbidity data					
	2007	2008	2009	2010	2011	2012
N Ireland						
Antrim	13.5	31.7	33.3	95.1	73.3	96.2
Belfast	33.3	32.9	46.6	52.8	42.0	50.6
Newry	26.7	90.5	100.0	95.2	100.0	88.9
Ulster	94.4	100.0	100.0	95.0	97.1	100.0
West NI	75.9	71.0	83.8	84.6	86.8	66.7
Wales						
Bangor	69.4	67.5	86.7	96.2	95.0	76.2
Cardff	10.9	16.0	23.2	28.5	32.8	21.8
Clwyd	47.6	53.3	60.0	57.1	76.5	81.8
Swanse	96.9	96.0	97.4	88.2	92.4	95.6
Wrexm	66.7	81.0	94.7	100.0	100.0	100.0
England	57.7	56.7	55.6	55.1	56.0	54.1
N Ireland	41.3	51.4	65.5	76.7	74.3	70.4
Wales	46.5	55.8	58.0	59.5	62.1	59.2
UK	56.4	56.5	56.0	56.0	56.9	54.8

Blank cell denotes no data returned for that year

Table 5.3. Summary of completeness of incident patient comorbidity returns (2007–2012)

	Years						Combined years
	2007	2008	2009	2010	2011	2012	
Renal centres included *N*	61	62	62	62	62	62	
New patients *N*	6,104	6,180	6,243	6,156	6,333	6,344	37,360
Patients with comorbid data entries *N*	3,445	3,490	3,493	3,450	3,606	3,479	20,963
Percentage of patients with comorbid data entries	56.4	56.5	56.0	56.0	56.9	54.8	56.1
Percentage restricted to centres reporting since 2007	56.4	57.0	56.1	56.3	57.3	55.1	56.4
Median percentage amongst only centres returning >0% comorbidity	71.2	71.0	71.4	75.8	81.6	81.8	75.8

Prevalence of comorbidity by ethnic origin

Figures 5.4 and 5.5 illustrate the presence of comorbidity by ethnic origin and age group. Figure 5.4 shows the prevalence of having at least one comorbidity recorded amongst patients of White origin was nearly 10% higher compared to incident patients from an ethnic minority. Figure 5.5 shows that this higher trend was observed across most age groups. However, diabetes mellitus specifically was much more frequently reported in South Asian patients (51.1%) than in White individuals (32.1%) (table 5.6). The reported prevalence of smoking was highest in individuals of White ethnicity (15%).

Table 5.4. Number of reported comorbidities in patients starting RRT, as a percentage of those for whom comorbidity data were available 2010–2012

Number of comorbidities	0	1	2	3	4	5+
Percentage	47.1	27.1	13.1	7.0	3.4	2.3

Prevalence of comorbidity amongst patients with diabetes mellitus

Table 5.7 describes comorbidity amongst patients with and without diabetes (as either primary renal disease or comorbidity). As would be expected, patients with diabetes mellitus had higher prevalence of peripheral vascular disease (20.9% compared to 7.0% in non-diabetic patients). Similarly, there was a statistically significant higher prevalence of ischaemic heart disease (27.7% and 14.4% respectively) and cerebrovascular disease (14.1% and 8.3% respectively) in the diabetic patients. Similar proportions of patients with diabetes and non-diabetic

Table 5.5. Frequency with which each condition was reported in incident RRT patients 2011–2012

Comorbidity	Age <65 years		Age ⩾65 years		p value*	% overall prevalence
	N	(%)	*N*	(%)		
Any comorbidity present	1,459	(41.6)	2,291	(64.0)	<0.0001	52.9
Angina	194	(5.6)	536	(15.2)	<0.0001	10.4
MI in past 3 months	42	(1.2)	99	(2.8)	<0.0001	2.0
MI >3 months ago	208	(6.0)	467	(13.2)	<0.0001	9.7
CABG/angioplasty	176	(5.1)	385	(10.9)	<0.0001	8.0
Cerebrovascular disease	231	(6.7)	496	(14.0)	<0.0001	10.4
Diabetes (not listed as PRD)	182	(5.2)	476	(13.5)	<0.0001	9.4
Diabetes listed as PRD	1,008	(29.1)	765	(21.7)	<0.0001	25.4
COPD	155	(4.5)	345	(9.8)	<0.0001	7.1
Liver disease	154	(4.4)	68	(1.9)	<0.0001	3.2
Claudication	142	(4.1)	277	(7.9)	<0.0001	6.0
Ischaemic/neuropathic ulcers	147	(4.2)	123	(3.5)	0.0989	3.9
Angioplasty/vascular graft	77	(2.2)	208	(5.9)	<0.0001	4.1
Amputation	110	(3.2)	86	(2.4)	0.06	2.8
Smoking	516	(15.4)	431	(12.6)	0.0008	14.0
Malignancy	234	(6.8)	659	(18.6)	<0.0001	12.7

*p values from Chi-squared tests for differences between age groups in the percentage with the comorbidity

patients were smokers at the time of initiation of RRT (14.0% and 13.8% respectively). Malignancy was more common in non-diabetic patients ($p < 0.0001$) and may reflect 'competing risks', with diabetic patients tending to die at a younger age with cardiovascular disease, rather than developing malignancy in older age.

Late presentation and comorbidity

Table 5.8 shows the presentation time for patients with various comorbidities. In total, 6,112 individuals contributed data to this analysis. Patients referred to a nephrologist early had a higher prevalence of peripheral vascular disease, and ischaemic heart disease. There was a much higher proportion of patients with malignancy in the late referral group.

Age and comorbidity in patients by treatment modality at start of RRT

All comorbidities were more prevalent in patients receiving haemodialysis as their initial modality of

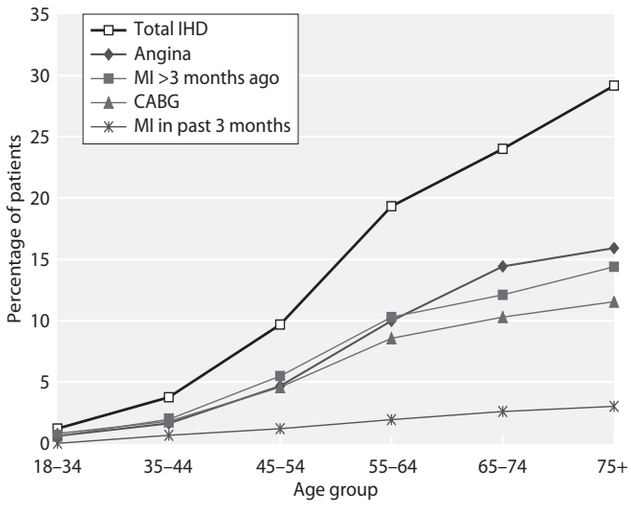

Fig. 5.2. Prevalence of ischaemic heart disease amongst incident patients 2011–2012 by age at start of RRT

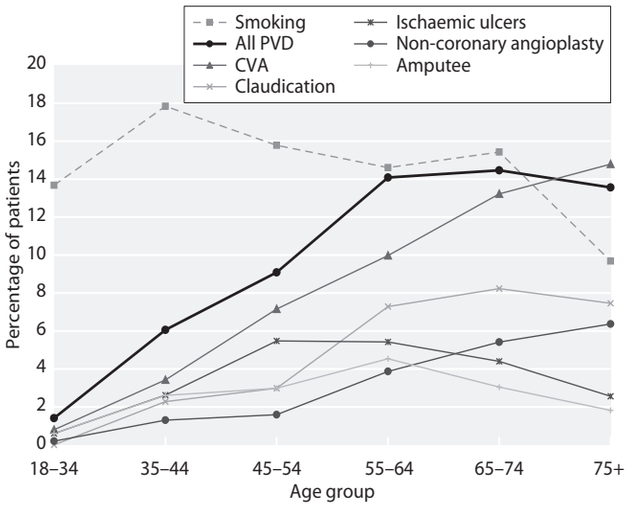

Fig. 5.3. Prevalence of non-coronary vascular disease amongst incident patients 2011–2012 by age at start of RRT

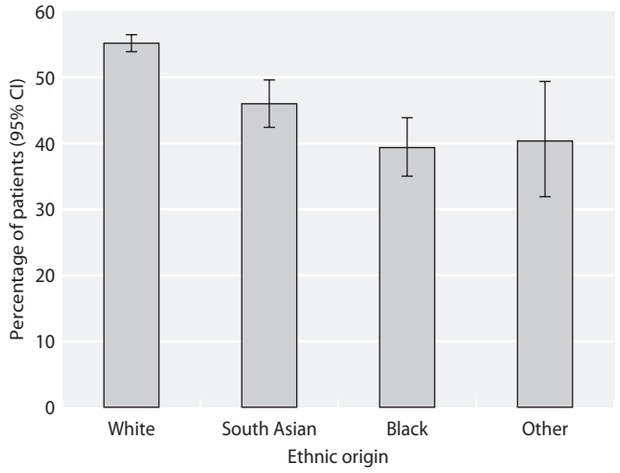

Fig. 5.4. Presence of comorbid conditions at the start of RRT by ethnic origin amongst patients starting RRT 2011–2012

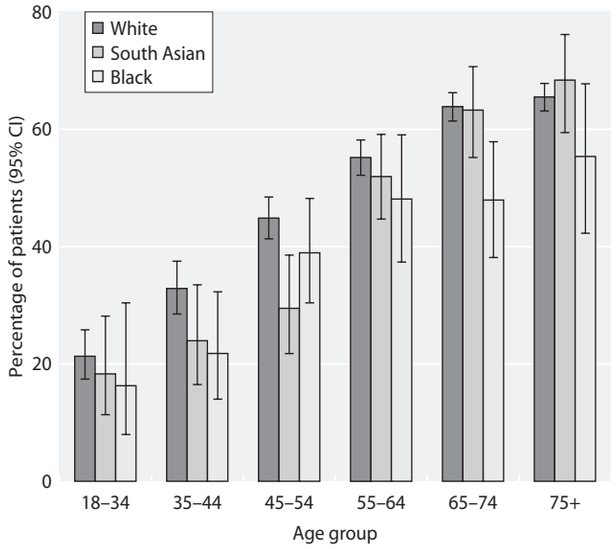

Fig. 5.5. Percentage of patients with comorbidity by ethnic origin in each age group at the start of RRT 2011–2012

Table 5.6. Prevalence of comorbidities amongst incident patients starting RRT 2011–2012 by ethnic group, as percentages of the total number of patients in that ethnic group for whom comorbidity data were available

	White		South Asian		Black		Other		
Comorbidity	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	p value*
Ischaemic heart disease	1,082	(19.4)	166	(22.9)	42	(9.2)	15	(12.8)	<0.0001
Cerebrovascular disease	562	(10.0)	80	(11.0)	64	(14.0)	6	(5.1)	0.01
Diabetes (not listed as PRD)	538	(9.6)	70	(9.6)	29	(6.3)	8	(6.8)	0.09
Diabetes listed as PRD	1,257	(22.5)	302	(41.5)	147	(32.2)	43	(36.1)	<0.0001
COPD	456	(8.2)	30	(4.1)	8	(1.7)	3	(2.6)	<0.0001
Liver disease	155	(2.8)	23	(3.2)	26	(5.7)	11	(9.4)	<0.0001
Peripheral vascular disease	723	(13.0)	43	(5.9)	28	(6.2)	8	(6.8)	<0.0001
Smoking	817	(15.0)	59	(8.4)	41	(9.4)	13	(11.5)	<0.0001
Malignancy	806	(14.4)	40	(5.5)	31	(6.8)	8	(6.8)	<0.0001

*p values from Chi-squared tests for differences between ethnic groups in the percentage with the comorbidities

Table 5.7. Number and percentage of patients with and without diabetes (either as primary diagnosis or comorbidity) who have other comorbid conditions

	Non-diabetic patients		Diabetic patients		
Comorbidity	*N*	(%)	*N*	(%)	p value*
Ischaemic heart disease	635	(14.4)	650	(27.7)	<0.0001
Cerebrovascular disease	366	(8.3)	331	(14.1)	<0.0001
COPD	312	(7.1)	170	(7.2)	0.79
Liver disease	135	(3.1)	79	(3.4)	0.50
Peripheral vascular disease	309	(7.0)	489	(20.9)	<0.0001
Smoking	592	(13.8)	320	(14.0)	0.78
Malignancy	635	(14.4)	218	(9.3)	<0.0001

*p values from Chi-squared tests for differences in the percentage with the comorbidities between diabetic and non-diabetic patients

Table 5.8. Percentage prevalence of specific comorbidities amongst patients presenting late (<90 days) compared with those presenting early (⩾90 days) (2011–2012 incident patients)

	Late referral		Early referral		
Comorbidity	*N*	(%)	*N*	(%)	p value*
Ischaemic heart disease	176	(16.3)	970	(19.5)	0.02
Cerebrovascular disease	105	(9.7)	500	(10.0)	0.7
Diabetes (not listed as PRD)	110	(10.2)	477	(9.6)	0.5
COPD	97	(9.0)	365	(7.3)	0.1
Liver disease	45	(4.2)	138	(2.8)	0.02
Peripheral vascular disease	95	(8.8)	633	(12.7)	0.0003
Malignancy	217	(19.9)	554	(11.1)	<0.0001
Smoking	158	(15.4)	690	(14.2)	0.3

*p values from Chi-squared tests for differences between referral groups in the percentage with the comorbidities

treatment than in those starting on peritoneal dialysis (table 5.9). The median age for all patients starting dialysis in England, Wales and Northern Ireland in 2011–2012 was 67.3 years (IQR 54.5–76.4) for haemodialysis and 60.5 years (IQR 46.6–71.8) for peritoneal dialysis. In comparison, the median age of patients with comorbidity data starting RRT on HD was 67.6 years compared with 60.6 years for those starting on PD. For patients with pre-emptive transplant the median age of patients with comorbidity data was 49.5 years. For most of the comorbid conditions, the median age of patients on HD was higher than for patients on PD (table 5.9). As it would be expected a greater percentage of the transplanted patients had no comorbidities when compared to non-transplanted patients (77.4% vs. 43.4% respectively) (table 5.10).

Comorbidity and survival within 90 days of starting RRT

In univariable analysis stratified by age, most comorbidity was associated with an increased risk of death in the first 90 days after starting RRT when compared with a patient in the same age group without that comorbidity. This was true amongst patients aged <65 years and those aged ⩾65 years, the associations being more profound for those aged <65 years (data not shown). Results of the multivariable stepwise Cox regression analyses stratified by age group (<65 and ⩾65) are

Table 5.9. Number (and percentage) of incident patients with comorbid conditions starting PD and HD 2011–2012

	HD			PD			
Comorbidity	*N*	(%)	Median age	*N*	(%)	Median age	p value*
Angina	625	(12.3)	72.7	100	(6.5)	70.0	<0.0001
MI in past 3 months	132	(2.6)	71.3	9	(0.6)	73.2	<0.0001
MI >3 months ago	556	(10.9)	72.3	114	(7.4)	69.4	<0.0001
CABG/angioplasty	426	(8.4)	71.1	121	(7.8)	70.7	0.483
Cerebrovascular disease	613	(12.0)	72.2	108	(7.0)	69.6	<0.0001
Diabetes (not listed as PRD)	558	(10.9)	72.9	87	(5.6)	68.9	<0.0001
COPD	439	(8.6)	71.5	56	(3.6)	67.6	<0.0001
Liver disease	187	(3.7)	58.8	29	(1.9)	58.4	0.001
Claudication	354	(6.9)	71.1	62	(4.0)	64.7	<0.0001
Ischaemic/neuropathic ulcers	223	(4.4)	64.6	37	(2.4)	60.2	0.0004
Angioplasty/vascular graft	241	(4.7)	72.6	41	(2.7)	66.3	0.0004
Amputation	163	(3.2)	64.0	30	(1.9)	61.0	0.01
Smoking	715	(14.5)	65.4	210	(13.8)	55.5	0.47
Malignancy	757	(14.8)	73.4	126	(8.1)	71.3	<0.0001

*p values from Chi-squared tests for differences between modalities in the percentage with the comorbidities

Table 5.10. Comorbidity amongst incident patients (2011–2012) who underwent transplantation (by the end of 2012) compared to those who remained on dialysis or died

	Not transplanted		Transplanted		
Comorbidity	*N*	(%)	*N*	(%)	p value*
Patients with comorbidity data	6,315		770		
No comorbidity present	2,739	43.4	596	77.4	<0.0001
Ischaemic heart disease	1,288	20.7	36	4.7	<0.0001
Cerebrovascular disease	711	11.4	16	2.1	<0.0001
Diabetes (not cause of ERF)	638	10.2	20	2.6	<0.0001
COPD	488	7.8	12	1.6	<0.0001
Liver disease	206	3.3	16	2.1	0.0775
Peripheral vascular disease	790	12.7	28	3.7	<0.0001
Smoking	885	14.7	62	8.3	<0.0001
Malignancy	875	14.0	18	2.4	<0.0001

shown in tables 5.11 and 5.12. As identified in the univariable models, the relative magnitude of the hazard ratios associated with comorbidity in younger patients tended to be greater than in the older patient group. Diabetes did not emerge as an independent predictor of death, perhaps explained by its close association with, and mediation in the causal pathway by, cardiovascular diseases. Some comorbidities may appear not to be associated with an increased risk of death in this analysis because of the low number of patients in these groups or because of selection within the cohort. For example, individuals with severe comorbid disease, and whose prognosis on RRT was considered very poor, may not have been started on RRT (for instance, liver disease in those aged ⩾65 years).

The final four variables in the model examining death within the first 90 days of starting RRT in patients aged <65 (table 5.11) explain 31% of the variation in survival. For patients aged ⩾65, the final eight variables in the model explain 12% of the variation in survival (table 5.12).

Table 5.11. Multivariable Cox proportional hazards model* for predictors of death within the first 90 days of starting RRT during 01/01/2007–30/09/2012: patients aged <65 years

Comorbidity	Hazard ratio	95% CI	p value
Malignancy	4.3	3.0–6.3	<0.0001
Ischaemic/ neuropathic ulcers	2.3	1.3–4.1	0.004
Angina	1.9	1.2–3.0	0.004
Age (per 10 years)	1.6	1.3–1.9	<0.0001

*This is the result of a stepwise procedure. The variables considered in the model were: age (in 10 year units) and the 14 comorbidity variables except that 'diabetes (not listed as PRD)' was replaced by 'diabetes of either category' which included 'diabetes listed as PRD'

Comorbidity and survival 1-year after 90 days of commencing RRT

Age, smoking and four other comorbidities were independently associated with an increased hazard of death within the first year after 90 days of commencing RRT for patients aged <65 years and three of these (age, malignancy and ischaemic/neuropathic ulcers) were among the nine variables independently associated with mortality beyond day 90 in patients ⩾65 years (tables 5.12, 5.13 and 5.14). Diabetes mellitus was independently associated with increased mortality in patients <65 years but not in those aged ⩾65 years. Overall the final six variables in the model exploring death in the year after the first 90 days of starting RRT in patients <65 years explain 26% of the variation in survival. For patients ⩾65 years, only 10% of the variation in survival was explained by the nine variables included in the final model.

Table 5.12. Multivariable Cox proportional hazards model* for predictors of death within the first 90 days of starting RRT during 01/01/2007–30/09/2012: patients aged ⩾65 years

Comorbidity	Hazard ratio	95% CI	p value
MI in past 3 months	2.0	1.4–2.9	0.000
Amputation	1.8	1.1–2.9	0.030
Ischaemic/neuropathic ulcers	1.7	1.1–2.6	0.012
Malignancy	1.6	1.3–1.9	<0.0001
Angina	1.5	1.2–1.9	<0.0001
Age (per 10 years)	1.5	1.3–1.7	<0.0001
COPD	1.4	1.0–1.8	0.022
Diabetes of either category	0.8	0.6–1.0	0.018

*This is the result of a stepwise procedure. The variables considered in the model were: age (in 10 year units), and the 14 comorbidity variables except that 'diabetes (not listed as PRD)' was replaced by 'diabetes of either category' which included 'diabetes listed as PRD'

Table 5.13. Multivariable Cox proportional hazards model* for predictors of death in the year after the first 90 days of starting RRT during 01/01/2007–30/09/2012: patients aged <65 years

Comorbidity	Hazard ratio	95% CI	p value
Malignancy	2.9	2.2–3.8	<0.0001
Liver disease	2.2	1.6–3.1	<0.0001
Ischaemic/neuropathic ulcers	2.1	1.5–3.0	<0.0001
Diabetes of either category	1.8	1.5–2.2	<0.0001
Smoking	1.5	1.2–1.9	0.001
Age (per 10 years)	1.5	1.3–1.6	<0.0001

*This is the result of a stepwise procedure. The variables considered in the model were: age (in 10 year units) and the 14 comorbidity variables except that 'diabetes (not listed as PRD)' was replaced by 'diabetes of either category' which included 'diabetes listed as PRD'

Table 5.14. Multivariable Cox proportional hazards model* for predictors of death in the year after the first 90 days of starting RRT during 01/01/2007–30/09/2012: patients aged ⩾65 years

Comorbidity	Hazard ratio	95% CI	p value
Malignancy	1.7	1.5–1.9	<0.0001
COPD	1.6	1.4–1.9	<0.0001
Age (per 10 years)	1.5	1.4–1.7	<0.0001
Amputation	1.5	1.0–2.2	0.047
Ischaemic/neuropathic ulcers	1.5	1.1–2.0	0.024
MI in past 3 months	1.4	1.0–1.9	0.027
Cerebrovascular disease	1.4	1.2–1.7	<0.0001
Angioplasty/vascular graft	1.3	1.1–1.7	0.016
Angina	1.3	1.1–1.5	0.004

*This is the result of a stepwise procedure. The variables considered in the model were: age (in 10 year units) and the 14 comorbidity variables except that 'diabetes (not listed as PRD)' was replaced by 'diabetes of either category' which included 'diabetes listed as PRD'

Discussion

Case-mix adjustment is integral to quality reporting [14, 15], risk adjustment in clinical research [16, 17], resource allocation and management of patients with comorbid conditions in day to day practice [18].

Comorbidity data completeness continues to be a cause for concern with overall completeness of comorbidity reporting to the UKRR being fairly static. Missing data may hamper case-mix adjustment but also introduces the risk of selection bias, so caution must be used in interpreting the influence of comorbidity on patient outcomes.

The Multivariable Cox proportional hazards model for predictors of death within the first 90 days of starting RRT account for 31% and 12% of the variation in survival in patients aged <65 and ⩾65 years respectively. Whereas for predictors of death in the year after the first 90 days of starting RRT the model accounted for 26% and 10% of the variation in survival in patients aged <65 and ⩾65 years respectively. It is noteworthy that even in analyses with 100% comorbidity completeness, the proportion of variance in survival that can be explained by these major medical disorders generally remains below 50% when age, primary renal disease, ethnicity and comorbidities are included in the statistical model.

A number of studies have demonstrated the association of various laboratory and physiological parameters, for example serum albumin, systolic blood pressure, body mass index, serum phosphate, and parathyroid hormone, with mortality and other outcomes in dialysis patients [19–22]. Future studies of survival should also consider other factors such as nutrition, mobility, cognition and socio-economic status in addition to centre level factors at the start of dialysis to better assess the risk factors and outcomes for RRT patients. Data completeness permitting, the UKRR is in a unique position to test the association of these parameters and account for the variation in survival.

A number of approaches are currently being explored by the UKRR to improve comorbidity data completeness, including collaboration with renal IT suppliers, linkage with other secondary data sources (e.g. Hospital Episode Statistics dataset) and statistical imputation techniques. Multiple imputation [23] is a statistical technique for estimating missing data. In multiple imputation, missing comorbidities for an individual patient are estimated dependent on available information that is correlated to the missing comorbidities or explains the reason for the missing data. In the future the UKRR is likely to use this combination of approaches to adjust for case-mix when exploring the variation in outcome between centres.

Conflicts of interest: none

References

1 U.S. Renal Data System. USRDS 2007 Annual data report: Atlas of chronic kidney disease and end-stage renal disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2007
2 Oreopoulos DG, Dimkovic N. Geriatric nephrology is coming of age. J Am Soc Nephrol 2003;14:1099–1101
3 van Manen JG, Korevaar JC, Dekker FW, Boeschoten EW, Bossuyt PM, et al. How to adjust for comorbidity in survival studies in ESRD patients: a comparison of different indices. Am J Kidney Dis 2002;40:82–89

4 Miskulin D. Characterizing comorbidity in dialysis patients: principles of measurement and applications in risk adjustment and patient care. Peritoneal Dialysis International 2005;25(4):320–332
5 Hodsman A, Ben-Shlomo Y, Roderick P, Tomson CRV: The 'centre effect' in nephrology: What do differences between nephrology centres tell us about clinical performance in patient management? Nephron Clin Pract 2011;119:1: c10–c17
6 Ansell D, Roderick P, Hodsman A, Steenkamp R, Tomson C: Chapter 6: Survival of Incident and Prevalent patients; in Ansell D, Feehally J, Feest TG, Tomson C, Williams AJ, Warwick G: UK Renal Registry Report 2007, UK Renal Registry, Bristol, UK, 2007
7 Khan IH, Campbell MK, Cantarovich D, Catto GR, Delcroix C, Edward N, Fontenaille C, Fleming LW, Gerlag PG, van Hamersvelt HW, Henderson IS, Koene RA, Papadimitriou M, Ritz E, Russell IT, Stier E, Tsakiris D, MacLeod AM: Survival on renal replacement therapy in Europe: Is there a 'centre effect'? Nephrol Dial Transplant 1996;11: 300–307
8 Marcelli D, Stannard D, Conte F, et al. ESRD patient mortality with adjustment for comorbid conditions in Lombardy (Italy) versus the United States. Kidney Int 1996;50(3):1013–1018
9 Jager KJ, Zoccali C. Comorbidity data collection by renal registries – a remaining challenge. Nephrol Dial Transplant 2009;24: 2311–2313
10 Collier T, Steenkamp R, Tomson C, Caskey F, Ansell D, Roderick P, Nitsch D: Patterns and effects if missing comorbidity data for patients starting renal replacement therapy in England, Wales and Northern Ireland. Nephrol Dial Transplant 2011;26:3651–3658
11 Office for National Statistics: The classification of ethnic groups (www.statistics.gov.uk). 2005
12 Ford DJ, Fogarty DG, Steenkamp R, Tomson CR, Ben-Shlomo Y, Ansell D: UK Renal Registry 12th Annual Report (December 2009): Chapter 13: the UK Renal Registry advanced CKD study: frequency of incorrect reporting of date of start of RRT. Nephron Clin Pract 2010; 115(Suppl.1):c271–278
13 Royston P, Sauerbrei W: A new measure of prognostic separation in survival data. Statistics in medicine 2004;23:723–748
14 Lacson Jr E, Teng M, Lazarus J, Lew N, Lowrie E, Owen W. Limitations of the facility-specific standardization mortality ratio for profiling health care quality in dialysis units. Am J Kidney Dis 2001;37:267–75
15 Lowrie EG, Lew NL. Death risk in hemodialysis patients:the predictive value of commonly measured variables and an evaluation of death rate differences between facilities.Am J Kidney Dis 1990;15:458–82
16 Greene T, Beck GJ, Gassman JJ, Gotch FA, Kusek JW, Levey AS, et al. Design and statistical issues of the Hemodialysis (HEMO) Study. Control Clin Trials 2000;21:502–25
17 Liu Y, Coresh J, Eustace J, Longenecker J, Jaar B, Fink N, et al. Association between cholesterol level and mortality in dialysis patients. JAMA 2004;291:451–9
18 Nissenson A, Collins J, Dickmeyer J, Litchfield T, Mattern W, McMahill C, et al. Evaluation of disease-state management of dialysis patients. Am J Kidney Dis 2001;37:938–44
19 Zager P, Nikolic J, Brown R, Campbell M, Hunt W, Peterson D, et al. "U" curve association of blood pressure and mortality in hemodialysis patients. Kidney Int 1998;54:561–9
20 Fleischmann E, Teal N, Dudley J, May W, Bower J, Salahudeen A. Influence of excess weight on mortality and hospital stay in 1346 hemodialysis patients. Kidney Int 1999;55:1560–7
21 Block G, Hulbert-Shearon T, Levin N, Port F. Association of serum phosphorus and calcium x phosphate product with mortality risk in chronic hemodialysis patients: a national study. Am J Kidney Dis 1998;31:604–17
22 Leavey S, Strawderman R, Jones C, Port F, Held P. Simple nutritional indicators as independent predictors of mortality in hemodialysis patients. Am J Kidney Dis 1998;31:997–1006
23 Sterne JAC, White IR, Carlin JB, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. BMJ 2009;338

UK Renal Registry 16th Annual Report: Chapter 6 Demographics and Outcomes of Patients from Different Ethnic Groups on Renal Replacement Therapy in the UK

Udaya Udayaraj[a], Rishi Pruthi[b], Anna Casula[b], Paul Roderick[c]

[a]Southmead Hospital, Bristol, UK; [b]UK Renal Registry, Bristol, UK; [c]Southampton University, Southampton, UK

Key Words

Access · Demography · Ethnic group · Ethnicity · Hospitalisation · Incidence · Outcome · Survival · Transplantation

Summary

- Data returns on ethnicity have significantly improved over the years to approximately 97% completeness in 2012.
- There was considerable variation in ethnicity breakdown between centres; at the London Barts and London West centres only 38% and 45% respectively of incident patients were White compared with 99% at some of the South West centres.
- The age–gender standardized incidence ratio of renal replacement therapy (RRT) was higher (2–3 times) in regions with a high ethnic minority population compared to those with a low ethnic minority population.
- South Asian and Black patients were significantly younger than Whites (with median ages of 58.7, 54.4, 65.5 years respectively, $p < 0.0001$); had more diabetes causing established renal failure (ERF) (40.2%, 31.0%, 25.0% respectively, $p < 0.0001$) and lived in more deprived areas.
- The proportion of patients with at least one comorbidity was greater amongst White patients compared to South Asian and Black patients (55.5%, 45.8%, 37.1% respectively, $p < 0.0001$).
- South Asian and Black patients were referred earlier to renal centres; started RRT at a lower eGFR and had a lower Hb at the start of RRT compared to White patients. The proportion of patients starting PD and having pre-emptive transplantation was lower amongst both ethnic minorities.
- The attainment of various laboratory standards was comparable or better for the ethnic minorities compared to White patients except for calcium standard attainment (for South Asians) and haemodialysis dose attainment (for Black patients).
- Compared to White patients, both ethnic minorities had similar rates of listing for deceased donor kidney transplantation but had lower rates of deceased donor transplantation once wait-listed, and lower rates of living kidney donor transplantation.
- One and five year kidney allograft adjusted survival was poorer for Black patients but similar for South Asians compared to White patients.
- Black and South Asian patients had a better survival on dialysis compared to White patients.

Introduction

The ethnic minority population in the UK has increased from 9.7 % in the 2001 Census to 13% in the most recent 2011 Census [1]. Although the ethnic make-up of the UK is increasingly diverse, this chapter mainly reports on the characteristics and comparisons of patient level outcomes of those on renal replacement therapy (RRT) from the three main ethnic groups: White, South Asian and Black. Patients from other ethnic groups were a heterogeneous population and accounted for a small proportion of all patients on RRT and therefore are not discussed in detail in this chapter.

Methods

Data on patients (>18 years old) from all 71 UK adult renal centres starting RRT between 2003 and 2012 and who did not recover renal function within 90 days and who had data on ethnicity were considered. Centres in Scotland were excluded from further analysis due to poor ethnicity data completeness (15.3%). The patient cohort used for the various analyses differ slightly, and these variations are described in the individual sections. Details of ethnicity coding used by centres and regrouping of these codes by the UK Renal Registry (UKRR) can be found in appendix H at www.renalreg.com.

Regional variations in RRT incidence rates by ethnic group

Data completeness for ethnicity for patients on RRT has improved over the years. The proportion of patients with missing ethnicity data has decreased from 13.3 % in 2003 to 3% in 2012. As missing ethnicity data would bias the estimates of incidence rates in a population, only patients starting RRT in the years 2010–2012 (~98 % ethnicity data completeness) were included in this analysis. Details of methods used to calculate age–gender standardized incidence rates can be found in appendix D at www.renalreg.com. As census data for Northern Ireland population by ethnic group was not available for all age groups above 65 years, Northern Ireland centres were excluded from analyses that required age–gender standardization.

Demographics and clinical characteristics

All patients starting RRT between 2003 and 2012 with data on ethnicity from centres in England, Wales and Northern Ireland were included for these analyses. The following patient characteristics at start of RRT were studied: age, gender, social deprivation, primary renal diagnosis, comorbidity, estimated glomerular filtration rate (eGFR), haemoglobin (Hb), time between first seen at renal centre and start of RRT (<90 days, 90–365 days, >365 days), and treatment modality at start, 90 days and at 1 year from start of RRT.

Details of EDTA coding for primary renal diagnosis used by renal centres can be found in appendix H at www.renalreg.com. Details of comorbid conditions listed in the UKRR dataset and their regrouping are described elsewhere [2]. Social deprivation was measured at super output area level using the adjusted Index of Multiple Deprivation (IMD) [3]. The super output areas were sorted by their IMD score and divided into quintiles, a high IMD quintile indicating a higher level of deprivation. Each patient was allocated an IMD score and a quintile by matching their postcode of residence to the 2001 Census lower layer super output area.

eGFR was calculated using the 4 variable MDRD study equation [4] using the most recent creatinine data that was available within 14 days before start of RRT. Similarly, the most recent Hb data within 14 days before start of RRT only were included in the analyses.

Chi-squared and Kruskal Wallis tests were used to compare groups where appropriate.

Patient outcome measures

1) Attainment of laboratory standards on dialysis

Only patients who started RRT from 2003 to 2011 and were on dialysis at the end of their first year of RRT were included in the analyses. Values from the 4th quarter (or 3rd quarter if 4th quarter reading not available) in the first year of RRT for each of the following variables were used to ascertain achievement of standards set by the UK Renal Association: Hb 100–120 g/L; phosphate (PO4) 1.1–1.7 mmol/L; corrected calcium (Ca) 2.2–2.5 mmol/L; parathyroid hormone (PTH) 16–72 pmol/L; urea reduction ratio (URR) >65%. Patients who did not have a recorded value for a laboratory variable either in the 3rd or 4th quarter in their first year of RRT were excluded from the analysis for that laboratory standard. For patients on HD, all the variables were measured pre-dialysis. For the analysis on URR in HD patients, patients on home dialysis and those who received less than three dialysis sessions per week were not included. Logistic regression analyses were performed to compare attainment of standards between ethnic groups adjusting for age (<35, 35–44, 45–54, 55–64, 65–74, 75+ years), gender, primary renal diagnosis, year of start of RRT, dialysis modality at one year, IMD quintile and centre as fixed effect. Adjustments for comorbidity were not performed due to incomplete data.

2) Access to kidney transplantation

The UKRR has previously reported on access to transplantation for the various ethnic groups in the UK and the detailed methodology is described in those reports [5, 6, 7].

3) Kidney transplant outcomes

Kidney allograft survival and allograft function amongst those with a functioning graft at one year and five years were compared between the ethnic groups. For those who had more than one kidney transplant during the study period, only the first transplant episode was included in the analyses. For the one year graft outcomes analyses, patients who had a kidney only transplant and who had data on ethnicity, IMD score, primary renal diagnosis and donor type between 2003 and 2011 were included. For the five year graft outcome analyses, patients who had a kidney only transplant between 2003 and 2007 were included in the analyses to allow five year follow up for all patients. Kaplan-Meier analyses with and without censoring for death were performed to compare unadjusted graft survival between ethnic groups. Cox proportional hazards model censoring for death, and death with functioning

graft as a competing event were performed adjusting for age at transplant as a continuous variable, gender, primary renal diagnosis, IMD quintile, year of transplant, time on RRT prior to transplantation and type of donor (post brain stem death donor versus post circulatory death donor versus live donor). Other donor details such as donor age, cold ischaemia time, human leucocyte antigen (HLA) mismatch were not available to be included in the adjusted analyses.

Graft function amongst those with a functioning graft at one year and five years was estimated using the CKD-EPI equation [8] from the most recent serum creatinine available in the last quarter of the first and fifth years post kidney transplantation respectively.

4) Patient survival on dialysis

Patients who started RRT between 2003 and 2012 (excluding patients in the last quarter of 2012 to allow at least 90 days of RRT) and who had data on ethnicity were considered. Unadjusted survival at 90 days from start of RRT, one year from start of RRT and one year after 90 days from start of RRT is reported. For the one year after 90 day survival analyses, patients who started RRT from the last quarter of 2011 were not included to allow adequate follow up. Kaplan Meier analyses and a Cox proportional hazards model adjusting for age as a continuous variable, gender, centre as random effect, year of RRT start and IMD quintile were used with and without censoring for transplantation to compare survival after 90 days from RRT start between the ethnic groups. Due to non-proportionality, stratified analyses were performed by primary renal disease (diabetic, non-diabetics), age group ($<$45, 45–64, $\geqslant$65 years) and dialysis modality at day 90 from RRT start. Patients were followed up until 31st December 2012 or death if earlier.

The EDTA codes for causes of death were used by centres and these can be found in appendix H at www.renalreg.com

There was no significant difference between those who were included and excluded due to missing ethnicity data except that the cohort without an ethnic code was older (median age 71.0 years vs. 64.2 years, $p < 0.0001$).

5) Hospitalisation episodes

The UKRR has done collaborative work using Hospital Episode Statistics (HES) data. This cohort included all RRT patients over the age of 18 years who started RRT for ERF in English renal centres between 1 January 2002 and 31 December 2006. Detailed methodology for this has been previously published [9]. This cohort was used to calculate unadjusted hospitalisation rates and cause of hospitalisation by ethnic group.

Results

Regional variations in incidence of RRT

Data completeness and ethnic composition by centre in the incident population 2003–2012 is shown in table 6.1. Overall completeness was 92%, excluding Scottish centres. There was huge variation between centres in the proportion of non-White patients on RRT in each centre, from 62% in London Barts and 55% in London West to 1% in some of the South West centres, with an overall median of 6%. Ethnic distribution of the population accounted for some of the regional variations in RRT incidence. The age–gender standardized incidence ratio of RRT was higher (2–3 times) in regions with a high ethnic minority population compared to those with a low ethnic minority population (figure 6.1). However previous work by the UKRR has shown that only 31% of this regional variation in RRT incidence in the UK could be explained by demographics, health and access to health service factors [10].

Age, gender and social deprivation

62.2% of patients were male; this degree of male preponderance was observed for White and South Asian patients although to a lesser extent with Black patients (58.0%, $p < 0.0001$) (table 6.2). The proportion of male patients amongst Black patients has however increased from the 48% observed in the 1997–2003 cohort.

Of all patients starting RRT in 2012, 49% were aged $\geqslant$65 years compared to only 16% aged $\geqslant$65 years in the general UK population [1]. The higher incidence of RRT amongst older people was more pronounced for Black and South Asian patients compared to White patients (incidence rate of 1,191, 1,133 and 283 per million population respectively), (table 6.3, figure 6.2).

Amongst all patients starting RRT, Black and South Asians were younger compared to White patients, with median ages of 54.4, 58.7 and 65.5 years respectively ($p < 0.0001$) (table 6.2).

Data on residence postcode to calculate IMD score was not available for 250 (0.5%) patients and this was not different between the ethnic groups. Black and South Asian patients predominantly lived in socially deprived areas. The proportion of patients living in IMD quintile 5 areas was greater for Black and South Asians than White patients (45.7%, 38.7%, 20.9% respectively, $p < 0.0001$) (table 6.4).

Primary renal disease causing ERF

Data on primary renal disease was missing for 2,473 (4.9%) of all patients and this was equally distributed between the ethnic groups.

Diabetes was the leading cause of ERF in all ethnic groups. However, the proportion of patients with diabetes as cause of ERF was greater amongst South Asian and Black patients compared to White patients (40.2%, 31.0%, 20.5% respectively) (table 6.5).

Amongst Black and South Asian patients diabetes was more common in those aged $\geqslant$65 years, as compared to

Table 6.1. Percentage of incident RRT patients (2003–2012) in different ethnic groups by centre

Centre	Percentage in each ethnic group					*N* with data	% completeness
	White	Asian	Black	Chinese	Other		
England							
B Heart	69.4	23.9	5.8	0.3	0.6	1,040	99.6
B QEH	68.2	19.6	8.8	0.6	2.9	1,932	99.6
Basldn	88.8	2.3	6.5	1.5	1.0	400	99.0
Bradfd	59.1	38.5	1.9	0.0	0.5	624	95.4
Brightn	93.6	3.6	2.1	0.0	0.8	899	83.4
Bristol	91.7	3.2	3.7	0.6	0.8	1,562	97.4
Camb	95.6	2.0	1.2	0.6	0.6	1,054	90.6
Carlis	98.5	0.8	0.0	0.4	0.4	267	98.5
Carsh	75.7	11.0	8.8	1.3	3.3	1,623	82.0
Chelms	94.0	3.5	1.6	0.6	0.3	319	76.9
Colchr	95.4	2.0	1.3	0.0	1.3	152	82.6
Covnt	82.1	13.1	4.1	0.7	0.0	970	96.6
Derby	85.5	8.9	3.9	1.2	0.5	662	88.9
Donc	96.7	1.4	1.4	0.0	0.5	211	98.6
Dorset	97.8	0.9	0.3	0.2	0.9	667	99.4
Dudley	88.7	7.4	3.0	0.2	0.7	462	97.5
Exeter	99.0	0.3	0.2	0.1	0.3	934	77.0
Glouc	96.0	1.7	1.0	0.2	1.0	577	93.2
Hull						405	39.9
Ipswi	96.1	0.8	3.1	0.0	0.0	382	94.3
Kent	96.1	1.9	0.6	0.3	1.1	787	97.3
L Barts	38.0	28.1	29.5	1.0	3.4	1,908	98.7
L Guys	62.9	5.7	27.9	0.9	2.6	1,183	87.7
L Kings	56.5	10.0	31.1	1.2	1.2	1,167	92.3
L Rfree	51.0	17.5	21.8	0.9	8.9	1,444	95.1
L St.G	57.9	14.3	21.3	1.2	5.3	489	89.1
L West	45.2	32.2	16.8	0.7	5.2	3,038	95.7
Leeds	82.4	12.7	3.8	0.1	1.0	1,388	89.3
Leic	80.0	15.7	3.0	0.3	1.0	2,213	98.3
Liv Ain	95.7	1.4	0.7	1.4	0.7	277	78.3
Liv RI	93.3	1.2	1.6	1.7	2.3	1,018	87.6
M RI	77.0	11.9	8.0	0.9	2.3	890	98.0
Middlbr	95.9	3.7	0.2	0.2	0.0	979	97.1
Newc	93.8	4.2	0.6	0.4	1.1	1,009	99.2
Norwch	95.8	0.8	0.3	2.5	0.6	649	77.6
Nottm	89.2	4.9	4.7	0.0	1.3	1,202	99.9
Oxford	85.6	7.5	4.0	0.6	2.2	1,570	96.6
Plymth	98.0	0.5	0.2	0.7	0.7	608	95.5
Ports	94.4	2.9	1.5	0.0	1.2	1,448	93.7
Prestn	85.9	12.9	0.9	0.0	0.3	1,175	97.1
Redng	74.9	17.9	5.4	0.4	1.5	822	96.3
Salford	83.4	13.5	1.5	0.3	1.3	1,235	97.6
Sheff	91.0	5.0	2.3	0.5	1.2	1,471	93.2
Shrew	95.8	2.7	0.8	0.2	0.4	474	97.3
Stevng	76.6	14.3	6.5	0.6	2.0	1,012	98.5
Sthend	88.7	2.8	3.5	2.1	2.8	283	83.2
Stoke	94.5	2.6	0.4	0.2	2.2	458	84.5
Sund	97.0	2.1	0.7	0.2	0.0	560	97.6
Truro	98.5	0.0	0.8	0.8	0.0	386	80.1
Wirral	97.1	1.2	0.0	1.2	0.6	523	94.6
Wolve	76.1	16.3	7.1	0.5	0.0	854	99.7
York	97.5	0.9	0.7	0.0	0.9	447	97.2

Table 6.1. Continued

Centre	Percentage in each ethnic group					*N* with data	% completeness
	White	Asian	Black	Chinese	Other		
N Ireland							
Antrim	98.8	1.2	0.0	0.0	0.0	259	95.6
Belfast	98.4	0.8	0.2	0.5	0.3	665	94.9
Newry	99.4	0.0	0.0	0.0	0.6	166	96.0
Ulster	96.5	2.8	0.0	0.7	0.0	144	98.0
West NI	98.7	0.8	0.0	0.4	0.0	237	99.2
Scotland							
Abrdn						128	23.0
Airdrie						206	42.0
D & Gall						10	5.9
Dundee						203	34.3
Dunfn						9	2.6
Edinb						26	2.9
Glasgw						51	2.8
Inverns	99.4	0.0	0.0	0.6	0.0	170	65.1
Klmarnk						44	11.2
Wales							
Bangor	97.6	0.7	0.7	0.4	0.7	286	89.1
Cardff	94.1	4.5	0.9	0.4	0.2	1,344	74.1
Clwyd	98.3	1.7	0.0	0.0	0.0	117	61.9
Swanse	98.1	1.1	0.7	0.0	0.1	1,161	98.9
Wrexm	98.3	0.9	0.4	0.0	0.4	230	83.0
England	**79.5**	**11.0**	**7.1**	**0.6**	**1.8**	**48,109**	**92.5**
N Ireland	**98.4**	**1.0**	**0.1**	**0.3**	**0.2**	**1,471**	**96.1**
Scotland						**847**	**15.3**
Wales	**96.3**	**2.6**	**0.7**	**0.2**	**0.2**	**3,138**	**83.1**
E, W & NI	**81.0**	**10.2**	**6.5**	**0.6**	**1.7**	**52,718**	**91.9**
UK	**81.3**	**10.1**	**6.4**	**0.6**	**1.6**	**53,565**	**85.2**

Blank cells denote <20 patients or <50% data completeness

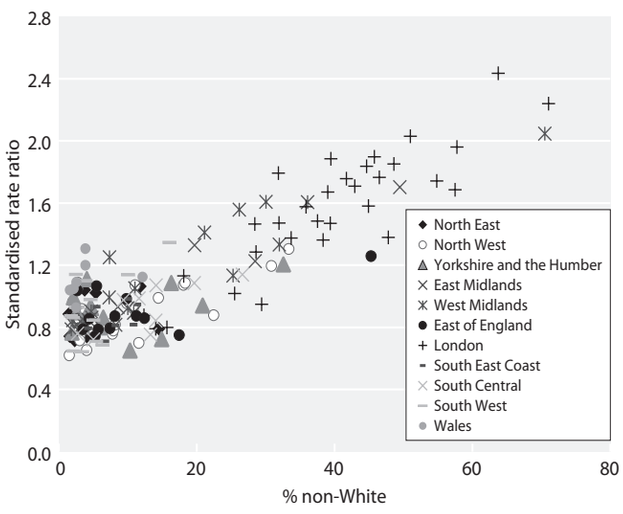

Fig. 6.1. Age/gender standardized incidence ratio (2010–2012) by percentage non-White

Table 6.2. Percentage distribution of gender and age at start of RRT by ethnic group in the incident population 2003–2012

	Asian	Black	White
N	5,383	3,442	42,723
% male	61.3	58.3	62.6
Age at RRT start			
% <65	64.9	67.6	48.8
% 65+	35.1	32.4	51.2
median	58.7	54.4	65.5
IQR	47.0–69.0	42.6–68.9	51.6–75.2

Table 6.3. Incidence rate by ethnic group in under 65 and over 65 year age groups at RRT start (2010–2012)

Incidence rate (pmp)	Asian	Black	White
<65 years	121	160	56
⩾65 years	1,133	1,191	283
Overall	179	224	97

Pmp = per million population

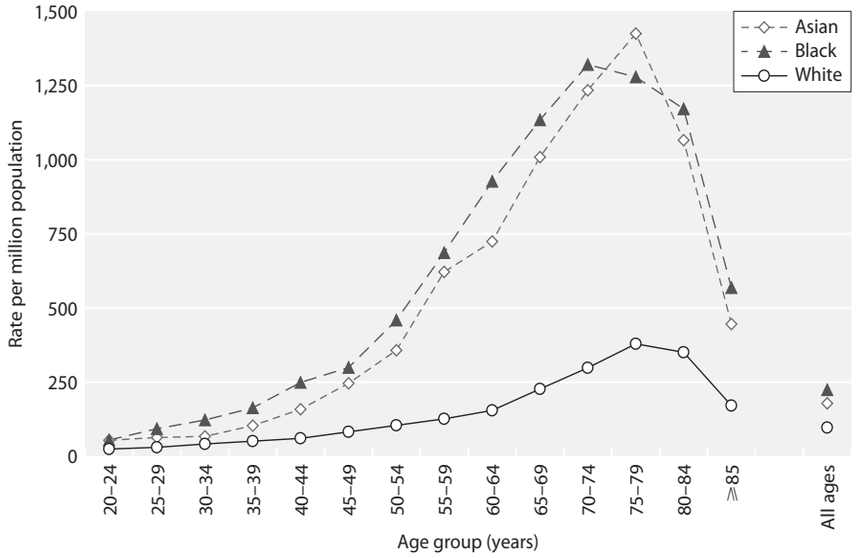

Fig. 6.2. Age profile of incident RRT patients (2010–2012), by ethnicity, in England and Wales

White patients where it was proportionally higher in those aged <65 years. This may reflect a difference between ethnic groups in the underlying type of diabetes leading to ERF. Adult polycystic kidney disease and renovascular disease accounted for a lower proportion of renal disease in the ethnic minority groups compared with White patients whilst hypertensive renal disease was more common amongst Black patients.

Table 6.4. Percentage distribution of deprivation by ethnic group in incident patients 2003–2012

Deprivation quintile* (%)	Asian	Black	White
1	7.8	4.2	17.3
2	10.1	6.4	19.9
3	17.0	12.5	21.0
4	26.5	31.3	21.0
5*	38.7	45.7	20.9

*Quintile 5 most deprived

Comorbidity

Patients with missing data on comorbidity ($N = 21{,}896$, 42%) were excluded from the analyses. Data incompleteness was comparable between ethnic groups ($p = 0.5$). The results presented here should be interpreted with caution due to significant missing data. There was a wide variation in data completeness on comorbidity between centres. Results from analyses including only centres with data completeness of ⩾50% were similar.

Overall, the proportion of patients with at least one comorbidity was greater amongst White patients compared to South Asians and Black patients (55.5%, 45.8%, 37.1% respectively, $p < 0.0001$). However

Table 6.5. Percentage distribution of primary renal diagnosis, by ethnic group, in the incident cohort 2003–2012

	Asian			Black			White		
Diagnosis	<65	65+	All ages	<65	65+	All ages	<65	65+	All ages
Diabetes	36.1	47.9	40.2	23.8	46.2	31.0	24.1	17.0	20.5
Uncertain aetiology	19.7	23.9	21.2	15.6	14.2	15.2	12.6	24.6	18.7
Other	13.1	7.3	11.0	18.4	10.5	15.9	17.8	16.4	17.1
Glomerulonephritis	14.4	4.8	11.0	15.1	5.6	12.0	17.3	10.0	13.6
Pyelonephritis	6.2	4.2	5.5	2.9	4.2	3.3	8.9	7.9	8.4
Polycystic kidney	3.8	1.6	3.1	4.9	1.4	3.8	12.3	3.6	7.9
Renovascular disease	1.7	4.6	2.7	1.5	4.6	2.5	2.4	13.2	7.9
Hypertension	5.1	5.7	5.3	17.7	13.2	16.3	4.6	7.3	6.0
N with data	3,279	1,765	5,044	2,186	1,036	3,222	19,201	19,965	39,166
% data not available*	4.9	5.3	5.1	5.4	6.6	5.8	4.2	5.5	4.9

*This includes data not sent and data from centres excluded from analysis because ⩾50% PRD of uncertain aetiology

Table 6.6. Percentage of patients with comorbidity at start of RRT (2003–2012) by ethnic origin

Comorbidity	Asian	Black	White
Coronary heart disease	25.1	9.8	22.0
Diabetes (not listed as PRD)	9.5	6.4	8.4
Diabetes (as PRD or comorbidity)	40.0	30.9	20.0
COPD*	3.7	2.2	7.6
Malignancy	4.1	6.2	13.5
Liver disease	4.0	4.7	2.6
Smoking	6.6	7.3	15.2
Vascular disease	15.2	14.8	20.1
One or more comorbidities present	45.8	37.1	55.5

*Chronic obstructive pulmonary disease

diabetes (both as primary renal disease and as a comorbidity not causing renal disease) was more common amongst the two ethnic minorities. Coronary heart disease was more common in South Asian and White patients compared to Black patients. Vascular disease, malignancy and smoking were more common amongst White patients (table 6.6). These trends were seen in both those aged <65 and $\geqslant 65$, although the magnitude of difference between the ethnic groups for the two age groups varied depending on the comorbidity (table 6.7).

Late presentation

19,817 (38.4%) patients were excluded from the analysis due to not having data on the date first seen by a nephrologist. Overall, late referral has decreased over the years with the majority (64%) of patients being referred at least a year or more prior to start of RRT compared to only 46% in 1997–2003, although one should interpret this with caution due to potential bias introduced by the significant proportion of missing data. This overall decrease in late referral compared to the previous cohort years was observed in all ethnic groups. However, late referral was more common amongst White patients compared to Black and South Asian patients (21.3%, 19.9%, 17.6% respectively, $p < 0.0001$). There was an age interaction with referral pattern between ethnic groups in that late referral was more common amongst White patients but only in those aged $\geqslant 65$ (table 6.8). When stratified by diabetic status, there was no difference in late referral between ethnic groups (table 6.9). This suggests that the early referral patterns observed in Black and South Asian patients was probably due to higher incidence of diabetes in these groups.

Treatment modality

Haemodialysis (HD) was the commonest starting RRT modality in all ethnic groups (73.3%) followed by peritoneal dialysis (PD) (21.2%) and pre-emptive transplantation (5.6%). The proportion of patients starting PD was lower amongst Black and South Asians compared to White patients (16.4%, 18.4%, 21.9% respectively, $p < 0.0001$). Similarly, pre-emptive transplantation rates were lower amongst South Asian and Black patients compared to White patients (3.1%, 4.2%, 6.0% respectively, $p < 0.0001$). There was no difference ($p = 0.6$) in the type of kidney donor (post circulatory death donor, post brain stem death donor, live donor) between the ethnic groups amongst those who had a pre-emptive kidney transplant. Compared to those referred late (<90 days of RRT start), patients who were referred earlier were more likely to start on PD (25.0% vs. 11.2%, $p < 0.0001$) and had more pre-emptively transplantation (6.9% vs. 1.0%, $p < 0.0001$). This trend was seen in all ethnic groups except in Black patients where the pre-emptive transplantation rate was similar amongst those referred early and late (data not shown).

Table 6.7. Percentage of patients with comorbidity at start of RRT (2003–2012) by age and ethnic origin

	Asian		Black		White	
Comorbidity	<65	65+	<65	65+	<65	65+
Coronary heart disease	19.1	37.1	5.7	18.9	13.4	30.2
Diabetes (not listed as PRD)	7.4	13.9	5.1	9.1	5.0	11.7
Diabetes (as PRD or comorbidity)	35.9	47.6	23.7	46.2	23.7	16.6
COPD*	3.0	5.1	1.4	4.0	4.8	10.2
Malignancy	2.4	7.6	3.9	11.4	7.5	19.2
Liver disease	3.9	4.1	5.3	3.2	3.4	1.7
Smoking	7.3	5.3	8.2	5.2	18.1	12.5
Vascular disease	11.6	22.7	10.1	25.1	14.7	25.2
One or more comorbidities present	37.4	62.8	30.0	52.4	44.4	66.2

*Chronic obstructive pulmonary disease

Table 6.8. Presentation in incident patients 2003–2012, by ethnicity and age

	Asian		Black		White	
Presentation	<65	65+	<65	65+	<65	65+
N	1,822	935	955	471	13,425	14,123
% <90 days	18.8	15.7	22.1	14.7	19.9	22.6
% 90–365 days	16.7	12.8	16.7	11.9	15.9	14.3
% >365 days	64.5	71.4	61.3	73.5	64.2	63.1

eGFR at start of RRT

The eGFR at start of RRT has increased over the years indicating patients are being started on RRT earlier in the course of their chronic kidney disease stage (CKD) (figure 6.3). This trend was observed in all ethnic groups. White patients started at a higher eGFR compared to Black and South Asian patients. The median eGFR at RRT start in 2003–2012 for White patients was 8.5 ml/min/1.73 m^2 compared to 8.0 ml/min/1.73 m^2 for Black and 7.8 ml/min/1.73 m^2 for South Asian patients ($p < 0.0001$). As missing data accounted for 49% of this cohort, caution should be taken in interpreting this result.

Preliminary work undertaken by the UKRR on a cohort of CKD stage 5 patients in the UK has shown that Black and South Asian patients had a much more rapid decline in their eGFR in the year preceding RRT compared to White patients despite adjustments for age, gender and primary renal disease (unpublished data).

Haemoglobin prior to start of RRT

Due to missing data, 25,134 (49%) patients were excluded. White patients had higher mean Hb (102.3 g/L) prior to start of RRT compared to South Asian patients (99.9 g/L, $p < 0.0001$) and Black patients (95.7 g/L, $p < 0.0001$). Data on erythropoietin use prior to start of RRT was not available to further explore the reasons for the differences in Hb at start of RRT between ethnic groups. As it is well known that diabetic patients (more common amongst Black and South Asian patients) become more anaemic earlier in their CKD course compared to non-diabetics [11], a stratified analysis by diabetes status was performed but the results were similar (data not shown).

Patient outcome measures

Attainment of laboratory standards on dialysis

The proportion of patients in each ethnic group who achieved the Renal Association standard varied depending on the outcome measure studied. Table 6.10 shows the multivariate logistic regression model with and without adjustments for various confounding factors. Compared to White patients, South Asian patients had similar attainment of the Hb and PTH standards; better attainment for the URR and phosphate standards; and lower attainment of the calcium standard. Black patients had similar attainment of the Hb, calcium and PTH standards; lower attainment of the URR standard but better attainment of the phosphate standard.

Access to kidney transplantation

The UKRR in collaboration with the Organ Donation Transplantation Directorate of NHS Blood and Transplant (ODT) previously reported on access to kidney transplantation for the ethnic minority patients starting RRT in the years 1997–2004 [5, 6, 7]. Compared to the White patients, South Asian (hazard ratio (HR) 1.10, 95% CI 0.97–1.24) and Black patients (HR 0.95, 95% CI. 0.79–1.14) had similar rates of being listed for a kidney transplant once adjusted for various patient characteristics including social deprivation and centre

Table 6.9. Presentation in incident patients 2003–2012, by ethnicity, stratified by diabetes

	Asian		Black		White	
Presentation	Diabetic	Non-diabetic	Diabetic	Non-diabetic	Diabetic	Non-diabetic
N	1,024	1,584	403	937	5,335	20,394
% <90 days	12.1	21.3	11.9	21.7	10.3	23.4
% 90–365 days	18.4	13.1	18.1	13.5	17.7	14.2
% >365 days	69.5	65.7	70.0	64.9	72.0	62.5

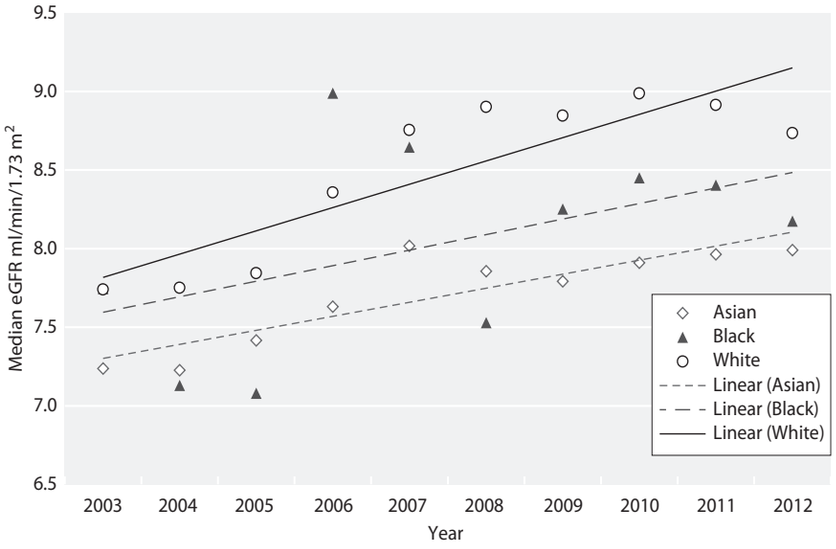

Fig. 6.3. Median eGFR at start of RRT by year of start and ethnic group

effects. However, once on the waiting list, South Asian (HR 0.74, 95% CI 0.65–0.85) and Black patients (HR 0.66, 95% CI 0.49–0.87) had lower rates of deceased donor kidney transplantation. Similarly the likelihood of living donor kidney transplantation in the fully adjusted analyses was lower for South Asian patients (odds ratio (OR) 0.66, 95% CI 0.45–0.96) and Black patients (OR 0.40, 95% CI 0.21–0.73) compared to White patients. A more recent analysis of patients starting RRT between 2006 and 2008 confirmed no ethnic disparities in access to waiting list but the lower rates of deceased donor transplantation once waitlisted, and for live donor transplantation persisted for the ethnic minorities [12].

Kidney transplant outcomes

One year graft outcomes

The analyses included 9,091 kidney only transplants. Of these kidney only transplants, 237 (2.5%) were excluded either due to lack of matching between the UKRR and ODT databases ($N = 159$) or lost to follow up ($N = 78$). Graft failure (excluding deaths with functioning grafts) in the first year following kidney transplantation was greater for Black patients (7.5%) and South Asian (6.1%) patients compared to White patients (4.2%) ($p = 0.0001$). However, in the multivariate Cox regression analyses censoring for death, South Asian patients had a similar graft survival but Black patients a lower graft survival compared to White patients (table 6.11). Results were similar when analyses were repeated with death as a competing risk event. Amongst those who had a functioning graft at one year post kidney transplantation ($N = 8,479$), the median eGFR was better for Black (57.2 ml/min/1.73 m^2, interquartile range (IQR) 42.9–71.5) and South Asian (58.5 ml/min/1.73 m^2, IQR 45.2, 73.3) patients compared to White (51.5 ml/min/1.73 m^2, IQR 40.0, 64.1, $p < 0.0001$) patients.

Five year graft outcomes

For the analyses, 2,912 kidney only transplants were included. Of these kidney only transplants, 126 (4.1%) were excluded either due to lack of matching between

Table 6.10. Odds ratio (OR) (95% confidence interval) of attainment of RA standards at one year after starting RRT in dialysis patients, in Asian and Black patients compared to White patients

	White		Asian			Black		
	OR	*N*	Unadjusted	Adjusted	*N*	Unadjusted	Adjusted	*N*
Haemoglobin	1	23,982	1.01 (0.94–1.09)	1.03 (0.94–1.11)	3,255	0.98 (0.90–1.07)	0.94 (0.85–1.04)	2,135
Calcium	1	21,375	0.85 (0.79–0.92)	0.89 (0.81–0.97)	3,018	0.86 (0.78–0.94)	0.95 (0.85–1.06)	2,023
Phosphate	1	23,559	1.03 (0.96–1.11)	1.15 (1.06–1.25)	3,221	1.05 (0.96–1.15)	1.21 (1.09–1.34)	2,114
PTH	1	20,553	1.12 (1.04–1.21)	1.05 (0.96–1.15)	2,685	1.05 (0.95–1.15)	0.97 (0.87–1.09)	1,737
URR	1	14,393	1.62 (1.42–1.84)	1.73 (1.49–2.00)	1,961	0.81 (0.70–0.93)	0.77 (0.65–0.91)	1,011

Table 6.11. Cox-regression analysis of one year graft failure by ethnicity of kidney-only transplants between 2003 and 2011

	Unadjusted Cox-regression		Adjusted Cox-regression	
	HR (95% CI)	p-value	HR (95% CI)	p-value
Asian	1.4 (1.1–1.9)	0.01	1.3 (0.9–1.9)	0.1
Black	1.8 (1.3–2.5)	0.0004	1.7 (1.2–2.3)	0.0007
White	1 (reference)		1 (reference)	

the UKRR and ODT databases ($N = 101$) or lost to follow up ($N = 25$). Graft failure (excluding deaths with functioning grafts) at five years following kidney transplantation was greater for Black patients (17.2%) compared to South Asian (9.2%) and White (9.8%) ($p = 0.03$) patients. In the multivariate Cox regression analyses censoring for death, White and South Asian patients had a similar graft survival but Black patients had lower graft survival (table 6.12). Results were similar when analyses were repeated with death as a competing risk event. Amongst those who had a functioning graft at five years post kidney transplantation ($N = 2{,}482$), the median eGFR was better for Black (60.4 ml/min/1.73 m^2, IQR 42.8–75.7) and South Asian (58.1 ml/min/1.73 m^2, IQR 44.7, 71.3) patients compared to White patients (50.3 ml/min/1.73 m^2, IQR 38.0, 64.2, $p < 0.0001$).

Patient survival

Figure 6.4 shows the unadjusted survival in the first year of RRT for the different age groups. Overall, South Asian and Black patients have better survival than White patients and this is more apparent in the 55–75 age groups. The survival of patients on RRT in the first year has improved over the years 2003–2011 for both South Asian and White patients but there appears to be a declining trend for Black patients (figure 6.5). In the multivariate adjusted Cox regression analysis including 41920 patients, survival after 90 days of starting RRT without censoring for transplantation was better for South Asian and Black patients compared to White patients (table 6.13). Results were similar when censored for transplantation (data not shown).

Deaths due to cerebrovascular disease, ischemic heart disease and infection were more common for South Asian and Black patients, whilst deaths due to malignancy, withdrawal from RRT and other causes were more common in White patients. These trends were seen both in those aged <65 and $\geqslant 65$ years (table 6.14).

Hospitalisation episodes

The number of admissions and the number of admitted days per year was greater for HD patients compared to PD patients. Amongst HD patients, the number of admissions and the number of admitted days per year was greater for White patients compared to South Asian and Black patients ($p < 0.001$); for PD patients, there was no major difference seen between the ethnic groups (unpublished data). The reasons for admission for the ethnic groups are shown in table 6.15. Cautious interpretation from these data is required as a significant proportion of patients had 'CKD not otherwise specified' coded as a reason for the hospitalisation.

Discussion

Data completeness on ethnicity has improved over the most recent years reducing the probability of selection bias that might have occurred due to missing ethnicity data in the previous years' reports. Therefore, one should interpret with caution any perceived time trends in incidence rates or patient demographics between ethnic groups.

Table 6.12. Cox-regression analysis of five year graft failure by ethnicity of kidney-only transplants between 2003 and 2007

	Unadjusted Cox-regression		Adjusted Cox-regression	
	HR (95% CI)	p-value	HR (95% CI)	p-value
Asian	0.9 (0.6–1.5)	0.8	0.9 (0.6–1.4)	0.6
Black	1.8 (1.1–2.8)	0.01	1.5 (1.1–2.1)	0.02
White	1 (reference)		1 (reference)	

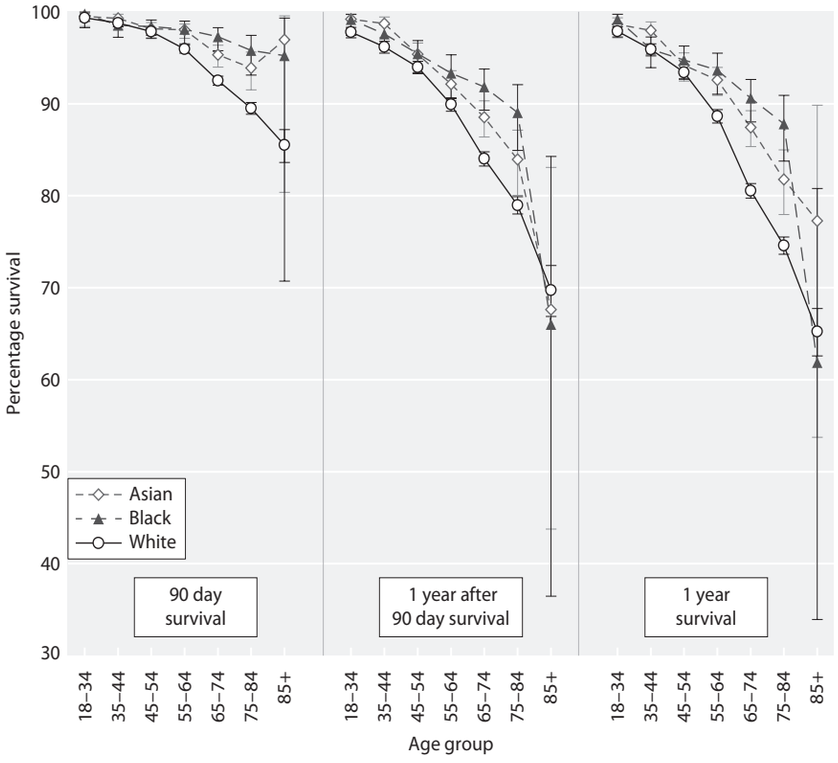

Fig. 6.4. Unadjusted survival by age group and ethnicity in patients starting RRT between 2003 and 2012

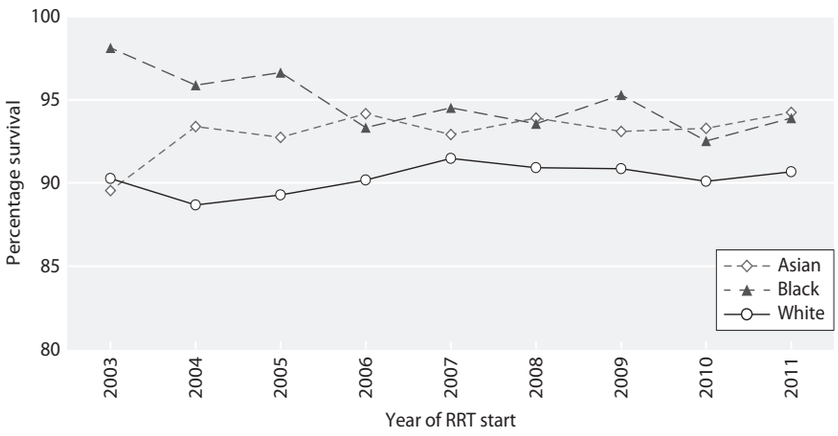

Fig. 6.5. Age-60 adjusted survival one year after 90 days of incident patients by year of RRT start and ethnic group

Table 6.13. Cox-regression analysis of patient survival after 90 days from RRT start, by ethnic group, incident cohort 2003–2012

	Unadjusted Cox-regression		Adjusted Cox-regression	
	HR (95% CI)	p-value	HR (95% CI)	p-value
Asian	0.63 (0.59–0.67)	<0.0001	0.68 (0.60–0.77)	<0.0001
Black	0.5 (0.46–0.54)	<0.0001	0.58 (0.52–0.64)	<0.0001
White	1 (reference)		1 (reference)	

Table 6.14. Cause of deaths for incident patients 2003–2012 that died by the end of 2012, by ethnic group

	All ages			Age <65			Age ⩾65		
	Asian	Black	White	Asian	Black	White	Asian	Black	White
N deaths	1,477	788	17,476	661	359	4,993	816	429	12,483
% of incident patients	27.4	22.9	40.9	18.9	15.4	24.0	43.2	38.5	57.0
COD (%)									
Cerebrovascular disease	6.7	8.4	3.9	7.2	8.3	3.4	6.3	8.5	4.0
Cardiac disease	29.8	26.2	22.0	32.0	25.4	25.0	27.9	27.0	20.9
Infection	22.2	19.1	17.3	21.9	23.3	18.0	22.5	15.2	17.0
Malignancy	6.4	7.2	9.5	5.9	6.2	10.7	6.9	8.1	9.1
Other	17.4	16.3	24.6	18.7	21.2	27.5	16.3	11.9	23.4
Treatment withdrawal	9.4	12.1	17.1	5.3	7.3	10.0	12.7	16.6	19.8
Uncertain	8.1	10.6	5.6	9.1	8.3	5.4	7.4	12.8	5.7
N with no COD data	654	384	7,984	286	166	2,348	368	218	5,636

COD = cause of death

Black and South Asian patients were younger compared to White patients. This, to a certain extent, was probably a reflection of the younger age distribution for ethnic minorities in the general population with only 6% of Black and South Asian patients being aged ⩾65 years compared to 18% of White patients [1]. It is well established that the progression to ERF and the incidence of RRT is much greater amongst ethnic minorities compared to Whites [13–18]. However, these analyses showed that the disparity in incidence rates was more pronounced amongst those aged ⩾65 years and the reasons for this are not obvious.

Table 6.15. Cause of hospitalisation from 90 days to one year following the start of dialysis amongst incident patients between 2002–2006, by ethnic group

	Percentage		
Cause of hospitalisation	Asian	Black	White
Abdominal pain	2.7	1.9	1.7
Access	19.6	23.3	17.9
Biochemistry	1.2	2.4	1.5
Bronchitis	4.7	3.2	3.6
Cancer	0.8	1.2	2.2
Catheter	1.0	1.3	1.6
Chest pain	2.7	1.4	1.6
CKD codes	32.5	33.3	34.1
CVA	0.7	0.7	0.7
Fracture	1.8	1.3	2.5
Gastroenteritis	3.7	2.6	3.4
GI bleed	0.3	0.4	0.8
Hernia	0.4	0.6	0.9
High risk sepsis	3.3	3.2	3.3
Ischaemic heart disease	6.3	3.7	5.9
Low risk sepsis	2.9	2.0	1.8
Miscellaneous	6.7	8.9	7.3
Neuro	1.9	2.2	1.9
Overload	2.5	2.6	2.4
Peritonitis	1.1	1.5	1.2
Syncope	1.6	1.4	2.0
UTI	1.7	0.8	1.7
Total numbers	**1,989**	**1,802**	**28,104**

CVA = cerebrovascular accident
UTI = urinary tract infection

Life expectancy estimates for ethnic minorities in the general population are lower than for the White population [19] and therefore the higher incidence amongst the elderly ethnic minority patients cannot be attributed to the possibility of them living longer to reach ERF. It is also not known if there are variations in the uptake of conservative management of ERF between the ethnic groups. Although the incidence of RRT (supply) is higher in the ethnic minorities, population estimates of CKD stage 5 (demand) are needed to ensure that there is no ethnic disparity in access to RRT (demand–supply mismatch).

The proportion of patients starting RRT who had at least one comorbidity was greater amongst White patients although ill-health is generally more frequently reported by ethnic minorities in the general population [20]. However, the comorbidity patterns in the RRT population are consistent with greater incidence of coronary heart disease in South Asian patients, cerebrovascular accidents in Black patients and lower cancer rates seen in ethnic minorities in the general population [20].

Early referral to a renal centre was associated with better uptake of PD. However despite being referred earlier, ethnic minorities had lower uptake of PD and lower Hb at start of RRT. They also started RRT at a

lower eGFR compared to White patients. The lower uptake of PD seen in ethnic minorities may however be as a consequence of confounding by differing centre practices of PD use. It is also possible that the unexpected rapid decline in kidney function in the preceding year of RRT (unpublished work by UKRR) could have resulted in insufficient time for adequate education about dialysis modalities to enable patients to choose PD, or the appropriate management of anaemia prior to the need for RRT.

However, once established on dialysis, the attainment of laboratory standards was better or similar for the ethnic minorities for most standards except calcium for South Asian and URR for Black patients. Importantly, the attainment of the Hb standard (which was lower at start of RRT) was no longer different between the ethnic groups at one year from start of RRT. Data on use of calcium containing phosphate binders, vitamin D analogues, duration of HD session and type of vascular access are not available to explore the reasons for these differences. These results are slightly different from those previously reported [21] on a cohort of patients starting RRT between 1997–2004 in which attainment of Hb $\geqslant$100 g/L was lower amongst Black patients and attainment of PTH $\leqslant$32 pmol/L was lower for South Asian and Black patients. These differences were probably due to the different range used for each of the laboratory measures analysed in this report to comply with current UK guidelines. When analyses were repeated using the previous RA standards, results were similar to the earlier report.

It is reassuring to note equitable access to the transplant waiting list for ethnic minorities but there continues to be a disparity in access to deceased donor transplantation once on the waiting list. It is well acknowledged that this is due to blood group and HLA disparity compared with the predominantly White donor pool in the UK. The new UK organ allocation scheme introduced in 2006 gave a greater emphasis in the points scoring system to patients waiting longer for a transplant. The lack of observed impact in this report following the introduction of the new scheme may be due to the fact that the majority of patients included in this report irrespective of their ethnicity would have waited for a similar duration of time on the waiting list, whereas the new allocation scheme would have improved access to a small proportion who were on the waiting list well before 2006. Living donor transplantation rates were lower for ethnic minorities and several recipient and donor factors have been suggested including fewer approaches or less active encouragement by nephrologists to seek living related donors [22]; lack of suitable donors with family members living outside the UK who are therefore unable to be assessed or complete donor work up; and high prevalence of diabetes in the immediate family [23]. It has also been observed that Black patients on dialysis had more positive coping strategies than Whites and this may affect their perception of the need for transplant [24].

The poor graft survival for Black patients reported in this cohort is consistent with previous reports from the UK [25, 26] and the USA [27, 28]. However a study from France suggested that compared to White patients, graft survival was similar for Black patients with a genetic pool similar to African Americans suggesting the possible role of social deprivation and health care access in poor outcomes for Black patients in the USA [29]. In the analyses, these disparities were observed despite adjustments for area level deprivation. Black and Indo Asian patients have a greater likelihood of receiving kidneys at higher risk of delayed or inferior outcomes, i.e. expanded criteria donor (ECD) kidneys, compared to White patients in the USA [30]. Previous UKRR work in collaboration with ODT has shown that Black and South Asian patients were more likely to receive kidneys with longer cold ischaemic time and HLA mismatches both of which could influence graft survival [7]. Donor information for this cohort was not available to explore the reasons for the apparent persistent inferior graft survival for Black patients in the UK.

There was a paradox in that Black and South Asian patients despite having reduced life expectancy in the general population [19] appeared to have better survival on dialysis. No adjustment for baseline comorbidity was made in this report due to incomplete data but these results are consistent with previous studies from North America and the UK that have adjusted for baseline comorbidity although residual confounding from missing comorbidity data could not be excluded in these studies [31, 32, 33].

Hospitalisation rates were higher for White patients on dialysis compared to South Asian and Black patients. Due to several of these episodes being coded as 'CKD not otherwise specified', it was not possible to determine if the increased hospitalisation rates amongst White dialysis patients was due to newly acquired comorbidity whilst on RRT that could account for the increased mortality. Several mechanisms including better adaptation on dialysis, better social support, less withdrawal from dialysis and greater use of Vitamin D analogues amongst ethnic minorities have also been suggested for

better survival amongst ethnic minority dialysis patients [34, 35, 36, 37]. Another possible mechanism suggested for this paradox is survivor bias i.e. ethnic minority patients with CKD and significant comorbidity are more likely to die prematurely before reaching ERF or possibly less likely to be referred or accepted onto RRT [38]. However a more recent study from the USA has shown that mortality is similar between Black and White patients with CKD stages 3–4 questioning this hypothesis [39].

Another possible mechanism is lead time bias. White patients started RRT at a slightly higher eGFR compared to ethnic minorities in this study. However, this difference was clinically very small to entirely account for the ethnic differences in mortality observed in this study. It is well established that Black and South Asian patients have rapid progression from their underlying CKD to ERF. It is therefore possible that they have less 'CKD vintage' compared to the White patients i.e may therefore start RRT early with a reduced arteriosclerotic load when compared with the White population. Although ischaemic heart disease was more common amongst South Asian patients, the proportion of patients with at least one comorbidity and those with vascular disease and smoking were more prevalent in White patients. Further studies examining survival from a predefined eGFR early in the course of CKD stage 4–5 are needed to explore this hypothesis with more detailed assessment of CVD (e.g. LVEF, ABPI etc.).

There are other patient outcome measures that merit comparison between ethnic groups on RRT in the UK such as quality of life and mental health. This is currently within the remit of collaborative work being considered by the UKRR. Data on cause of hospitalisation episodes for dialysis patients are required to help understand the differences in survival between the ethnic groups.

This report confirms the persistent high incidence of RRT, the better survival on dialysis and the poor access to kidney transplantation for South Asian and Black patients and early allograft loss for Black patients.

This, in the context of increasing ethnic diversity of the general population and ageing of ethnic minorities will have a significant impact on the prevalence of ethnic minority patients on dialysis and impose a disproportionate demand on dialysis provision in those areas with a high ethnic minority population. More effort is needed to reduce progression of CKD to ERF in ethnic minorities.

Conflicts of interest: none

References

1 Office for National Statistics, 2011 Census: Aggregate data (England and Wales). UK Data Service Census Support
2 Shaw C et al. UK Renal Registry 14th annual report: Chapter 4 comorbidities and current smoking status amongst patients starting renal replacement therapy in England, Wales and Northern Ireland from 2009 to 2010. Nephron Clin Pract 2012;120(suppl 1):c81–c91
3 Payne RA and GA Abel. UK indices of multiple deprivation – a way to make comparisons across constituent countries easier. Health Statistics Quarterly 53, Spring 2012. Office of National statistics. London
4 Levey AS et al. A simplified equation to predict glomerular filtration rate from serum creatinine [abstract]. J Am Soc Nephrol 2000;11:A0828
5 Udayaraj et al. Social deprivation, ethnicity, and uptake of living kidney donor transplantation in the United Kingdom. Transplantation 2012; Mar 27;93(6)
6 Udayaraj et al. Social deprivation, ethnicity, and access to the deceased donor kidney transplant waiting list in England and Wales. Transplantation 2010 Aug 15;90(3):279–285
7 Udayaraj et al. Social deprivation, ethnicity and renal replacement therapy in England and Wales: Equity of access and outcomes (Dissertation). University of Bristol, England, 2009
8 Levey A, Stevens L, Schimd C, et al. A new equation to estimate glomerular filtration rate. Ann Intern Med 2009;150(9):604–612
9 Fotheringham J et al. Variation in centre-specific survival in patients starting renal replacement therapy in England is explained by enhanced comorbidity information from hospitalization data. Nephrol Dial Transplant (2013) 0:doi: 10.1093/ndt/gft363
10 Castledine et al. How much of the regional variation in RRT incidence rates within the UK is explained by the health needs of the general population? Nephrol Dial Transplant 2012 Oct;27(10):3943–3950
11 Anemia management in people with chronic kidney disease. National Institute for Health and Care Excellence 2011. Downloaded from www.nice.org.uk
12 Pruthi R et al. UK Renal Registry 15th annual report: Chapter 9 centre variation in access to renal transplantation in the UK (2006–2008). Nephron Clin Pract 2013:123(suppl 1):183–193
13 Department of Health: Saving lives: Our healthier nation. London: HMSO. 1999
14 Bryson CL, Ross HJ, Boyko EJ, Young BA. Racial and ethnic variations in albuminuria in the US Third National Health and Nutrition Examination Survey (NHANES III) population: associations with diabetes and level of CKD. Am J Kidney Dis 2006;48(5):720–726
15 Krop JS, Coresh J, Chambless LE, Shahar E, Watson RL, Szklo M et al. A community-based study of explanatory factors for the excess risk for early renal function decline in blacks vs. whites with diabetes: the Atherosclerosis Risk in Communities study. Arch Intern Med 1999; 159(15):1777–1783
16 Tarver-Carr ME, Powe NR, Eberhardt MS, LaVeist TA, Kington RS, Coresh J et al. Excess risk of chronic kidney disease among African-American versus white subjects in the United States: a population-based study of potential explanatory factors. J Am Soc Nephrol 2002; 13(9):2363–2370
17 Hsu CY, Lin F, Vittinghoff E, Shlipak MG. Racial differences in the progression from chronic renal insufficiency to end-stage renal disease in the United States. J Am Soc Nephrol 2003;14(11):2902–2907
18 Peralta CA, Ziv E, Katz R, Reiner A, Burchard EG, Fried L et al. African ancestry, socioeconomic status, and kidney function in elderly African Americans: a genetic admixture analysis. J Am Soc Nephrol 2006; 17(12):3491–3496

19 Wohland P et al. Life Expectancy variation across England's local areas by ethnic group in 2001. Journal of Maps; 6(1):354–359
20 Ethnicity and ill health. Postnote (276). Parlimetnary Office of Science and Technology. London, 2007
21 Udayaraj et al. Ethnicity, socioeconomic status, and attainment of clinical practice guideline standards in dialysis patients in the United Kingdom. Clin J Am Soc Nephrol 2009;4(5):979–987
22 Navaneethan SD, Singh S. A systematic review of barriers in access to renal transplantation among African Americans in the United States. Clin Transplant 2006;20:769–775
23 Tankersley MR, Gaston RS, Curtis JJ et al. The living donor process in kidney transplantation: influence of race and comorbidity. Transplant Proc 1997;29:3722–3723
24 Lunsford SL, Simpson KS, Chavin KD et al. Racial differences in coping with the need for kidney transplantation and willingness to ask for live organ donation. Am J Kidney Dis 2006;47:324–331
25 Rudge C et al. Renal transplantation in the United Kingdom for patients from ethnic minorities Transplantation 2007;83(9):1169–1173
26 Loucaidou M et al. Outcome of renal transplantation in south asian recipients is similar to that in non-asians. Transplantation 2004;78: 1021–1024
27 Press R, Carrasquillo O, Nickolas T, Radhakrishnan J, Shea S, Barr RG. Race/ethnicity, poverty status, and renal transplant outcomes. Transplantation 2005;80(7):917–924
28 Isaacs RB, Nock SL, Spencer CE, Connors AF, Jr., Wang XQ, Sawyer R et al. Racial disparities in renal transplant outcomes. Am J Kidney Dis 1999;34(4):706–712
29 Pallet N et al. Kidney transplant in black recipients: are African Europeans different from African Americans? Am J Transplant 2005; 5(11):2682–2687
30 Schold JD, Kaplan B, Chumbler NR, Howard RJ, Srinivas TR, Ma L et al. Access to quality: evaluation of the allocation of deceased donor kidneys for transplantation. J Am Soc Nephrol 2005;16(10):3121–3127
31 Pei YP, Greenwood CM, Chery AL, Wu GG. Racial differences in survival of patients on dialysis. Kidney Int 2000;58(3):1293–1299
32 Yan G et al. The relationship of age, race, and ethnicity with survival in dialysis patients. Clin J Am Soc Nephrol 2013;8(6):953–961
33 Roderick, P et al. Survival of patients from South Asian and Black populations starting renal replacement therapy in England and Wales. Nephrol Dial Transplant 2009 Dec;24(12):3774–3782
34 Lunsford SL, Simpson KS, Chavin KD, Hildebrand LG, Miles LG, Shilling LM et al. Racial differences in coping with the need for kidney transplantation and willingness to ask for live organ donation. Am J Kidney Dis 2006;47(2):324–331
35 Powe NR. Let's get serious about racial and ethnic disparities. J Am Soc Nephrol 2008;19(7):1271–1275
36 Wolfe M et al. Impact of activated vitamin D and race on survival among hemodialysis patients. J Am Soc Nephrol 2008 Jul;19(7):1379–1388
37 Nicholas SB et al. Racial disparities in kidney disease outcomes. Semin Nephrol 2013;33(5):409–415
38 Mehrotra R, Kermah D, Fried L, Adler S, Norris K. Racial differences in mortality among those with CKD. J Am Soc Nephrol 2008;19(7): 1403–1410
39 Babayev R et al. Association of race and body mass index with ESRD and mortality in CKD stages 3–4: results from the Kidney Early Evaluation Program (KEEP). Am J Kidney Dis 2013;61(3):404–412

UK Renal Registry 16th Annual Report: Chapter 7 Demography of the UK Paediatric Renal Replacement Therapy population in 2012

Rishi Pruthi[a], Catherine O'Brien[b], Anna Casula[a], Fiona Braddon[a], Malcolm Lewis[c], Heather Maxwell[d], Jelena Stojanovic[e], Yincent Tse[f], Carol Inward[g], Manish D Sinha[e]

[a]UK Renal Registry, Bristol, UK; [b]Birmingham Children's Hospital, Birmingham, UK; [c]Manchester Children's Hospital, Manchester, UK; [d]Royal Hospital for Sick Children (Yorkhill), Glasgow, UK; [e]Evelina Childrens Hospital, London, UK; [f]Royal Victoria Infirmary, Newcastle, UK; [g]Bristol Royal Hospital for Children, Bristol, UK

Key Words
Aetiology · Children · Demography · End stage renal disease · Established renal failure · Incidence · Prevalence · Ethnicity · Renal replacement therapy · Survival

Summary

- A total of 861 children and young people under 18 years with established renal failure (ERF) were receiving treatment at paediatric nephrology centres in 2012.
- At the census date, 80.2% had a functioning kidney transplant, 10.6% were receiving haemodialysis (HD) and 9.2% were receiving peritoneal dialysis (PD).
- In patients aged <16 years the prevalence of ERF was 56.7 pmarp and the incidence 9.0 pmarp.
- A third of patients had one or more reported comorbidities.
- Over the past 15 years for those referred early, there has been a rise in pre-emptive transplantation rates, rising from 26.2% in 1998–2002 to 36.3% in 2008–2012.
- At transfer to adult services, 81.5% of patients had a functioning kidney transplant.
- Being on dialysis was seen to lower survival significantly compared to having a functioning transplant with a hazard ratio of 6.3 (CI: 3.4–11.7).

Introduction

Established renal failure (ERF) requiring renal replacement therapy (RRT) is a rare but significant cause of long term morbidity and mortality during childhood, with specialist care being provided in 13 paediatric nephrology centres in the UK. All centres are equipped to provide peritoneal dialysis and haemodialysis, with ten centres also undertaking kidney transplantation for children. In the United Kingdom (UK) in 2011, the prevalence rate of treated ERF in children aged under 16 years was 56.8 and the incidence rate was 8.3 per million age related population (pmarp).

The objectives of this report are:

(i) To describe the UK prevalence, incidence, causes of ERF and modality of treatment of children on RRT on 31st December 2012
(ii) To describe trends of the same over the past 15 years, and
(iii) To describe pre-emptive transplantation rates and survival of children on RRT aged <16 years old in the UK.

Methods

Data collection was performed by all 13 paediatric nephrology centres managing children on RRT in the UK in 2012. Most centres submitted data electronically to the UK Renal Registry (UKRR) with only two centres submitting data using paper-based data returns this year. These data items were then manually entered into the current paediatric UKRR database. Thus 92% of data returns including 791 of 861 children were performed electronically in 2012.

In this report, patient groups are described as: (i) 'prevalent' group: patients who were receiving RRT on the 31st December 2012; (ii) 'incident' group: patients who started RRT between 1st January and 31st December 2012; and (iii) '5 year' groups: patients who started RRT in the periods of 1998–2002, 2003–2007 and 2008–2012.

The populations used to calculate the incidence and prevalence rates were obtained from the Office for National Statistics (ONS) [1]. The mid-2012 population estimate produced by the ONS, based on the 2011 Census, was used for calculating the 2012 incident and prevalent group rates; the 2001 Census data was used for the 1998–2002, 2003–2007 and 2008–2012 '5 year' groups.

Infants under the age of three months and 'late presenters' (defined as children commencing dialysis within three months following review by a paediatric nephrologist) were excluded from analyses when calculating pre-emptive transplantation rates. For survival analysis, only patients starting RRT between 1st January 1998 and 31st December 2011 were included to ensure a minimum of 1 year follow up at the census date, and were followed up to a maximum age of 16 years.

Statistical analyses

Statistical analyses were performed using SAS 9.3, with group analyses using Chi-square test and median analyses using Kruskal-Wallis test. A Cox regression model was used in calculating hazard ratios for patient survival, adjusting for gender, age at start of RRT, and RRT modality as a time dependent variable. Survival probabilities were calculated using univariate Kaplan Meier curves.

Results

Accuracy and completeness of data returns

Efforts to improve the overall accuracy of the entire paediatric dataset by clinical teams, data managers and statisticians over these past few years have resulted in improved accuracy of the database, analyses and conclusions. The data returns, now showing near 100% data completeness being achieved by all centres for a range of data items including, gender, ethnicity, treatment modality and age at start of RRT. Data completeness for other core items was better than previous reports and is shown in table 7.1 [2].

The UK paediatric prevalent ERF population in 2012

A total of 861 children and young people under 18 years with ERF were receiving treatment at paediatric nephrology centres in 2012. At the census date, 80.2% had a functioning kidney transplant, 10.6% were receiving haemodialysis (HD) and 9.2% were receiving peritoneal dialysis (PD).

Patients aged 16–18 years may receive their medical care either in a paediatric or in an adult nephrology centre. As data were incomplete for the 16–18 year old adolescent patients, they have been excluded from the majority of subsequent analyses (particularly when describing incidence and prevalence rates).

There were 679 children under 16 years of age receiving RRT in the UK in 2012. Table 7.2 shows the number of patients receiving RRT by age group and gender plus rate of RRT pmarp. The prevalence of RRT increased with age and was higher in males across all age groups with an overall male to female prevalence ratio of 1.5. The reported prevalence rate in under 16 year olds was 56.7 pmarp.

Table 7.3 shows the ethnic origin of current RRT patients and their prevalence rates. Children from ethnic minorities displayed higher prevalent rates of

Table 7.1. Data completeness for paediatric prevalent ERF population in 2012

		Percentage completeness				
Centre	*N*	First seen date	Height at RRT start	Weight at RRT start	Creatinine at RRT start	Primary renal diagnosis
Blfst_P	36	94.4	86.1	88.9	94.4	100.0
Bham_P	89	100.0	95.5	96.6	97.8	97.8
Brstl_P	54	100.0	98.2	98.2	100.0	100.0
Cardf_P	26	96.2	100.0	100.0	100.0	100.0
Glasg_P	53	96.2	90.6	94.3	96.2	98.1
L Eve_P	96	100.0	64.6	70.8	71.9	100.0
L GOSH_P	172	98.3	88.4	95.9	95.4	100.0
Leeds_P	77	100.0	85.7	98.7	98.7	100.0
Livpl_P	34	97.1	79.4	85.3	88.2	97.1
Manch_P	73	98.6	93.2	98.6	98.6	100.0
Newc_P	35	100.0	82.9	85.7	88.6	100.0
Nottm_P	90	96.7	71.1	85.6	98.9	100.0
Soton_P	26	100.0	76.9	76.9	92.3	96.2
UK	**861**	**98.5**	**84.9**	**91.1**	**93.7**	**99.4**

Table 7.2. The UK paediatric prevalent ERF population in 2012, by age group and gender

	All patients		Males		Females		
Age group	*N*	pmarp	*N*	pmarp	*N*	pmarp	Ratio M:F
0–1.99 years	21	12.9	16	19.3	5	6.3	3.1
2–3.99 years	46	29.1	35	43.2	11	14.2	3.0
4–7.99 years	140	46.1	86	55.4	54	36.5	1.5
8–11.99 years	186	67.1	115	81.0	71	52.5	1.5
12–15.99 years	286	96.3	164	107.8	122	84.2	1.3
Under 16 years	**679**	**56.7**	**416**	**67.8**	**263**	**45.0**	**1.5**

pmarp – per million age related population

RRT when compared with White children, with South Asian children displaying the highest rates.

Modality of treatment

Current treatment modality in the prevalent paediatric population less than 16 years old in 2012 is displayed in figure 7.1. Of the 79% with a functioning transplant, 52% received a deceased donor transplantation and 48% a living donor transplantation.

The treatment modality in use at the start of RRT is displayed in figure 7.2. This shows that 48% of patients were treated with PD at the start of RRT whilst 29% of

Table 7.3. The UK paediatric prevalent ERF population by age and ethnic group in 2012[a]

	White		South Asian		Black		Other[b]
Age group	*N*	pmarp	*N*	pmarp	*N*	pmarp	*N*
0–3.99 years	47	18.2	13	61.6	0	0.0	3
4–7.99 years	97	40.5	25	128.2	5	64.1	4
8–11.99 years	140	54.7	29	139.1	8	95.9	13
12–15.99 years	211	78.3	45	204.9	9	102.5	8
Under 16 years	**495**	**48.4**	**112**	**134.3**	**22**	**65.9**	**28**

pmarp – per million age related population
[a]ethnicity data missing in two children who are excluded from this table
[b]pmarp not expressed for group 'Other', as heterogeneous group

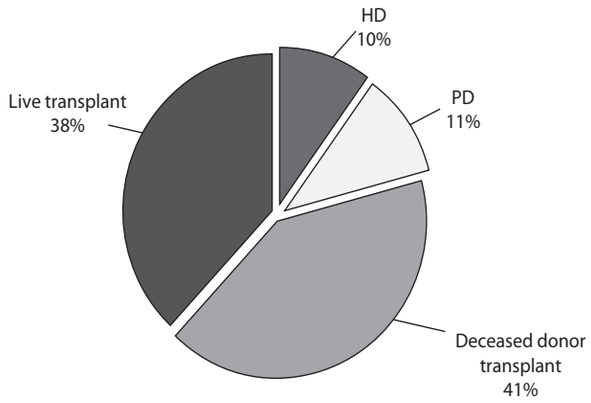

Fig. 7.1. RRT treatment used by prevalent paediatric patients <16 years old in 2012

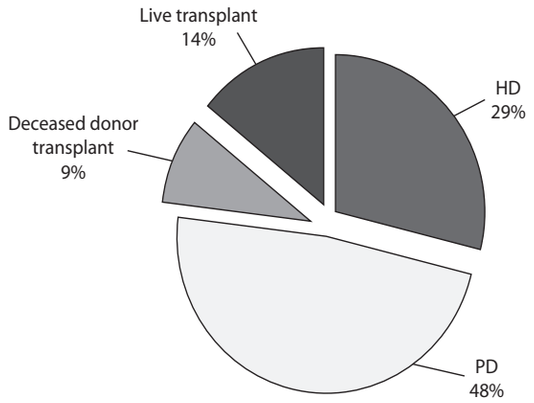

Fig. 7.2. Treatment modality at start of RRT in prevalent paediatric patients under 16 years of age in 2012

patients were treated with HD. Twenty-three percent of children under 16 were reported to have received a pre-emptive transplant.

Further treatment modality analysis by age is shown in table 7.4 which demonstrates that in the under two year old age group no children received a transplant and that the majority of patients were being treated with PD (57.1%). This contrasts with older children in the 12 to 15.99 year age group where 85% had a functioning graft and where similar proportions were on HD and PD. Subsequent analysis of RRT modality by gender and ethnicity showed no difference. However as absolute sub-group numbers are small, caution is needed in conducting any comparative analyses.

Cause of ERF

Table 7.5 and figure 7.3 show the diagnostic categories for the prevalent ERF population under 16 years in 2012. There has been a marked improvement in data completeness in this category over the last few years with missing data falling to only 0.7% which was similar to that seen in the 2011 report [2]. Of the 679 patients, renal dysplasia ± reflux remained the commonest condition causing ERF (33%), whilst there were no documented patients with drug nephrotoxicity.

As for associated comorbidities at the onset of RRT, table 7.6 shows that congenital abnormalities were the commonest, reported in 9.4% of patients, followed by syndromic diagnosis at 8.8%. Overall 65.5% of patients had no registered comorbidities, with 23% having one comorbidity listed, and 11.5% having two or more comorbidities. Centre analysis showed significant variation in reporting of registered comorbidities, with some centres, Cardiff (90%), Birmingham (84%), Glasgow (80%) and GOSH (79%) reporting no comorbidity in the majority of their patients, as compared to other centres

Table 7.4. Current treatment modality by age in the prevalent paediatric ERF population in 2012

	Current treatment							
	HD		PD		Live transplant		Deceased donor transplant	
Age group	*N*	%	*N*	%	*N*	%	*N*	%
0–1.99 years	9	42.9	12	57.1	0	0.0	0	0.0
2–3.99 years	9	19.6	11	23.9	21	45.7	5	10.9
4–7.99 years	14	10.0	18	12.9	62	44.3	46	32.9
8–11.99 years	17	9.1	12	6.5	69	37.1	88	47.3
12–15.99 years	21	7.3	22	7.7	105	36.7	138	48.3
16–17.99 years	21	11.5	4	2.2	67	36.8	90	49.5
Under 16 years	**70**	**10.3**	**75**	**11.0**	**257**	**37.8**	**277**	**40.8**
Under 18 years	**91**	**10.6**	**79**	**9.2**	**324**	**37.6**	**367**	**42.6**

Table 7.5. Number, percentage and gender by primary renal disease as cause of ERF in the prevalent paediatric ERF population under 16 years in 2012*

Diagnostic group	Total	%	Male	Female	M:F ratio
Renal dysplasia ± reflux	224	33.0	140	84	1.7
Obstructive uropathy	126	18.6	118	8	14.8
Glomerular disease	81	11.9	38	43	0.9
Congenital nephrotic syndrome	66	9.7	37	29	1.3
Tubulo-interstitial diseases	50	7.4	23	27	0.9
Uncertain aetiology	33	4.9	16	17	0.9
Renovascular disease	31	4.6	18	13	1.4
Polycystic kidney disease	28	4.1	11	17	0.6
Metabolic	20	2.9	8	12	0.7
Malignancy & associated disease	15	2.2	6	9	0.7
Missing	5	0.7	1	4	0.3
Total	**679**	**100**	**416**	**263**	**1.6**

*In 2012 there were no patients with ERF secondary to 'drug nephrotoxicity'

which reported no comorbidity in a smaller proportion of patients, Bristol (27%) and Manchester (42%). This variation in reporting needs further investigation.

The UK incident paediatric ERF population in 2012

There were 117 patients under 18 years of age who commenced RRT at paediatric renal centres in 2012. As previously, the following analyses are restricted to the 108 patients who were under 16 years of age.

The incidence rate of RRT was 9.0 pmarp in 2012. Patients commencing RRT in 2012 are displayed by age and gender in table 7.7.

Table 7.8 shows that the reported incidence of RRT has been rising since 1998, the highest incidence rates seen in the 12–15.99 year age group, with the 0–1.99 year age group having the next highest rates.

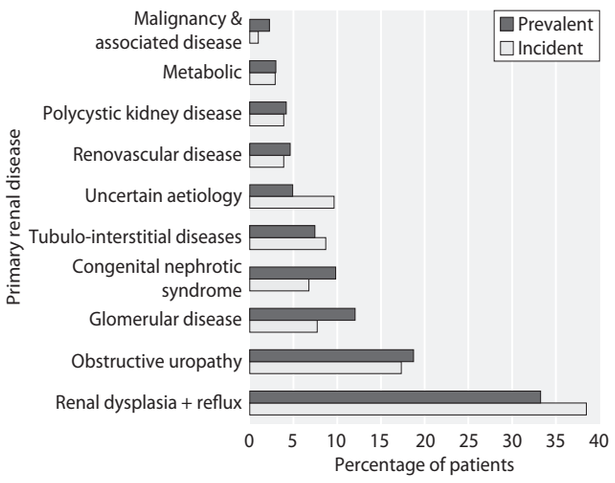

Fig. 7.3. Primary renal disease percentage in incident and prevalent paediatric ERF patients in 2012 for whom a causative diagnosis was reported

Trends in ERF demographics

There were 1,656 children under 16 years of age who had received RRT in the UK over the 15-year period between 1998–2012. Analysis of ERF demographics for children less than 16 years of age over this period included 547 patients reported to the paediatric registry between 1998–2002, 536 between 2003–2007 and 573 between 2008–2012. Comparing the current 5-year

Table 7.6. Registered comorbidities at onset of RRT in prevalent paediatric patients aged <16 years with ERF in 2012

Comorbidity	*N*	Percentage of all RRT patients
Cerebral palsy	7	1.0
Chromosomal abnormality	17	2.5
Congenital abnormality	64	9.4
Congenital heart disease	14	2.1
Consanguinity	27	4.0
Developmental delay	54	8.0
Diabetes	3	0.4
Family member with ERF	19	2.8
Liver disease	12	1.8
Malignancy	4	0.6
Neural tube defect	4	0.6
Prematurity	54	8.0
Psychological disorder	6	0.9
Syndromic diagnosis	60	8.8
No reported comorbidity	445	65.5
One reported comorbidity	156	23.0
Two or more comorbidities	78	11.5

Table 7.7. The incident paediatric ERF population in the UK in 2012, by age group and gender

	All patients		Male		Female		
Age group	*N*	pmarp	*N*	pmarp	*N*	pmarp	M:F ratio
0–1.99 years	20	12.3	16	19.3	4	5.1	3.8
2–3.99 years	12	7.6	8	9.9	4	5.2	1.9
4–7.99 years	19	6.3	10	6.4	9	6.1	1.1
8–11.99 years	19	6.9	10	7.0	9	6.7	1.1
12–15.99 years	38	12.8	3	15.1	15	10.4	1.5
Under 16 years	**108**	**9.0**	**67**	**10.9**	**41**	**7.0**	**1.6**

pmarp – per million age related population

period with the two previous 5-year periods there has been an overall increase in the number of children treated with RRT, particularly in children aged under two years (table 7.9). The percentage of children on RRT who were from South Asian or Black ethnic backgrounds also increased during this period (table 7.10). The reported patient population at most paediatric renal centres has similarly grown in size since 1998–2002 (table 7.11).

Table 7.12 shows the number and percentage of children receiving RRT with each of the major reported comorbidities over the last 15 years. Syndromic diagnoses (8.6%), congenital abnormalities (8.0%), developmental delay (7.9%) were the most common reported co-morbidities in 2008–2012, with little change in the percentage of children receiving RRT with a reported comorbidity over the last 15 years.

As for changes in modality at the start of RRT, figure 7.4 shows that the percentage of children who were using PD at the start of RRT has fallen from 54.7% in 1998–2002 to 43.7% in 2008–2012, whilst the percentage commencing RRT on HD increased from 23.1% in 1998–2002 to 29.1% in 2008–2012. During this period the overall percentage receiving a transplant at the start of RRT remained largely unchanged although living donation has risen from 7.1% in 1998–2002 to 18.0% in 2008–2012, with a corresponding fall in deceased donor transplantation from 15.1% to 9.3% for the same time period.

Table 7.13 shows the diagnostic categories for 540 of the 546 (98.9%) patients in 1998–2002, for 525 of the 536 (97.9%) patients in 2003–2007 and 564 of the 573 (98.4%) patients in 2008–2012 aged <16 years for whom a causative diagnosis was reported.

Table 7.8. Reported average incident rate by age group, in 5-year time periods, of children under 16 years of age commencing RRT

	Per million age related population		
Age group	1998–2002	2003–2007	2008–2012
0–1.99 years	11.3	12.7	12.5
2–3.99 years	6.7	5.2	7.6
4–7.99 years	5.5	6.3	6.5
8–11.99 years	8.9	7.7	8.8
12–15.99 years	13.2	13.5	13.9
Under 16 years	**9.1**	**9.3**	**9.9**

Table 7.9. Number and percentage of children who commenced RRT, by age group and 5-year period, at start of RRT

	1998–2002		2003–2007		2008–2012		1998–2012
Age group	*N*	%	*N*	%	*N*	%	% change
0–1.99 years	78	14.3	90	16.8	99	17.3	3.0
2–3.99 years	48	8.8	35	6.5	59	10.3	1.5
4–7.99 years	81	14.8	87	16.2	92	16.1	1.2
8–11.99 years	139	25.4	113	21.1	120	20.9	−4.5
12–15.99 years	201	36.7	211	39.4	203	35.4	−1.3
Under 16 years	**547**		**536**		**573**		

Table 7.10. Number and percentage of children under 16 years who commenced RRT, by ethnicity and 5-year period of starting RRT*

	1998–2002		2003–2007		2008–2012		1998–2012
Ethnic group	*N*	%	*N*	%	*N*	%	% change
White	428	79.0	407	76.9	407	71.9	−7.1
S Asian	84	15.5	82	15.5	98	17.3	1.8
Black	13	2.4	18	3.4	21	3.7	1.3
Other	17	3.1	22	4.2	40	7.1	3.9
Under 16 years	**542**		**529**		**566**		

*Five children in 1998–2002, seven in 2003–2007 and seven in 2008–2012 with no ethnicity recorded are excluded from this table

Table 7.11. Number and percentage of children under 16 years reported to the UKRR, by renal centre and 5-year period of starting RRT*

	1998–2002		2003–2007		2008–2012		1998–2012
Centre	*N*	%	*N*	%	*N*	%	% change
Blfst_P	17	3.1	15	2.8	26	4.5	1.4
Bham_P	51	9.3	55	10.3	66	11.5	2.2
Brstl_P	36	6.6	40	7.5	29	5.1	−1.5
Cardf_P	17	3.1	24	4.5	17	3.0	−0.1
Glasg_P	40	7.3	36	6.7	43	7.5	0.2
L Eve_P	61	11.2	45	8.4	62	10.8	−0.4
L GOSH_P	87	15.9	102	19.0	115	20.1	4.1
Leeds_P	46	8.4	55	10.3	44	7.7	−0.7
Livpl_P	23	4.2	28	5.2	16	2.8	−1.4
Manch_P	58	10.6	44	8.2	54	9.4	−1.2
Newc_P	28	5.1	28	5.2	23	4.0	−1.1
Nottm_P	60	11.0	51	9.5	57	9.9	−1.0
Soton_P	22	4.0	13	2.4	21	3.7	−0.4
Total <16	**546**		**536**		**573**		

*One child in 1998–2002 with unknown centre of RRT start was excluded from this table

Table 7.12. Trends in comorbidity at the start of RRT in the paediatric population under 16 years, by 5-year period

	1998–2002		2003–2007		2008–2012		1998–2012
Comorbidity	*N*	%	*N*	%	*N*	%	% change
Cerebral palsy	6	1.1	12	2.2	7	1.2	0.1
Chromosomal abnormality	18	3.3	17	3.2	9	1.6	−1.7
Congenital abnormality	43	7.9	49	9.1	46	8.0	0.2
Congenital heart disease	15	2.7	13	2.4	13	2.3	−0.5
Consanguinity	29	5.3	15	2.8	19	3.3	−2.0
Developmental delay	47	8.6	39	7.3	45	7.9	−0.7
Diabetes	2	0.4	6	1.1	2	0.3	0.0
Family member with ERF	21	3.8	16	3.0	12	2.1	−1.7
Liver disease	3	0.5	11	2.1	10	1.7	1.2
Malignancy	7	1.3	5	0.9	2	0.3	−0.9
Neural tube defect	2	0.4	5	0.9	4	0.7	0.3
Prematurity	31	5.7	24	4.5	37	6.5	0.8
Psychological disorder	11	2.0	6	1.1	10	1.7	−0.3
Syndromic diagnosis	30	5.5	52	9.7	49	8.6	3.1
No reported comorbidity	369	67.5	347	64.7	399	69.6	2.2
One reported comorbidity	118	21.6	133	24.8	115	20.1	−1.5
Two or more comorbidities	60	11.0	56	10.4	59	10.3	−0.7

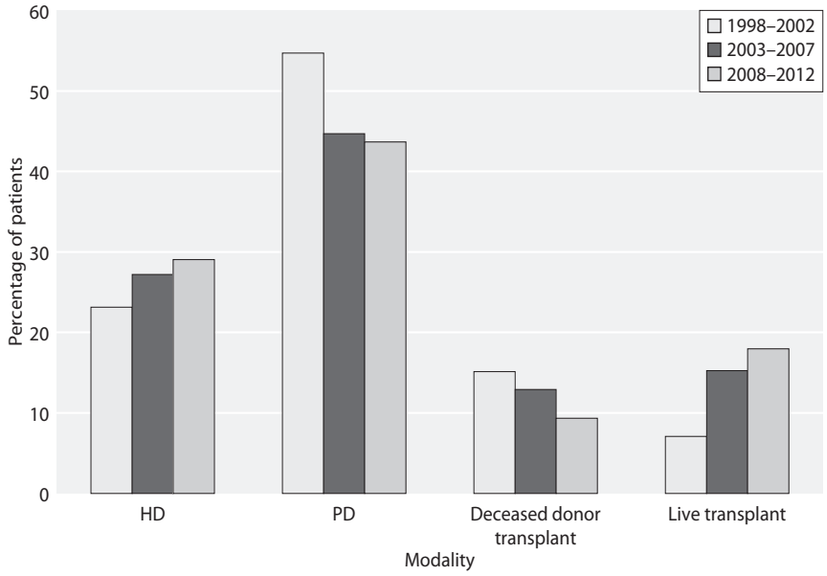

Fig. 7.4. Treatment modality at start of RRT by 5-year time period

Overall there has been an increase in the percentage of children receiving RRT with renal dysplasia ± reflux and interestingly also those with an uncertain aetiology between 1998–2002 and 2008–2012 although absolute numbers are very small (table 7.13).

Pre-emptive transplantation

Of a total of 1,656 patients who started RRT between 1998–2012, 460 patients were excluded from this analysis (94 patients were excluded due to being aged <3 months, and a further 366 patients were excluded due to being late presenters). Of 1,196 patients identified as being aged three months to <16 years and having started RRT between 1998–2012, pre-emptive transplantation was seen to occur in 32.5% of patients and was significantly higher in males (35.4%) than females (27.8%), $p = 0.006$ (table 7.14). Ethnicity was also seen to be a significant factor, with children from Black (14.7%) and South Asian (19.3%) ethnicity having significantly lower rates of transplantation than their White counterparts (35.8%), $p < 0.0001$. Analysis by age at start of RRT showed that as expected, the lowest rate of pre-emptive transplantation was in the three months to two year group (5.1%), whilst children aged four to sixteen years had similar rates of pre-emptive transplantation. As for PRD, children with polycystic

Table 7.13. Number and percentage of children under 16 years for whom a primary renal diagnosis had been reported as a cause of ERF, by 5 year time period and observed change in proportion of patients in each diagnostic group*

	1998–2002		2003–2007		2008–2012		1998–2012
Primary renal diagnosis	*N*	%	*N*	%	*N*	%	% change
Renal dysplasia ± reflux	149	27.6	182	34.7	181	32.1	4.5
Obstructive uropathy	84	15.6	75	14.3	95	16.8	1.3
Glomerular disease	130	24.1	105	20.0	96	17.0	−7.1
Congenital nephrotic syndrome	30	5.6	26	5.0	37	6.6	1.0
Tubulo-interstitial diseases	38	7.0	48	9.1	44	7.8	0.8
Uncertain aetiology	11	2.0	28	5.3	34	6.0	4.0
Renovascular disease	26	4.8	13	2.5	20	3.5	−1.3
Polycystic kidney disease	15	2.8	17	3.2	20	3.5	0.8
Metabolic	34	6.3	18	3.4	30	5.3	−1.0
Malignancy & associated disease	7	1.3	9	1.7	6	1.1	−0.2
Drug nephrotoxicity	16	3.0	4	0.8	1	0.2	−2.8

*Six children in 1998–2002, eleven in 2003–2007 and nine in 2008–2012 with no PRD recorded are excluded from this table

Table 7.14. Demographics of pre-emptive transplantation in children aged 3 months to 16 years in the UK between 1998–2012, analysed by 5-year time period, gender, ethnicity, age at start of RRT and primary renal diagnosis

	N	*N* (%) pre-emptively transplanted
Total cohort analysed (1998–2012)	1,196	389 (32.5)
Time period		
1998–2002	408	107 (26.2)
2002–2007	388	137 (35.3)
2008–2012	400	145 (36.3)
Gender		
Male	742	263 (35.4)
Female	454	126 (27.8)
Ethnicity		
Black	34	5 (14.7)
Other	49	16 (32.7)
South Asian	197	38 (19.3)
White	899	322 (35.8)
Age at start of RRT		
3 months–1.99 years	117	6 (5.1)
2–3.99 years	118	32 (27.1)
4–7.99 years	211	75 (35.6)
8–11.99 years	288	101 (35.1)
12–15.99 years	462	175 (37.9)
Primary renal diagnosis		
Renal dysplasia + reflux	387	161 (41.6)
Glomerular disease	223	26 (11.7)
Obstructive uropathy	219	94 (42.9)
Congenital nephrotic syndrome	78	5 (6.4)
Tubulo-interstitial diseases	73	19 (26.0)
Metabolic	69	29 (42.0)
Polycystic kidney disease	40	18 (45.0)
Renovascular disease	37	15 (40.5)
Uncertain aetiology	25	8 (32.0)
Malignancy & associated disease	13	1 (7.7)
Drug nephrotoxicity	12	3 (25.0)

kidney disease (45%) and obstructive uropathy (42.9%) had the highest rates of pre-emptive transplantation, whilst those with congenital nephrotic syndrome (6.4%) had the lowest rate. Over time there appears to have been a rise in pre-emptive transplantation rates, rising from 26.2% in 1998–2002 to 36.3% in 2008–2012, $p = 0.004$ (table 7.14).

Transfer of patients to adult renal services in 2012

A total of 81 patients were reported by paediatric nephrology centres to have been transferred to adult renal services in 2012. The median age of patients transferred out was 18.1 years with an inter-quartile range of 17.7 years to 18.5 years.

Table 7.15. Modality, gender, ethnicity and primary renal diagnosis of patients transferred out of paediatric nephrology centres in 2012

	N	% distribution
Modality		
HD	11	13.6
PD	4	4.9
Transplant	66	81.5
Gender		
Female	27	33.3
Male	54	66.7
Ethnicity*		
Black	3	3.7
Other	2	2.5
South Asian	13	16.3
White	62	77.5
Primary Renal Diagnosis*		
Glomerular disease	22	27.5
Renal dysplasia ± reflux	21	26.3
Obstructive uropathy	12	15.0
Congenital nephrotic syndrome	6	7.4
Uncertain aetiology	6	7.5
Metabolic	4	5.0
Tubulo-interstitial diseases	3	3.8
Drug nephrotoxicity	2	2.4
Polycystic kidney disease	2	2.5
Malignancy & associated disease	1	1.3
Renovascular disease	1	1.3

*Ethnicity missing in 1 patient, and PRD missing in 1 patient

Table 7.15 shows that of the transferred patients 66.7% were male, with ethnic minorities constituting 22.5% of patients. The vast majority (81.5%) had a functioning renal transplant at the time of transfer to an adult renal centre. Glomerular disease and renal dysplasia ± reflux accounted for the primary renal diagnosis in over 50% of patients.

Survival of children on RRT during childhood

Of patients under the age of 16, 1,548 were identified as starting RRT between 1998 and 2011 at paediatric centres in the UK and were included in the survival analyses. At the census date (31st December 2012) there were a total of 103 deaths within the cohort on RRT at age <16, with a median follow up time of 3.6 years (range of one day to 15 years). Table 7.16 shows the survival hazard ratios after adjustment for age at start of RRT, gender and RRT modality, and

Table 7.16. Survival hazard ratio during childhood for paediatric RRT patients aged <16 years in the UK adjusted for age at start of RRT, gender and RRT modality

	Hazard ratio	Confidence interval	p-value
Age			
0–1.99 years	4.7	2.4–9.3	<0.0001
2–3.99 years	2.4	1.1–5.5	0.03
4–7.99 years	1.6	0.7–3.7	0.23
8–11.99 years	1.3	0.6–3.0	0.48
12–16 years	1.0	–	–
Gender			
Female	1.3	0.9–1.9	0.19
Male	1.0	–	
RRT modality			
Dialysis	6.3	3.4–11.7	<0.0001
Transplant	1.0	–	

highlights that children starting RRT at 0–1.99 years had the worst survival outcomes with a hazard ratio of 4.7 (CI 2.4–9.3, $p < 0.0001$) when compared to 12–16 year olds. Outcomes in the 2–3.99 age group were also significantly worse with a hazard ratio of 2.4 (CI 1.1–5.5, $p = 0.03$). Being on dialysis, as expected, was seen to lower survival significantly compared to having a functioning transplant with a hazard ratio of 6.3 (3.4–11.7, $p < 0.0001$). Figure 7.5 shows unadjusted Kaplan Meier survival probabilities. As the maximum age of follow up was restricted to 16 years, it was not possible to calculate 10 year survival probabilities for patients starting RRT aged >8 years, or 5 year survival probability for children starting RRT aged >12 years. This figure again highlights worse outcomes for those aged 0–1.99 years.

Mortality data in 2012

There were nine deaths in renal paediatric centres in 2012, eight children were aged <16 and one between 16–18 years at the time of death. In children aged <16 years with treated ERF, the reported mortality in 2012 in the UK at paediatric centres was 1.2% (8/679). The median age at death was 10.8 years with a range of 0.2 years to 17.1 years. At the time of death, three children had received a kidney transplant and three were on dialysis (one haemodialysis and two PD).

Septicaemia was cited as a cause of death in three patients, two of which were associated with transplantation and one with peritoneal dialysis. One patient died as a result of chest complications during PD catheter insertion. Three further patients were receiving active palliative care at the time of death. A clear cause of death could not be identified in the two remaining patients who died in 2012.

Discussion

This report from the Paediatric Renal Registry has focussed on the current demography and the demographic trends over the past 15 years of the UK paediatric ERF population.

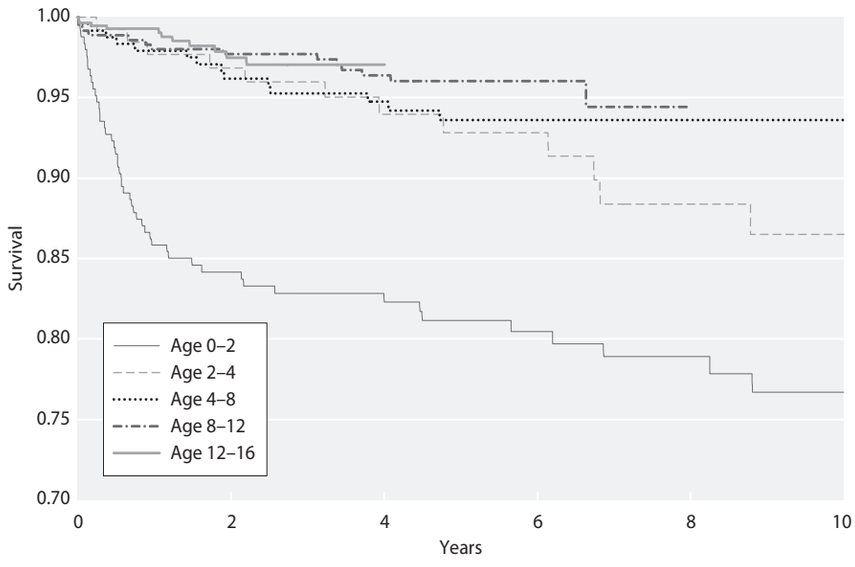

Fig. 7.5. Unadjusted KM in paediatric patients starting RRT between 1998 and 2011, by age at start

This report includes 679 children and adolescents under 16 years of age, who were receiving RRT in 2012. The sub-section on the trends in demographics includes children and adolescents under 16 years of age on RRT; 546 from 1998–2002, 536 from 2003–2007 and 573 from 2008–2012.

Data completeness

The ongoing sustained effort to improve data accuracy must continue and the aim to move to full electronic annual returns from all centres remains. A revised data set (The NEW Paediatric Dataset) will be used in the near future to improve registry returns. These ongoing efforts to improve the quality and consistency of the data received will be rewarded by enabling enhanced interpretation of centre specific measures of clinical performance. Nearly 92% of data was submitted electronically from 11 of 13 paediatric nephrology centres in the UK. Data returns were complete for key data items and this together with improved checking and validation procedures within the registry contributed to continuing quality improvement.

Incidence, prevalence and trends

The incidence rate of RRT in the less than 16 year age group was 9.0 pmarp in 2012; this rate has been rising since 1998. The overall prevalence rate of RRT in the less than 16 year age group was 56.7 pmarp. The prevalence of RRT increased with age and was higher in males across all age groups. Overall, there was a continuing trend of increased prevalence of children on RRT with increased age, in keeping with improved survival with increasing age. This coupled with an increase in the number of children receiving RRT over the past 15 years has led to a steady increase in the prevalent ERF population.

Treatment modality of ERF

Peritoneal dialysis was the initial treatment modality for 48% of children at the start of treatment, 29% commenced HD and 23% received a pre-emptive transplant. Age influenced the modality of RRT with the majority of the under two's (57%) receiving PD. Overall the majority of prevalent children (79%) on RRT had a functioning transplant.

Pre-emptive transplantation

Over the last 15 years, pre-emptive transplantation was seen to occur in 32.5% of children under 16 years age. The rate of pre-emptive transplantation has increased over the past 15 years (26.2% in 1998–2002 to 36.3% in 2008–2012). There were significantly lower rates of pre-emptive transplantation in girls and ethnic minorities and further detailed studies investigating these would be important.

Comorbidities

At the onset of RRT, 34.5% of patients had one or more associated comorbidities. This overall proportion of children with associated comorbidities has shown little change over the past 15 years. There continues to be significant variation in registered comorbidity rates between centres (10–73%, data not shown); it is likely that this is influenced by different reporting practices between centres. This remains an area for further work from the registry and individual centres.

Causes of ERF and observed trends 1998–2012

As previously, renal dysplasia $\pm$ reflux (33%), glomerular disease (11.9%) and obstructive uropathy (18.6%) were the commonest listed aetiologies for children with ERF. These accounted for 63.5% of all patients for whom a primary diagnosis had been reported. Observation of trends over the 15-year period showed an increase in the percentage of children receiving RRT with renal dysplasia $\pm$ reflux and those with unknown aetiology.

Transfer out and survival data

Data relating to transfer to adult renal services is included in the current report. The median age of transfer was 18.1 years. Of patients receiving RRT, 81.5% transferred with a functioning renal transplant. There appears to be variation in practice between centres regarding transition and transfer out arrangements; it is also likely that variability exists in reporting of 'transfer out' timelines to the registry for patients being transitioned to adult centres. Unpublished results from a survey conducted by the paediatric subcommittee of the registry earlier this year highlighted that transition practices varied as to when children began the process (range: 15–16 years); and when they were expecting to have successfully 'transitioned children' and transferred them out into adult services with some centres aiming for 16 years whilst others for 18 years. Consensus regarding terminology and process will facilitate future comparative interpretation.

Survival data of children on ERF during childhood who commenced RRT between 1998 and 2011 highlights the less favourable outcome for children less than two years of age. The data also highlights the significantly

better survival of children with functioning transplants when compared to those on dialysis. Longer term survival data up to five years was available for those aged <12 years and 10 year survival data for those <8 years only. For the majority of children on RRT long term survival data needs follow up into young adulthood. This is the focus of an ongoing project of the UK Renal Registry.

Conflicts of interest: none

References

1 http://www.Ons.Gov.Uk/census
2 Pruthi R, O'Brien C, Casula A, Braddon F, Lewis M, Maxwell H, Tse Y, Inward C, Sinha MD. UK Renal Registry 15th Annual Report (December 2011): Chapter 4 Demography of the UK Paediatric Renal Replacement Therapy Population in 2011. Nephron Clin Pract. 2013;123(suppl 1): 81–92. doi: 10.1159/000353323

UK Renal Registry 16th Annual Report: Chapter 8 Survival and Cause of Death of UK Adult Patients on Renal Replacement Therapy in 2012: National and Centre-specific Analyses

Rishi Pruthi, Retha Steenkamp, Terry Feest

UK Renal Registry, Bristol, UK

Key Words

Cause of death · Comorbidity · Dialysis · End stage renal disease · Established renal failure · Haemodialysis · Median life expectancy · Outcome · Peritoneal dialysis · Renal replacement therapy (RRT) · Survival · Transplant · Vintage

Summary

- Unadjusted 1 year after 90 day survival for patients starting renal replacement therapy (RRT) in 2011 increased to 87.5% from 87.3% for those starting in 2010.
- In incident patients aged ⩾65 years, unadjusted 1 year after 90 day survival increased from 63.9% in 1997 to 80.6% in the 2011 cohort. An increase in survival was also observed between the 2010 and 2011 cohorts.
- In incident patients aged ⩾65 years the one year survival of diabetic patients was better than that of non-diabetic patients, and three year survival was similar.
- One year age adjusted survival for prevalent dialysis patients remained relatively unchanged at 89.7% in the 2011 cohort compared to 89.8% in the 2010 cohort.
- One year survival for prevalent diabetic patients increased from 81.6% in the 2002 cohort to 84.9% in the 2011 cohort. An increase in survival was also observed between the 2010 and 2011 cohorts.
- RRT patients aged 35–39 had a mortality rate 16.6 times higher than the age matched general population, whereas RRT patients aged 85+ had a mortality rate only 2.7 times higher. The overall relative risk of death improved across most age groups in the 2011 cohort.
- In the prevalent RRT dialysis population, cardiovascular disease accounted for 22% of deaths and treatment withdrawal 19%, whilst 21% were recorded as other cause of death.
- The median life years remaining for an incident patient aged 25–29 years was 18.5 years and approximately 2.4 years for a 75+ year old.

Introduction

The analyses presented in this chapter examine: a) survival from the start of renal replacement therapy (RRT) of adults; b) survival amongst all prevalent adult dialysis patients alive on 31st December 2011; c) the cause of death for incident and prevalent adult patients and d) the projected life years remaining for adult patients starting RRT. They encompass the outcomes from the total incident adult UK dialysis population reported to the UK Renal Registry (UKRR), including the 19.5% who started on peritoneal dialysis and the 7% who received a pre-emptive renal transplant. These results are therefore a true reflection of the outcomes in the whole UK adult RRT population. Analyses of survival within the first year of starting RRT include patients who were recorded as having started RRT for established renal failure (as opposed to acute kidney injury) but who had died within the first 90 days of starting RRT, a group excluded from most other countries' registry data. As is common in other countries, survival analyses are also presented for the first year after 90 days.

The term established renal failure (ERF) used throughout this chapter is synonymous with the terms end stage renal failure (ESRF) and end stage renal disease (ESRD) which are in more widespread international usage. Within the UK, patients have disliked the term 'end stage'; the term ERF was endorsed by the English National Service Framework for Renal Services, published in 2004.

The prevalent dialysis patient group was defined as all patients over 18 years old, alive and receiving dialysis on 31st December 2011 who had been on dialysis for at least 90 days at one of the UK adult renal centres.

Since 2006, the UKRR has openly reported and published centre attributable RRT survival data. It is again stressed that these are raw data which continue to require very cautious interpretation. The UKRR can adjust for the effects of the different age distributions of patients in different centres, but lacks sufficient data from many participating centres to enable adjustment for primary renal diagnosis, other comorbidities at start of RRT (age and comorbidity, especially diabetes, are major factors associated with survival [1–3]) and ethnic origin, which have been shown to have an impact on outcome (for instance, better survival is expected in centres with a higher proportion of Black and South Asian patients) [4]. This lack of information on case-mix makes interpretation of any apparent difference in survival between centres difficult. Despite the uncertainty about any apparent differences in outcome, for centres which appear to be outliers the UKRR will follow the clinical governance procedures as set out in chapter 2 of the 2009 UKRR Report [5].

Methods

The unadjusted survival probabilities (with 95% confidence intervals) were calculated using the Kaplan–Meier method, in which the probability of surviving more than a given time can be estimated for members of a cohort of patients, without any adjustment for age or other factors that affect the chances of survival. Where centres are small, or the survival probabilities are greater than 90%, the confidence intervals are only approximate.

In order to estimate the difference in survival of different sub-groups of patients within the cohort, a stratified proportional hazards model (Cox) was used where appropriate. The results from the Cox model were interpreted using a hazard ratio. When comparing two groups, the hazard ratio is the ratio of the estimated hazard for group A relative to group B, where the hazard is the risk of dying at time t given that the individual has survived until this time. The underlying assumption of a proportional hazards model is that the hazard ratio remains constant throughout the period under consideration. Whenever used, the assumptions of the proportional hazards model were tested.

To allow comparisons between centres with differing age distributions, survival analyses were statistically adjusted for age and reported as survival adjusted to age 60. This gives an estimate of what the survival would have been if all patients in that centre had been aged 60 at the start of RRT. This age was chosen because it was approximately the average age of patients starting RRT 15 years ago at the start of the UKRR's data collection. The average age of patients commencing RRT in the UK has been stable recently around an age of 62 years, but the UKRR has maintained age adjustment to 60 years for comparability with all previous years' analyses. Diabetic patients were included in all analyses unless stated otherwise, and in many analyses diabetic patients were also analysed separately and compared to non-diabetic patients. All analyses were undertaken using SAS 9.3.

Definition of renal replacement therapy start date

The incident survival figures quoted in this chapter are from the first day of renal replacement therapy whether with dialysis or a pre-emptive transplant. In the UKRR all patients starting RRT for ERF are included from the date of the first RRT treatment wherever it took place (a date currently defined by the clinician) if the clinician considered the renal failure irreversible. Should a patient recover renal function within 90 days they were then excluded. These UK data therefore may include some patients who died within 90 days who had developed acute potentially reversible renal failure but were recorded by the clinician as being in irreversible established renal failure.

Previously, the UKRR asked clinicians to re-enter a code for established renal failure in patients initially coded as having acute renal failure once it had become clear that there was no

recovery of kidney function. However, adherence to this requirement was very variable, with some clinicians entering a code for established renal failure only once a decision had been made to plan for long-term RRT [6]. All UK nephrologists have now been asked to record the date of the first haemodialysis session and to record whether the patient was considered to have acute kidney injury (acute renal failure) or to be in ERF at the time. For patients initially categorised as 'acute', but who were subsequently categorised as ERF, the UKRR assigns the date of this first 'acute' session as the date of start of RRT.

UKRR analyses of electronic data extracted for the immediate month prior to the start date of RRT provided by clinicians highlighted additional inconsistencies in the definition of this first date when patients started on peritoneal dialysis, with the date of start reported to the UKRR being later than the actual date of start. These findings are described in detail in chapter 13 of the 2009 Report [6]. This concern is unlikely to be unique to the UK, but will be common to analyses from all renal centres and registries.

In addition to these problems of defining day 0 within one country, there is international variability on when patient data are collected by national registries with some countries (often for financial re-imbursement or administrative reasons) defining the 90th day after starting RRT as day 0, whilst others collect data only on those who have survived 90 days and report as zero the number of patients dying within the first 90 days.

Thus as many other national registries do not include reports on patients who do not survive the first 90 days, survival from 90 days onwards is also reported to allow international comparisons. This distinction is important, as there is a much higher death rate in the first 90 days, which would distort comparisons.

Methodology for incident patient survival

Patients were considered 'incident' at the time of their first RRT, thus patients re-starting dialysis after a failed transplant were not included.

Some patients recover renal function after more than 90 days but subsequently returned to RRT. If recovery was for less than 90 days, the start of renal replacement therapy was calculated from the date of the first episode and the recovery period ignored. If recovery was for 90 days or more, the length of time on RRT was calculated from the day on which the patient restarted RRT.

The incident survival cohort was **NOT** censored at the time of transplantation and therefore included the survival of the 7% who received a pre-emptive transplant. An additional reason for not censoring was to facilitate comparison between centres. Centres with a high proportion of patients of South Asian and Black origin are likely to have a healthier dialysis population, because South Asian and Black patients are less likely to undergo early transplantation [7], and centres with a high pre-emptive transplant rate are likely to have a less healthy dialysis population as transplantation selectively removes fit patients only.

The incident ('take-on') population in any specific year excludes those who recovered within 90 days from the start of RRT, but includes patients who recovered from ERF after 90 days. For survival analyses, patients newly transferred into a centre who were already on RRT were excluded from the incident population for that centre and were counted at the centre at which they started RRT.

The one year incident survival is for patients who started RRT from 1st October 2010 until the 30th September 2011 and followed up for one full year (e.g. patients starting RRT on 1st December 2010 were followed through to 30th November 2011). The 2012 incident patients could not be analysed as they had not yet been followed for a sufficient length of time.

For analysis of 1 year after 90 day survival, patients who started RRT from 1st October 2010 until 30th September 2011 were included in the cohort and they were followed up for a full one year after 90 days.

To help identify any centre differences in survival from the small centres (where confidence intervals are large), an analysis of 1 year after 90 day survival using a rolling four year combined incident cohort from 2008 to 2011 was also undertaken. For those centres which had joined the UKRR after 2008, data were not available for all the years but the available data were included.

The death rate per 1,000 patient years was calculated by dividing the number of deaths by the person years exposed. Person years exposed are the total days at risk for each patient (until death, recovery or lost to follow-up) expressed as years. All patients, even those who died within the first 90 days of RRT, were included in the death rate calculation.

Adjustment of 1 year after 90 day survival for the effect of comorbidity was undertaken using a rolling five year combined incident cohort from 2007 to 2011. Twenty-one centres returned >85% of comorbidity data for patients in the combined cohort. Adjustment was first performed to a mean age of 60 years, then to the average distribution of primary diagnoses for all 21 centres. The individual centre data were then further adjusted for average distribution of comorbidity present at these centres. The survival hazard function was calculated as the probability of dying in a short time interval considering survival to that interval.

Methodology for prevalent dialysis patient survival

For prevalent dialysis patients, all patients who had been established on dialysis for at least 90 days on 31st December 2011 were included in these analyses. Prevalent dialysis patients on 31st December 2011 were followed up in 2012 and were censored at transplantation. When a patient is censored at transplantation, this means that the patient is considered as alive up to the point of transplantation, but the patient's status post-transplant is not considered.

As discussed in previous reports, comparison of survival of prevalent dialysis patients between centres is complex. Survival of prevalent dialysis patients can be studied with or without censoring at transplantation and it is common practice in some registries to censor at transplantation. Censoring could cause apparent differences in survival between those renal centres with a high transplant rate and those with a low transplant rate, especially in younger patients where the transplant rate is highest. Censoring at transplantation systematically removes younger fitter patients from the survival data. The differences are likely to be small due to the relatively small proportion of patients being transplanted in a given year compared to the whole dialysis population (about 22% of the dialysis population aged under 65 and 3% of the population aged 65 years and over). To allow comparisons with other registries the survival results for prevalent dialysis patients **CENSORED** for transplantation have been quoted. To understand survival of patients, including

survival following transplantation, the incident patient analyses should be viewed.

Methodology of cause of death

The EDTA-ERA Registry codes for cause of death were used. These have been grouped into the following categories:

- Cardiac disease
- Cerebrovascular disease
- Infection
- Malignancy
- Treatment withdrawal
- Other
- Uncertain

Some centres had high completeness of data returns to the UKRR for cause of death, whilst others returned no information. Completeness of cause of death data was calculated for all prevalent patients on RRT that died in a specific year with cause of death data completed for that year.

Adult patients aged 18 years and over from England, Wales, Scotland and Northern Ireland were included in the analyses of cause of death. The incident patient analysis included all patients starting RRT in the years 2000–2011. Analysis of prevalent patients included all those aged over 18 years and receiving RRT on 31st December 2011. The death rate was calculated for the UK general population (data from the Office of National Statistics) by age group and compared with the same age group for prevalent patients on RRT on 31st December 2011.

Methodology of median life expectancy (life table calculations)

Kaplan Meier survival analyses were used to calculate the hazard of death by age group (18–34, 35–44, 45–54, 55–64, 65–74, 75+) for incident patients starting RRT from 2000–2009, with at least three years follow-up from 2010 to 2012. The patient inclusion criteria are the same to that of the incident patient cohort described above. Patients were followed until death, censoring (recovery or lost to follow-up) or the end of the study period. Life expectancy which gives the probability of surviving until the next time period was calculated as: 1 – hazard of death. Median life years remaining is then the difference between the age when reaching the 50% probability of survival and the age of starting RRT.

Methodology for comparing mortality in prevalent RRT patients with the mortality in the general population

Data on the UK population in mid-2012 and the number of deaths in each age group in 2012 were obtained from the Office of National Statistics. The age specific UK death rate was calculated as the number of deaths in the UK per thousand people in the population. The age specific expected number of deaths in the RRT population was calculated by applying the UK age specific death rate to the total of years exposed for RRT patients in that age group. This is expressed as deaths per 1,000 patient years. The age specific number of RRT deaths is the actual number of deaths observed in 2012 in RRT patients. The RRT observed death rate was calculated as number of deaths observed in 2012 per 1,000 patient years exposed. Relative risk of death was calculated as the ratio of the observed and expected death rates for RRT patients.

Results of incident (new RRT) patient survival

The 2011 incident cohort included 6,750 patients who started RRT, without any period of renal function recovery lasting more than 90 days. The unadjusted 1 year after 90 day survival for incident patients starting RRT in 2011 (table 8.1) has increased to 87.5% compared to 87.3% in the 2010 cohort.

Comparison of survival between UK countries

Two years incident data have been combined to increase the size of the patient cohort, so that any differences between the four UK countries are more likely to be reliably identified (table 8.2). These data have not been adjusted for differences in primary renal diagnosis, ethnicity, socio-economic status or comorbidity, nor for differences in life expectancy in the general populations of the four UK countries. There was no significant difference in the 90 day survival between the UK countries. One year after 90 day survival was significantly lower in Wales compared to England. It has been postulated that a greater prevalence of cardiovascular disease in Wales compared to England may account for the difference.

There are known regional differences in the life expectancy of the general population within the UK. Table 8.3 shows differences in life expectancy between the UK countries. These differences in life expectancy are not accounted for in these analyses and are likely to be one of the reasons behind the variation in survival between renal centres and UK countries.

Modality

It is impossible to obtain truly valid comparisons of survival of patients starting RRT on different treatment modalities, as modality selection is not random. In the UK, patients starting peritoneal dialysis as a group were younger and fitter than those starting haemodialysis and were transplanted more quickly. The age adjusted 1 year survival estimates for incident patients starting RRT on HD and PD were 89.3% and 92.9% respectively, both showing a slight increase from the previous year (figure 8.1, table 8.4). Over the last six years the one

Table 8.1. Unadjusted survival of incident patients, 2011 cohort

Interval	Survival (%)	*95% CI*	*N*
Survival at 90 day	94.5	93.9–95.0	6,750
Survival 1 year after 90 days	87.5	86.7–88.3	6,359

Table 8.2. Incident patient survival across the UK countries, combined 2 year cohort (2010–2011), adjusted to age 60

Interval	England	N Ireland	Scotland	Wales	UK
Survival at 90 day (%)	96.2	96.0	95.8	96.6	96.2
95% CI	*95.8–96.6*	*94.4–97.7*	*94.7–96.8*	*95.6–97.7*	*95.8–96.5*
Survival 1 year after 90 days (%)	90.5	90.4	88.9	88.2	90.3
95% CI	*89.9–91.1*	*87.7–93.1*	*87.1–90.7*	*86.1–90.3*	*89.7–90.9*

Table 8.3. Life expectancy in years in UK countries, 2008–2010 (source ONS [8])

	At birth		At age 65	
Country	Male	Female	Male	Female
England	78.6	82.6	18.2	20.8
Northern Ireland*	77.1	81.5	17.4	20.2
Scotland	75.8	80.4	16.8	19.3
Wales	77.6	81.8	17.7	20.3
UK	**78.2**	**82.3**	**18.0**	**20.6**

*Provisional data for Northern Ireland

Table 8.4. One year after 90 day incident patient survival by first established modality 2005–2011 cohort (adjusted to age 60) (excluding patients whose first modality was transplantation)

	Age adjusted 1 year after 90 days % survival *95% CI*	
Year	HD	PD
2011	89.3	92.9
	88.3–90.3	*91.6–94.3*
2010	87.7	93.3
	86.6–88.8	*91.9–94.7*
2009	87.6	93.1
	86.5–88.7	*91.6–94.6*
2008	87.1	93.1
	86.0–88.2	*91.7–94.4*
2007	87.8	94.5
	86.7–88.9	*93.3–95.7*
2006	86.5	94.1
	85.4–87.7	*92.8–95.4*
2005	85.3	92.5
	84.0–86.5	*91.1–94.0*

year after 90 days survival has progressively improved in HD patients, but remained static in PD patients (table 8.4).

Age

Tables 8.5 to 8.10 show survival of all incident patients, those aged 65 and above and those aged below 65 years, for up to ten years after start of renal replacement therapy. In the UK, short term survival (survival at 90 days) increased to 94.5% (94.2% for patients starting RRT in 2010) (table 8.5). Survival 1 year after 90 days also increased compared to last year and this was mainly due to an increase in survival for patients aged younger than 65 years (table 8.6). Longer term survival of patients on RRT continued to improve (tables 8.8, 8.9, 8.10). There is a steep decline in survival with advancing age (figures 8.2 and 8.3).

There was a curvilinear increase in death rate per 1,000 patient years with age, shown in figure 8.3 for the period one year after 90 days. There were differences between the overall death rates across all age groups with the

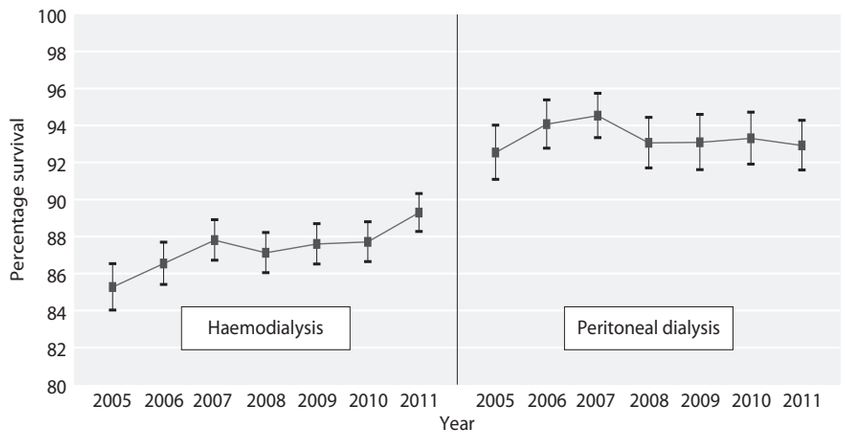

Fig. 8.1. Trend in 1 year after 90 day incident patient survival by first modality, 2005–2011 cohort (adjusted to age 60) (excluding patients whose first modality was transplantation)

Table 8.5. Unadjusted 90 day survival of incident patients, 2011 cohort, by age

Age	Survival (%)	*95% CI*	*N*
18–64	97.8	*97.2–98.2*	3,370
⩾65	91.2	*90.2–92.1*	3,380
All ages	94.5	*93.9–95.0*	6,750

Table 8.6. Unadjusted 1 year after day 90 survival of incident patients, 2011 cohort, by age

Age	Survival (%)	*95% CI*	*N*
18–64	94.1	*93.2–94.8*	3,284
⩾65	80.6	*79.1–82.0*	3,075
All ages	87.5	*86.7–88.3*	6,359

death rate in Scotland and Wales significantly higher than in England.

The effect of censoring age related survival at the time of transplantation

The current method for calculating survival for incident patients does not censor at transplantation. From

Table 8.7. Increase in proportional hazard of death for each 10 year increase in age, 2011 incident cohort

Interval	Hazard of death for 10 year age increase	*95% CI*
First 90 days	1.70	*1.56–1.85*
1 year after first 90 days	1.64	*1.55–1.73*

Table 8.8. Unadjusted survival of incident patients, 1997–2011 cohort for patients aged 18–64

Cohort	1 year	2 year	3 year	4 year	5 year	6 year	7 year	8 year	9 year	10 year	*95% CI for latest year*	*N*
2011	**93.4**										***92.5–94.2***	**3,370**
2010	92.2	86.6									*85.4–87.7*	3,375
2009	91.3	85.4	80.8								*79.4–82.2*	3,160
2008	91.6	86.2	81.4	77.3							*75.8–78.6*	3,481
2007	92.7	87.2	82.0	77.1	73.4						*71.8–74.8*	3,347
2006	90.8	85.2	80.3	76.0	72.4	68.5					*66.8–70.1*	3,182
2005	89.7	83.6	78.6	73.8	69.3	65.7	62.6				*60.8–64.4*	2,828
2004	89.7	83.6	78.2	72.8	68.2	64.5	61.5	57.7			*55.7–59.6*	2,571
2003	89.5	82.8	77.5	72.6	67.6	63.5	59.8	57.0	54.4		*52.3–56.5*	2,271
2002	88.7	80.9	74.9	69.4	65.3	61.4	58.0	55.1	52.0	49.9	*47.7–52.1*	2,034
2001	88.3	81.3	75.5	70.5	65.3	60.6	56.5	53.0	50.2	48.2	*45.7–50.7*	1,611
2000	89.2	81.4	74.6	69.3	64.0	59.4	55.9	52.7	50.3	47.6	*45.0–50.1*	1,533
1999	87.0	81.1	73.4	67.6	62.2	58.1	54.0	51.1	48.7	47.1	*44.4–49.8*	1,349
1998	87.6	80.3	74.5	69.6	64.2	59.2	55.4	53.4	50.2	47.9	*45.0–50.8*	1,172
1997	85.3	77.5	69.6	63.7	58.8	54.5	51.5	49.1	47.9	44.1	*40.0–48.1*	589

Table 8.9. Unadjusted survival of incident patients, 1997–2011 cohort for patients aged ⩾65

Cohort	1 year	2 year	3 year	4 year	5 year	6 year	7 year	8 year	9 year	10 year	*95% CI for latest year*	*N*
2011	**77.5**										***76.1–78.9***	**3,380**
2010	76.4	63.6									*61.9–65.2*	3,287
2009	76.9	63.8	52.8								*51.1–54.6*	3,147
2008	74.8	61.5	50.3	40.9							*39.2–42.6*	3,184
2007	75.3	61.5	50.2	41.0	32.5						*30.9–34.1*	3,221
2006	72.1	58.6	47.4	37.8	29.6	23.8					*22.3–25.3*	3,139
2005	71.3	57.4	45.5	36.4	28.2	21.5	16.9				*15.6–18.3*	2,946
2004	69.3	54.4	43.0	34.6	27.4	21.6	17.0	13.5			*12.2–14.9*	2,633
2003	68.4	53.9	42.1	32.2	24.7	18.5	14.6	11.5	8.9		*7.8–10.1*	2,317
2002	66.1	50.9	40.6	32.2	24.3	18.7	14.1	11.3	8.7	6.9	*5.9–8.1*	2,090
2001	66.6	52.0	38.1	28.9	21.7	16.3	12.2	9.6	8.1	6.2	*5.1–7.6*	1,557
2000	66.0	52.4	39.6	28.6	22.3	17.4	13.4	10.0	7.8	6.0	*4.8–7.2*	1,497
1999	68.4	51.7	39.3	30.1	22.5	16.6	12.0	9.0	6.9	5.5	*4.3–6.9*	1,218
1998	62.7	45.6	36.3	26.6	20.2	14.1	10.7	7.7	5.7	4.6	*3.5–6.1*	1,017
1997	63.3	46.5	31.7	22.8	14.6	9.9	5.9	4.5	2.7	2.0	*0.9–3.7*	412

Table 8.10. Unadjusted survival of incident patients, 1997–2011 cohort for patients of all ages

Cohort	1 year	2 year	3 year	4 year	5 year	6 year	7 year	8 year	9 year	10 year	*95% CI for latest year*	*N*
2011	**85.5**										***84.6–86.3***	**6,750**
2010	84.4	75.2									*74.2–76.3*	6,662
2009	84.1	74.6	66.9								*65.7–68.0*	6,307
2008	83.6	74.4	66.5	59.9							*58.7–61.0*	6,665
2007	84.1	74.6	66.4	59.3	53.3						*52.0–54.5*	6,568
2006	81.5	72.0	64.0	57.1	51.2	46.3					*45.1–47.6*	6,321
2005	80.3	70.3	61.7	54.8	48.3	43.2	39.3				*38.1–40.6*	5,774
2004	79.4	68.8	60.4	53.5	47.6	42.9	39.0	35.4			*34.1–36.7*	5,204
2003	78.8	68.2	59.7	52.3	46.1	40.9	37.1	34.2	31.6		*30.2–33.0*	4,588
2002	77.2	65.7	57.5	50.6	44.6	39.8	35.8	32.9	30.0	28.2	*26.8–29.6*	4,124
2001	77.7	66.9	57.2	50.1	44.0	38.9	34.9	31.8	29.6	27.7	*26.1–29.3*	3,168
2000	77.7	67.1	57.3	49.3	43.5	38.7	35.0	31.7	29.4	27.1	*25.5–28.7*	3,030
1999	78.2	67.2	57.2	49.8	43.4	38.5	34.1	31.2	28.9	27.4	*25.7–29.2*	2,567
1998	76.0	64.3	56.8	49.7	43.8	38.3	34.7	32.2	29.6	27.9	*26.0–29.8*	2,189
1997	76.3	64.8	54.0	46.9	40.7	36.2	32.9	30.8	29.4	26.8	*24.1–29.6*	1,001

figure 8.4, it can be seen that 50% of patients starting RRT aged between 45–54 survived for over 10 years, 50% of patients starting RRT aged between 55–64 survived for 5.75 years and 50% of patients starting RRT aged between 65–74 survived for 3.3 years.

Figure 8.5 shows the survival of incident patients, excluding those who died within the first 90 days and shows that 50% of patients aged between 55–64 years survived for 6 years and 50% of patients aged between 65–74 years survived for 3.6 years.

Censoring at transplantation would make the longer term outcomes of younger patients (who were more likely to have undergone transplantation) appear worse than they actually were. Without censoring, the 10 year

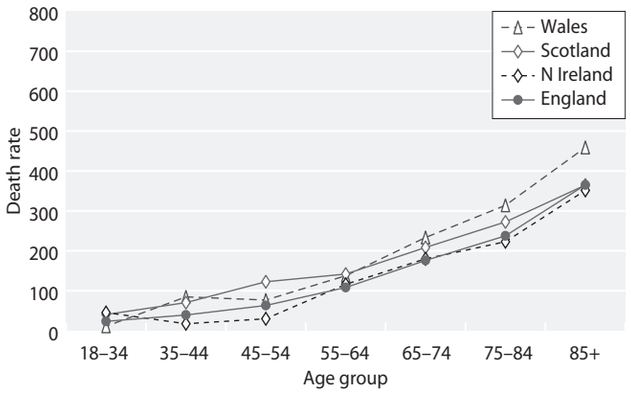

Fig. 8.3. One year after 90 days death rate per 1,000 patient years by UK country and age group for incident patients, 2008–2011 cohort

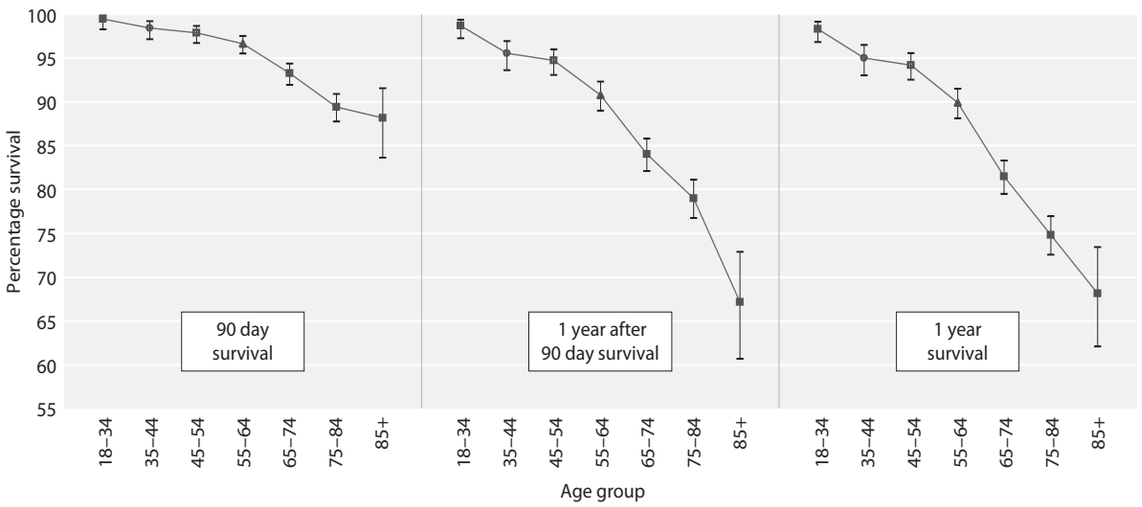

Fig. 8.2. Unadjusted survival of incident patients by age group, 2011 cohort

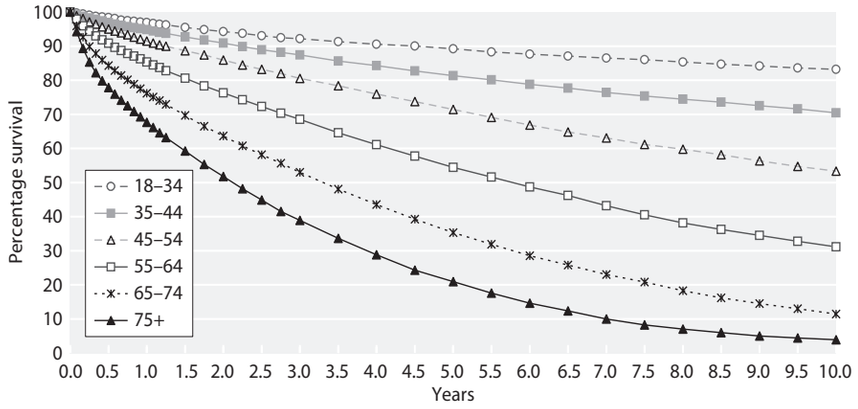

Fig. 8.4. Survival of incident patients (unadjusted), 1997–2011 cohort (from day 0), without censoring at transplantation

survival for patients aged 18–34 years was 83.6% (figure 8.4), which contrasts with a 57.5% survival if censoring at the time of transplantation (data not shown). For more detailed information on this effect, refer to the 2008 Report [9].

Age and hazard of death by age in the first 12 months

Figure 8.6 shows the monthly hazard of death from the first day of starting RRT by age group, which falls sharply during the first 4–5 months, particularly for older patients.

A 10 year increase in patient age was associated with a 1.70 times increased risk of death within 90 days and a 1.64 times increased risk of death within 1 year after 90 days (table 8.7).

Changes in survival in the 2000–2011 cohort

The death rate per 1,000 patient years in the first year of starting RRT from 2000 to 2011 is shown in figure 8.7. There was a declining trend in the overall death rate, although this appears to have levelled off during the last four years. There has been a steeper rate of decline in the older age group (aged 65 years and older).

It is important to note that these death rates are not directly comparable with those produced by the USRDS Registry, as the UK data include the first 90 day period when death rates are higher than subsequent time periods.

The unadjusted survival analyses (tables 8.8, 8.9, 8.10, figures 8.8, 8.9) and annual death rates (figure 8.7) show a large improvement in 1 to 10 year survival across the years for both those aged under and those over 65 years. One year survival amongst patients aged less than 65 years at start of RRT has improved from 85.3% in the 1997 cohort to 93.4% in the 2011 cohort.

Similarly, for patients aged 65 years and over there has been a 14.2% absolute improvement in one year survival from the 1997 to 2011 cohorts. As these are observational data it remains difficult to attribute this reduction in risk of death to any specific improvements in care.

Gender

There were no survival differences between genders in an incident cohort of patients starting RRT from 2000 to 2009 and followed up for a minimum of three years until 2012 (figure 8.10). Gender differences were investigated

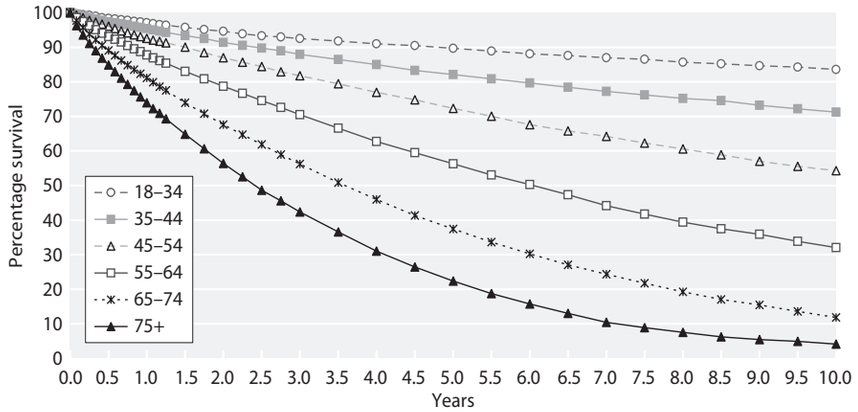

Fig. 8.5. Survival of incident patients (unadjusted), 1997–2011 cohort (from day 90), without censoring at transplantation

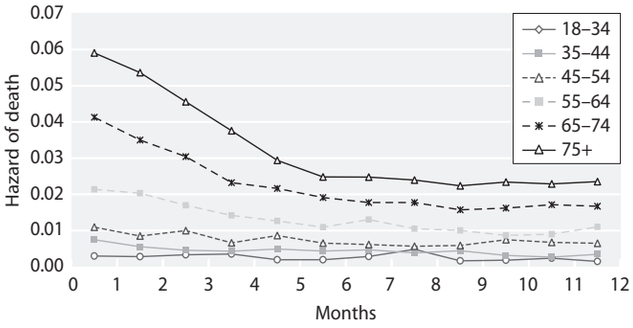

Fig. 8.6. First year monthly hazard of death, by age group 1997–2011 combined incident cohort

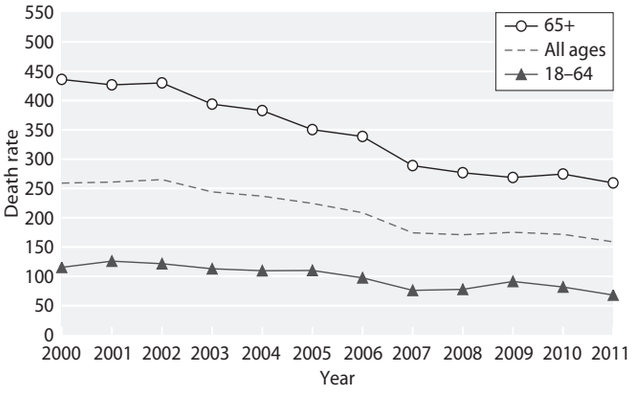

Fig. 8.7. One-year incident death rate per 1,000 patient years by age group, 2000–2011 cohort

in the first 90 days and 1 year after the first 90 days and there was also no evidence of a survival difference (data not shown).

Change in survival on renal replacement therapy by vintage

Incident RRT patients in the UK continued to show little evidence of a worsening prognosis with time on

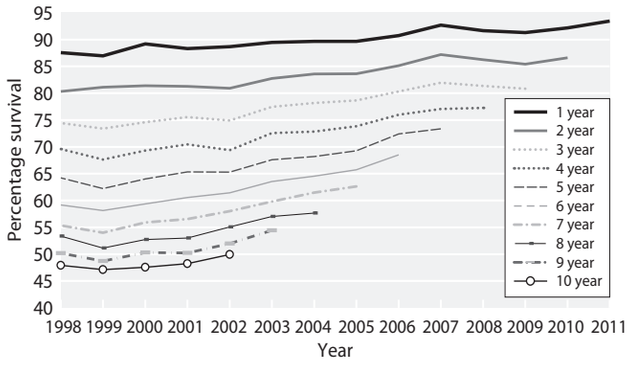

Fig. 8.8. Change in long term survival by year of starting RRT, for incident patients aged 18–64 years

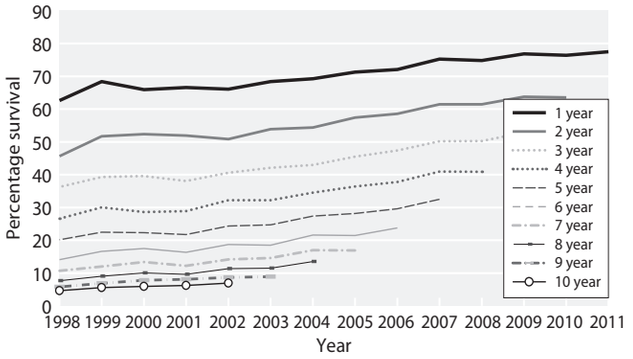

Fig. 8.9. Change in long term survival by year of starting RRT, for incident patients aged ⩾65 years

RRT (vintage) when comparing survival without censoring for transplantation. Figure 8.11 shows the instantaneous hazard of death by age group. The apparent vintage effect when censoring for transplantation (data not shown) is at least in part because these younger and healthier patients are only included in the survival calculation up to the date of transplantation. In the older age groups there were decreasing numbers remaining alive beyond seven years accounting for the increased variability seen. Figures 8.12 and 8.13 show these data for the non-diabetic and diabetic patients respectively. Non-diabetic patients were defined as all incident patients excluding patients with diabetes as the primary renal disease.

Time trend changes in incident patient survival, 2000–2011 cohort

The time trend changes are shown in figure 8.14. The left hand plot, which includes only those centres that have been sending data continuously since 2000, shows a similar improvement in survival to the plot in which data from all renal centres are analysed.

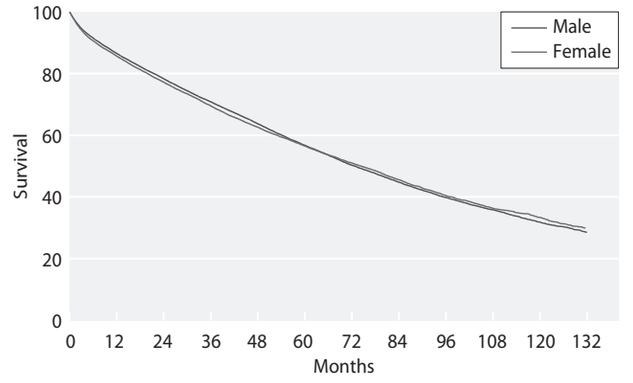

Fig. 8.10. Long term survival of incident patients by gender, 2000–2009 combined cohort, adjusted to age 60

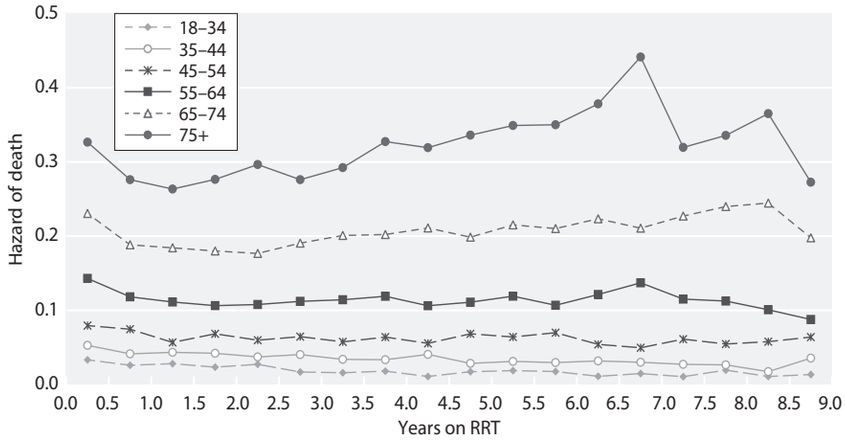

Fig. 8.11. Six monthly hazard of death, by vintage and age group, 1997–2011 incident cohort after day 90 (not censored at transplantation)

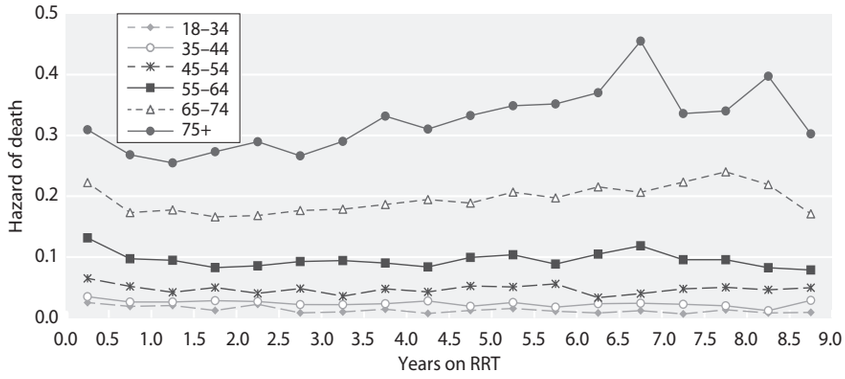

Fig. 8.12. Six monthly hazard of death, by vintage and age group, 1997–2011 non-diabetic incident cohort after day 90 (not censored at transplantation)

Analysis of centre variability in 1 year after 90 days survival

The one year after 90 day survival for the 2011 incident cohort is shown in figure 8.15 for each renal centre. The tables for these data and for 90 day survival are given in appendix 1 at the end of this chapter (tables 8.25 and 8.26). The age adjusted individual centre survival for each of the last nine years can also be found in appendix 1, table 8.27. There was much variability in survival between centres, but these results have to be interpreted cautiously as they were not adjusted for comorbidity, ethnicity or primary renal disease and patient numbers were small in many centres. Survival results for centres with less than 20 incident patients in 2011 (Clwyd, Dumfries & Galloway, Inverness) are not shown in figure 8.15, although they were included in the national and UK survival calculations.

In the analysis of 2011 incident cohort survival data, some of the smaller centres had wide confidence intervals (figure 8.15) due to small numbers of patients. This was

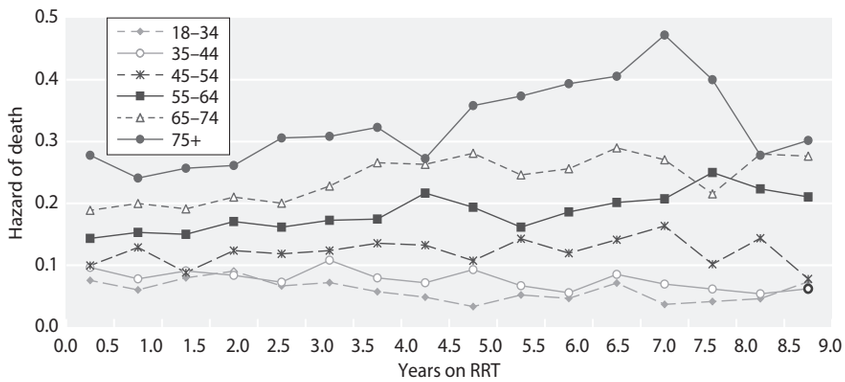

Fig. 8.13. Six monthly hazard of death, by vintage and age group, 1997–2011 diabetic incident cohort after day 90 (not censored at transplantation)

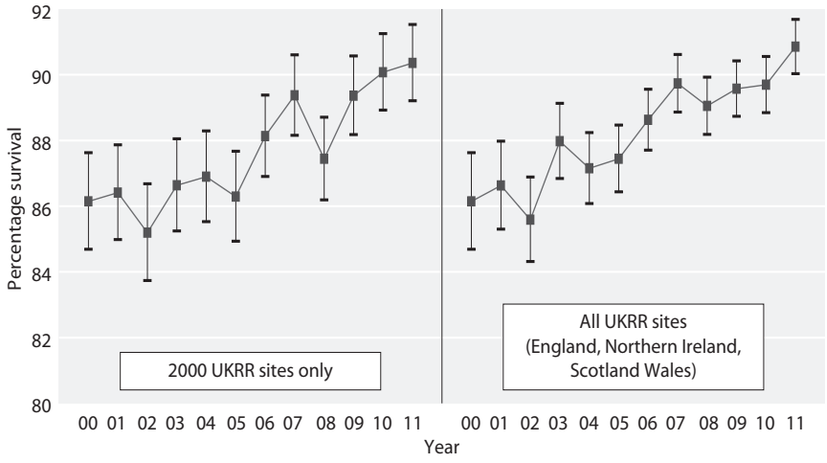

Fig. 8.14. Change in one-year after 90 day survival, 2000–2011 incident cohort (adjusted to age 60)
Showing 95% confidence intervals

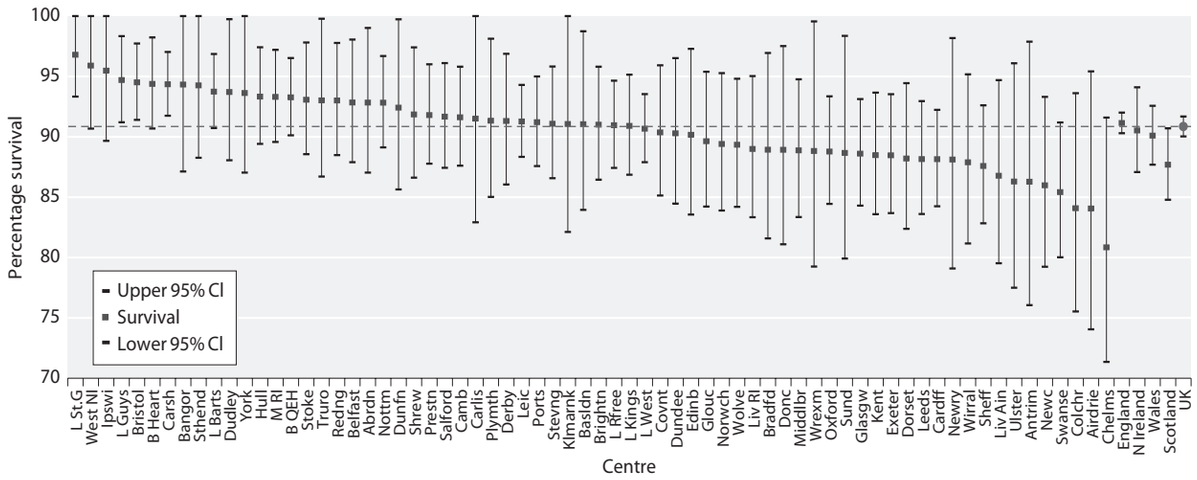

Fig. 8.15. Survival one-year after 90 days, adjusted to age 60, 2011 incident cohort

addressed by including a larger cohort across several years, which will also assess sustained performance. Similar to previous years, this is shown as a rolling four year cohort from 2008 to 2011. These data are presented as a funnel plot in figure 8.16. For any number of patients in the incident cohort (x-axis) one can identify whether any given survival rate (y-axis) falls within, plus or minus 2 standard deviations (SDs) from the national mean (solid lines, 95% limits) or 3 SDs (dotted lines, 99.9% limits). Table 8.11 allows centres to be identified on this graph by finding the number of patients treated by the centre and then looking up this number on the x-axis. Two centres (Swansea, Glasgow) had survival below the 95% lower limit whilst seven centres (Ipswich, London St. George's, Stevenage, London Guys, London Barts, London West, Western Trust Northern Ireland) had survival above the 95% upper limit. Amongst these, St George's was above the 99% upper limit having consistently had survival above the 95% upper limit for the last few years. With 71 centres it would be expected that only three centres would be outside these limits by chance. It is important to acknowledge that these data have not been adjusted for any patient related factor

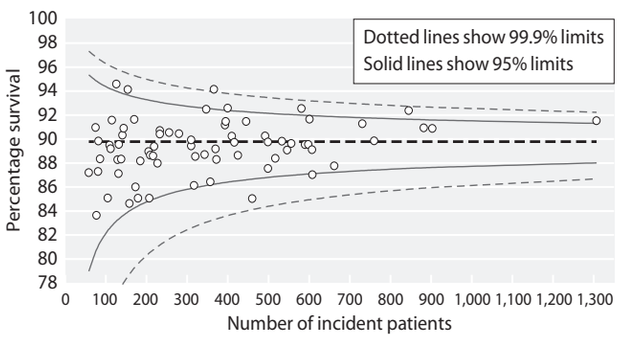

Fig. 8.16. Funnel plot for age adjusted 1 year after 90 days survival, 2008–2011 incident cohort

Table 8.11. Age adjusted (to age 60) 1 year after 90 day survival, 2008–2011 incident cohort

Centre	*N*	1 year after 90 day survival %	Centre	*N*	1 year after 90 day survival %
D & Gall	58	87.2	Redng	347	92.5
Clwyd	75	91.0	Middlbr	357	86.4
Ulster	77	83.6	L St.G	366	94.1
Wrexm	81	87.3	Hull	370	89.2
Inverns	82	89.8	Newc	372	88.3
Newry	86	88.3	B Heart	393	91.2
Carlis	105	85.1	Liv RI	395	91.5
Bangor	109	89.5	Stevng	400	92.6
Sthend	112	89.2	Covnt	410	90.2
Antrim	115	91.6	Camb	416	89.7
West NI	126	94.6	Brightn	425	88.6
Basldn	129	88.3	Nottm	445	91.5
Colchr	131	87.1	Swanse	460	85.0
Donc	132	89.5	Exeter	492	90.2
Klmarnk	138	88.3	Prestn	499	87.5
York	141	90.3	Kent	499	89.7
Dunfn	144	90.9	Salford	517	88.4
Ipswi	154	94.1	Leeds	533	89.8
Liv Ain	158	84.6	L Kings	546	89.1
Truro	170	91.6	M RI	556	89.6
Airdrie	173	86.0	L Guys	581	92.5
Dudley	179	85.1	Oxford	590	89.5
Chelms	185	88.2	Ports	598	89.6
Wirral	205	88.9	Sheff	601	91.7
Sund	207	85.1	Bristol	607	89.1
Abrdn	209	88.6	Glasgw	608	87.0
Dundee	216	88.6	Cardff	662	87.8
Shrew	219	89.4	L Rfree	731	91.3
Bradfd	227	88.0	Carsh	760	89.8
Glouc	233	90.7	L Barts	845	92.4
Plymth	233	90.4	B QEH	882	90.9
Belfast	256	90.5	Leic	903	90.9
Dorset	280	90.4	L West	1,307	91.5
Derby	310	89.4	**England**	**21,226**	**90.1**
Norwch	310	89.9	**N Ireland**	**660**	**90.4**
Edinb	317	86.1	**Scotland**	**1,945**	**87.8**
Wolve	320	88.6	**Wales**	**1,387**	**87.2**
Stoke	343	88.7	**UK**	**25,218**	**89.8**

except age (i.e. not comorbidity, primary renal disease or ethnicity) and have not been censored at transplantation, so the effect of differing centre rates of transplantation was not taken into account. Variation in the proportion of patients with terminal illness receiving RRT between centres could also contribute to variations in survival and provide a possible explanation for lower survival than expected for some centres. In addition, another possible reason why several of the best performing centres are London based could be that they serve large ethnic minority populations which are known to have better survival on dialysis [4].

Analysis of the impact of adjustment for comorbidity on the 1 year after 90 day survival

Although comorbidity returns to the UKRR have remained poor, there was an increase in the number of centres returning more than 85% of comorbidity data to the UKRR for patients starting RRT in 2011. Using the combined incident cohort from 2007–2011, it was found that 21 centres had returned comorbidity data for more than 85% of patients and these centres were included in this analysis. Adjustment was first performed to age 60, then to the average distribution of primary diagnoses for all 21 centres. Further adjustment was

Table 8.12. The effect of adjustment for age, PRD and comorbidity on survival, 2007–2011 incident cohort, % survival 1 year after 90 days

Centre*	Unadjusted	Age adjusted	Age, PRD adjusted	Age, PRD and comorbidity adjusted
Ulster	78.9	85.2	86.7	87.3
Swanse	80.9	86.8	88.4	90.0
Sund	84.6	86.6	87.4	88.2
Bradfd	84.8	86.9	87.6	88.9
Basldn	84.9	89.6	90.4	91.3
Middlbr	85.5	88.7	89.4	90.2
Dorset	85.9	90.7	90.8	91.2
Wolve	85.9	89.0	89.8	90.0
Derby	86.4	90.3	91.2	91.4
Wrexm	86.5	90.1	90.9	90.5
Leeds	86.6	89.4	90.2	91.0
L Kings	86.6	88.8	89.9	90.0
Hull	86.9	90.0	90.5	91.0
Bristol	87.8	90.8	91.3	91.7
Oxford	88.3	90.5	90.9	90.9
Shrew	89.2	92.3	92.8	90.8
Nottm	89.2	91.7	92.4	92.8
Truro	90.4	93.2	93.7	93.3
Kent	90.8	93.0	93.3	93.0
York	91.8	93.9	94.3	93.9
Stevng	93.8	94.8	95.4	94.9
All 21 centres	87.3	90.3	91.0	91.3

*Centre included if >85% comorbidity data available

then made to the average distribution of comorbidities present at those centres.

Research has suggested that adjustment for comorbidity explains a modest part of the variance in ERF patient outcomes [10]. At centre level however, the prevalence of comorbidities could vary substantially between patient populations of different centres and it could be expected that adjustment for comorbidity may explain an increased amount of the variance in outcome. It can be seen that adjustment for age has the largest effect, most notably in those centres with the lower unadjusted survival figures. There were only minor differences for most centres after adjustment for primary renal diagnosis. In four centres (Swansea, Bradford, Basildon, Middlesbrough) adjustment for comorbidity had a noticeable effect on adjusted survival (table 8.12, figure 8.17) helping explain the lower survival noted in figure 8.15.

Survival in patients with diabetes

Although it has previously been shown that diabetic patients have worse long term survival compared to non-diabetic patients [3], non-diabetic patient survival in the older age group (65 years and older) was worse compared to diabetic patients in the same age group during the first 90 days of starting RRT (2011 cohort) (figure 8.18) and in the subsequent year (figure 8.19); this might be due to patient selection.

Long term survival for diabetic and non-diabetic patients was evaluated in a cohort of patients starting RRT from 2000 to 2009 with a minimum of three years follow-up until 2012. These data show large differences in the 18–44 year and 45–64 year age groups between diabetic and non-diabetic patient survival, but there was very little difference in three year survival between diabetics and non-diabetics in the older age group. In the age group 18–44, 89% of non-diabetic patients were alive five years after start of RRT compared to 70% for diabetic patients. In the age group 45–64, 66% of non-diabetic patients were alive 5 years after start of RRT compared to 49% for diabetic patients (figure 8.20).

Standard primary renal disease and survival

It is hard to set survival standards because these should be age, gender, ethnicity and comorbidity adjusted and this is not yet possible from UKRR data. The current 5th edition of the Renal Association Clinical Practice Guidelines [11] does not set any standards for audit of patient survival.

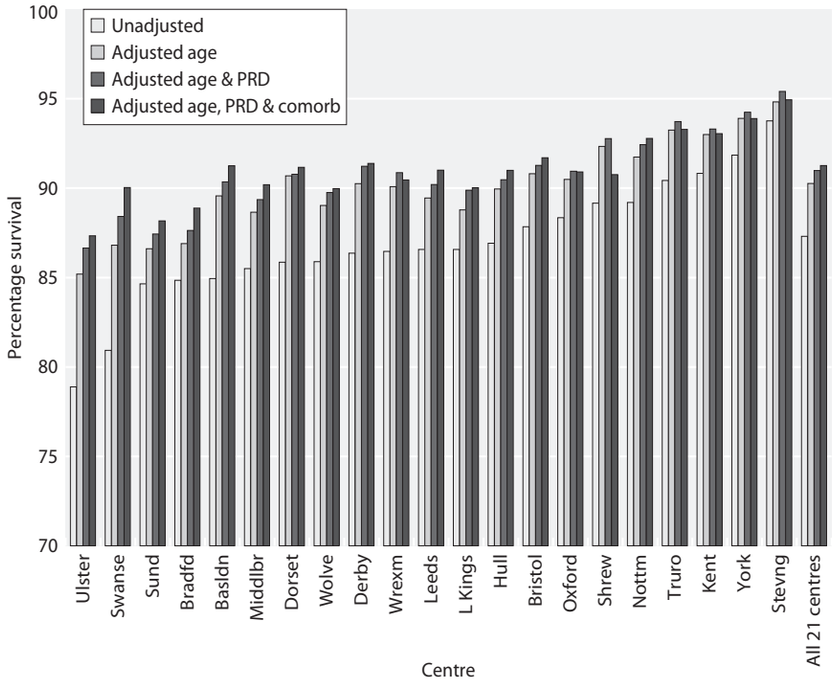

Fig. 8.17. The effect on survival after sequential adjustment for age, PRD and comorbidity, 2007–2011 incident cohort

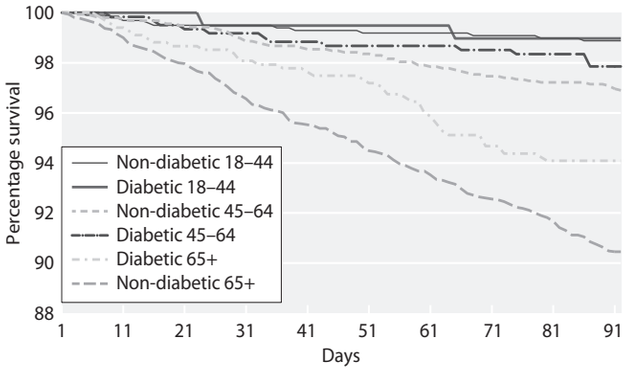

Fig. 8.18. Survival at 90 days for incident diabetic and non-diabetic patients by age group for patients starting RRT, 2011 cohort

The 3rd Renal Standards document defined standard primary renal disease using the EDTA-ERA diagnosis codes (including only codes 00–49); this excluded patients with renal disease due to diabetes and other systemic diseases. It is more widespread practice to simply exclude patients with diabetes, so these analyses are also included in this report to allow comparison with reports from other registries. The survival for patients starting RRT in the 2011 cohort in younger age groups (aged 18–54) and followed up for a maximum of one year is shown in table 8.13. For a longer term comparison, the 2002 cohort is also included (table 8.13).

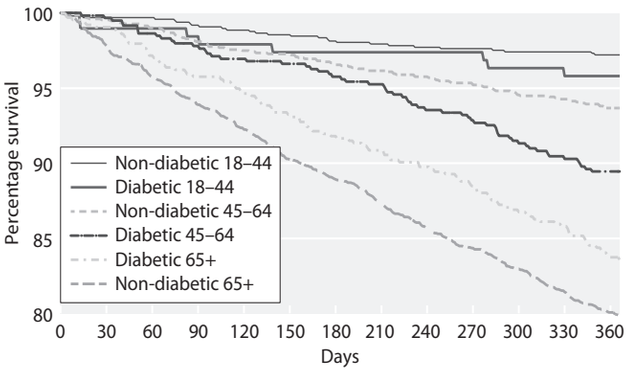

Fig. 8.19. Survival at 1 year after 90 days for incident diabetic and non-diabetic patients by age group for patients starting RRT, 2011 cohort

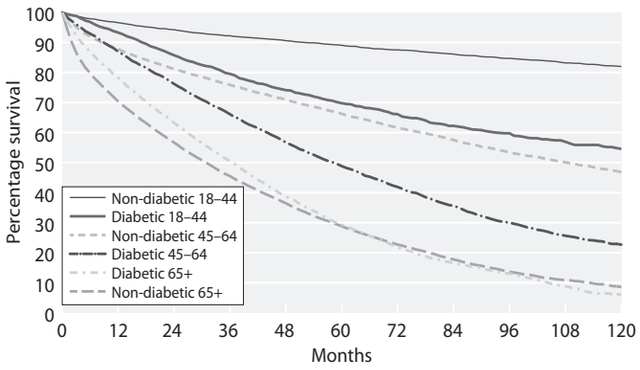

Fig. 8.20. Long term survival for incident diabetic and non-diabetic patients by age group, 2000–2009 cohort, followed up for a minimum of 3 years

Table 8.13. One-year incident dialysis patient survival (from day 0–365), patients aged 18–54, 2011 and 2002 cohort (excludes patients whose first modality was transplantation)

	2011 cohort		2002 cohort	
First treatment	Standard primary renal disease[a]	All primary renal diseases except diabetes[b]	Standard primary renal disease[a]	All primary renal diseases except diabetes[b]
All dialysis %	97.1	95.3	95.4	93.9
95% CI	*95.8–98.0*	*94.0–96.3*	*93.7–97.1*	*92.2–95.5*
HD %	96.5	94.3	93.4	91.6
95% CI	*94.7–97.7*	*92.7–95.6*	*90.7–96.0*	*89.2–94.0*
PD %	98.3	97.4	98.6	97.9
95% CI	*96.0–99.3*	*95.4–98.6*	*71.1–100*	*96.3–99.6*

[a]Includes patients with EDTA diagnostic codes 00–49
[b]Excludes patients with diabetes as primary renal disease

Results of prevalent patient survival analyses

Tables 8.14 and 8.16 show the one year survival on dialysis, after censoring at the time of transplantation. Patients who have been on dialysis for less than 90 days were excluded. One year survival for prevalent dialysis patients remained relatively unchanged at 89.7% in the 2011 cohort compared to 89.8% in the 2010 cohort.

Table 8.15 gives the 2011 cohort one year death rate for prevalent dialysis patients in each UK country. The one-year death rate in Wales was significantly higher than in the three other UK countries: the higher median age in Wales together with socio-economic reasons probably explains this.

Figure 8.21 shows the one year survival of dialysis patients who were alive and receiving dialysis on 31st December 2011, stratified by age group.

One year survival of prevalent dialysis patients by centre

The age-adjusted one year survival of dialysis patients in each centre is shown in table 8.14 and is illustrated in figures 8.22 and 8.23; the data for those patients aged <65 years and those aged 65 years and over are separated. Figure 8.24 shows the age adjusted (adjusted to age 60) data and in figure 8.25 as a funnel plot. The solid lines show the 2 standard deviation limits (95% limits) and the dotted lines the limits for 3 standard deviations (99.9% limits). With over 70 centres included, it would be expected by chance that three centres would fall outside the 95% (1 in 20) confidence limits. The survival for two centres (Leeds, Cardiff) was below the 95% confidence limits and for two centres (London West, Birmingham QEH) was above the 95% confidence limits. The funnel plot analysis shows an improvement in prevalent dialysis patient survival compared to the 2010 cohort when three centres were outliers below the 95% lower limits compared to two centres in this most recent analysis. The number of centres that were outliers above the 95% upper limit decreased from five in the 2010 cohort to two in this most recent analysis.

The effect of censoring at transplantation on survival was investigated in the 2011 prevalent dialysis cohort. Results show that this had a minimal effect on prevalent dialysis patient 1 year survival and outlier status (data not shown). Table 8.14 allows centres in figure 8.25 to be identified by finding the number of patients treated by the centre and the corresponding survival and then looking this up on the axes of the funnel plot.

The one year death rate in prevalent dialysis patients in the 2011 cohort by age group

The death rates for prevalent patients on dialysis by age group are shown in figure 8.26. The younger patients included in this analysis are a selected higher risk group, as the similar aged transplanted patients have been excluded. The increase in the death rate was not linear with age; with a 10 year increase in age in the younger patients, the death rate increased by about 10 deaths per 1,000 patient years compared with an increase of 160 deaths per 1,000 patient years in the older age groups. The apparent differences between the countries were not statistically significant except for Wales where the death rate was significantly higher compared to England.

One year survival of prevalent dialysis patients by UK country, 2000 to 2011 cohort

One year survival for prevalent patients seemed to be improving in most of the UK countries (figure 8.27). In Northern Ireland and Wales numbers were much

Table 8.14. One year survival of prevalent dialysis patients in each centre (adjusted to age 60), 2011 cohort

Centre	*N*	Adjusted 1 year survival	Lower 95% CI	Upper 95% CI
England				
B Heart	466	88.3	85.8	91.0
B QEH	1,037	91.7	90.1	93.2
Basldn	181	88.4	84.5	92.5
Bradfd	218	87.7	83.7	91.8
Brightn	415	89.4	86.9	92.0
Bristol	524	90.6	88.5	92.8
Camb	460	88.9	86.5	91.3
Carlis	82	88.8	83.0	95.0
Carsh	809	91.2	89.6	92.9
Chelms	148	90.7	86.8	94.7
Colchr	106	89.1	84.3	94.2
Covnt	424	91.7	89.4	94.0
Derby	327	90.1	87.3	93.0
Donc	180	91.1	87.6	94.7
Dorset	293	90.4	87.7	93.2
Dudley	202	91.4	88.1	94.9
Exeter	426	88.0	85.5	90.6
Glouc	227	90.6	87.6	93.7
Hull	399	91.1	88.8	93.6
Ipswi	157	90.4	86.5	94.5
Kent	441	89.3	86.8	91.8
L Barts	994	90.0	88.2	91.8
L Guys	634	91.1	89.1	93.1
L Kings	563	89.9	87.6	92.2
L Rfree	740	90.2	88.3	92.1
L St.G	340	88.5	85.6	91.5
L West	1,383	91.5	90.2	92.8
Leeds	569	86.7	84.3	89.2
Leic	954	90.2	88.6	91.9
Liv Ain	153	83.8	78.7	89.2
Liv RI	499	89.0	86.5	91.6
M RI	537	90.5	88.2	92.8
Middlbr	304	89.0	86.0	92.0
Newc	304	89.4	86.2	92.7
Norwch	350	91.3	88.9	93.7
Nottm	477	88.9	86.5	91.4
Oxford	498	88.1	85.6	90.6
Plymth	167	84.2	79.5	89.2
Ports	564	89.9	87.7	92.1
Prestn	555	90.6	88.4	92.8
Redng	318	90.8	88.0	93.7
Salford	469	88.9	86.2	91.6
Sheff	632	88.8	86.7	91.0
Shrew	212	89.9	86.5	93.4
Stevng	505	91.9	89.9	94.0
Sthend	135	87.8	83.3	92.5
Stoke	379	90.6	88.1	93.2
Sund	179	86.4	81.8	91.2
Truro	166	89.6	85.8	93.5
Wirral	236	90.4	87.1	93.8
Wolve	367	88.6	85.8	91.5
York	146	88.6	84.2	93.2
N Ireland				
Antrim	160	91.5	88.1	95.1
Belfast	288	89.8	86.8	92.9
Newry	125	84.1	78.7	90.0
Ulster	116	91.6	87.7	95.6
West NI	181	92.3	89.0	95.7
Scotland				
Abrdn	230	90.9	87.6	94.3
Airdrie	168	86.4	81.6	91.4
D & Gall	65	87.4	80.9	94.3
Dundee	214	92.0	89.1	95.0
Dunfn	180	88.2	84.3	92.4
Edinb	313	90.7	87.8	93.8
Glasgw	657	88.5	86.4	90.7
Inverns	98	88.0	82.9	93.4
Klmarnk	185	89.8	86.0	93.7
Wales				
Bangor	107	89.8	84.9	95.0
Cardff	574	86.3	83.9	88.8
Clwyd	95	90.8	86.0	95.9
Swanse	404	86.6	83.8	89.5
Wrexm	107	88.1	83.0	93.4
England	**21,851**	**89.9**	**89.4**	**90.3**
N Ireland	**870**	**90.1**	**88.4**	**91.9**
Scotland	**2,110**	**89.3**	**88.1**	**90.5**
Wales	**1,287**	**87.1**	**85.5**	**88.8**
UK	**26,118**	**89.7**	**89.3**	**90.1**

smaller, the death rate was therefore more variable with very wide confidence intervals and it is difficult to draw conclusions on trends in these countries. The change in prevalent survival by centre over the cohort years 2002 to 2011 is shown in this chapter, appendix 1, table 8.28.

Table 8.15. One-year death rate per 1,000 prevalent dialysis patient years in the 2011 cohort and median age of prevalent patients by country

	England	N Ireland	Scotland	Wales
Death rate	149	155	156	207
95% CI	144–155	129–185	139–175	181–235
Median age	66.1	68.6	66.1	68.1

One year survival of prevalent dialysis patients with a primary diagnosis of diabetes, 2002 to 2011 cohort years

The age-adjusted survival for patients with diabetic renal disease in the UK has increased slightly in the 2011 cohort year to 84.9% (table 8.17).

Table 8.16. One-year survival of prevalent RRT patients in the UK (unadjusted unless indicated otherwise)

Patient group	Patients	Deaths	Survival	*95% CI*
Dialysis patients 2011 cohort				
All	26,118	3,555	85.8	*85.4–86.2*
All – adjusted to age 60	26,118	3,555	89.7	*89.3–90.1*
2 year survival – dialysis patients				
All patients alive on 31/12/2010	25,567	6,171	73.9	*73.3–74.5*
Dialysis patients 2011 cohort				
All age <65	12,293	897	92.2	*91.6–92.6*
All age 65+	13,825	2,658	80.5	*79.8–81.2*
Non-diabetic <55	6,095	246	95.6	*95.1–96.1*
Non-diabetic 55–64	3,673	315	90.9	*89.9–91.8*
Non-diabetic 65–74	4,757	650	86.0	*84.9–86.9*
Non-diabetic 75+	6,265	1,454	76.7	*75.6–77.7*
Non-diabetic <65	9,768	561	93.8	*93.3–94.3*
Diabetic <65	2,525	336	85.9	*84.4–87.2*
Non-Diabetic 65+	11,022	2,104	80.6	*79.9–81.4*
Diabetic 65+	2,803	554	80.0	*78.5–81.4*

Cohorts of patients alive on 31/12/2011 unless indicated otherwise

Death rate on RRT compared with the UK general population

The death rate compared to the general population is shown in table 8.18. Figure 8.28 shows that the relative risk of death on RRT decreased with age from 16.6 times that of the general population at age 35–39 years to 2.7 times the general population at age 85 and over. Figure 8.28 also shows that the relative risk of death has decreased substantially for the younger age groups (<50 years of age) compared to the relative risk of death in the 1998–2001 cohort. The relative risk of death was unchanged at 6.1, in the 2011 cohort as it was in the 2010 cohort. With the reduction in rates of death on RRT over the last 10 years, the relative risk of death is falling (7.7 in 1998–2001 cohort, 6.1 in 2011 cohort).

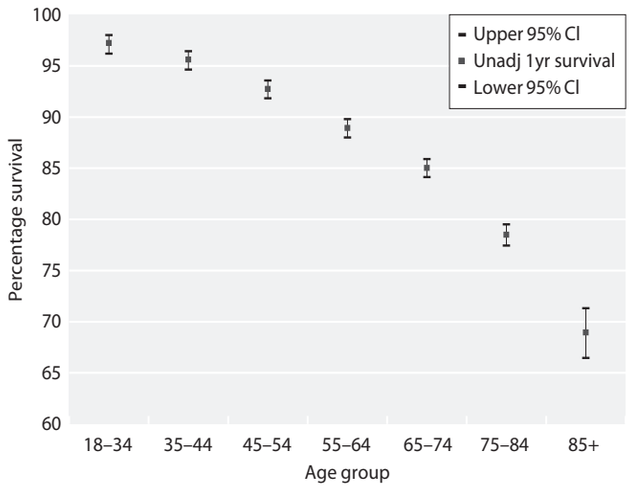

Fig. 8.21. One year survival of prevalent dialysis patients by age group, 2011 cohort

Results of analyses on causes of death

Data completeness

Having increased significantly in recent years, data completeness for cause of death data in the UK showed only a marginal rise of 0.2% (table 8.19) with both Northern Ireland and Scotland recording more than 85% of cause of death data. Northern Ireland centres overall had the highest rate of data return for cause of death (92.3%) and their cause of death completeness improved by about 3% compared with the previous year. Patterns of cause of death must be cautiously interpreted, as there are significant differences between the cause of death for centres with a high proportion of non-returns when compared to centres with good returns (⩾70%). Some centres consistently achieve a very high rate of data return for cause of death because a process is in place to ensure that these data were entered. Several centres have shown significant improvement in data returns, but unfortunately some centres that were reporting these data in previous years have stopped reporting cause of death data. There is still much variability between the centres regarding the completeness of

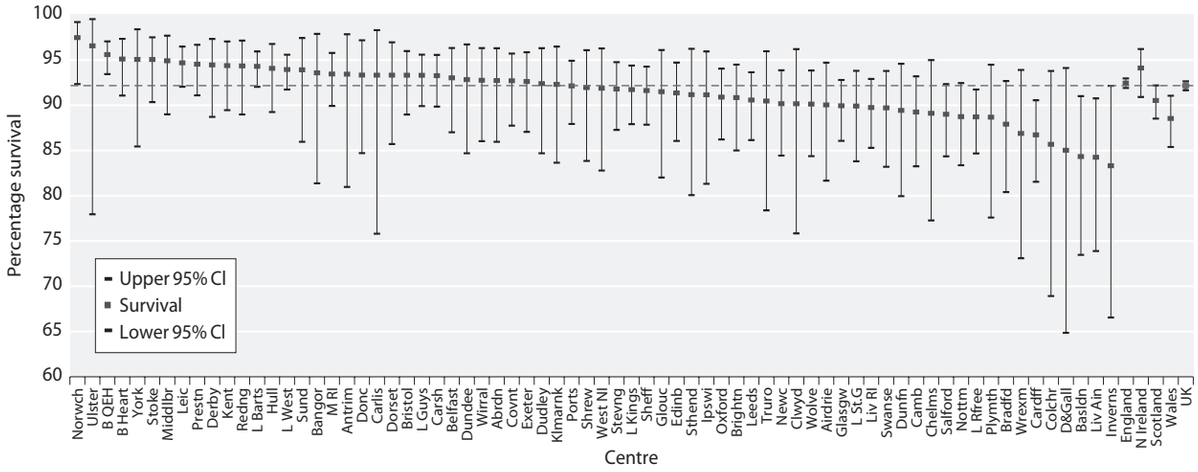

Fig. 8.22. One year survival of prevalent dialysis patients aged under 65 by centre, 2011 cohort

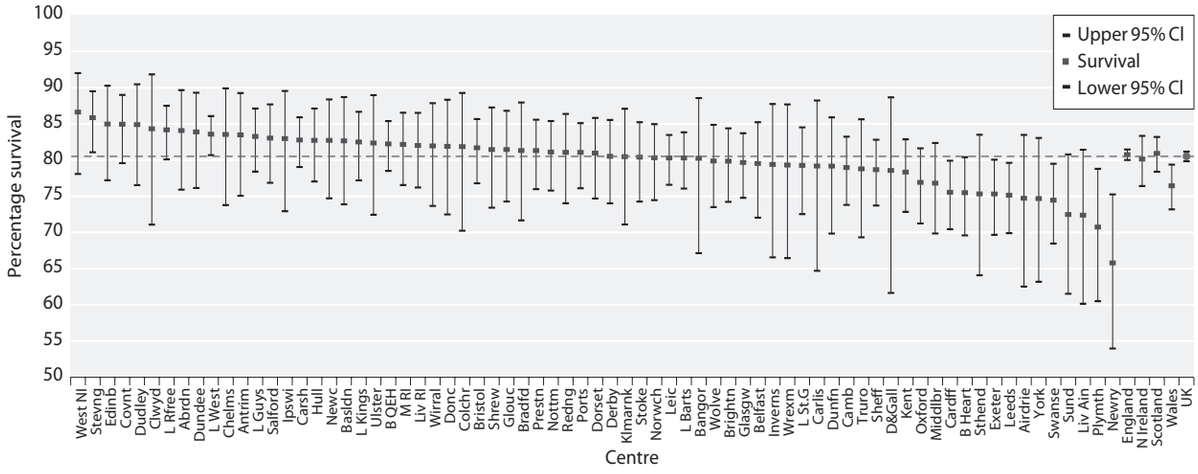

Fig. 8.23. One year survival of prevalent dialysis patients aged 65 years and over by centre, 2011 cohort

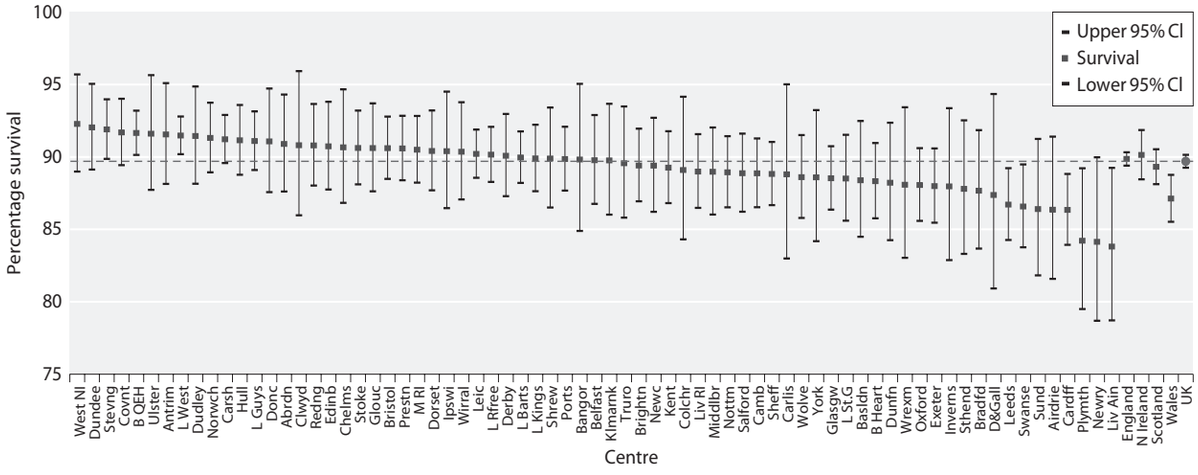

Fig. 8.24. One year survival of prevalent dialysis patients by centre adjusted to age 60, 2011 cohort

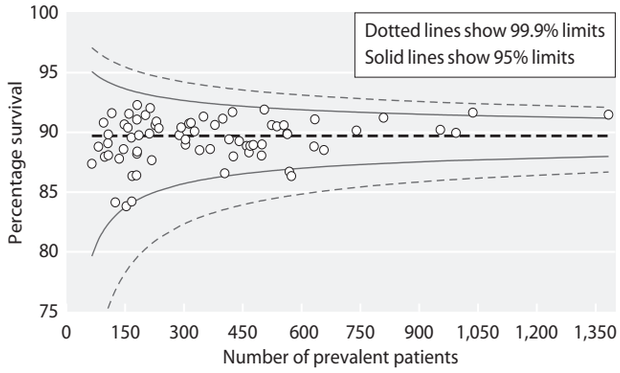

Fig. 8.25. One year survival funnel plot of prevalent dialysis patients by centre adjusted to age 60, 2011 cohort

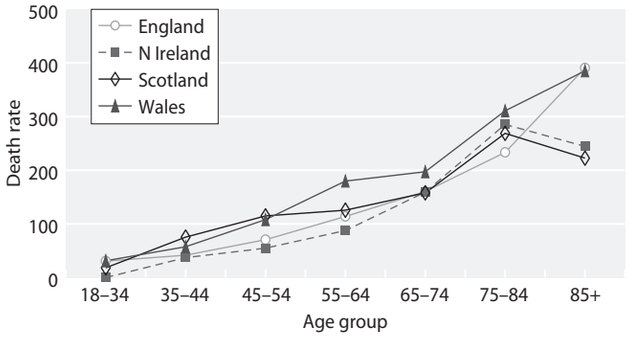

Fig. 8.26. One year death rate per 1,000 patient years by UK country and age group for prevalent dialysis patients, 2011 cohort

cause of death with some centres returning no data and other centres having 100% completeness (table 8.19).

Causes of death in incident RRT patients

Causes of death within the first 90 days

See table 8.20.

Cause of death within one year after 90 days

Treatment withdrawal as a cause of death (tables 8.20, 8.21) in incident patients in the first 90 days and one year after 90 days was more common in older (aged 65+) patients and malignancy more common in younger patients (<65 years old). Infection within the first 90 days as the cause of death was more common in older patients. Cardiac disease remained the leading cause of death both in the first 90 days and one year after 90 days.

Cause of death in prevalent RRT patients in the 2011 cohort

Table 8.22, figures 8.29 and 8.30 show the cause of death for both prevalent dialysis and transplant patients in the 2011 cohort. These data are neither age adjusted nor adjusted for differences in the comorbidity between the two groups. Cardiac disease as a cause of death was less common in transplanted patients as these were a pre-selected low risk group of patients. Malignancy and infection were both responsible for a greater percentage of deaths in prevalent transplanted patients, with treatment withdrawal a common cause of death in the prevalent dialysis population.

Table 8.23 shows that malignancy and infection were slightly more common in younger (<65 years) prevalent transplanted patients as the cause of death than in older (⩾65 years old) transplanted patients.

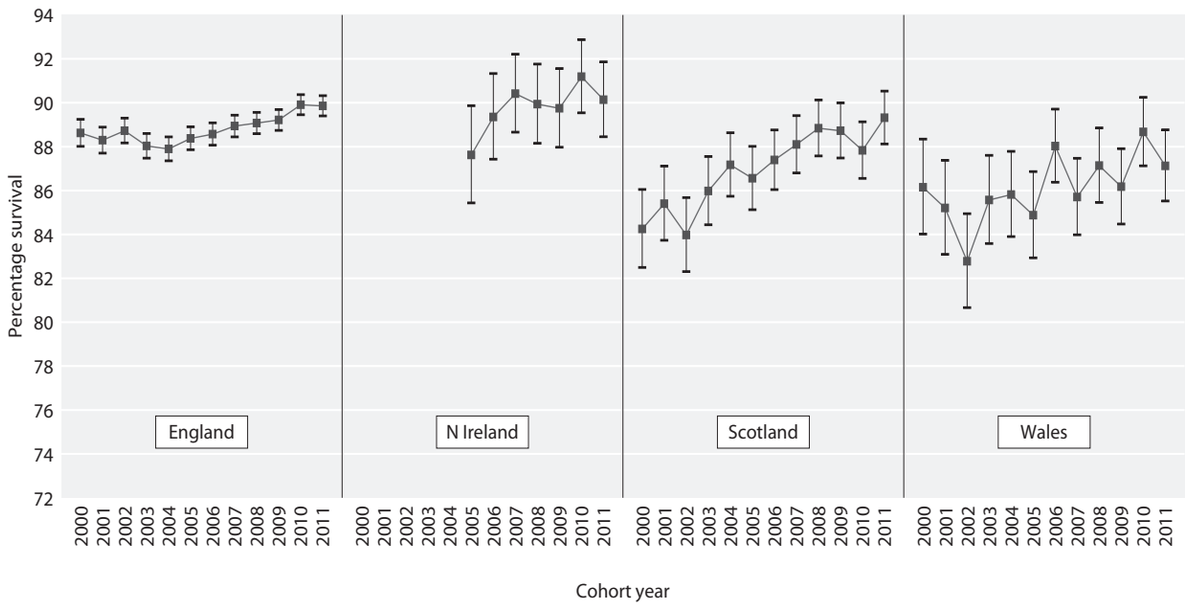

Fig. 8.27. Serial 1 year survival for prevalent dialysis patients by UK country, 2000 to 2011 cohort years, adjusted to age 60

Table 8.17. Serial 1 year survival of prevalent dialysis patients with a primary diagnosis of diabetes, 2002–2011 cohort years

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1 year survival %	81.6	81.7	82.8	82.4	84.7	83.5	83.9	83.3	84.8	84.9

Table 8.18. Death rate by age group for all prevalent RRT patients, 2011 cohort, compared with the general population and with previous analyses in the 1998–2001 cohort

Age group	UK population mid 2012 (thousands)	UK deaths in 2012	Death rate per 1,000 population	Expected number of deaths in UKRR population	UKRR deaths in 2012	UKRR death rate per 1,000 prevalent RRT patients	Relative risk of death in 2012	Relative risk of death 1998–2001 cohort
20–24	4,332	1,550	0.4	0	10	10	28.8	41.1
25–29	4,318	1,982	0.5	1	18	12	25.1	41.8
30–34	4,240	2,661	0.6	1	18	9	13.7	31.2
35–39	4,036	3,690	0.9	3	43	15	16.6	26.0
40–44	4,567	6,315	1.4	6	89	21	15.5	22.6
45–49	4,686	9,690	2.1	11	141	27	13.0	19.0
50–54	4,236	13,384	3.2	17	226	41	13.0	12.8
55–59	3,684	18,736	5.1	27	284	53	10.4	10.1
60–64	3,624	29,012	8.0	44	437	79	9.8	10.4
65–69	3,345	41,101	12.3	64	553	107	8.7	7.9
70–74	2,476	51,932	21.0	96	682	149	7.1	7.2
75–79	2,047	71,835	35.1	132	792	211	6.0	5.3
80–84	1,534	96,291	62.8	149	652	275	4.4	4.0
85+	1,439	215,351	149.7	166	452	408	2.7	3.0
Total	**48,564**	**563,530**	**11.6**	**717**	**4,397**	**87**	**6.1**	**7.7**

Table 8.24 shows the cause of death for prevalent dialysis patients in the 2011 cohort. Prevalent dialysis patients aged 65 years and over were substantially more likely to withdraw from treatment than younger patients and cardiac disease was much more common as a cause of death in younger (<65 years) dialysis patients. Figure 8.31 shows cause of death for prevalent patients in the 2000 to 2011 cohort. Over time, cardiac disease as cause of death has decreased markedly and there has been a gradual decline in cerebrovascular disease as a cause of death. The proportion of patients coded with 'other' cause of death has increased, as has treatment withdrawal (19% in 2011 cohort). Infection as cause of death remained at a similar level to the 2000 cohort (figure 8.31).

Median life expectancy on RRT

The statistical methodology for this analysis is described in the methodology section at the start of this

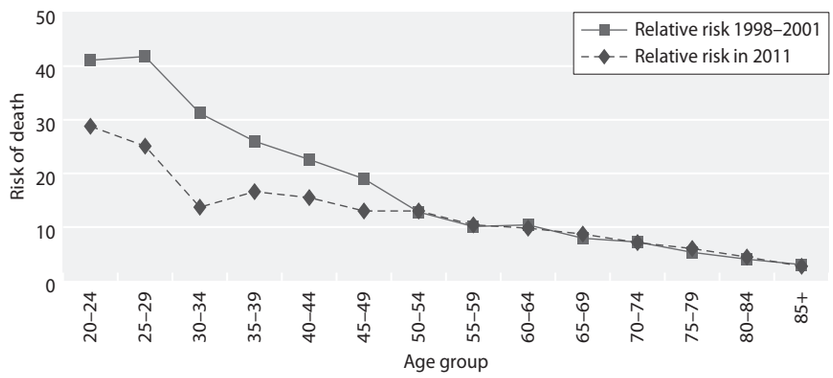

Fig. 8.28. Relative risk of death in all prevalent RRT patients in the 2011 cohort compared with the UK general population

Table 8.19. Percentage completeness of EDTA cause of death for prevalent patients by centre and year

Centre	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
England										
B Heart	76.3	76.4	68.1	85.7	84.5	93.9	100.0	96.6	96.1	96.6
B QEH		0.0	60.2	4.8	5.1	3.5	0.7	1.2	2.0	2.1
Basldn	92.3	84.0	45.0	22.7	45.5	47.6	80.0	68.8	84.6	88.9
Bradfd	88.1	83.3	87.8	90.0	88.2	92.5	79.5	97.0	97.6	97.7
Brightn		0.0	0.0	0.0	12.0	0.0	1.1	2.4	1.1	1.1
Bristol	85.0	89.9	76.7	60.2	58.7	65.8	70.0	89.4	95.2	82.2
Camb	0.0	1.6	1.5	1.3	0.0	0.0	5.0	10.3	62.0	94.1
Carlis	60.0	77.3	87.0	91.3	73.9	47.6	80.6	100.0	92.9	94.7
Carsh	0.0	0.0	0.0	0.0	0.8	0.8	0.8	6.7	25.0	40.8
Chelms		35.0	69.7	64.0	76.5	71.4	86.7	86.7	87.0	100.0
Colchr						0.0	50.0	77.3	82.6	100.0
Covnt	3.0	1.7	0.0	0.0	0.0	1.2	0.0	0.0	1.4	33.3
Derby	11.1	69.0	77.6	75.6	83.3	97.8	73.5	91.2	88.5	85.2
Donc						100.0	94.3	90.9	91.7	92.6
Dorset	0.0	30.6	61.5	66.7	87.2	88.9	85.2	95.7	94.9	88.9
Dudley	3.4	31.7	14.3	5.9	6.3	5.3	0.0	94.3	88.1	90.9
Exeter	35.1	40.8	34.7	17.5	4.7	2.1	3.0	89.5	84.6	95.1
Glouc	63.0	43.2	51.6	44.4	55.6	60.4	65.8	97.2	93.6	91.5
Hull	38.9	83.6	81.5	76.0	76.5	51.6	17.3	90.8	93.5	96.9
Ipswi	47.1	30.4	10.3	21.9	35.5	13.6	18.8	70.0	77.8	77.4
Kent						56.8	89.2	89.0	96.2	94.9
L Barts		86.5	83.3	87.4	74.6	77.0	70.1	74.6	82.6	79.9
L Guys	1.2	0.0	0.0	0.0	3.5	0.0	0.0	69.5	84.2	58.8
L Kings	31.5	66.7	85.7	90.6	75.6	88.2	67.1	96.1	97.6	100.0
L Rfree				0.0	0.0	0.0	0.9	1.7	0.0	7.0
L St.G					16.7	17.9	21.4	77.6	47.9	42.4
L West	79.1	67.5	79.8	31.3	18.9	5.8	2.2	2.2	95.0	96.8
Leeds	58.6	73.8	67.2	66.7	29.6	27.9	33.6	99.0	99.1	97.7
Leic	77.0	88.2	71.5	77.0	65.5	69.5	69.3	74.5	60.9	94.1
Liv Ain	100.0	66.7	50.0	81.3	73.3	66.7	100.0	85.0	95.7	0.0
Liv RI	74.1	69.9	39.8	65.5	76.8	75.6	79.2	71.6	76.4	2.8
M RI					4.0	0.9	1.0	4.7	3.1	9.9
Middlbr	66.7	42.0	77.6	63.5	54.8	23.4	46.7	88.2	97.5	94.9
Newc	29.9	27.1	19.4	29.8	48.7	35.7	40.8	14.0	45.0	16.9
Norwch		30.8	21.0	21.4	18.2	21.2	44.4	75.8	70.3	76.1
Nottm	90.6	94.4	97.0	87.5	87.0	98.8	97.1	98.8	100.0	99.0
Oxford	8.7	1.9	2.8	0.0	0.0	1.0	0.0	84.6	97.4	92.7
Plymth	52.8	46.9	43.2	39.6	56.7	70.7	47.5	78.7	43.6	41.2
Ports	32.7	55.1	21.5	7.3	17.5	5.9	43.6	67.0	23.3	19.8
Prestn	73.8	75.9	50.0	55.4	47.8	38.1	17.9	95.7	98.9	97.6
Redng	86.0	77.1	81.5	77.1	97.8	89.6	83.0	100.0	96.7	91.2
Salford	1.7	1.3	0.0	0.0	1.3	0.0	1.3	0.0	0.0	0.0
Sheff	98.8	19.6	3.1	5.5	8.1	0.9	1.9	3.0	0.8	0.8
Shrew		25.0	66.7	53.1	85.7	62.5	20.5	46.0	0.0	7.9
Stevng	71.0	66.2	75.0	57.5	52.2	60.3	70.0	86.3	86.8	67.7
Sthend	66.7	25.0	41.2	9.4	3.2	57.7	75.0	92.3	90.0	100.0
Stoke					16.1	21.0	28.6	53.9	57.9	89.6
Sund	53.1	54.8	56.3	60.0	60.5	50.0	78.9	93.5	95.1	97.4
Truro	80.6	57.1	2.3	6.9	0.0	18.4	26.3	93.3	94.9	78.8
Wirral	85.7	64.5	31.3	88.2	68.4	87.5	24.2	62.2	0.0	2.7
Wolve	98.5	96.6	92.2	48.5	52.3	65.8	76.4	96.9	94.1	90.9
York	82.5	67.6	41.4	83.3	38.5	62.1	64.3	96.6	97.3	100.0
N Ireland										
Antrim			4.3	10.0	8.8	3.8	26.9	100.0	100.0	100.0
Belfast			17.2	33.8	38.3	20.0	26.2	81.4	80.0	79.7
Newry			0.0	42.9	16.7	15.4	85.7	95.2	100.0	96.7
Ulster			100.0	85.7	92.9	90.0	75.0	95.0	95.2	100.0
West NI			46.2	57.7	38.9	25.0	45.8	100.0	87.0	100.0

Table 8.19. Continued

Centre	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Scotland										
Abrdn	47.7	31.7	2.8	0.0	0.0	82.9	97.6	92.1	97.6	65.7
Airdrie	26.7	10.3	40.0	26.3	26.8	79.3	100.0	96.8	97.0	93.9
D & Gall	69.2	76.9	80.0	76.9	100.0	93.3	94.1	100.0	100.0	81.3
Dundee	92.1	92.1	86.1	2.8	0.0	50.0	90.6	85.7	59.5	62.2
Dunfn	80.0	66.7	81.3	50.0	53.8	61.9	89.3	78.6	90.0	87.5
Edinb	60.4	44.2	50.9	29.3	45.0	85.9	96.2	98.3	95.1	100.0
Glasgw	49.6	41.9	40.2	53.2	55.3	75.4	88.0	66.9	98.5	96.0
Inverns	0.0	0.0	0.0	0.0	0.0	65.2	90.0	91.7	100.0	95.7
Klmarnk	4.0	10.0	0.0	11.1	9.4	95.8	93.3	93.9	94.4	96.8
Wales	34.1	30.7	28.6	30.0	43.4	36.4	47.2	53.0	48.6	50.3
Bangor	39.1	42.1	66.7	35.0	86.2	52.4	76.9	73.9	90.0	100.0
Cardff	3.5	2.6	3.5	2.2	4.1	0.0	1.6	6.0	7.9	0.6
Clwyd	22.2	0.0	0.0	11.1	45.5	84.2	83.3	100.0	85.7	89.5
Swanse	92.0	89.2	85.7	92.4	97.3	94.8	89.8	98.0	87.5	97.1
Wrexm	10.7	3.7	3.7	0.0	22.7	69.2	100.0	95.7	92.6	100.0
England	**52.3**	**51.8**	**46.8**	**40.8**	**36.8**	**36.0**	**37.8**	**58.3**	**63.4**	**64.3**
N Ireland			**20.4**	**38.7**	**33.6**	**22.4**	**42.1**	**91.5**	**89.0**	**92.3**
Scotland	**50.5**	**42.5**	**40.3**	**32.3**	**33.5**	**75.2**	**92.5**	**83.8**	**93.1**	**89.1**
Wales	**34.1**	**30.7**	**28.6**	**30.0**	**43.4**	**36.4**	**47.2**	**53.0**	**48.6**	**50.3**
UK	**50.5**	**49.2**	**44.2**	**39.2**	**36.8**	**39.3**	**43.4**	**61.2**	**66.1**	**66.3**

Blank cells denote data not available for that year

Table 8.20. Cause of death in the first 90 days for incident patients by age group, 2000–2011 cohort

	All age groups		<65 years		⩾65 years	
Cause of death	*N*	%	*N*	%	*N*	%
Cardiac disease	644	27	152	29	492	26
Cerebrovascular disease	120	5	25	5	95	5
Infection	416	17	76	14	340	18
Malignancy	216	9	65	12	151	8
Treatment withdrawal	367	15	53	10	314	17
Other	554	23	138	26	416	22
Uncertain	95	4	16	3	79	4
Total	**2,412**		**525**		**1,887**	
No cause of death data	2,537	51	555	51	1,982	51

Table 8.21. Cause of death in 1 year after 90 days for incident patients by age group, 2000–2011 cohort

	All age groups		<65 years		⩾65 years	
Cause of death	*N*	%	*N*	%	*N*	%
Cardiac disease	1,000	23	316	26	684	22
Cerebrovascular disease	228	5	60	5	168	5
Infection	804	18	226	18	578	18
Malignancy	460	10	155	13	305	10
Treatment withdrawal	732	17	104	8	628	20
Other	934	21	291	24	643	20
Uncertain	232	5	73	6	159	5
Total	**4,390**		**1,225**		**3,165**	
No cause of death data	4,430	50.2	1,255	50.6	3,175	50.1

Table 8.22. Cause of death in prevalent RRT patients by modality, 2011 cohort

	All modalities		Dialysis		Transplant	
Cause of death	*N*	%	*N*	%	*N*	%
Cardiac disease	647	22	575	22	72	18
Cerebrovascular disease	135	5	118	5	17	4
Infection	532	18	437	17	95	23
Malignancy	292	10	208	8	84	20
Treatment withdrawal	511	17	498	19	13	3
Other	624	21	528	21	96	23
Uncertain	245	8	212	8	33	8
Total	**2,986**		**2,576**		**410**	
No cause of death data	1,414	32	1,160	31	254	38

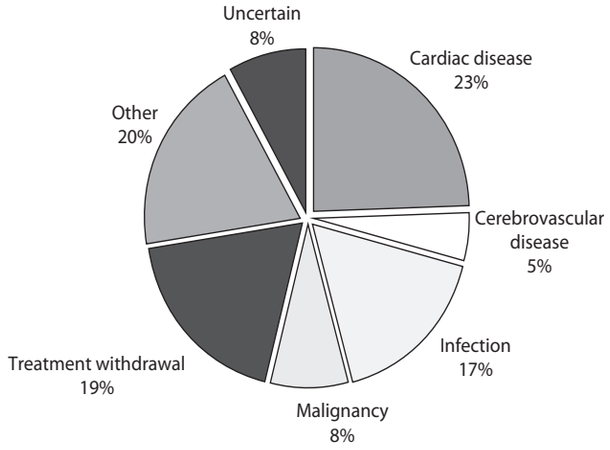

Fig. 8.29. Percentage contribution to cause of death for prevalent dialysis patients, 2011 cohort

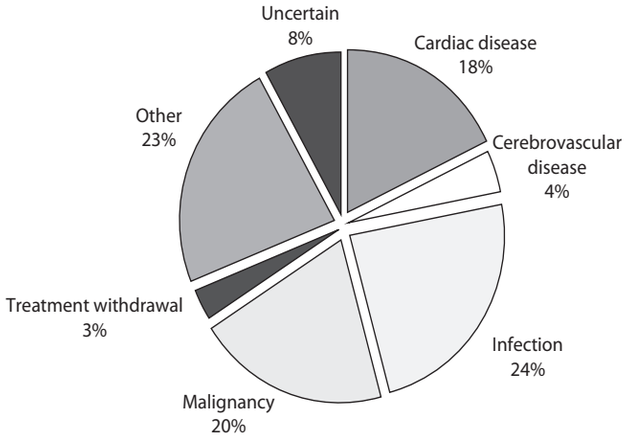

Fig. 8.30. Percentage contribution to cause of death for prevalent transplant patients, 2011 cohort

chapter. Figure 8.32 shows median life expectancy on RRT after 90 days by age group. All incident patients starting RRT from 2000 to 2009 have been included in this analysis and patients were followed up for a minimum of three years. The estimated median survival will be different for low risk patients (e.g. polycystic kidney disease with a transplant) vs. high risk patients (diabetes with previous myocardial infarction on dialysis) even within the same age group. Median life years remaining for non-diabetic and diabetic patients (figure 8.33) were

Table 8.23. Cause of death in prevalent transplanted patients by age group, 2011 cohort

	All age groups		<65 years		⩾65 years	
Cause of death	*N*	%	*N*	%	*N*	%
Cardiac disease	72	18	36	18	36	17
Cerebrovascular disease	17	4	8	4	9	4
Infection	95	23	48	24	47	22
Malignancy	84	20	42	21	42	20
Treatment withdrawal	13	3	5	3	8	4
Other	96	23	43	22	53	25
Uncertain	33	8	16	8	17	8
Total	**410**		**198**		**212**	
No cause of death data	254	38	126	39	128	38

Table 8.24. Cause of death in prevalent dialysis patients by age group, 2011 cohort

	All age groups		<65 years		⩾65 years	
Cause of death	*N*	%	*N*	%	*N*	%
Cardiac disease	575	22	172	28	403	21
Cerebrovascular disease	118	5	32	5	86	4
Infection	437	17	105	17	332	17
Malignancy	208	8	45	7	163	8
Treatment withdrawal	498	19	59	10	439	22
Other	528	21	143	23	385	20
Uncertain	212	8	58	9	154	8
Total	**2,576**		**614**		**1,962**	
No cause of death data	1,160	31	331	35	829	30

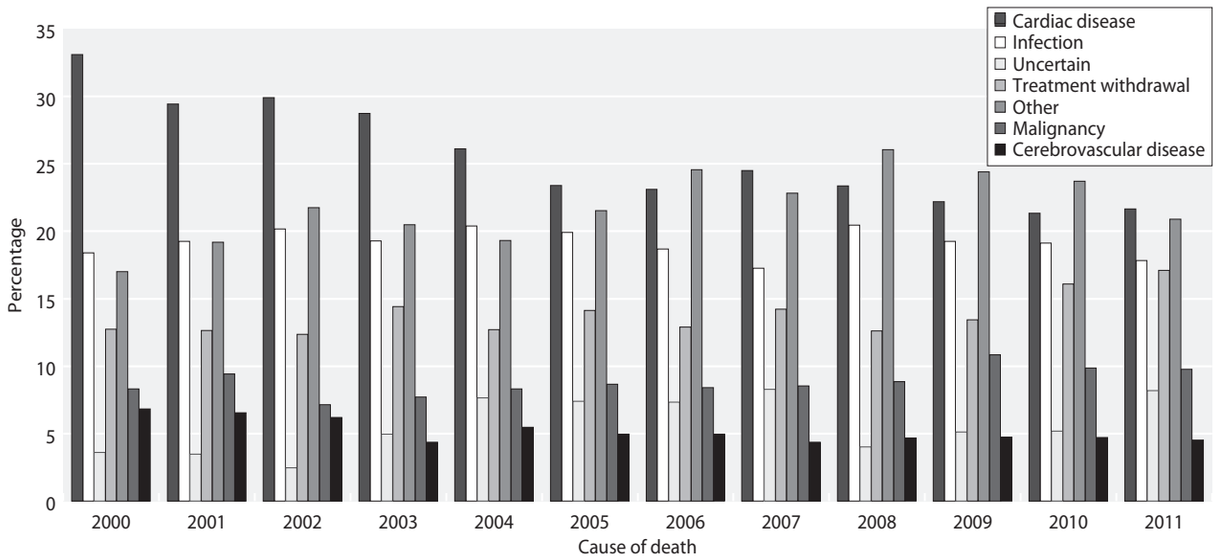

Fig. 8.31. Cause of death in prevalent RRT patients by cohort year

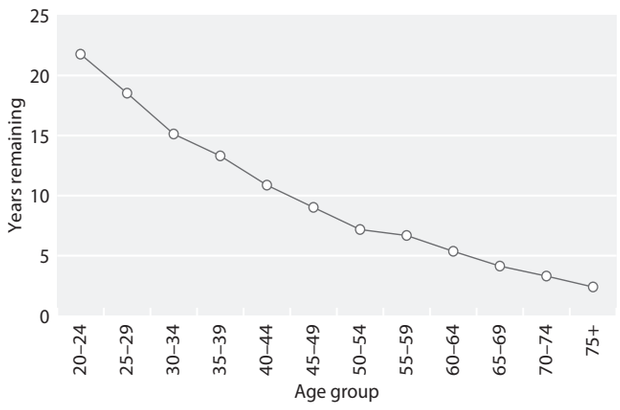

Fig. 8.32. Median life expectancy on RRT after 90 days, by age group, incident patients starting RRT from 2000–2009

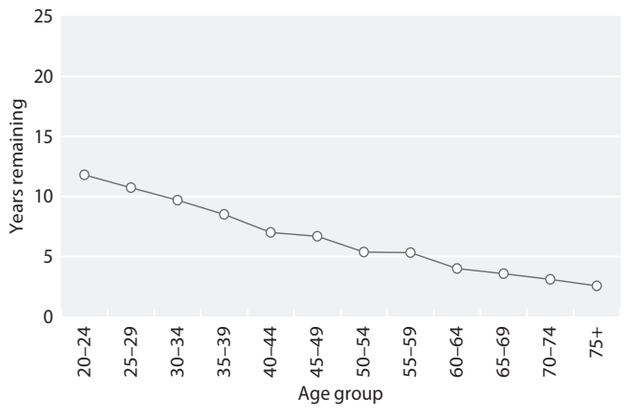

Fig. 8.33. Median life expectancy on RRT after 90 days by age group, incident diabetic patients starting RRT from 2000–2009

also calculated and show that median life expectancy for patients younger than 45 was on average nine years more for non-diabetic patients (data not shown) compared with age matched diabetic patients. In the older age group ($\geqslant$65 years) the median life years remaining were similar between diabetic and non-diabetic patients.

Conflicts of interest: none

References

1 Plantinga LC, Fink NE, Levin NW, et al. Early, Intermediate, and Long-Term Risk Factors for Mortality in Incident Dialysis Patients: The Choices for Healthy Outcomes in Caring for ESRD (CHOICE) Study. American journal of kidney diseases: the official journal of the National Kidney Foundation 2007;49(6):831–40

2 Miskulin DC, Meyer KB, Martin AA, et al. Comorbidity and its change predict survival in incident dialysis patients. American journal of kidney diseases: the official journal of the National Kidney Foundation 2003;41(1):149–61

3 Nitsch D, Burden R, Steenkamp R, Ansell D, Byrne C, Caskey F, et al. Patients with diabetic nephropathy on renal replacement therapy in England and Wales. Qjm-an International Journal of Medicine. 2007 Sep;100(9):551–60

4 Roderick P, Byrne C, Casula A, Steenkamp R, Ansell D, Burden R, et al. Survival of patients from South Asian and Black populations starting renal replacement therapy in England and Wales. Nephrology Dialysis Transplantation. 2009 Dec;24(12):3774–82

5 Tomson C, Maggs C. UK Renal Registry 12th Annual Report (December 2009): Chapter 2: introduction. Nephron Clin Pract. 2010;115(suppl 1): c3–8

6 Ford DJ, Fogarty DG, Steenkamp R, Tomson CRV, Ben-Shlomo Y, Ansell D. Chapter 13: The UK Renal Registry Advanced CKD Study: frequency of incorrect reporting of date of start of RRT. Nephron Clinical Practice;115(suppl 1):c271–c78

7 Malek SK, Keys BJ, Kumar S, Milford E, Tullius SG. Racial and ethnic disparities in kidney transplantation. Transplant International 2011;24(5):419–24 doi: 10.1111/j.1432–2277.2010.01205.x[published Online First: Epub Date]

8 Office for National Statistics. www.ons.gov.uk, http://www.ons.gov.uk/ons/dcp171778_238743.pdf

9 Ansell D, Roderick P, Hodsman A, Ford D, Steenkamp R, Tomson C. UK Renal Registry 11th Annual Report (December 2008): Chapter 7 Survival and cause of death of UK adult patients on renal replacement therapy in 2007: national and centre-specific analyses. Nephron Clin Pract. 2009;111(suppl 1):c113–39

10 van Manen JG, van Dijk PCW, Stel VS, Dekker FW, Cleries M, Conte F, et al. Confounding effect of comorbidity in survival studies in patients on renal replacement therapy. Nephrology Dialysis Transplantation. 2007; 22(1):187–95.

11 Renal Association. Clinical Practice Guidelines. 5th edition. 2010; http://www.renal.org/Clinical/GuidelinesSection/Guidelines.aspx

Appendix 1: Survival tables

Table 8.25. One-year after 90–day incident survival percentage by centre, 2011 cohort, unadjusted and adjusted to age 60

Centre	Unadjusted 1 year after 90 days survival	Adjusted 1 year after 90 days survival	*Adjusted 1 year after 90 days 95% CI*
England			
B Heart	92.0	94.4	*90.7–98.2*
B QEH	91.2	93.3	*90.1–96.5*
Basldn	85.7	91.0	*83.9–98.7*
Bradfd	87.0	88.9	*81.6–96.9*
Brightn	86.7	91.0	*86.4–95.8*
Bristol	92.0	94.5	*91.4–97.7*
Camb	86.4	91.6	*87.6–95.8*
Carlis	88.5	91.5	*82.9–100.0*
Carsh	90.8	94.3	*91.7–97.0*
Chelms	75.6	80.8	*71.4–91.6*
Colchr	72.5	84.1	*75.5–93.6*
Covnt	88.4	90.4	*85.1–95.9*
Derby	87.8	91.3	*86.1–96.9*
Donc	83.8	88.9	*81.1–97.5*
Dorset	82.4	88.2	*82.4–94.4*
Dudley	90.0	93.7	*88.1–99.7*
Exeter	82.9	88.5	*83.7–93.5*
Glouc	80.6	89.6	*84.2–95.4*
Hull	89.7	93.3	*89.4–97.4*
Ipswi	94.6	95.5	*89.7–100.0*
Kent	84.3	88.5	*83.6–93.7*
L Barts	92.9	93.7	*90.7–96.9*
L Guys	93.2	94.7	*91.2–98.3*
L Kings	88.0	90.9	*86.9–95.1*
L Rfree	89.1	91.0	*87.4–94.6*
L St.G	95.9	96.8	*93.3–100.0*
L West	88.5	90.7	*87.9–93.5*
Leeds	85.0	88.2	*83.6–93.0*
Leic	88.1	91.3	*88.3–94.3*
Liv Ain	81.8	86.8	*79.5–94.7*
Liv RI	87.8	89.0	*83.3–95.0*
M RI	92.1	93.3	*89.6–97.2*
Middlbr	84.6	88.9	*83.4–94.8*
Newc	84.0	86.0	*79.2–93.3*
Norwch	84.0	89.4	*83.9–95.3*
Nottm	87.9	92.8	*89.1–96.7*
Oxford	85.9	88.8	*84.4–93.3*
Plymth	88.2	91.3	*85.0–98.1*
Ports	87.7	91.2	*87.6–95.0*
Prestn	89.9	91.8	*87.8–96.0*
Redng	90.4	93.0	*88.5–97.8*
Salford	90.1	91.7	*87.4–96.1*
Sheff	83.8	87.6	*82.8–92.6*
Shrew	86.7	91.9	*86.6–97.4*
Stevng	88.5	91.1	*86.6–95.8*
Sthend	89.3	94.3	*88.3–100.0*
Stoke	88.9	93.1	*88.6–97.8*
Sund	88.2	88.7	*79.9–98.4*
Truro	89.9	93.0	*86.7–99.8*
Wirral	83.5	87.9	*81.2–95.2*
Wolve	83.7	89.3	*84.2–94.8*
York	92.5	93.6	*87.0–100.0*
N Ireland			
Antrim	78.3	86.3	*76.1–97.9*
Belfast	89.9	92.8	*87.9–98.1*
Newry	83.3	88.1	*79.1–98.2*
Ulster	79.4	86.3	*77.5–96.1*
West NI	94.3	95.9	*90.7–100.0*
Scotland			
Abrdn	89.8	92.8	*87.0–99.0*
Airdrie	81.3	84.1	*74.1–95.4*
Dundee	83.8	90.3	*84.5–96.5*
Dunfn	90.2	92.4	*85.6–99.7*
Edinb	89.3	90.2	*83.6–97.3*
Glasgw	85.1	88.6	*84.3–93.1*
Klmarnk	88.0	91.1	*82.1–100.0*
Wales			
Bangor	92.1	94.3	*87.1–100.0*
Cardff	83.3	88.1	*84.2–92.2*
Swanse	79.2	85.4	*80.0–91.2*
Wrexm	83.3	88.8	*79.3–99.6*
England	**88.0**	**91.1**	***90.3–92.0***
N Ireland	**86.4**	**90.5**	***87.1–94.1***
Scotland	**86.8**	**90.1**	***87.7–92.6***
Wales	**82.6**	**87.7**	***84.8–90.7***
UK	**87.5**	**90.9**	***90.0–91.7***

Excluded: centres with less than 20 patients (Clwyd, Dumfries & Galloway, Inverness)

Table 8.26. Ninety day incident survival percentage by centre, 2011 cohort, unadjusted and adjusted to age 60

Centre	Unadjusted 90 day survival	Adjusted 90 day survival	*Adjusted 90 day 95% CI*
England			
B Heart	97.1	98.2	*96.1–100.0*
B QEH	95.9	97.0	*95.0–99.1*
Basldn	97.2	98.4	*95.4–100.0*
Bradfd	93.2	94.5	*89.4–99.9*
Brightn	89.2	93.4	*89.8–97.1*
Bristol	96.5	97.8	*95.8–99.7*
Camb	96.0	97.7	*95.6–99.7*
Carlis	96.4	97.5	*92.8–100.0*
Carsh	93.6	96.3	*94.4–98.4*
Chelms	90.0	93.6	*88.3–99.1*
Colchr	97.4	98.7	*96.2–100.0*
Covnt	88.9	91.9	*87.5–96.4*
Derby	89.2	92.8	*88.3–97.5*
Donc	92.5	95.5	*90.8–100.0*
Dorset	93.7	96.2	*93.0–99.5*
Dudley	93.0	96.2	*92.0–100.0*
Exeter	94.9	96.9	*94.5–99.4*
Glouc	95.4	97.8	*95.4–100.0*
Hull	92.4	95.4	*92.3–98.6*
Kent	94.3	96.1	*93.3–99.0*
L Barts	97.7	98.1	*96.5–99.8*
L Guys	97.6	98.2	*96.3–100.0*
L Kings	97.3	98.1	*96.2–100.0*
L Rfree	96.2	97.2	*95.3–99.1*
L St.G	96.1	97.0	*93.8–100.0*
L West	96.6	97.5	*96.1–98.9*
Leeds	93.6	95.4	*92.6–98.2*
Leic	94.6	96.3	*94.5–98.2*
Liv Ain	87.5	92.3	*87.3–97.6*
Liv RI	91.7	93.3	*89.2–97.6*
M RI	94.6	95.8	*93.0–98.7*
Middlbr	93.4	95.8	*92.5–99.1*
Newc	90.2	92.2	*87.4–97.2*
Norwch	89.4	93.6	*89.6–97.8*
Nottm	90.2	94.5	*91.4–97.6*
Oxford	94.6	96.1	*93.6–98.6*
Plymth	96.2	97.4	*94.0–100.0*
Ports	95.4	97.0	*94.9–99.1*
Prestn	97.9	98.4	*96.7–100.0*
Redng	91.3	94.2	*90.4–98.2*
Salford	94.3	95.5	*92.6–98.6*
Sheff	93.8	95.8	*93.1–98.5*
Shrew	90.9	95.0	*91.1–99.0*
Stevng	99.1	99.4	*98.1–100.0*
Sthend	96.6	98.3	*95.0–100.0*
Stoke	92.3	95.5	*92.1–99.1*
Sund	95.7	96.0	*90.9–100.0*
Truro	91.1	94.3	*89.2–99.8*
Wirral	91.0	94.0	*89.4–98.8*
Wolve	93.5	96.1	*93.2–99.2*
York	95.2	96.3	*91.4–100.0*
N Ireland			
Antrim	92.0	95.4	*89.6–100.0*
Belfast	98.6	99.1	*97.4–100.0*
Newry	96.8	98.0	*94.4–100.0*
Ulster	94.4	96.6	*92.1–100.0*
West NI	97.2	98.2	*94.8–100.0*
Scotland			
Abrdn	94.2	96.2	*92.0–100.0*
Airdrie	97.6	98.0	*94.4–100.0*
Dundee	93.3	96.3	*92.8–99.9*
Dunfn	89.1	91.9	*85.5–98.9*
Edinb	95.7	96.4	*92.4–100.0*
Glasgw	93.4	95.3	*92.7–98.1*
Klmarnk	78.1	85.5	*76.3–95.9*
Wales			
Cardff	96.9	98.0	*96.4–99.6*
Swanse	94.2	96.6	*94.1–99.1*
Wrexm	92.3	95.1	*88.7–100.0*
England	**94.4**	**96.3**	***95.7–96.8***
N Ireland	**96.5**	**97.8**	***96.2–99.4***
Scotland	**93.1**	**95.3**	***93.7–96.9***
Wales	**95.8**	**97.4**	***96.1–98.7***
UK	**94.5**	**96.3**	***95.8–96.8***

Excluded: centres with less than 20 patients (Clwyd, Dumfries & Galloway, Inverness) and centres with no deaths recorded in the first 90 days of RRT (Ipswich and Bangor)

Table 8.27. One year after 90-day incident survival by centre for incident cohort years 2003–2011 adjusted to age 60

Centre	2003	2004	2005	2006	2007	2008	2009	2010	2011
England									
B Heart	88.2	86.4	83.6	88.5	93.5	93.6	84.3	92.0	94.4
B QEH		88.0	90.4	86.9	92.9	89.8	92.2	88.3	93.3
Basldn	92.6	92.3	92.8	90.9	89.9	89.3	88.5	84.8	91.0
Bradfd	88.3	80.9	86.1	80.8	84.2	84.4	92.4	87.6	88.9
Brightn		90.6	84.3	87.2	94.2	89.3	84.7	88.3	91.0
Bristol	85.7	88.0	82.8	92.6	91.4	84.0	88.7	88.9	94.5
Camb	89.4	86.9	89.8	90.9	93.4	91.2	87.7	89.5	91.6
Carlis	82.5	86.9	79.5	89.9	96.5	87.8	71.5	86.3	91.5
Carsh	89.4	85.8	90.2	88.7	87.2	86.6	88.0	89.8	94.3
Chelms		82.2	82.8	94.3	86.6	90.8	93.4	85.6	80.8
Colchr						86.6	84.6	96.8	84.1
Covnt	81.8	87.6	82.5	88.6	90.4	86.9	94.2	89.0	90.4
Derby	86.5	83.7	87.9	93.1	96.6	90.5	87.6	87.4	91.3
Donc						89.8	84.6	91.5	88.9
Dorset	85.9	91.3	82.5	86.3	90.4	93.5	92.7	87.4	88.2
Dudley	90.5	81.3	97.3	92.7	85.6	70.3	84.6	87.8	93.7
Exeter	82.3	88.5	86.1	88.9	86.4	87.0	88.5	95.3	88.5
Glouc	82.9	83.4	95.1	89.7	87.0	94.3	90.1	92.3	89.6
Hull	89.3	88.8	85.7	93.6	89.8	85.4	88.9	88.0	93.3
Ipswi	93.2	97.4	84.4	93.9	96.0	95.8	91.3	93.2	95.5
Kent					91.8	90.0	89.3	90.6	88.5
L Barts		87.1	91.0	94.0	86.5	93.1	90.1	91.9	93.7
L Guys	94.8	91.6	90.4	92.9	92.0	90.5	95.0	91.4	94.7
L Kings	88.0	86.9	91.8	86.5	87.9	89.7	86.3	89.7	90.9
L Rfree			93.3	89.8	94.4	95.2	88.6	90.3	91.0
L St.G					92.1	94.0	92.2	93.7	96.8
L West	95.9	92.4	94.4	92.8	92.9	94.5	93.8	88.8	90.7
Leeds	87.1	89.6	89.9	85.7	87.4	88.7	89.9	92.7	88.2
Leic	89.0	87.5	84.6	87.9	89.8	90.5	90.2	91.6	91.3
Liv Ain				87.0	82.9	78.6	82.5	89.1	86.8
Liv RI	90.2	80.9	90.1	86.7	86.2	94.1	94.4	88.5	89.0
M RI					90.2	87.8	87.6	89.5	93.3
Middlbr	82.4	85.3	83.3	91.5	87.8	82.3	87.9	88.1	88.9
Newc	87.2	85.4	82.1	86.3	85.8	91.5	84.5	88.8	86.0
Norwch		84.0	90.7	86.4	91.1	89.0	92.0	92.1	89.4
Nottm	85.9	85.6	86.9	92.0	90.0	91.1	88.6	93.5	92.8
Oxford	89.4	87.8	87.8	90.2	89.3	87.1	91.0	90.6	88.8
Plymth	84.0	77.7	84.5	81.2	90.1	87.8	89.9	93.8	91.3
Ports	89.8	88.4	82.4	87.6	88.7	88.8	88.9	88.1	91.2
Prestn	85.2	87.2	88.5	83.7	91.4	82.1	86.8	87.6	91.8
Redng	92.1	90.7	90.5	91.3	90.7	95.2	89.5	92.9	93.0
Salford	88.4	85.1	89.0	90.6	89.2	86.0	88.3	86.7	91.7
Sheff	87.5	91.7	90.6	88.7	90.9	92.5	93.7	92.2	87.6
Shrew		87.4	86.2	87.8	91.8	93.0	83.6	86.9	91.9
Stevng	93.8	93.3	76.7	85.4	90.7	90.2	96.3	93.8	91.1
Sthend	91.8	90.4	91.1	94.9	91.8	86.5	91.2	83.0	94.3
Stoke					87.4	89.9	85.5	87.0	93.1
Sund	80.6	86.7	80.5	83.6	88.7	85.3	79.9	84.1	88.7
Truro	86.9	92.7	90.6	89.6	90.2	89.2	93.9	90.8	93.0
Wirral	96.6	85.5	86.9	86.0	88.9	90.4	83.9	93.0	87.9
Wolve	83.6	88.0	84.1	89.3	89.5	89.1	90.3	87.5	89.3
York	76.1	91.2	83.9	82.5	95.1	86.2	93.9	86.3	93.6

Table 8.27. Continued

Centre	2003	2004	2005	2006	2007	2008	2009	2010	2011
N Ireland									
Antrim			87.3	94.0	86.9	92.2	97.2	90.1	86.3
Belfast			86.8	93.2	91.0	88.4	90.4	89.3	92.8
Newry			90.1					92.0	88.1
Ulster								90.9	86.3
West NI				90.2	97.3	93.1	97.5	91.3	95.9
Scotland									
Abrdn	86.0	88.7	84.1	82.7	86.0	86.4	89.2	85.4	92.8
Airdrie	74.6	86.3	75.1	80.7	76.7	88.3	94.0	81.9	84.1
D & Gall	84.5				87.5				
Dundee	86.9	85.7	84.8	89.5	82.0	86.2	87.4	90.2	90.3
Dunfn	88.2	89.8	78.2	80.3	87.4	87.0	89.9	93.5	92.4
Edinb	86.7	79.4	83.2	88.8	90.0	84.2	84.2	86.3	90.2
Glasgw	87.4	80.9	86.2	83.4	88.0	84.2	87.8	86.8	88.6
Inverns	87.6	89.2	84.2	83.9	90.6	87.2		96.7	
Klmarnk	83.7	87.4	96.3	82.8	87.6	90.1	82.9	88.3	91.1
Wales									
Bangor	91.1	80.8	82.2	81.5	92.3	87.6	87.1	89.1	94.3
Cardff	87.2	85.6	87.2	87.5	84.5	83.6	89.6	89.7	88.1
Clwyd			75.3	96.9			92.1		
Swanse	84.6	78.0	83.0	84.3	89.0	85.2	83.5	86.9	85.4
Wrexm	93.4	79.7	97.7	85.6	89.9			82.0	88.8
England	**88.4**	**87.8**	**87.9**	**89.1**	**90.3**	**89.6**	**89.6**	**89.9**	**91.1**
N Ireland			**88.9**	**91.7**	**90.9**	**88.9**	**92.0**	**90.3**	**90.5**
Scotland	**86.0**	**84.7**	**84.5**	**84.6**	**86.6**	**86.0**	**86.7**	**87.8**	**90.1**
Wales	**87.0**	**82.8**	**86.0**	**86.4**	**86.8**	**84.6**	**87.9**	**88.7**	**87.7**
UK	**88.0**	**87.2**	**87.4**	**88.6**	**89.7**	**89.0**	**89.4**	**89.7**	**90.9**

Blank cells: centres with less than 20 patients for that year or centres with no data available for that year

Table 8.28. One year prevalent patient survival by centre for prevalent cohort years 2002–2011, adjusted to age 60

Centre	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
England										
B Heart	87.9	86.8	88.1	86.5	87.1	90.1	90.7	87.4	89.4	88.3
B QEH	99.7	89.1	89.1	88.4	88.5	88.4	90.2	89.5	91.2	91.7
Basldn	84.6	87.9	90.4	90.2	90.5	92.7	91.8	88.8	91.1	88.4
Bradfd	83.2	88.2	86.3	82.8	84.2	87.8	84.6	89.3	88.0	87.7
Brightn	99.7	87.1	84.3	87.6	87.4	89.0	87.5	90.1	88.4	89.4
Bristol	89.0	86.8	87.4	87.6	89.1	87.3	84.9	85.7	89.6	90.6
Camb	87.3	88.1	87.4	89.4	88.0	92.6	90.0	91.4	93.1	88.9
Carlis	83.4	82.9	83.7	83.8	85.7	86.9	80.2	80.4	93.2	88.8
Carsh	84.6	87.4	86.3	89.4	88.7	90.1	89.0	89.5	89.8	91.2
Chelms	98.4	86.4	82.9	85.6	87.5	85.0	86.0	89.5	84.1	90.7
Colchr							91.0	86.5	88.9	89.1
Covnt	87.0	89.0	89.1	85.1	87.0	87.1	90.8	90.0	90.9	91.7
Derby	86.7	88.7	87.9	88.8	87.2	90.7	90.8	90.3	90.2	90.1
Donc						88.7	83.8	88.8	91.8	91.1
Dorset	90.3	88.3	89.4	87.0	87.7	89.8	90.0	93.0	89.9	90.4
Dudley	85.0	86.4	85.9	87.2	87.2	88.7	88.6	90.7	87.6	91.4
Exeter	86.9	86.2	83.7	90.9	87.1	85.3	85.3	86.5	88.2	88.0
Glouc	83.5	88.8	88.1	91.1	88.2	86.1	91.7	92.1	89.5	90.6
Hull	86.0	86.2	84.6	85.9	90.0	86.9	88.0	87.5	90.0	91.1
Ipswi	84.8	90.2	86.0	84.5	86.5	92.7	84.8	87.8	92.0	90.4
Kent						86.2	87.9	90.5	89.8	89.3
L Barts		83.8	85.7	88.3	89.2	88.8	90.9	92.9	91.7	90.0
L Guys	88.8	88.5	89.3	87.4	90.5	90.3	91.3	91.0	93.9	91.1
L Kings	77.7	81.1	86.7	89.2	84.9	88.0	88.0	89.4	90.1	89.9
L Rfree			90.2	90.4	90.3	91.3	89.8	90.3	91.6	90.2
L St.G					95.8	94.3	89.2	90.8	91.9	88.5
L West	91.3	91.0	91.1	91.1	91.4	90.1	91.9	90.3	90.4	91.5
Leeds	86.3	85.9	89.1	88.7	88.3	87.4	88.9	90.9	88.8	86.7
Leic	83.8	85.2	86.7	84.4	89.7	89.6	88.6	90.4	89.8	90.2
Liv Ain	91.5	88.0	97.2	87.2	90.7	88.5	92.0	89.9	89.7	83.8
Liv RI	84.4	85.7	84.2	88.0	85.0	86.9	89.5	89.3	90.8	89.0
M RI					86.3	86.4	87.5	86.8	88.4	90.5
Middlbr	84.6	83.6	86.2	85.4	87.4	87.0	86.6	83.7	93.1	89.0
Newc	81.0	81.0	86.1	83.9	86.1	86.4	87.2	86.3	85.2	89.4
Norwch		87.3	88.3	90.2	87.5	91.0	89.4	89.8	91.2	91.3
Nottm	85.3	86.7	84.7	83.4	89.5	88.4	87.9	89.7	90.1	88.9
Oxford	87.0	88.3	87.3	87.2	86.8	87.8	88.6	87.4	88.0	88.1
Plymth	84.7	85.7	87.6	83.5	82.5	87.8	85.6	85.0	89.7	84.2
Ports	82.1	89.1	85.9	85.2	89.8	88.4	89.2	88.3	88.2	89.9
Prestn	84.8	85.6	85.8	86.3	90.7	90.1	89.7	90.1	88.1	90.6
Redng	82.7	89.2	86.2	89.0	90.6	88.8	92.3	88.8	89.3	90.8
Salford	84.4	81.8	83.6	85.9	88.0	86.5	87.9	85.2	87.7	88.9
Sheff	91.1	87.8	87.0	89.2	88.8	88.8	89.7	89.6	88.7	88.8
Shrew	94.5	84.7	86.3	86.6	89.1	88.9	87.9	85.9	87.4	89.9
Stevng	88.6	89.5	88.7	89.5	89.7	92.4	90.4	89.9	92.7	91.9
Sthend	87.3	88.5	87.0	83.4	86.3	90.2	91.0	92.4	90.3	87.8
Stoke					84.5	87.3	88.5	86.8	90.9	90.6
Sund	75.5	81.8	86.4	79.4	83.7	87.5	85.2	84.7	83.7	86.4
Truro	90.3	89.9	85.1	91.8	89.3	89.4	89.0	90.7	89.0	89.6
Wirral	83.5	87.4	89.4	88.5	88.1	89.6	90.2	88.6	90.7	90.4
Wolve	85.0	87.6	86.8	89.3	87.8	92.8	89.4	87.4	89.3	88.6
York	81.1	83.0	89.4	84.0	88.5	87.9	88.8	90.0	84.1	88.6

Table 8.28. Continued

Centre	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
N Ireland										
Antrim			83.5	92.2	86.0	89.5	90.7	89.8	92.8	91.5
Belfast			85.8	86.4	90.9	88.9	88.8	88.8	89.9	89.8
Newry			87.2	87.5	87.4	90.9	94.3	88.2	92.1	84.1
Ulster			86.1	91.6	89.4	92.6	88.2	90.6	90.5	91.6
West NI			88.9	83.7	91.5	93.0	89.7	91.8	91.5	92.3
Scotland										
Abrdn	80.1	85.4	87.8	86.3	87.3	89.6	89.4	89.4	89.0	90.9
Airdrie	84.5	84.2	83.0	79.9	79.5	86.1	85.6	89.4	88.5	86.4
D & Gall	85.1	83.1	92.1	82.1	90.6	84.6	88.4	87.3	91.3	87.4
Dundee	83.5	86.0	87.4	87.6	84.1	84.2	93.8	87.9	88.4	92.0
Dunfn	84.2	88.9	91.0	88.7	88.8	91.0	87.9	88.0	90.2	88.2
Edinb	83.2	86.4	86.4	87.4	88.5	88.9	86.8	89.6	83.3	90.7
Glasgw	84.1	85.6	87.5	86.4	88.1	88.3	88.5	88.7	88.1	88.5
Inverns	87.6	86.9	87.2	86.5	93.8	89.2	92.2	89.0	86.8	88.0
Klmarnk	82.8	87.6	85.2	92.2	87.3	89.3	88.4	88.4	89.1	89.8
Wales										
Bangor	81.2	89.8	86.6	88.5	81.4	88.7	85.0	85.4	86.8	89.8
Cardff	80.7	84.7	84.2	84.0	88.8	82.6	86.6	86.0	88.4	86.3
Clwyd	90.0	76.5	83.6	79.2	91.3	88.0	89.6	80.0	93.7	90.8
Swanse	82.0	87.2	89.2	85.9	88.2	89.5	87.4	87.7	89.2	86.6
Wrexm	86.0	85.9	83.6	85.8	88.2	85.9	89.6	87.5	86.1	88.1
England	**88.7**	**88.0**	**87.9**	**88.4**	**88.6**	**88.9**	**89.1**	**89.2**	**89.9**	**89.9**
N Ireland			**86.1**	**87.6**	**89.4**	**90.4**	**89.9**	**89.7**	**91.2**	**90.1**
Scotland	**84.0**	**86.0**	**87.2**	**86.6**	**87.4**	**88.1**	**88.8**	**88.7**	**87.8**	**89.3**
Wales	**82.8**	**85.6**	**85.8**	**84.9**	**88.0**	**85.7**	**87.1**	**86.2**	**88.7**	**87.1**
UK	**88.2**	**88.0**	**87.7**	**88.0**	**88.5**	**88.7**	**89.0**	**89.0**	**89.7**	**89.7**

Blank cells: data not reported for that year or less than 20 patients in the year

UK Renal Registry 16th Annual Report: Chapter 9 Adequacy of Haemodialysis in UK Adult Patients in 2012: National and Centre-specific Analyses

Catriona Shaw[a], Retha Steenkamp[a], Andrew Davenport[b]

[a]UK Renal Registry, Bristol, UK; [b]Royal Free Hospital, London, UK

Key Words
Adequacy · Haemodialysis · Urea reduction ratio

Summary

- Data suitable for urea reduction ratio (URR) analyses were available in 15,286 (75.2%) of the 20,332 patients receiving haemodialysis (HD) in the UK on the 30/9/2012.
- In 2012, 88% of prevalent HD patients achieved a URR >65%. The between centre range of prevalent patients achieving this target was wide (69.7–100%).
- The median URR in 2012 was 75%.
- URR was greater in those with longer dialysis vintage. Ninety one percent of patients who had survived on renal replacement therapy (RRT) for more than two years achieved a URR >65% compared with only 74% of those on RRT for only six months.
- Large variation between centres in the percentage of patients achieving the UK Renal Association's (RA) URR guideline persists. The UK Renal Registry (UKRR) will explore a possible move to reporting Kt/V combined with residual renal function.

Introduction

Amongst patients with established renal failure (ERF), the delivered dose of HD is an important predictor of outcome [1] and has been shown to influence survival [2–4]. The delivered dose of HD depends on treatment (duration and frequency of dialysis, dialyser size, dialysate and blood flow rate) and patient characteristics (size, weight, haematocrit and vascular access) [5]. The two widely accepted measures of urea clearance are Kt/V, the ratio between the product of urea clearance (K, in ml/min) and dialysis session duration (t, in minutes) divided by the volume of distribution of urea in the body (V, in ml) and URR which is derived solely from the percentage fall in serum urea (URR) during a dialysis treatment. Whilst Kt/V is a more accurate descriptor of urea clearance, its calculation is more complex and requires additional data items not commonly reported by most UK renal centres [6, 7]. The UKRR has historically presented analyses based on URR rather than Kt/V for comparative audit of haemodialysis adequacy as these data are more widely available.

Based on published evidence, clinical practice guidelines have been developed by various national and regional organisations [8–11]. There is considerable uniformity between them with regard to the recommendations for minimum dose of dialysis although there are differences in the methodology advised. The main objective of this chapter is to determine the extent to which patients undergoing HD treatment for established renal failure in the UK received the dose of HD, as measured by URR, recommended in the UK RA current clinical practice guidelines [9].

Methods

Seventy-one renal centres in the UK submitted data electronically to the UKRR on a quarterly basis [12]. The majority of these centres have satellite units but for the purposes of this study the data from the renal centres and their associated satellite units were amalgamated. However, because not all centres report frequency of HD, it is possible that data from a small number of patients receiving HD at a different frequency were included in the analyses. Data from two groups of patients were analysed. Firstly, analysis was undertaken using data from the prevalent adult HD patient population as of the 30th September 2012. For this analysis, data for URR were taken from the 3rd quarter of 2012 unless that data point was missing in which case data from the 2nd quarter were taken. The prevalent population only included patients receiving HD who were alive on September 30th 2012. This change in the methodology from using data from the 4th quarter of the year to the 3rd quarter was because many centres reported a dialysis frequency of less than 3 times a week in the 4th quarter. This could be due to changes in dialysis patterns during the December holiday season, or due to some inaccuracy in the data on the part of some renal centres. Data from those patients who had died before that date have not been included in the analysis. The second analysis involved adult incident patients who had commenced treatment with HD during 2011. For these patients, analysis was undertaken using the last recorded URR in the quarter in which the patient had started dialysis. The incident HD patient cohort was followed up for one year and the last recorded URR in the quarter after one year follow-up was used for this analysis.

Data from patients known to be receiving more or less than thrice weekly HD were omitted from analysis for both the incident and prevalent population. Patients whose data recording for the number of dialysis sessions per week were missing, were assumed to be dialysing thrice weekly. Home HD patients were excluded from the analysis.

Analyses of the data from both groups of patients included calculation of the median URR and of the proportion of patients who had achieved the RA guideline (as outlined below) in each of the renal centres as well as for the country as a whole. This year the median URR and proportion of patients who achieved the RA guideline were also calculated separately for males and females. The number of dialysis sessions per week and the time per dialysis session is new in this year's report and is shown by renal centre. The nine centres in Scotland do not provide data on number of dialysis sessions per week and the time per dialysis session to the UKRR and are not included in these analyses.

All patients with data were included in the statistical analyses at a national level, although centres with fewer than 20 patients, or providing less than 50% data completeness were excluded from the comparison between centres. The number preceding the centre name in each figure indicates the percentage of missing data for that centre.

The UK RA clinical practice guidelines [9] in operation at the time these data were collected were as follows:

HD should take place at least three times per week in nearly all patients. Reduction of dialysis frequency to twice per week because of insufficient dialysis facilities is unacceptable.

Every patient receiving thrice weekly HD should have consistently:

- ***either URR >65%***
- ***or equilibrated Kt/V (eKt/V) of >1.2 (or single pool Kt/V of >1.3) calculated from pre- and post-dialysis urea values, duration of dialysis and weight loss during dialysis).***

To achieve a URR above 65% or eKt/V above 1.2 consistently in the vast majority of the HD population clinicians should aim for a minimum target URR of 70% or minimum eKt/V of 1.4 in individual patients.

The duration of thrice weekly HD in adult patients with minimal residual renal function should not be reduced below 4 hours without careful consideration.

Patients receiving HD twice weekly for reasons of geography should receive a higher sessional dose of HD. If this

cannot be achieved, then it should be recognised that there is a compromise between the practicalities of HD and the patient's long-term health.

Measurement of the 'dose' or 'adequacy' of HD should be performed monthly in all hospital HD patients and may be performed less frequently in home HD patients. All dialysis units should collect and report this data to their regional network and the UKRR.

Post-dialysis blood samples should be collected either by the slow-flow method, the simplified stop-flow method, or the stop dialysate flow method. The method used should remain consistent within renal units and should be reported to the Registry.

The RA clinical practice guidelines for HD dose apply specifically to patients undergoing thrice weekly HD. In these patients it is recommended that blood for biochemical measurement (including pre-dialysis urea for URR) should be taken before the mid-week dialysis session [9].

Results

Data completeness

Data providing HD dose (URR) were available from 63 of the 71 renal centres which submitted data to the UKRR (table 9.1). Data were available for 75.2% ($n = 15{,}286$) of the total prevalent population ($n = 20{,}332$) treated with HD who met the inclusion criteria for these analyses.

Completeness in the 63 centres reporting URR data was generally good, with 49 centres reporting data on more than 90% of patients. Three centres reported URR data on less than 50% of prevalent patients (Reading, Newcastle and Sunderland). URR data were not received from eight centres (Brighton, London Barts, London Kings, London Royal Free, London St Georges, Liverpool Aintree, Liverpool Royal Infirmary and Wirral).

Several centres had a reduction in the completeness of URR data submitted to the UKRR in 2012 compared with 2010 (data not shown). These changes may represent changes in data extraction, or a move by centres to utilising Kt/V rather than URR as the preferred measure of dialysis dose.

Of the total incident patient population ($n = 4{,}387$) who started HD during 2011 and meeting the inclusion criteria for URR analyses, 47.0% ($n = 2{,}062$) had URR data available during the first quarter of treatment.

Percentage completeness of data returns on the number of HD sessions varied across centres (table 9.2). Ten centres in England and two centres in Wales returned no data on this variable. All centres in Northern Ireland returned over 88% data.

For those centres that did return data, three dialysis sessions a week was most prevalent, although several centres reported >10% of the HD population undergoing HD for more or less than three sessions. For example, Salford reported 22.9% of their prevalent haemodialysis population having more than three sessions a week whereas Southend reported that 13.3% and Bradford 28.6% of their population in 2012 had fewer than three sessions per week respectively.

Table 9.1. Percentage completeness of URR data returns for prevalent patients on HD by centre, on 30/9/2012

Centre	% completeness	Centre	% completeness
Abrdn	99.5	L Rfree	0.0
Airdrie	100.0	L St.G	0.0
Antrim	99.2	L West	94.7
B Heart	99.5	Leeds	99.6
B QEH	94.8	Leic	99.2
Bangor	100.0	Liv Ain	0.0
Basldn	95.5	Liv RI	0.0
Belfast	95.8	M RI	51.1
Bradfd	96.8	Middlbr	97.2
Brightn	0.0	Newc	1.7
Bristol	100.0	Newry	87.1
Camb	96.8	Norwch	96.3
Cardff	94.0	Nottm	93.7
Carlis	100.0	Oxford	75.3
Carsh	86.8	Plymth	97.4
Chelms	98.1	Ports	95.8
Clwyd	94.3	Prestn	82.9
Colchr	89.6	Redng	3.2
Covnt	98.1	Salford	59.1
D & Gall	100.0	Sheff	94.4
Derby	94.3	Shrew	96.7
Donc	95.4	Stevng	98.6
Dorset	93.7	Sthend	97.8
Dudley	91.6	Stoke	99.6
Dundee	99.4	Sund	1.8
Dunfn	98.6	Swanse	55.1
Edinb	99.6	Truro	69.5
Exeter	98.8	Ulster	97.8
Glasgw	98.7	West NI	95.0
Glouc	100.0	Wirral	0.0
Hull	97.7	Wolve	88.2
Inverns	98.6	Wrexm	96.2
Ipswi	100.0	York	99.2
Kent	92.8	**England**	**71.6**
Klmarnk	100.0	**N Ireland**	**95.4**
L Barts	0.0	**Scotland**	**99.3**
L Guys	73.3	**Wales**	**82.5**
L Kings	0.0	**UK**	**75.2**

Table 9.2. Percentage completeness for the number of dialysis sessions for prevalent patients on HD by centre, on 30/9/2012

Centre	Percentage completeness	Percentage		
		<3 sessions	3 sessions	>3 sessions
England				
B Heart	89.5	5.7	93.4	0.9
B QEH	0.0			
Basldn	97.9	2.9	93.5	3.6
Bradfd	3.7	28.6	71.4	0.0
Brightn	99.3	0.0	99.7	0.3
Bristol	100.0	3.3	96.3	0.5
Camb	99.4	12.0	85.8	2.2
Carlis	86.7	9.6	90.4	0.0
Carsh	0.0			
Chelms	100.0	8.7	90.4	0.9
Colchr	99.1	0.0	100.0	0.0
Covnt	2.2	0.0	100.0	0.0
Derby	89.8	0.6	99.4	0.0
Donc	99.4	1.3	98.7	0.0
Dorset	98.8	2.9	96.7	0.4
Dudley	97.3	3.5	96.5	0.0
Exeter	99.7	2.0	96.0	2.0
Glouc	0.0			
Hull	2.9	11.1	88.9	0.0
Ipswi	86.8	6.1	93.9	0.0
Kent	98.2	6.0	92.9	1.2
L Barts	0.0			
L Guys	0.0			
L Kings	0.0			
L Rfree	0.0			
L St.G	67.4	0.6	99.4	0.0
L West	45.5	0.7	98.4	1.0
Leeds	15.7	2.9	95.7	1.4
Leic	98.7	0.4	99.6	0.0
Liv Ain	100.0	1.9	96.8	1.3
Liv RI	97.9	0.9	90.3	8.8
M RI	51.6	1.4	97.2	1.4
Middlbr	15.5	0.0	100.0	0.0
Newc	99.2	1.3	98.7	0.0
Norwch	98.2	2.5	96.0	1.4
Nottm	99.4	0.6	99.4	0.0
Oxford	0.0			
Plymth	0.0			
Ports	99.2	5.0	93.3	1.7
Prestn	0.0			
Redng	100.0	0.4	99.6	0.0
Salford	99.7	0.6	76.5	22.9
Sheff	99.2	3.1	96.9	0.0
Shrew	100.0	5.0	93.8	1.3
Stevng	98.4	5.2	92.6	2.2
Sthend	99.1	13.3	86.7	0.0
Stoke	99.6	0.4	97.8	1.8
Sund	98.9	0.0	91.1	8.9
Truro	92.4	12.4	83.5	4.1
Wirral	92.4	2.5	87.4	10.1
Wolve	10.7	0.0	100.0	0.0
York	38.7	0.0	97.8	2.2

Table 9.2. Continued

Centre	Percentage completeness	Percentage		
		<3 sessions	3 sessions	>3 sessions
N Ireland				
Antrim	99.2	0.8	99.2	0.0
Belfast	88.5	0.6	98.2	1.2
Newry	97.8	7.8	92.2	0.0
Ulster	96.8	1.1	97.8	1.1
West NI	98.4	0.0	95.2	4.8
Wales				
Bangor	77.6	7.7	92.3	0.0
Cardff	0.0			
Clwyd	94.4	3.0	97.0	0.0
Swanse	0.0			
Wrexm	100.0	1.2	97.5	1.2
England	**54.2**	**2.9**	**94.9**	**2.2**
N Ireland	**95.2**	**1.7**	**96.8**	**1.5**
Wales	**21.7**	**3.5**	**96.0**	**0.5**
E, W & NI	**53.9**	**2.9**	**95.0**	**2.1**

Blank cells denote no data returned by that centre

Wide between centre variation in completeness of data on dialysis session time was also evident (table 9.3). In centres that reported data the most frequently reported dialysis session length was 3–5 hours.

Achieved URR

For prevalent patients, the median URR (75.0% for UK, centre range 70.5–81.0%) and percentage of patients attaining the RA guideline of a URR >65% (88.4% for the UK; centre range 69.7–100%) are shown in figures 9.1a and figure 9.2 respectively. The median URR in women was 78.0% (95% CI 73.0–82.0%) compared with a UK median in men of 74.0% (95% CI 69.0–78.0%) (figures 9.1b, 9.1c).

There continued to be variation between renal centres in the percentage of prevalent patients with a URR of >65%, with 21 centres attaining the RA clinical practice guideline in >90% of patients, 38 centres attaining the guideline in 70–90% of patients and one centre in less than 70% of patients (figure 9.2). There has been an improvement compared with 2010, when five centres reported fewer than 70% of their patients with a URR of >65%.

Changes in URR over time

The change in the percentage attainment of the current RA clinical practice guidelines (URR >65%) and the median URR for the UK from 2000 to 2012 is shown in figure 9.3. The proportion of patients attaining the RA guideline increased from 68.8% to 88.3% whilst the median URR has risen from 69.0% to 75.0% during the same time period. There has been no substantial change in the median URR between 2009 and 2012 in the UK.

Variation of achieved URR with time on dialysis

The proportion of patients who attained the RA guideline for HD was greater in those who had been on RRT for the longest time (figure 9.4). In 2012, of those dialysed for less than 6 months, 74% had a URR >65%, whilst 91% of patients who had survived and continued on RRT for more than two years attained the guideline target. In all strata of time on dialysis, there has been an improvement in the proportion of patients receiving the target dose of HD over the last 13 years.

The median URR during the first quarter of starting HD treatment of the incident HD population in the UK in 2011 was 67.5% (centre range 58.0–76.0%) (figure 9.5a). At the end of one year for this incident cohort, the median URR was higher and more uniform across renal centres (median URR 74.0%, centre range 69.0–80.0%) (figure 9.5b).

Table 9.3. Percentage completeness for time per dialysis session for prevalent patients on HD by centre, on 30/9/2012

Centre	Percentage completeness	Percentage per dialysis session		
		<3.5 hours	3.5–5 hours	5+ hours
England				
B Heart	83.1	4.3	92.0	3.7
B QEH	0.0			
Basldn	97.9	13.0	86.3	0.7
Bradfd	98.4	8.2	91.9	0.0
Brightn	97.7	3.4	96.6	0.0
Bristol	100.0	5.9	94.2	0.0
Camb	0.0			
Carlis	86.7	7.7	92.3	0.0
Carsh	0.0			
Chelms	100.0	9.6	90.4	0.0
Colchr	99.1	1.0	99.1	0.0
Covnt	7.8	44.0	56.0	0.0
Derby	89.8	1.3	98.7	0.0
Donc	99.4	12.4	87.6	0.0
Dorset	98.8	9.0	91.0	0.0
Dudley	97.3	6.3	93.7	0.0
Exeter	99.7	20.3	79.4	0.3
Glouc	0.0			
Hull	2.9	11.1	88.9	0.0
Ipswi	86.8	3.0	97.0	0.0
Kent	98.2	14.6	85.4	0.0
L Barts	0.0			
L Guys	18.5	0.0	100.0	0.0
L Kings	0.0			
L Rfree	0.0			
L St.G	61.8	0.0	100.0	0.0
L West	45.9	3.1	94.8	2.1
Leeds	100.0	8.3	91.7	0.0
Leic	91.9	2.6	97.0	0.4
Liv Ain	100.0	15.6	84.4	0.0
Liv RI	100.0	11.0	88.7	0.3
M RI	50.1	1.9	97.6	0.5
Middlbr	100.0	28.2	71.8	0.0
Newc	99.2	11.4	87.3	1.3
Norwch	98.2	22.3	77.7	0.0
Nottm	16.4	7.3	92.7	0.0
Oxford	0.0			
Plymth	0.0			
Ports	0.0			
Prestn	0.9	0.0	100.0	0.0
Redng	91.3	1.3	98.3	0.4
Salford	97.2	11.1	88.9	0.0
Sheff	82.1	56.3	43.3	0.5
Shrew	99.4	25.8	74.2	0.0
Stevng	99.5	60.8	38.9	0.3
Sthend	99.1	23.8	76.2	0.0
Stoke	100.0	6.2	93.8	0.0
Sund	87.8	8.8	91.2	0.0
Truro	97.7	28.1	71.9	0.0
Wirral	94.2	16.7	81.5	1.9
Wolve	9.6	7.7	92.3	0.0
York	98.3	6.8	93.2	0.0

Table 9.3. Continued

Centre	Percentage completeness	Percentage per dialysis session		
		<3.5 hours	3.5–5 hours	5+ hours
N Ireland				
Antrim	98.4	0.8	99.2	0.0
Belfast	89.1	11.1	88.9	0.0
Newry	97.8	8.9	91.1	0.0
Ulster	96.8	3.3	96.7	0.0
West NI	98.4	11.3	88.7	0.0
Wales				
Bangor	77.6	11.5	88.5	0.0
Cardff	0.0			
Clwyd	94.4	29.9	70.2	0.0
Swanse	0.0			
Wrexm	100.0	3.7	96.3	0.0
England	**52.4**	**13.8**	**85.8**	**0.5**
N Ireland	**95.2**	**7.5**	**92.5**	**0.0**
Wales	**21.7**	**14.5**	**85.5**	**0.0**
E, W & NI	**52.3**	**13.4**	**86.2**	**0.4**

Blank cells denote no data returned by that centre

Discussion

The dose of delivered HD is recognised as having an important influence on outcome in established renal failure (ERF) patients treated with low flux HD. Survival has been shown to depend on achieving a minimum urea clearance target [1–3]. It is therefore reassuring that the proportion of UK patients achieving the RA guideline for URR has increased in the last decade, with 88.4% of the HD population achieving the URR guideline in 2012, with a median URR of 75.0%. This increment will not only reflect improvements in practice and delivery of dialysis, but also enhanced coverage and quality of the data collected by the UKRR and renal centres over the years.

Post hoc analyses of the HEMO study and observational studies have suggested that women may benefit from a higher dialysis dose than men [12, 13]. Current RA guidelines do not differentiate on the basis of gender [9]. It is an interesting observation that the UK median URR achieved in women was higher than in

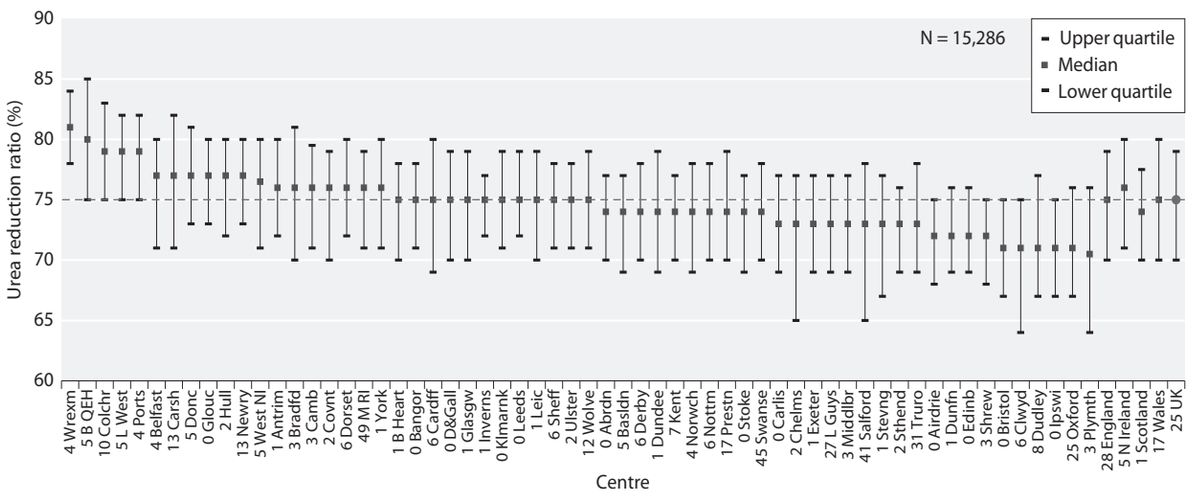

Fig. 9.1a. Median URR achieved in prevalent patients on HD by centre, 30/9/2012

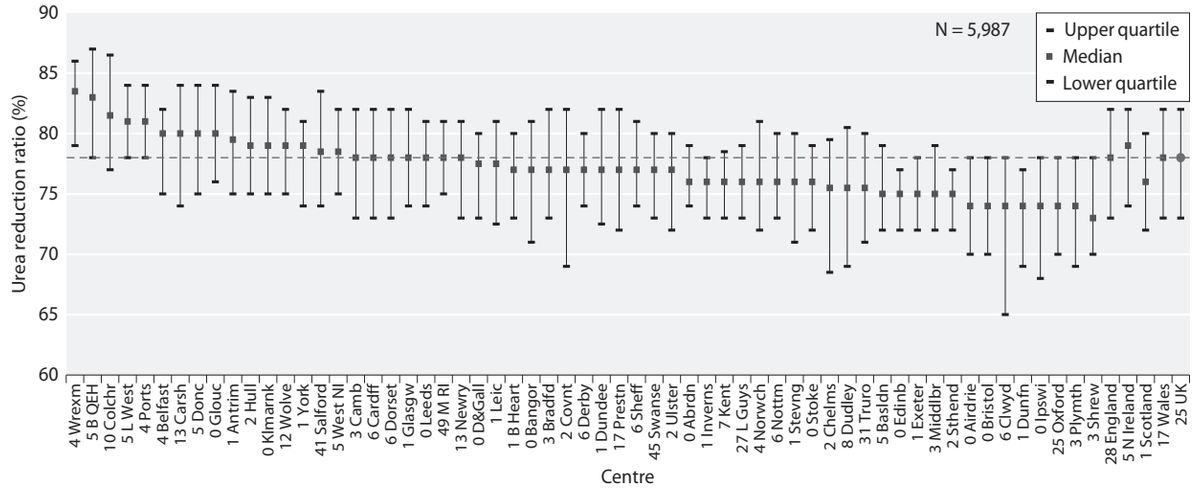

Fig. 9.1b. Median URR achieved in female prevalent patients on HD by centre, 30/9/2012

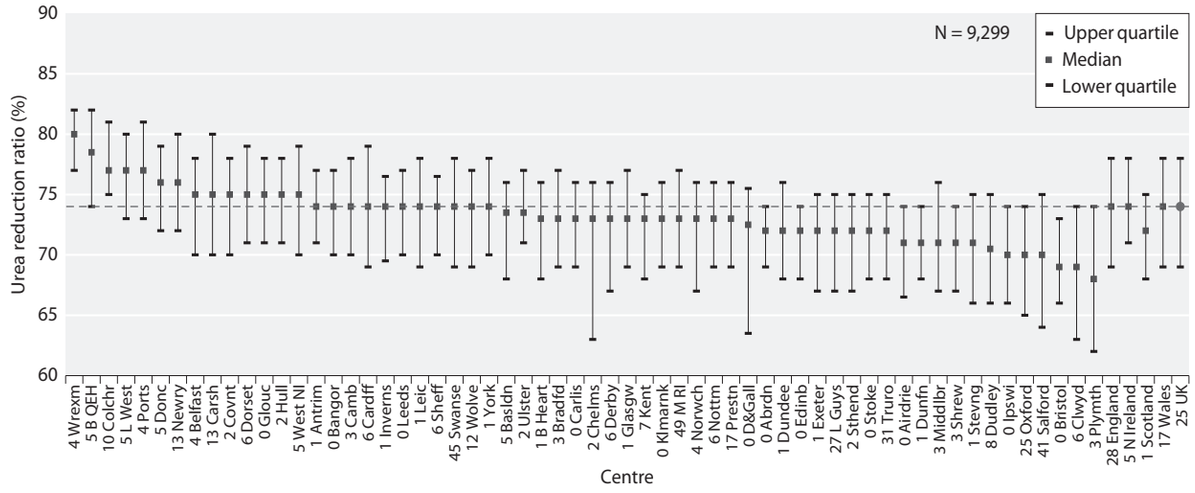

Fig. 9.1c. Median URR achieved in male prevalent patients on HD by centre, 30/9/2012

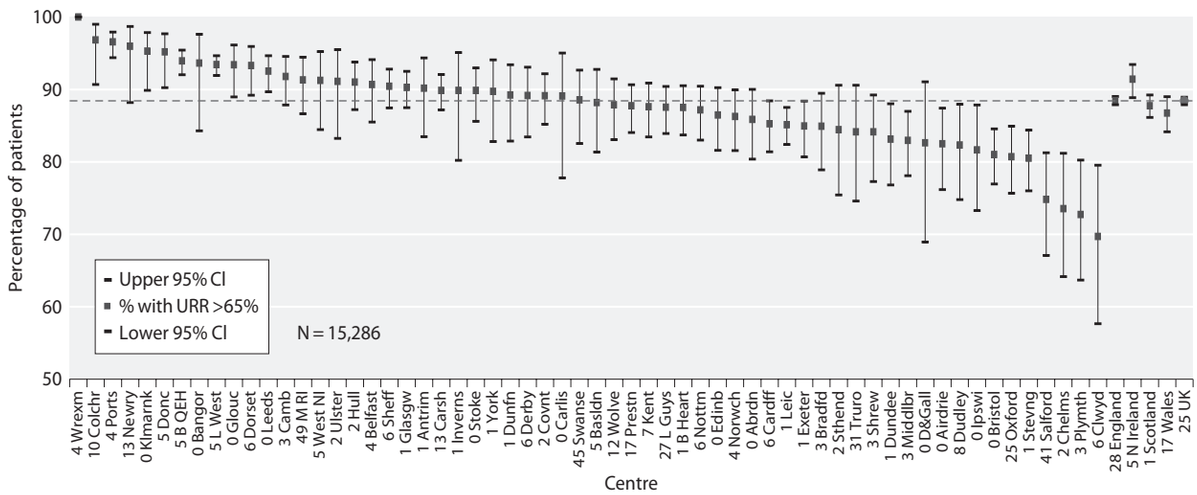

Fig. 9.2. Percentage of prevalent patients with URR >65% on HD by centre, 30/9/2012

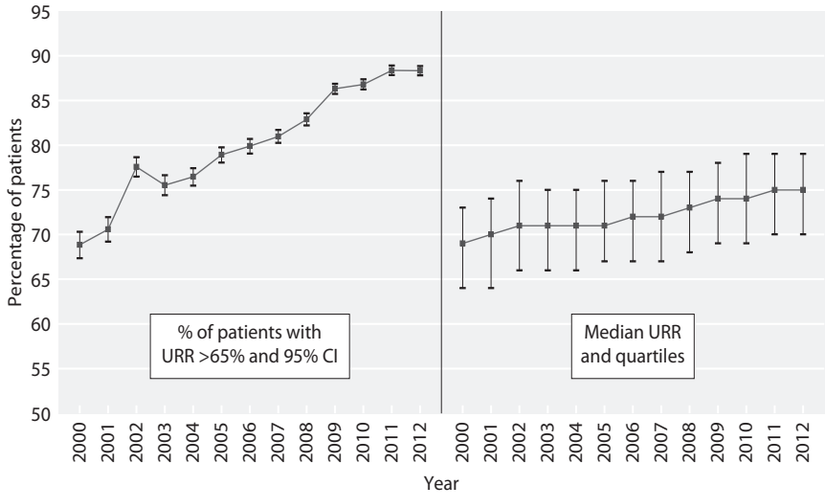

Fig. 9.3. Change in the percentage of prevalent patients on HD with URR >65% and the median URR between 2000 and 2012 in the UK

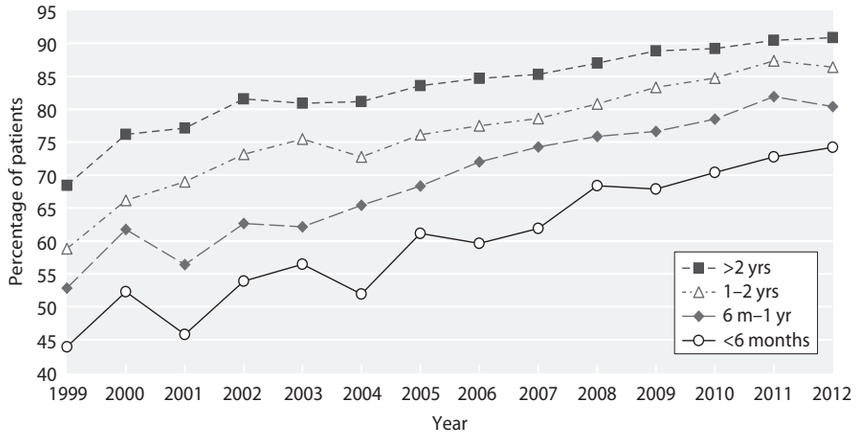

Fig. 9.4. Percentage of prevalent patients on HD achieving URR >65% by time on RRT between 1999 and 2012

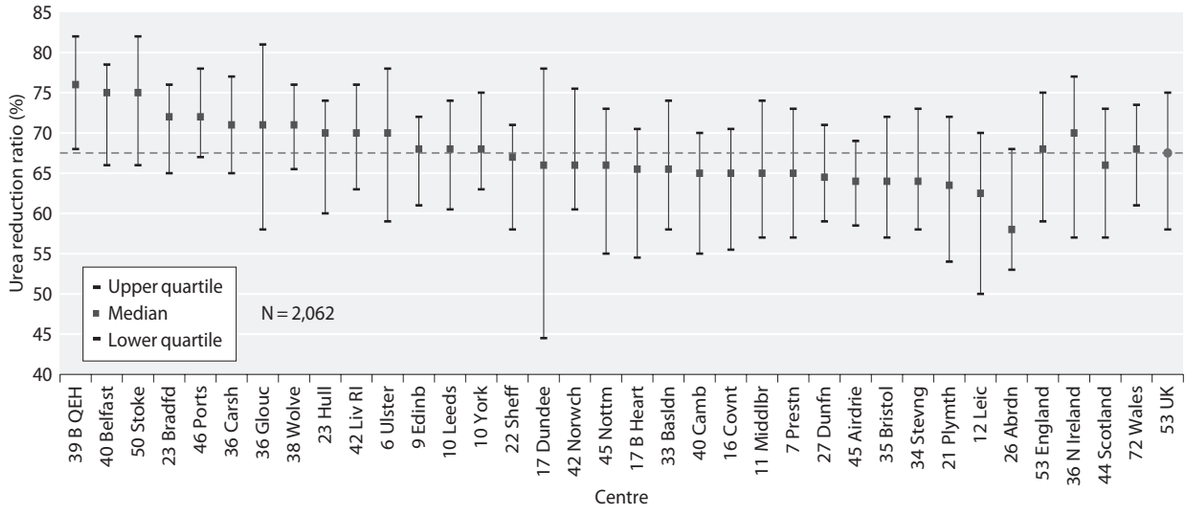

Fig. 9.5a. Median URR in the first quarter of starting RRT in incident patients who started haemodialysis in 2011

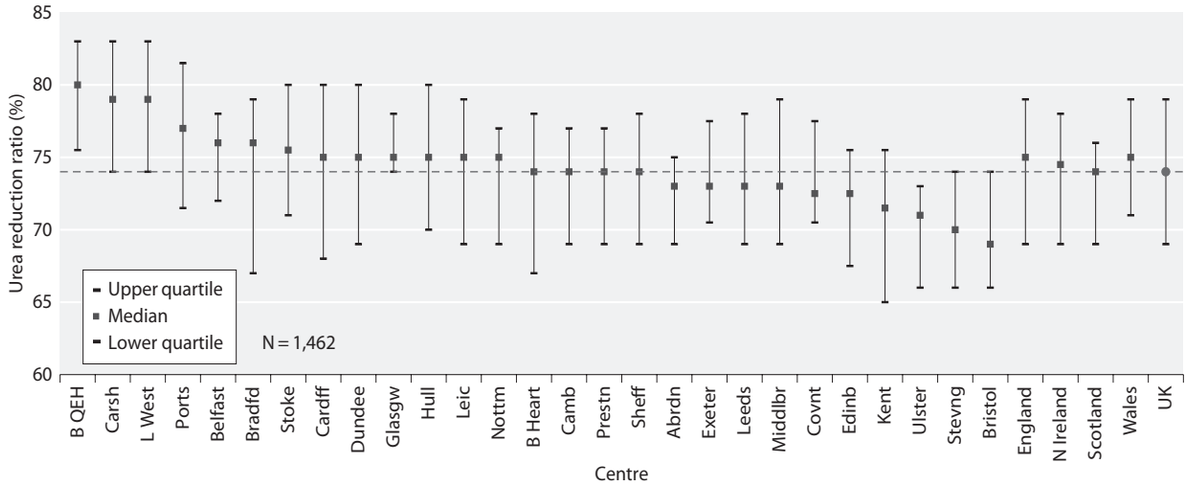

Fig. 9.5b. Median URR one year after starting RRT for patients who started haemodialysis in 2011

men in this analysis. This may simply reflect differences in dietary intake and lower pre-dialysis serum urea values in women, and as such does not necessarily imply improved urea clearances for women [14, 15].

In the prevalent haemodialysis population there was a wide range (69.7–100%) of achievement of the RA guideline for URR between different centres which is likely to reflect genuine differences in HD dose with both individual and centre level contributors. Understanding more fully individual renal centre practice would be informative. In the incident population, the variation in the between centre median URR within the first quarter for incident patients may represent variation in dialysis prescription practice for patients starting RRT. Some renal centres may use dialysis initially as a 'top-up' in individuals with residual renal function, whilst other centres use a more standardised 'full-dose' approach to dialysis prescription, irrespective of residual function. Although evidence supports that preservation of residual renal function is associated with improved survival [16], how much individualisation of dialysis prescription based on residual renal function is practiced across UK renal centres and how this correlates with outcomes is not currently known. Similarly, it is not known whether the decline in residual renal function is affected by differences in centre practice approach to initiating dialysis. Varied completeness of data returns across other important factors such as dialysis session also limits the interpretation of the data, and increases the risk of misclassification of patients in the presented analyses. For example, some patients who were receiving more or less frequent dialysis sessions than three times per week may be incorrectly categorised and introduce bias into the median estimate of URR and the percentage achieving the URR RA standard. Although RA guidelines recommend standardised methods for urea sampling, inconsistency in sampling methodology for the post-dialysis urea sample may also play a part in the variations seen [9].

Debate continues as to the toxicity of urea, and how representative urea clearance is of other azotaemic toxin clearances. In addition, the dialysis prescription should also be designed to achieve volume, sodium and divalent cation balance and correct metabolic acidosis. As such basing HD dosing simply on urea clearance is criticised by some [13] arguing that patient outcomes are improved by longer treatment times independent of urea removal [5, 17–22] and that clearance of 'middle molecules' has an important impact [23, 24]. However, no consensus has yet emerged on alternative markers of HD adequacy. The UKRR has historically reported URR, predominantly for logistical reasons with the URR being the easiest measure to calculate, and the measure of dialysis adequacy that is most complete when returned to the UKRR. However, the limitations of the URR are recognised. Although URR correlates well with single pool Kt/V (spKt/V) in population studies, significant variability in correlation in individual patients occurs because URR fails to include both the contraction in extracellular volume (ECV) and the urea generation during routine HD [11]. Neither URR nor spKt/V take into account post-dialysis urea rebound, potentially resulting in an over-estimate of the amount of dialysis actually delivered. A possible move to reporting eKt/V to the UKRR in addition to high quality data on

residual renal function, weights and dialysis prescription practice including duration and frequency of sessions would enhance the quality of analyses the UKRR could provide for the renal community, and would potentially allow for evaluation of different approaches to the initiation of dialysis and the effect of residual renal function.

Conflicts of interest: none

References

1 Gotch FA, Sargent JA: A mechanistic analysis of the National Cooperative Dialysis Study (NCDS). Kidney Int 1985;28:526–534
2 Owen WF, Lew NL, Liu Y, Lowrie EG, Lazarus JM: The Urea Reduction Ratio and Serum Albumin Concentration as Predictors of Mortality in Patients Undergoing Hemodialysis. N Engl J Med 1993;329:1001–1006
3 Held PJ, Port FK, Wolfe RA, Stannard DC, Carroll CE, Daugirdas JT, Bloembergen WE, Greer JW, Hakim RM: The dose of hemodialysis and patient mortality. Kidney Int 1996;50:550–556
4 Tentori F, Hunt WC, Rohrscheib M, Zhu M, Stidley CA, Servilla K, Miskulin D, Meyer KB, Bedrick EJ, Johnson HK, Zager PG: Which Targets in Clinical Practice Guidelines Are Associated with Improved Survival in a Large Dialysis Organization? J Am Soc Nephrol 2007;18: 2377–2384
5 Locatelli F, Buoncristiani U, Canaud B, Kohler H, Petitclerc T, Zucchelli P: Dialysis dose and frequency. Nephrol Dial Transplant 2005;20: 285–296
6 Depner TA: Assessing adequacy of hemodialysis: urea modeling. Kidney Int 1994;45:1522–1535
7 Movilli E: Simplified approaches to calculate Kt/V. It's time for agreement. Nephrol Dial Transplant 1996;11:24–27
8 Vanbelleghem H, Vanholder R, Levin NW, Becker G, Craig JC, Ito S, Lau J, Locatelli F, Zoccali C, Solez K, Hales M, Lameire N, Eknoyan G: The Kidney Disease: Improving Global Outcomes website: Comparison of guidelines as a tool for harmonization. Kidney Int 2007;71:1054–1061
9 UK Renal Association Clinical Practice Guidelines Committee. Haemodialysis, 2009 http://www.renal.org/Clinical/GuidelinesSection/Haemodialysis.aspx
10 European Best Practice Guidelines Expert Group on Haemodialysis. Nephrol Dial Transplant 2002:17(suppl 7):S16–S31
11 NKF-KDOQI clinical practice guidelines; update 2006. Am J Kidney Dis 2006:48(suppl 1):S2–S90
12 Depner T, Daugirdas J, Greene T, Allon M, Beck G, Chumlea C, Delmez J, Gotch F, Kusek J, Levin N, Macon E, Milford E, Owen W, Star R, Toto R, Eknoyan G, Hemodialysis Study Group Dialysis dose and the effect of gender and body size on outcome in the HEMO Study. Kidney Int. 2004;65(4):1386
13 Port FK, Wolfe RA, Hulbert-Shearon TE, McCullough KP, Ashby VB, Held PJ. High dialysis dose is associated with lower mortality among women but not among men. Am J Kidney Dis. 2004;43(6):1014
14 Lowrie EG: The Kinetic Behaviors of Urea and Other Marker Molecules During Hemodialysis. Am J Kidney Dis 2007;50:181–183
15 Spalding EM, Chandna SM, Davenport A, Farrington K. Kt/V underestimates the haemodialysis dose in women and small men. Kidney Int 2008;74:348–355
16 Hanson JA, Hulbert-Shearon TE, Ojo AO, et al.: Prescription of twice-weekly hemodialysis in the USA. Am J Nephrol 1999;19:625–633
17 Vanholder R, Eloot S, Van Biesen W: Do we need new indicators of dialysis adequacy based on middle-molecule removal? Nature Clinical Practice Nephrology 2008;4:174–175
18 Tattersall J, Martin-Malo A, Pedrini L, Basci A, Canaud B, Fouque D, Haage P, Konner K, Kooman J, Pizzarelli F, Tordoir J, Vennegoor M, Wanner C, ter Wee P, Vanholder R: EBPG guideline on dialysis strategies. Nephrol Dial Transplant 2007;22:ii5–21
19 Saran R, Bragg-Gresham JL, Levin NW, Twardowski ZJ, Wizemann V, Saito A, Kimata N, Gillespie BW, Combe C, Bommer J, Akiba T, Mapes DL, Young EW, Port FK: Longer treatment time and slower ultrafiltration in hemodialysis: Associations with reduced mortality in the DOPPS. Kidney Int 2006;69:1222–1228
20 Marshall MR, Byrne BG, Kerr PG, McDonald SP: Associations of hemodialysis dose and session length with mortality risk in Australian and New Zealand patients. Kidney Int 2006;69:1229–1236
21 Eloot S, Van Biesen W, Dhondt A, Van de Wynkele H, Glorieux G, Verdonck P, Vanholder R: Impact of hemodialysis duration on the removal of uremic retention solutes. Kidney Int 2007;73:765–770
22 Basile C, Lomonte C: Dialysis time is the crucial factor in the adequacy of hemodialysis. Kidney Int 2008;74:965–966
23 Eloot S, Torremans A, De Smet R, Marescau B, De Deyn PP, Verdonck P, Vanholder R: Complex Compartmental Behavior of Small Water-Soluble Uremic Retention Solutes: Evaluation by Direct Measurements in Plasma and Erythrocytes. Am J Kidney Dis 2007;50:279–288
24 Davenport A. How best to improve survival in haemodialysis patients: solute clearance or volume control? Kidney Int. 2011;80(10):1018–20

UK Renal Registry 16th Annual Report: Chapter 10 Haemoglobin, Ferritin and Erythropoietin amongst UK Adult Dialysis Patients in 2012: National and Centre-specific Analyses

Anirudh Rao[a], Julie Gilg[a], Andrew Williams[b]

[a]UK Renal Registry, Bristol, UK; [b]Morriston Hospital, Swansea, UK

Key Words

Anaemia · Chronic kidney disease · Dialysis · End stage renal disease · Epidemiology · Erythropoietin · Erythropoietin stimulating agent · European Best Practice Guidelines · Ferritin · Haemodialysis · Haemoglobin · NICE · Peritoneal dialysis · Renal Association

Summary

In the UK in 2012:

- The median Hb of patients at the time of starting dialysis was 100 g/L with 51% of patients having a Hb $\geqslant$100 g/L.
- The median Hb in patients starting haemodialysis (HD) was 97 g/L (IQR 89–106) and in patients starting peritoneal dialysis (PD) was 109 g/L (IQR 99–118).
- At start of dialysis, 54% of patients presenting early had Hb $\geqslant$100 g/L whilst 34% of patients presenting late had Hb $\geqslant$100 g/L.
- The median Hb of prevalent patients on HD was 112 g/L with an IQR of 103–121 g/L.
- The median Hb of prevalent patients on PD was 114 g/L with an IQR of 105–123 g/L.
- 82% of HD and 85% of PD patients had Hb $\geqslant$100 g/L.
- 57% of HD patients and 55% of PD patients had Hb $\geqslant$100 and $\leqslant$120 g/L.
- The median ferritin in HD patients was 431 μg/L (IQR 285–623) and 95% of HD patients had a ferritin $\geqslant$100 μg/L.

In England, Wales and Northern Ireland in 2012:

- The median ferritin in PD patients was 285 μg/L (IQR 164–466) with 88% of PD patients having a ferritin $\geqslant$100 μg/L.
- The median erythropoietin stimulating agent (ESA) dose was higher for HD than PD patients (7,248 vs. 4,250 IU/week).

Introduction

This chapter describes the UK Renal Registry (UKRR) data relating to the management of anaemia in dialysis patients during 2012. The chapter reports on the analyses of submitted variables in the context of the UK Renal Association – Anaemia in CKD guidelines and recommendations.

In this report, haemoglobin levels are given in g/L as the majority of UK laboratories have now switched to reporting using these units.

Anaemia in adults with CKD is diagnosed when the Hb concentration is <130 g/L in males and <120 g/L in females [1]. The degree of renal impairment affects the likelihood of any patient developing anaemia. Although current treatment with ESAs is not recommended unless Hb falls consistently below 110 g/L, other causes of anaemia should be excluded in patients with Hb below the normal range.

The renal National Service Framework (NSF) part one [2] and the RA minimum standards document 3rd edition [3] state that individuals with chronic kidney disease (CKD) should achieve a haemoglobin (Hb) of at least 100 g/L within six months of being seen by a nephrologist, unless there is a specific reason why it is unachievable. The UKRR does not collect Hb measurements from patients with CKD six months after meeting a nephrologist. However, an indication of the attainment of this standard is given by the Hb of the incident patient population at the start of dialysis. Achievement of these standards is mainly through the use of iron therapy (oral and intravenous) and erythropoietin stimulating agents (ESAs).

The European Best Practice Guidelines (EBPG) published in 2009 recommend that Hb values of 110–120 g/L should be generally sought in the CKD population without intentionally exceeding 130 g/L [4]. The 5th edition of the UK Renal Association's Anaemia in CKD guideline was published at the end of 2010 and attempted to unify targets with those published in the 2011 update NICE guideline on anaemia management in CKD and other guidelines [5, 6]. The target outcome Hb for RRT patients on ESA treatment in these guidelines is between 100 and 120 g/L. The rationale behind choosing a wide target Hb range (100–120 g/L) is that when the target Hb level is narrow (e.g. 100 g/L), variability in achieved Hb levels around the target is high, the proportion of prevalent patients with achieved Hb levels within the target range is low and ESA dose titration is required frequently during maintenance therapy. The recently updated KDOQI guidelines suggest ESAs should not be used to maintain Hb concentration routinely above 115 g/L with careful consideration in patients who require individualization of therapy for improvements in quality of life at Hb concentration above 115 g/L [7]. The target of Hb 100–120 g/L has been used for both HD and PD patients in keeping with the above recommendations. There are also some analyses showing attainment of the minimum standard of Hb $\geqslant$100 g/L.

In patients on peritoneal dialysis (PD), the timing of the blood sample draw is not critical because plasma volume in these patients remains relatively constant. In haemodialysis (HD) patients, interdialytic weight gain contributes to a decrease in Hb level, whereas intradialytic ultrafiltration leads to an increase. Thus, a predialysis sample underestimates the euvolaemic Hb level, whereas a postdialysis sample overestimates the euvolaemic Hb. Given the relationship between Hb level and the dialysis related weight change, midweek pre-dialysis sampling is recommended for regular Hb monitoring [8].

The 2010 Renal Association (RA) Clinical Practice Guidelines document, revised European Best Practice Guidelines (EBPGII), Dialysis Outcomes Quality Initiative (DOQI) guidelines and UK NICE anaemia guidelines all recommend a target serum ferritin greater than 100 μg/L and percentage transferrin saturation (TSAT) of more than 20% in patients with CKD. RA guidelines and EBPGII recommend hypochromic red cells (HRC) less than 10%. In addition, EBPGII recommends target reticulocyte Hb content (CHr) of greater than 29 pg/cell. KDOQI recommends a serum ferritin >200 μg/L for HD patients. The NICE guidelines suggest that a hypochromic red cell value >6% indicates ongoing iron deficiency.

To achieve adequate iron status across a patient population, RA guidelines [6] advocate population target medians for ferritin of 200–500 μg/L in HD patients and 100–500 μg/L for PD patients, for TSAT of 30–40%, for hypochromic red cells of <2.5% and CHr of 35 pg/cell. EBPGII comments that a serum ferritin target for the treatment population of 200–500 μg/L ensures that 85–90% of patients attain a serum ferritin of 100 μg/L. All guidelines advise that serum ferritin levels should not exceed 800 μg/L since the potential risk of toxicity increases without conferring additional benefit. The KDOQI and NICE guidelines advise against intravenous iron administration to patients with a ferritin >500 μg/L.

Serum ferritin has some disadvantages as an index of iron status. It measures storage iron rather than available

iron, behaves as an acute phase reactant and is therefore increased in inflammatory states, malignancy and liver disease and may not accurately reflect iron stores if measured within a week of the administration of intravenous iron. Serum ferritin level is less reliable in the evaluation of iron stores in HD patients, because ferritin level is affected by other factors in addition to iron storage status. In relatively healthy HD patients, before widespread use of IV iron therapy, the finding of a ferritin level less than 50 ng/ml was not uncommon and was associated with absent bone marrow iron in approximately 80% of patients. However, in HD patients with several comorbidities, absent iron stores may still be found at ferritin levels approaching or even exceeding 200 ng/ml [9].

Of the alternative measures of iron status available, HRC and CHr are generally considered superior to TSAT. Both however require specialised analysers to which not all UK renal centres have easy access. Since TSAT is measured infrequently in many centres and most UK centres continue to use serum ferritin for routine iron management, ferritin remains the chosen index of iron status for this report.

Anaemia treatment in CKD patients has changed dramatically since the implementation of erythropoietin stimulating agents (ESAs) into clinical practice in 1987. This has reduced the need for blood transfusions and improved quality of life for patients [10]. These agents are relatively expensive and thus approaches to achieving optimal haemoglobin levels with the lowest possible doses are desirable. The health economics of anaemia therapy using ESAs has been subject to a NICE systematic review [5] which concluded that treating to a target Hb 110–120 g/L is cost effective in HD patients.

The risks associated with low (<100 g/L) and high (>130 g/L) Hb are not necessarily equivalent. Two important studies of patients not yet on dialysis, CHOIR [11] and CREATE [12] showed an increased risk of cardiovascular events amongst the patients assigned to the higher Hb targets. In the TREAT study [13] although there was no difference between the two arms in the primary outcome of death, cardiovascular event or end stage renal disease, there was an increase in fatal or non-fatal stroke in the treatment arm.

Methods

The incident and prevalent RRT cohorts for 2012 were analysed. The UKRR extracted quarterly data electronically from renal centres in England, Wales and Northern Ireland; data from Scotland were provided by the Scottish Renal Registry.

For the analyses of Hb for incident patients, those patients commencing RRT on PD or HD were included whilst those receiving a pre-emptive transplant were excluded. Hb measurements from after starting dialysis but still within the same quarter of the year were used. Therefore, depending on when in the quarter a patient started RRT the Hb could be from 0 to 90 days later. The haemoglobin values the UKRR receives should be the closest available measurement to the end of the quarter. Patients who died within the first 90 days on treatment were excluded. Results are also shown with the cohort subdivided into early and late presenters (date first seen by a nephrologist, 90 or more days and less than 90 days before starting dialysis respectively).

For the analyses of prevalent patients, those patients receiving dialysis on 31st December 2012 were included if they had been on the same modality of dialysis in the same centre for at least three months. In order to improve completeness the last available measurement for each patient from the last two quarters for Hb and from the last three quarters for ferritin was used. Scotland was excluded from the analysis for ferritin for PD patients as this data was not available.

The completeness of data items were analysed at both centre and country level. As in previous years, all patients were included in analyses but centres with less than 50% completeness were excluded from the caterpillar and funnel plots showing centre performance. Centres providing relevant data from less than 10 patients were also excluded from the plots. The number preceding the centre name in the caterpillar plots indicates the percentage of data missing for that centre.

The data were analysed to calculate summary statistics including maximum, minimum and average (mean and median) values. Standard deviations and inter-quartile ranges (IQR) were also calculated. These are shown using caterpillar plots giving median values and the inter-quartile ranges.

The percentages achieving RA and other standards were calculated for Hb and ferritin. These are displayed using caterpillar plots with the percentages meeting the targets and 95% confidence intervals (CIs) shown. Funnel plots show the distribution of the percentages meeting the various targets and also whether any of the centres are significantly different from the average.

Longitudinal analysis was performed to show overall changes in achievement of standards from 1998 to 2012.

Erythropoietin data from the last quarter of 2012 were used to define which patients were receiving ESAs. Scotland was excluded from this analysis as data regarding ESA was not included in its return. Each individual was defined as being on ESA if a drug type and/or a dose was present in the data. Centres reporting fewer than 60% of HD patients or fewer than 45% of PD patients being treated with ESAs were considered to have incomplete data and were excluded from further analysis. It is recognised that these exclusion criteria are relatively arbitrary but they are in part based upon the frequency distribution graph of centres' ESA use as it appears in the data. The percentage of patients on ESAs is calculated from these data and incomplete data returns risk seriously impacting on any conclusions drawn.

For analyses of ESA dose, values are presented as weekly erythropoietin dose. Doses of less than 150 IU/week (likely to be darbepoietin) were harmonised with erythropoietin data by multiplying by 200. No adjustments were made with respect to route of

administration. Patients who were not receiving ESAs were not included in analyses of dose (rather than being included with dose = 0).

Until last year, reports have only used the dose from the final quarter of the year. Now, as last year, starting with the cohort of patients receiving ESAs in the final quarter and having a dose value present for that quarter, any further dose values available from the earlier three quarters of the year were used (provided the patient was on the same treatment and receiving the same drug in those quarters). The average (mean) of the available values was then used in analyses rather than the dose in the final quarter.

The ESA data were collected electronically from renal IT systems but in contrast to laboratory linked variables the ESA data required manual data entry. The reliability depended upon the data source, whether the entry was linked to the prescription or whether the prescriptions were provided by the primary care physician. In the latter case, doses may not be as reliably updated as the link between data entry and prescription is indirect.

Results

Anaemia management in incident dialysis patients

Haemoglobin in incident dialysis patients

The Hb at the time of starting RRT gives the only indication of concordance with current anaemia management recommendations in the pre-dialysis (CKD 5 not yet on dialysis) group.

The percentage of data returned and outcome Hb are listed in table 10.1. Results are not shown for two centres (Kent and Inverness) because data completeness was less than 50%.

The median Hb of patients at the time of starting dialysis in the UK was 100 g/L. The median starting Hb by centre is shown in figure 10.1. The percentage of patients having a Hb $\geqslant$100 g/L has fallen over the last couple of years to 51% from 55% in the 2009 cohort. The percentage starting with a Hb $\geqslant$100 g/L by centre is given in figure 10.2.

The variation in the proportion of patients starting renal replacement therapy with Hb $\geqslant$100 g/L between centres remained high (32–87%). Using only centres with time of presentation data, the median Hb in the late presenters was 94 g/L with only 34% of patients having a Hb $\geqslant$100 g/L compared with a median Hb of 101 g/L and 54% of the patients having a Hb $\geqslant$100 g/L in the early presenters group. In the late presenters group there was a large variation between centres in percentage of patients having a Hb $\geqslant$100 g/L (9%–64%). The lower median Hb in late presenters may reflect inadequate pre-dialysis care with limited anaemia management, anaemia of multisystem disease or inter-current illness.

Median Hb of patients at the time of starting HD was 97 g/L (IQR 89–106 g/L) and in those starting PD was 109 g/L (IQR 99–118 g/L). When starting dialysis, 44% of HD patients had a Hb $\geqslant$100 g/L, compared with 75% of PD patients.

Incident dialysis patients from 2011 were followed for one year and the median haemoglobin (and percentage with a Hb $\geqslant$100 g/L) of survivors on the same treatment at the same centre after a year was calculated for each quarter. Only patients who had Hb data for each of the four time points were included in this analysis. This was sub-analysed by modality and length of pre-RRT care (figures 10.3 and 10.4). Hb was higher in the second quarter on dialysis than during the quarter at start of dialysis reflecting the benefits of treatment administered. Over 76% of incident patients surviving to a year had Hb $\geqslant$100 g/L regardless of the modality or the length of pre-RRT care.

The annual distribution of Hb in incident dialysis patients is shown in figure 10.5. Since 2006, the proportion of incident patients with Hb $\geqslant$120 g/L has fallen from 17% to 10% and the proportion of patients with Hb $<$100 g/L continues to gradually increase over the years from 40% to 49%. In the 2012 cohort, 66% of patients in the late presentation group had Hb $<$100 g/L compared with 46% in the early presentation group.

ESA by time on dialysis in early vs. late presenters

Incident dialysis patients from 2011 were followed for one year and the percentages receiving an ESA were calculated for each quarter for survivors on the same treatment at the same centre after a year. This was sub-analysed by modality and length of pre-RRT care (figure 10.6). For HD patients at the start of treatment there was a relatively small difference between early and late presenters in the percentage of patients receiving an ESA. This difference had disappeared within one year of starting dialysis. For PD patients there was a more marked difference between the early and late group which was highest in the second quarter at more than 10%. The difference was lowest 1 year after starting dialysis. Caution is advised in interpreting this figure as the number of patients in the PD late group is relatively small (22).

Anaemia management in prevalent dialysis patients

Compliance with data returns for haemoglobin and serum ferritin and percentages on ESA are shown for the 71 renal centres in the UK in table 10.2 for both HD and PD patients. Completeness of data returns was

Table 10.1. Haemoglobin data for incident patients starting haemodialysis or peritoneal dialysis during 2012, both overall and by presentation time

	All incident patients				Early presenters only (⩾90 days)		Late presenters only (<90 days)	
Centre	% data return	*N* with data	Median Hb g/L	% Hb ⩾100 g/L	Median Hb g/L	% Hb ⩾100 g/L	Median Hb g/L	% Hb ⩾100 g/L
England								
B Heart	100	96	96	39	94	37		
B QEH	94	179	95	36	98	44	88	17
Basldn	100	45	94	40	97	44		
Bradfd	97	56	103	59	104	64		
Brightn	97	118	103	63	107	67	93	40
Bristol	100	128	97	45	99	48	85	26
Camb	94	81	100	51	102	58	94	36
Carlis	100	15	114	87	116	92		
Carsh	99	204	103	60	103	63	99	48
Chelms	97	37	101	59	104	65		
Colchr	52	14	97	36	97	42		
Covnt	96	90	101	56	101	58	94	44
Derby	97	68	100	53	102	57	93	27
Donc	100	41	96	41	96	45		
Dorset	97	63	106	57	106	59		
Dudley	96	47	100	51	100	53		
Exeter	100	125	102	57	103	61	97	44
Glouc	100	68	101	53	104	57	96	40
Hull	88	74	106	64	109	68		
Ipswi	100	38	97	45	96	40	108	58
Kent	46	44						
L Barts	100	241	99	49				
L Guys	56	63	98	44				
L Kings	99	114	96	42	96	43	96	39
L Rfree	68	140	103	55	105	60	98	44
L St.G	89	64	95	39				
L West	79	176	105	69				
Leeds	98	111	95	36	96	40	90	14
Leic	98	186	95	38	97	43	90	20
Liv Ain	98	57	102	58	103	60		
Liv RI	95	70	102	51	104	55	95	41
M RI	97	116	98	47	97	46	104	64
Middlbr	98	93	93	32	97	38	83	16
Newc	98	82	102	57	101	56	109	64
Norwch	95	61	105	64				
Nottm	99	72	98	49	100	51		
Oxford	99	131	96	44	97	45	90	30
Plymth*	100	41	100	51				
Ports	100	134	102	60	104	63	99	40
Prestn	100	116	99	45	99	45	99	43
Redng	100	67	103	61	108	71	94	31
Salford	90	110	99	47				
Sheff	100	133	100	50	101	52	95	38
Shrew	100	49	106	57	106	56		
Stevng	99	73	98	48	98	48	98	50
Sthend	100	25	99	48	100	53		
Stoke	99	66	102	55	104	60	95	39
Sund	96	54	101	52	101	53		
Truro	100	42	102	62	106	80	91	9
Wirral	98	44	104	70				
Wolve	99	72	102	54	111	65	92	22
York	100	46	95	33	98	40	87	9

Table 10.1. Continued

Centre	All incident patients				Early presenters only (⩾90 days)		Late presenters only (<90 days)	
	% data return	*N* with data	Median Hb g/L	% Hb ⩾100 g/L	Median Hb g/L	% Hb ⩾100 g/L	Median Hb g/L	% Hb ⩾100 g/L
N Ireland								
Antrim	100	26	102	54	104	58		
Belfast	95	57	101	56	101	58	98	42
Newry	100	18	104	61	104	67		
Ulster	100	21	109	71	109	76		
West NI	89	16	98	38	98	36		
Scotland								
Abrdn	100	54	98	46				
Airdrie	68	40	95	40				
D & Gall	65	11	99	45				
Dundee	89	33	98	42				
Dunfn	77	20	107	60				
Edinb	83	53	101	57				
Glasgw	64	103	98	47				
Inverns	46	6						
Klmarnk	78	29	94	45				
Wales								
Bangor	95	18	102	67	101	64		
Cardff	100	137	103	61	104	65	94	29
Clwyd	100	19	103	63	103	67		
Swanse	99	97	99	46	103	58	89	16
Wrexm	97	30	108	67	109	71		
England	**93**	**4,480**	**100**	**51**	**101**	**53**	**94**	**34**
N Ireland	**97**	**138**	**103**	**57**	**104**	**59**	**95**	**38**
Scotland	**75**	**349**	**99**	**48**				
Wales	**99**	**301**	**102**	**57**	**104**	**64**	**92**	**26**
UK	**92**	**5,268**	**100**	**51**	**101**	**54**	**94**	**34**

Blank cells denote centres excluded from analyses due to poor data completeness or low patient numbers or because presentation time data not available

*Plymouth, approximately 33% of incident patients were missing from the data extract

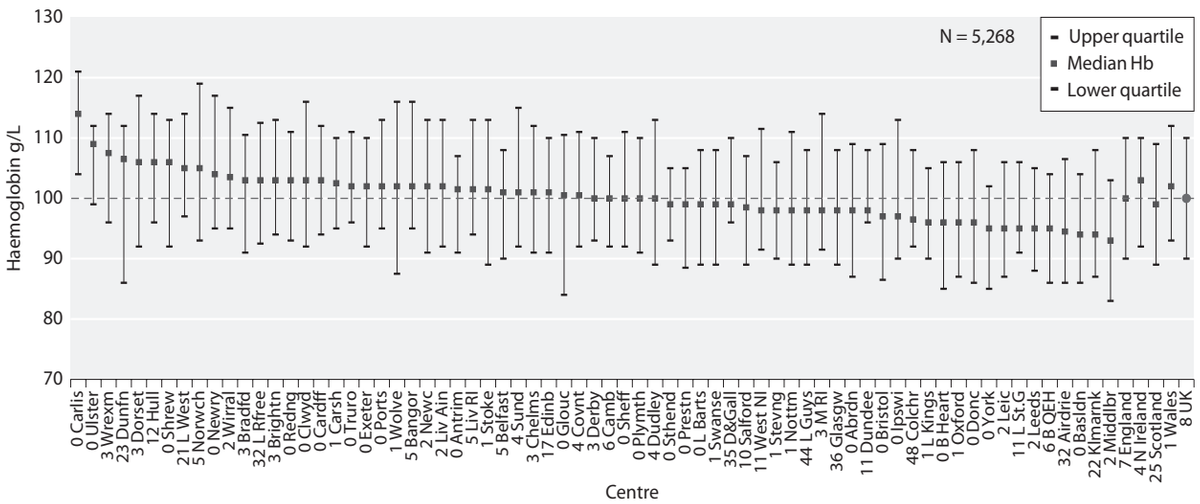

Fig. 10.1. Median haemoglobin for incident dialysis patients at start of dialysis treatment in 2012

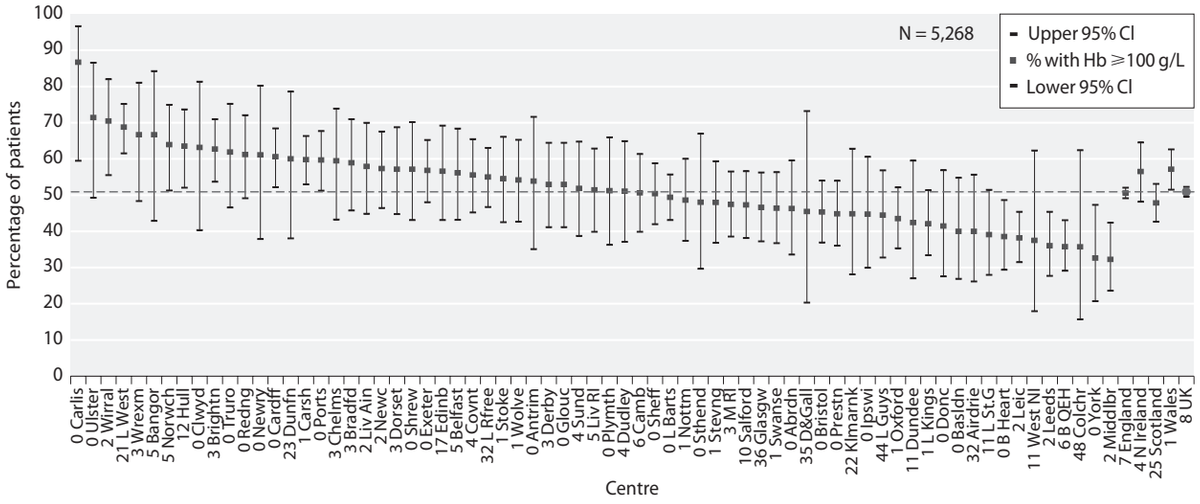

Fig. 10.2. Percentage of incident dialysis patients with Hb ⩾100 g/L at start of dialysis treatment in 2012

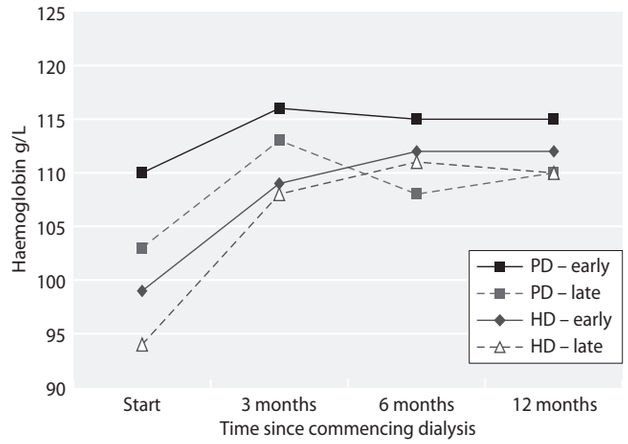

Fig. 10.3. Median haemoglobin, by time on dialysis and length of pre-RRT care, for incident dialysis patients in 2011

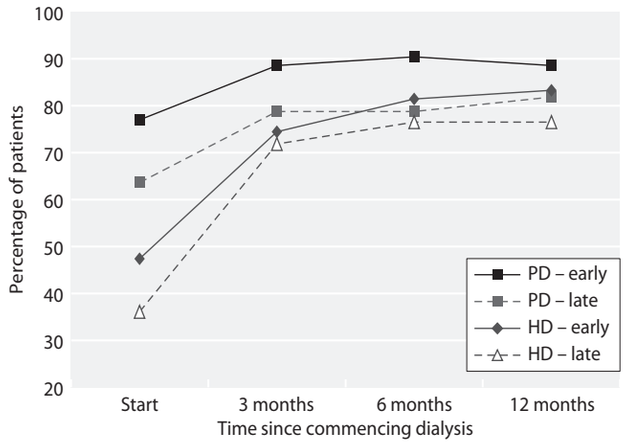

Fig. 10.4. Percentage of incident dialysis patients in 2011 with Hb ⩾100 g/L, by time on dialysis and by length of pre-RRT care

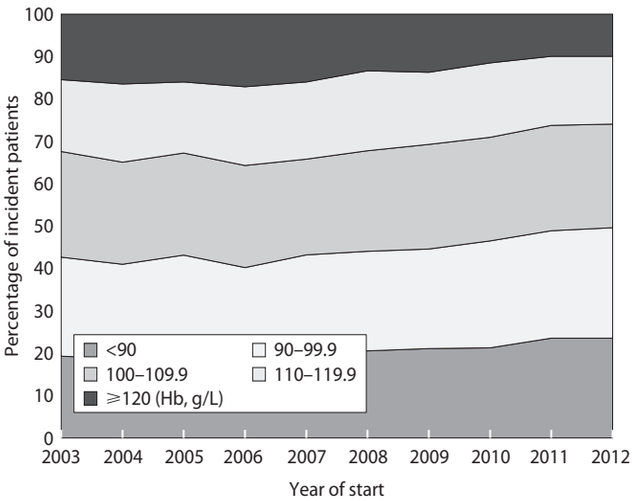

Fig. 10.5. Distribution of haemoglobin in incident dialysis patients by year of start

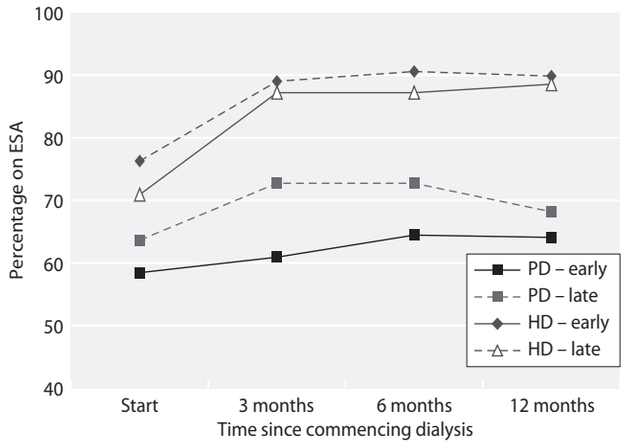

Fig. 10.6. Percentage of incident dialysis patients in 2011 on ESA, by time on dialysis and by length of pre-RRT care

Table 10.2. Percentage completeness of data returns for haemoglobin and serum ferritin and percentages on ESA for prevalent HD and PD patients in 2012

	HD				PD			
Centre	*N*	Hb	Ferritin	% on ESA	*N*	Hb	Ferritin	% on ESA
England								
B Heart	401	100	100	77	42	100	98	48
B QEH	864	97	96	84	149	99	97	62
Basldn	150	98	97	91	28	100	100	61
Bradfd	189	98	98	96	24	100	100	83
Brightn	338	96	86	0	69	94	83	0
Bristol	461	100	100	92	56	100	100	66
Camb	324	95	76	43	32	100	97	59
Carlis	57	100	70	68	21	100	95	67
Carsh	698	95	92	0	97	98	99	0
Chelms	121	100	99	97	25	100	100	76
Colchr	108	93	95	29				
Covnt	335	100	99	91	84	96	89	68
Derby	209	100	99	0	84	100	99	0
Donc	158	100	100	91	23	100	100	70
Dorset	244	100	98	97	38	95	87	68
Dudley	153	100	99	3	53	100	89	4
Exeter	351	100	100	93	69	100	100	72
Glouc	193	100	98	91	31	100	77	55
Hull	310	100	99	0	79	97	95	0
Ipswi	124	100	99	65	30	100	90	70
Kent	361	100	99	91	55	100	96	67
L Barts	846	100	99	0	167	99	95	0
L Guys	592	91	81	19	27	96	96	7
L Kings	460	100	97	0	76	100	99	0
L Rfree	668	86	81	0	102	99	86	0
L St.G	271	97	92	0	48	98	96	0
L West	1,342	98	99	0	47	98	98	0
Leeds	454	100	100	94	77	100	100	78
Leic	801	100	100	98	143	98	98	80
Liv Ain	166	99	98	0	17	100	100	0
Liv RI	345	99	99	0	55	98	96	0
M RI	474	93	92	0	76	100	100	0
Middlbr	312	98	98	78	8	88	88	75
Newc	262	100	100	69	37	86	92	0
Norwch	303	100	98	91	48	100	98	71
Nottm	355	100	100	90	72	100	100	69
Oxford	389	100	100	93	69	100	99	81
Plymth	119	100	98	0	31	97	77	0
Ports	510	100	99	10	78	100	100	12
Prestn	496	100	99	88	59	100	100	75
Redng	251	100	100	90	63	100	98	2
Salford	345	88	0	68	90	93	0	77
Sheff	562	100	100	86	67	100	100	60
Shrew	184	100	99	88	33	97	94	61
Stevng	380	99	99	0	27	100	89	0
Sthend	107	100	100	97	14	100	100	57
Stoke	294	86	99	1	69	100	99	0
Sund	184	99	93	95	17	100	94	65
Truro	134	99	99	0	19	100	89	0
Wirral	177	98	97	0	29	79	62	0

Table 10.2. Continued

	HD				PD			
Centre	*N*	Hb	Ferritin	% on ESA	*N*	Hb	Ferritin	% on ESA
Wolve	270	100	99	85	83	100	100	63
York	122	100	100	93	27	100	96	70
N Ireland								
Antrim	126	100	100	92	10	100	100	80
Belfast	208	99	97	90	25	100	96	80
Newry	85	99	28	95	14	100	100	86
Ulster	101	100	100	93	6	100	100	100
West NI	129	98	59	92	15	100	100	67
Scotland								
Abrdn	214	100	93		20	100		
Airdrie	176	100	97		10	100		
D & Gall	48	100	98		14	93		
Dundee	171	99	88		19	95		
Dunfn	140	100	89		20	95		
Edinb	250	100	93		35	100		
Glasgw	579	99	72		40	100		
Inverns	73	100	64		15	93		
Klmarnk	141	100	91		40	100		
Wales								
Bangor	82	100	100	79	14	100	100	50
Cardff	448	100	99	61	71	100	73	27
Clwyd	76	100	100	0	15	100	93	0
Swanse	308	100	100	92	54	100	89	78
Wrexm	86	100	73	91	20	100	45	55
England	**18,324**	**98**	**95**	**88**	**2,864**	**98**	**92**	**69**
N Ireland	**649**	**99**	**82**	**92**	**70**	**100**	**99**	**80**
Scotland	**1,792**	**100**	**85**		**213**	**98**		
Wales	**1,000**	**100**	**97**	**76**	**174**	**100**	**79**	**68**
UK	**21,765**	**98**	**93**	**87***	**3,321**	**99**	**94***	**69***

*The overall averages given are for E, W & NI (not UK)
Blank cells denote centres with no PD patients or because data was not available
Percentages on ESA are shown, but it is believed that there were data problems for those centres with apparently less than 60% of HD patients or 45% of PD patients on ESA
The country level averages for the % on ESA are based only on those centres whose % was above the limits mentioned above

generally good for Hb and ferritin. The percentages on ESA are shown as they appear in the data received by the registry. For some centres, the ESA data was completely missing and for others it appears to be partially complete with, for example, only 10 or 20% of patients appearing to be on ESAs. It is believed that there were problems with data entry and/or data transfer in those centres with apparently less than 60% of HD patients or 45% of PD patients on ESA. These centres have been excluded from further analyses of ESA use.

Summary statistics for haemoglobin, serum ferritin and ESA are shown for the 71 renal centres in the UK in tables 10.3 for HD and 10.4 for PD patients respectively.

Haemoglobin in prevalent haemodialysis patients

The median Hb of patients on HD in the UK was 112 g/L with an IQR of 103–121 g/L and 82% of HD patients had a Hb $\geqslant$100 g/L (table 10.3). The median Hb by centre is shown in figure 10.7. Compliance with the target range of Hb $\geqslant$100 and $\leqslant$120 g/L continues to increase year on year, 52.7% in 2010, 56.1% in 2011 and 57% in 2012 (figure 10.8). The percentages of HD patients with Hb below 100 g/L and above 120 g/L, as well as the percentages meeting the target, are shown by centre in figure 10.9.

Funnel plots are shown for the minimum (Hb $\geqslant$100 g/L) and target range (Hb $\geqslant$100 and $\leqslant$120 g/L) in figures 10.10 and 10.11 respectively. Many centres

Table 10.3. Summary statistics for haemoglobin, serum ferritin and ESA for prevalent HD patients in 2012

Centre	*N* with Hb data	Median Hb g/L	% Hb ⩾100 g/L	% Hb 100–120 g/L	Median ferritin μg/L	% ferritin ⩾100 μg/L	% ferritin >200 and ⩽500 μg/L	% on ESA	Median ESA dose (IU/week)	% with Hb ⩾100 g/L and not on ESA
England										
B Heart	401	108	70	52	333	94	57	77	6,667	21
B QEH	838	111	82	59	354	95	77	84	7,000	14
Basldn	147	108	67	47	339	93	72	91	6,000	6
Bradfd	186	112	78	52	497	95	39	96	6,500	4
Brightn	323	110	81	65	510	99	45			
Bristol	461	113	85	57	564	96	31	92	7,500	8
Camb	309	113	85	59	306	88	56			
Carlis	57	115	84	42	439	93	50	68	4,750	32
Carsh	660	111	84	70	375	95	63			
Chelms	121	118	93	50	631	100	22	97	10,000	3
Colchr	100	117	89	50	500	99	48			
Covnt	335	110	78	61	336	95	67	91	11,000	8
Derby	208	113	84	61	428	97	47			
Donc	158	111	77	53	401	99	59	91	6,500	9
Dorset	244	115	85	52	453	97	51	97	9,250	3
Dudley	153	111	76	50	333	95	70			
Exeter	351	112	83	62	265	90	62	93	7,500	6
Glouc	193	111	83	63	330	89	49	91		8
Hull	309	116	88	51	393	99	64			
Ipswi	124	111	80	55	611	98	28	65	7,500	29
Kent	361	113	86	59	445	93	38	91	8,250	7
L Barts	844	109	76	61	432	95	53			
L Guys	537	107	71	55	693	97	26			
L Kings	460	107	73	61	579	98	35			
L Rfree	576	112	84	58	425	91	41			
L St.G	263	111	80	59	458	97	47			
L West	1,314	117	91	54	477	99	50			
Leeds	454	110	78	57	499	95	39	94	4,000	5
Leic	799	113	83	54	337	95	63	98	6,190	1
Liv Ain	164	110	78	59	703	98	22			
Liv RI	343	118	83	41	475	92	35			
M RI	439	114	82	53	396	94	56			
Middlbr	307	112	79	56	676	94	22	78	5,000	18
Newc	262	116	84	50	424	95	43	69	11,025	28
Norwch	302	115	87	59	444	93	35	91	8,000	9
Nottm	354	113	84	62	582	99	24	90	7,500	10
Oxford	389	112	81	55	308	94	57	93	8,000	6
Plymth	119	112	83	60	752	97	22			
Ports	509	117	89	49	357	97	67			
Prestn	494	113	83	58	577	94	30	88		11
Redng	251	116	84	56	536	98	38	90		8
Salford	303	108	73	58				68	6,000	14
Sheff	562	112	79	54	488	96	45	86	7,500	11
Shrew	184	115	89	55	391	98	57	88		11
Stevng	376	114	86	60	521	97	37			
Sthend	107	111	82	66	313	98	72	97	9,000	3
Stoke	254	115	84	54	405	97	49			
Sund	183	111	81	56	615	95	26	95		5
Truro	133	111	83	66	460	97	52			
Wirral	173	112	82	62	537	98	35			
Wolve	269	115	86	53	473	96	44	85	6,750	14
York	122	110	75	57	414	97	69	93	4,000	6

Table 10.3. Continued

Centre	*N* with Hb data	Median Hb g/L	% Hb ⩾100 g/L	% Hb 100–120 g/L	Median ferritin μg/L	% ferritin ⩾100 μg/L	% ferritin >200 and ⩽500 μg/L	% on ESA	Median ESA dose (IU/week)	% with Hb ⩾100 g/L and not on ESA
N Ireland										
Antrim	126	115	88	60	469	98	52	92	6,000	7
Belfast	205	111	78	57	434	95	41	90	8,000	7
Newry	84	112	86	62				95	4,300	5
Ulster	101	113	86	61	677	99	20	93	5,875	6
West NI	126	111	79	61	640	93	17	92	8,000	8
Scotland										
Abrdn	213	108	69	50	634	99	32			
Airdrie	176	113	86	62	669	99	30			
D & Gall	48	108	85	67	648	96	23			
Dundee	170	113	82	64	289	84	47			
Dunfn	140	118	92	50	622	90	21			
Edinb	249	119	91	47	372	94	47			
Glasgw	573	115	85	53	437	96	44			
Inverns	73	116	97	59	426	98	57			
Klmarnk	141	113	82	52	332	91	54			
Wales										
Bangor	82	116	89	59	432	96	54	79	9,000	17
Cardff	447	112	83	58	301	94	64	61		33
Clwyd	76	113	89	61	358	100	68			
Swanse	308	112	85	66	386	94	45	91	7,500	8
Wrexm	86	113	87	58	485	97	43	92	5,000	8
England	**17,885**	**112**	**82**	**57**	**432**	**96**	**48**	**88**	**7,333**	**10**
N Ireland	**642**	**112**	**82**	**60**	**535**	**96**	**35**	**92**	**6,500**	**7**
Scotland	**1,783**	**114**	**85**	**54**	**448**	**94**	**40**			
Wales	**999**	**113**	**85**	**60**	**348**	**95**	**56**	**76**	**7,500**	**21**
UK	**21,309**	**112**	**82**	**57**	**431**	**95**	**48**	**87**	**7,248**	**11**

Blank cells denote centres excluded from analyses due to poor data completeness or low patient numbers or because the data item was not available
ESA data only shown for those centres for which the % on ESA was 60% or more
For ESA, the overall averages given are for E, W & NI not UK

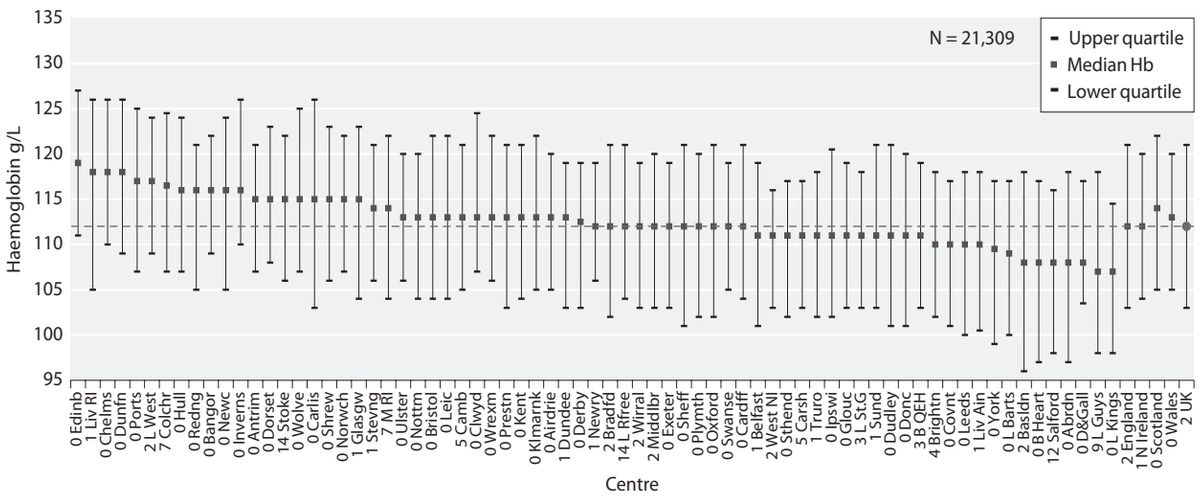

Fig. 10.7. Median haemoglobin in patients treated with HD by centre in 2012

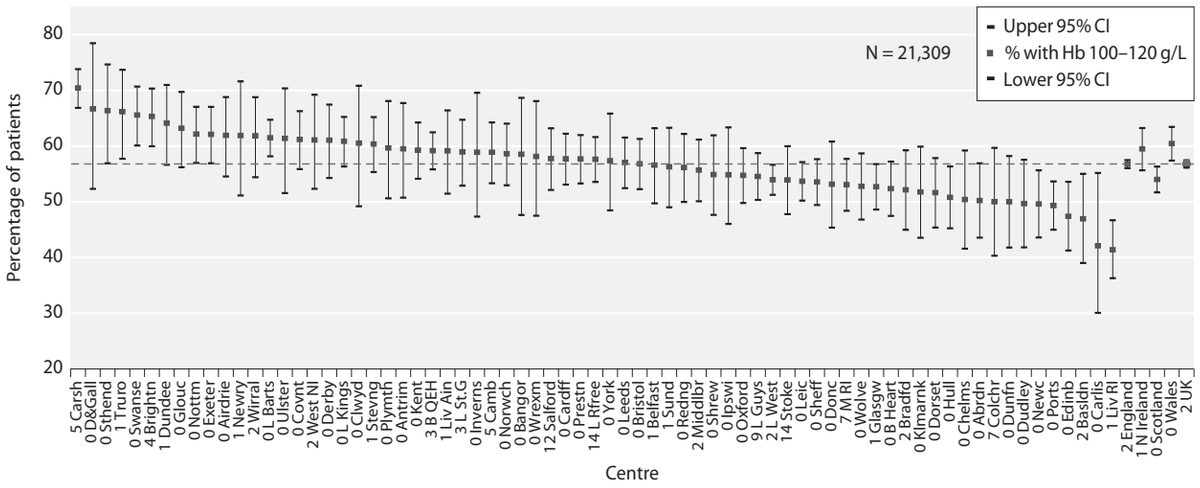

Fig. 10.8. Percentage of HD patients with Hb ⩾100 and ⩽120 g/L by centre in 2012

complied well with respect to both the minimum and target range Hb standards. Some centres complied well with the percentage with Hb ⩾100 g/L (figure 10.10) but had a poor compliance with percentage of patients with Hb ⩾100 and ⩽120 g/L (figure 10.11). This demonstrates that compliance with one standard can be achieved without compliance with another standard. Table 10.3 can be used in conjunction with figures 10.10 and 10.11 to identify centres.

Haemoglobin in prevalent peritoneal dialysis patients

Overall, 85% of patients on PD had a Hb ⩾100 g/L (table 10.4). The median Hb of patients on PD in the UK in 2012 was 114 g/L with an IQR of 105–123 g/L. The median Hb by centre is shown in figure 10.12. The compliance with Hb ⩾100 and ⩽120 g/L is shown in figure 10.13. In 2012, 55% of prevalent PD patients had a Hb within the target range. The distribution of Hb in PD patients by centre is shown in figure 10.14. The funnel plots for percentage with Hb ⩾100 g/L and for the percentage of patients with Hb ⩾100 and ⩽120 g/L are shown in figures 10.15 and 10.16 respectively. Table 10.4 can be used in conjunction with figures 10.15 and 10.16 to identify centres in the funnel plot.

Relationship between Hb in incident and prevalent dialysis patients in 2012

The relationship between the percentage of incident and prevalent dialysis (HD and PD) patients with a Hb ⩾100 g/L is shown in figure 10.17. As expected, all

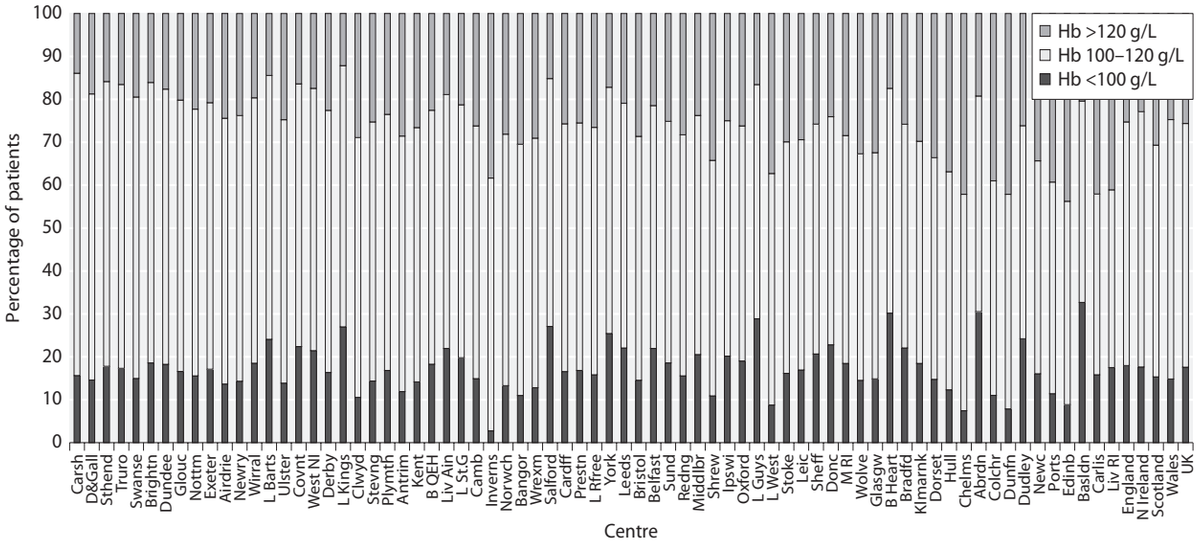

Fig. 10.9. Distribution of haemoglobin in patients treated with HD by centre in 2012

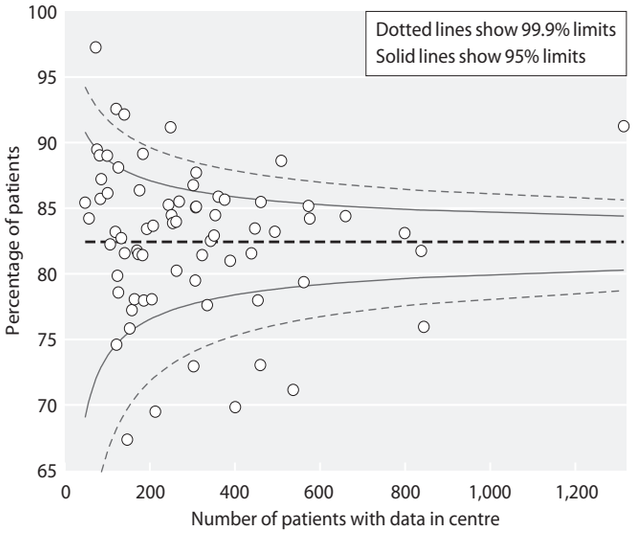

Fig. 10.10. Funnel plot of percentage of HD patients with Hb ⩾100 g/L by centre in 2012

centres had a higher percentage of prevalent patients achieving a Hb ⩾100 g/L than that for incident patients. Overall in the UK, 83% of prevalent patients, compared with 51% of incident patients, had a Hb ⩾100 g/L in 2012. Compliance with 'current' minimum standards by year (1998–2012) for incident and prevalent patients (all dialysis patients) is shown in figure 10.18. The decline in achieving this standard for incident and prevalent patients continues.

Ferritin in prevalent haemodialysis patients

The median and IQR for serum ferritin for patients treated with HD are shown in figure 10.19. The

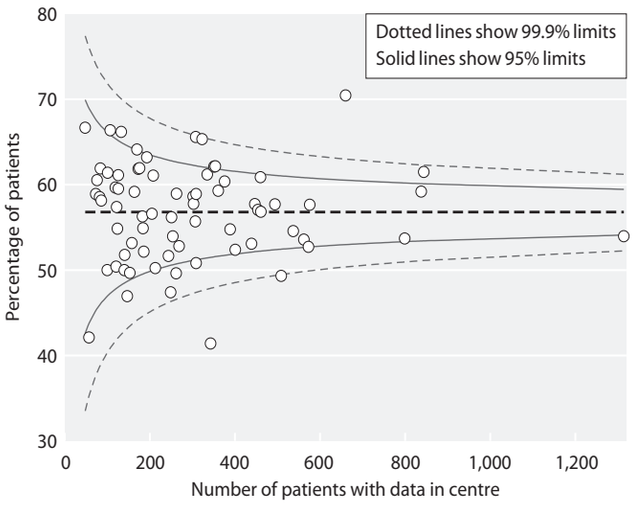

Fig. 10.11. Funnel plot of percentage of HD patients with Hb ⩾100 and ⩽120 g/L by centre in 2012

percentages with serum ferritin ⩾100 μg/L, >200 μg/L and ⩽500 μg/L, and ⩾800 μg/L are shown in figures 10.20, 10.21 and 10.22 respectively. Most centres achieved greater than 90% compliance with a serum ferritin ⩾100 μg/L for HD patients. The HD population had a median ferritin value of 431 μg/L, IQR 285–623. Seventeen of the 69 centres who had returns for ferritin had greater than 20% (21–47%) of their patients with ferritin ⩾800 μg/L (figure 10.22). The serum ferritin correlated poorly with median Hb achieved and ESA dose (table 10.3).

Ferritin in prevalent peritoneal dialysis patients

The median and IQR for serum ferritin for patients treated with PD are shown in figure 10.23. The percentages with serum ferritin ⩾100 μg/L, >100 μg/L and ⩽500 μg/L, and ⩾800 μg/L are shown in figures 10.24, 10.25 and 10.26 respectively. The PD population had a lower median ferritin value (285 μg/L, IQR 164–466) than the HD population. In 2012, 31 centres reported less than 90% of PD patients compliant with serum ferritin ⩾100 μg/L, although this had little bearing on their achieved median Hb or median ESA dose when compared with other centres (table 10.4).

Erythropoietin stimulating agents in prevalent haemodialysis patients

As shown in previous reports there was substantial variation in the average dose of ESA prescription used. The median dose for prevalent HD patients in England, Wales and Northern Ireland was 7,248 IU/week. The median dose varied from 4,000 IU/week (Leeds, York) to 11,025 IU/week (Newcastle) with a median Hb for these centres of 110 g/L (Leeds, York) and 116 g/L (Newcastle) (table 10.3). Over the last three years there has been a fall in the median ESA dose, 8000 IU in 2010, 7,450 IU in 2011 and 7,248 IU in 2012.

Erythropoietin stimulating agents in prevalent peritoneal dialysis patients

In 2012, the median dose was substantially lower in prevalent PD patients at 4,250 (range 2,231–9,500) IU/week (table 10.4) compared with HD patients.

ESA prescription and association with achieved haemoglobin

For HD patients, centre level median Hb is plotted against median ESA dose in figure 10.27 and compliance with the RA standards for Hb ⩾100 g/L and ⩽120 g/L is plotted against median ESA dose in figure 10.28. For these figures, Hb data was only used for those patients

Table 10.4. Summary statistics for haemoglobin, serum ferritin and ESA for prevalent PD patients in 2012

Centre	*N* with Hb data	Median Hb g/L	% Hb ⩾100 g/L	% Hb 100–120 g/L	Median ferritin μg/L	% ferritin ⩾100 μg/L	% ferritin >100 and ⩽500 μg/L	% on ESA	Median ESA dose (IU/week)	% with Hb ⩾100 g/L and not on ESA
England										
B Heart	42	114	86	57	182	85	73	48	6,000	50
B QEH	147	114	81	49	308	85	66	62	5,000	37
Basldn	28	112	71	46	189	82	68	61	3,750	39
Bradfd	24	111	83	58	302	88	54	83	4,000	17
Brightn	65	113	88	52	314	95	74			
Bristol	56	112	73	50	383	95	66	66	4,885	32
Camb	32	114	91	63	334	90	65	59	3,600	41
Carlis	21	116	95	62	346	95	65	67	4,125	33
Carsh	95	112	81	56	173	79	72			
Chelms	25	119	96	48	200	76	60	76	4,000	24
Colchr	n/a									
Covnt	81	114	89	62	257	84	72	68	8,000	30
Derby	84	114	81	52	341	94	63			
Donc	23	113	78	52	266	96	65	70	4,000	30
Dorset	36	120	92	44	347	94	61	68	2,900	31
Dudley	53	112	85	53	150	68	66			
Exeter	69	114	96	67	212	83	74	72	4,000	28
Glouc	31	114	84	58	173	75	71	55		35
Hull	77	114	84	48	295	99	75			
Ipswi	30	116	87	50	390	85	44	70	3,000	30
Kent	55	113	85	55	259	83	68	67	4,000	31
L Barts	165	113	78	44	307	89	63			
L Guys	26	112	81	58	207	81	73			
L Kings	76	110	84	58	219	83	77			
L Rfree	101	110	76	53	430	95	49			
L St.G	47	114	87	55	317	93	87			
L West	46	114	83	46	251	89	76			
Leeds	77	114	88	62	328	92	74	78	3,333	22
Leic	140	115	86	56	344	95	74	80	3,900	14
Liv Ain	17	112	76	53	434	100	59			
Liv RI	54	115	83	52	325	85	49			
M RI	76	116	84	54	174	83	70			
Middlbr	7									
Newc	32	114	88	50	426	97	50			
Norwch	48	117	96	58	131	68	53	71	3,725	29
Nottm	72	113	83	60	339	93	71	69	3,333	29
Oxford	69	113	80	55	179	87	76	81	6,000	16
Plymth	30	119	90	53	345	92	58			
Ports	78	119	95	53	310	96	72			
Prestn	59	115	85	58	339	83	54	75		25
Redng	63	116	87	54	378	92	65			
Salford	84	112	86	56				77	9,500	19
Sheff	67	113	85	60	538	97	42	60	5,292	39
Shrew	32	116	84	44	214	74	61	61	4,000	41
Stevng	27	109	78	59	196	75	63			
Sthend	14	117	93	57	241	100	100	57	7,500	43
Stoke	69	115	86	59	447	94	50			
Sund	17	117	82	41	570	94	25	65	2,231	29
Truro	19	114	89	63	268	100	82			
Wirral	23	113	87	57	497	94	44			
Wolve	83	116	88	51	244	76	54	63	4,000	36
York	27	109	81	59	170	88	73	70	4,000	30

Table 10.4. Continued

Centre	*N* with Hb data	Median Hb g/L	% Hb ⩾100 g/L	% Hb 100–120 g/L	Median ferritin μg/L	% ferritin ⩾100 μg/L	% ferritin >100 and ⩽500 μg/L	% on ESA	Median ESA dose (IU/week)	% with Hb ⩾100 g/L and not on ESA
N Ireland										
Antrim	10	115	100	70	239	80	60	80	3,833	20
Belfast	25	114	88	56	221	96	75	80	3,000	20
Newry	14	108	86	71	192	64	57	86	2,458	14
Ulster	6									
West NI	15	122	93	40	277	100	73	67	2,500	33
Scotland										
Abrdn	20	115	85	55						
Airdrie	10	113	90	70						
D & Gall	13	115	92	69						
Dundee	18	109	78	72						
Dunfn	19	118	84	42						
Edinb	35	113	86	60						
Glasgw	40	113	90	60						
Inverns	14	116	100	79						
Klmarnk	40	111	73	45						
Wales										
Bangor	14	117	86	43	179	57	50	50	4,000	50
Cardff	71	110	87	65	151	67	63			
Clwyd	15	108	73	53	238	86	64			
Swanse	54	111	87	69	328	85	63	78	4,500	22
Wrexm	20	121	85	35				55	8,000	40
England	**2,819**	**114**	**85**	**54**	**288**	**88**	**66**	**69**	**4,500**	**29**
N Ireland	**70**	**115**	**91**	**56**	**239**	**88**	**67**	**80**	**3,000**	**20**
Scotland	**209**	**114**	**85**	**58**						
Wales	**174**	**112**	**86**	**60**	**198**	**76**	**64**	**68**	**6,000**	**31**
UK	**3,272**	**114**	**85**	**55**	**285**	**88**	**65**	**69**	**4,250**	**29**

Blank cells denote centres excluded from analyses due to poor data completeness or low patient numbers or because the data item was not available
n/a – no PD patients
ESA data only shown for those centres for which the % on ESA was 45% or more
For ferritin and for ESA the overall averages given are for E, W & NI not UK

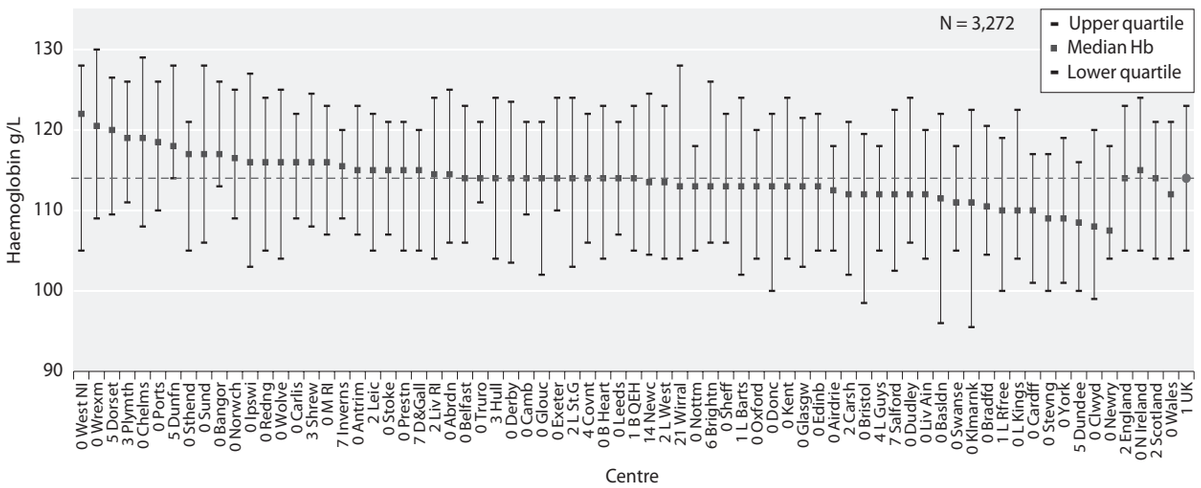

Fig. 10.12. Median haemoglobin in patients treated with PD by centre in 2012

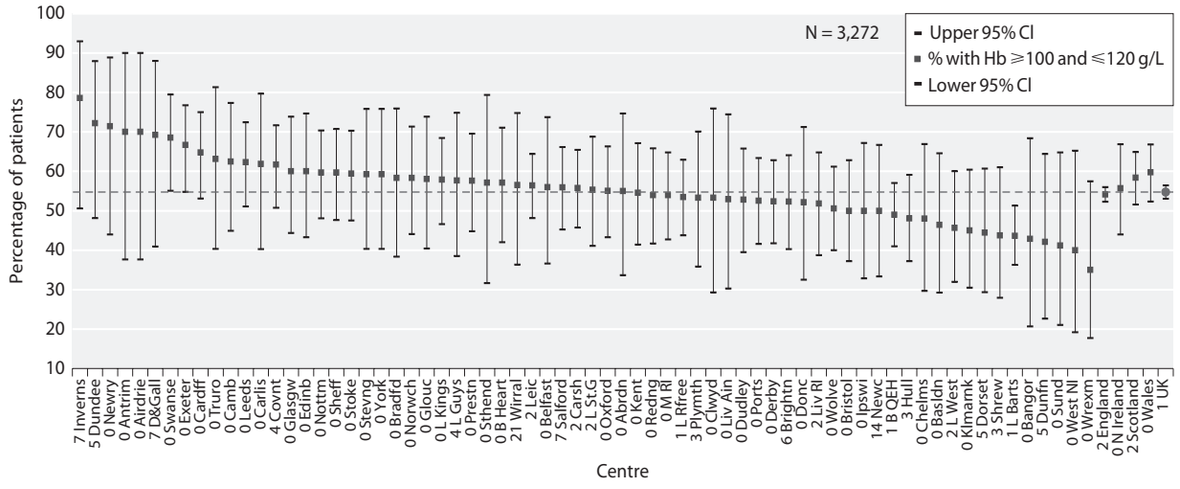

Fig. 10.13. Percentage of PD patients with Hb ⩾100 and ⩽120 g/L by centre in 2012

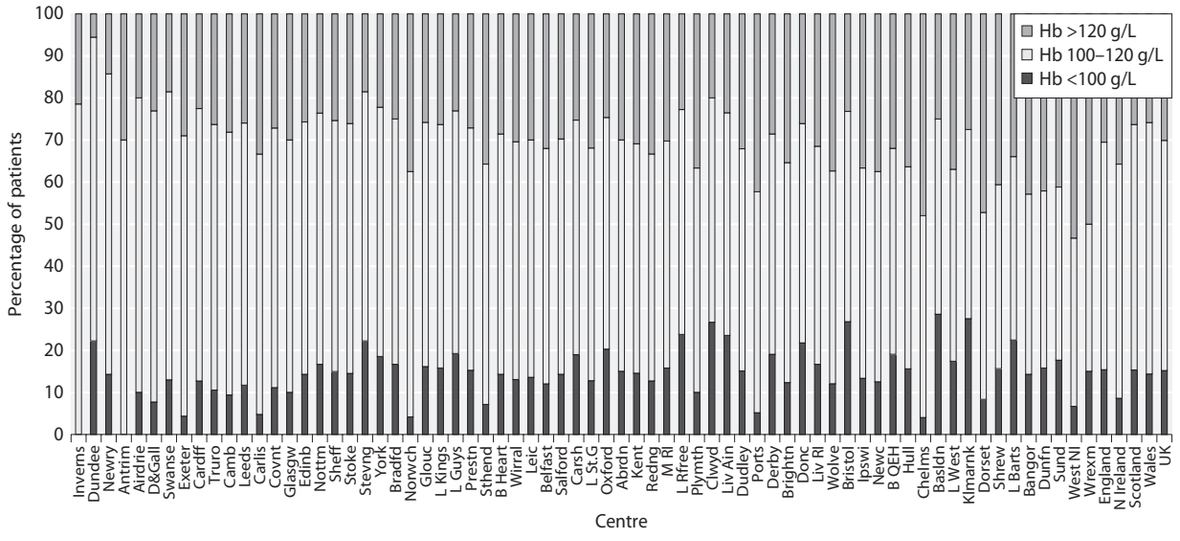

Fig. 10.14. Distribution of haemoglobin in patients treated with PD by centre in 2012

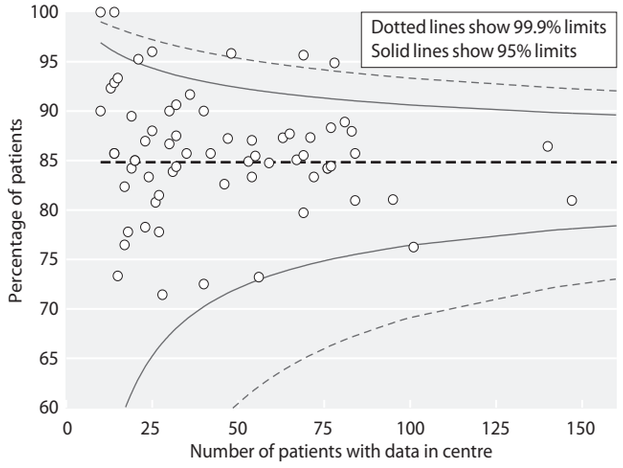

Fig. 10.15. Funnel plot of percentage of PD patients with Hb ⩾100 g/L by centre in 2012

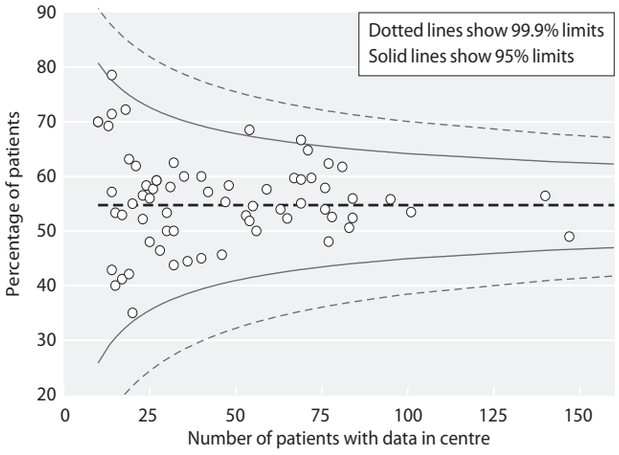

Fig. 10.16. Funnel plot of percentage of PD patients with Hb ⩾100 g/L and ⩽120 g/L by centre in 2012

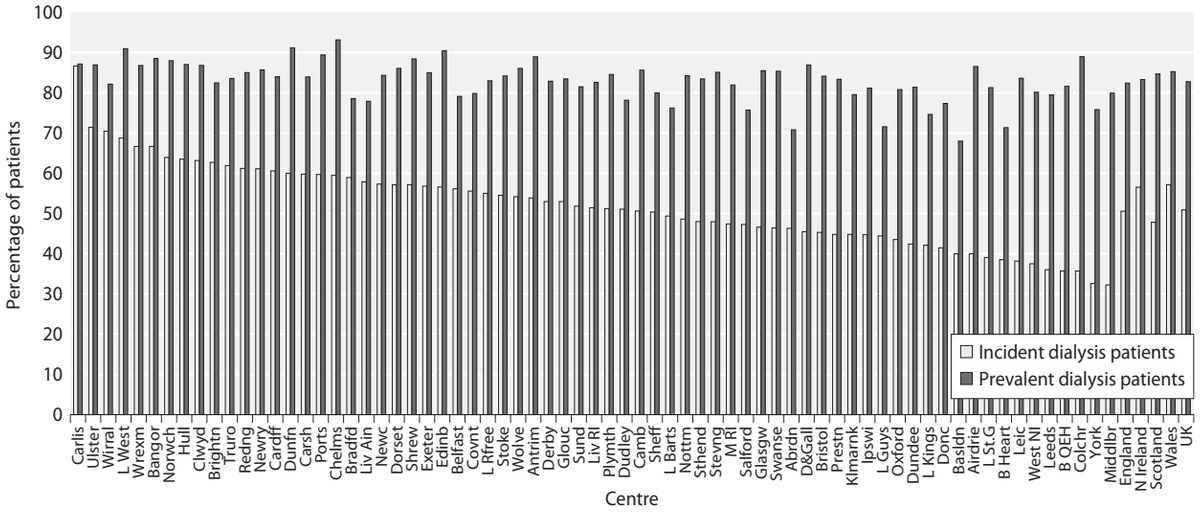

Fig. 10.17. Percentage of incident and prevalent dialysis patients with Hb ⩾100 g/L by centre in 2012

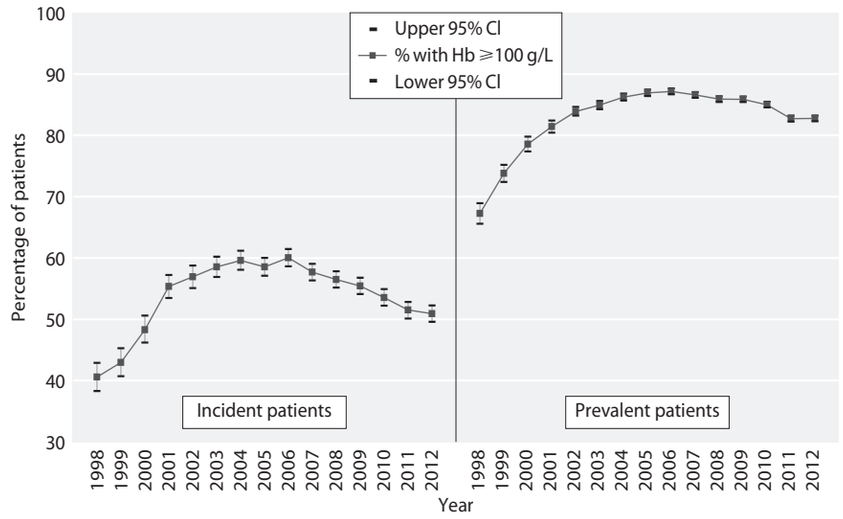

Fig. 10.18. Percentage of incident and prevalent dialysis patients (1998–2012) with Hb ⩾100 g/L

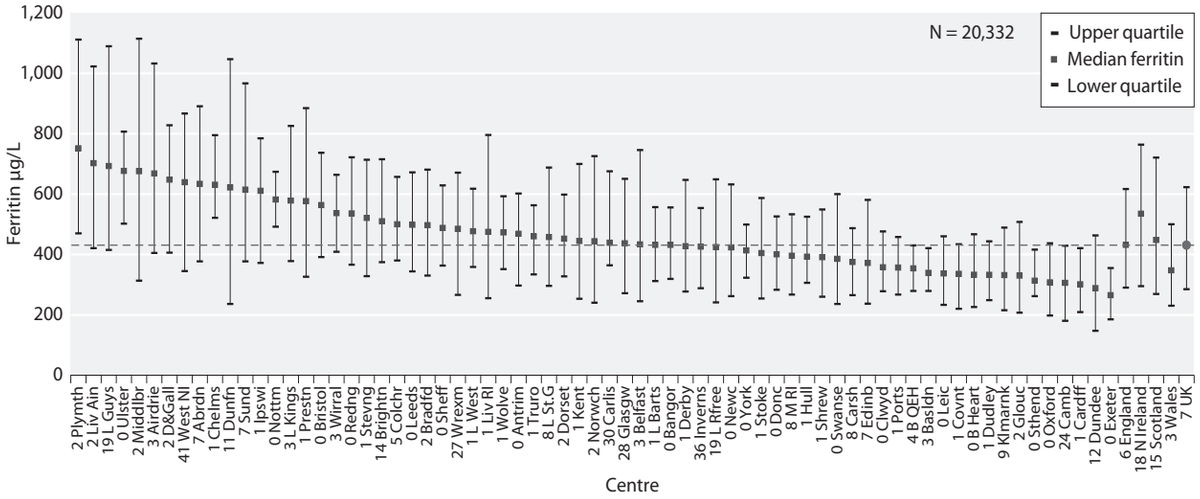

Fig. 10.19. Median ferritin in patients treated with HD by centre in 2012

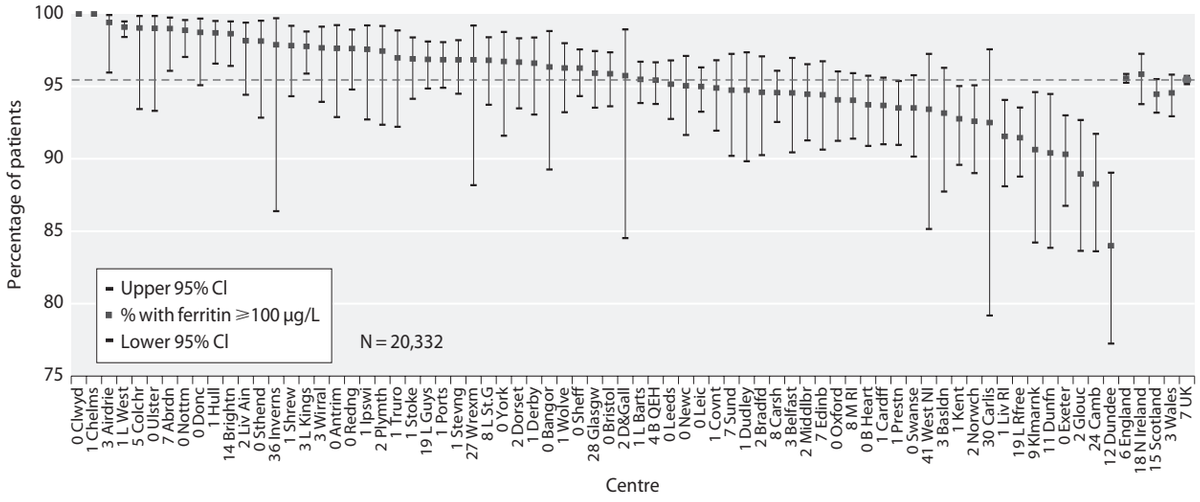

Fig. 10.20. Percentage of HD patients with ferritin ⩾100 µg/L by centre in 2012

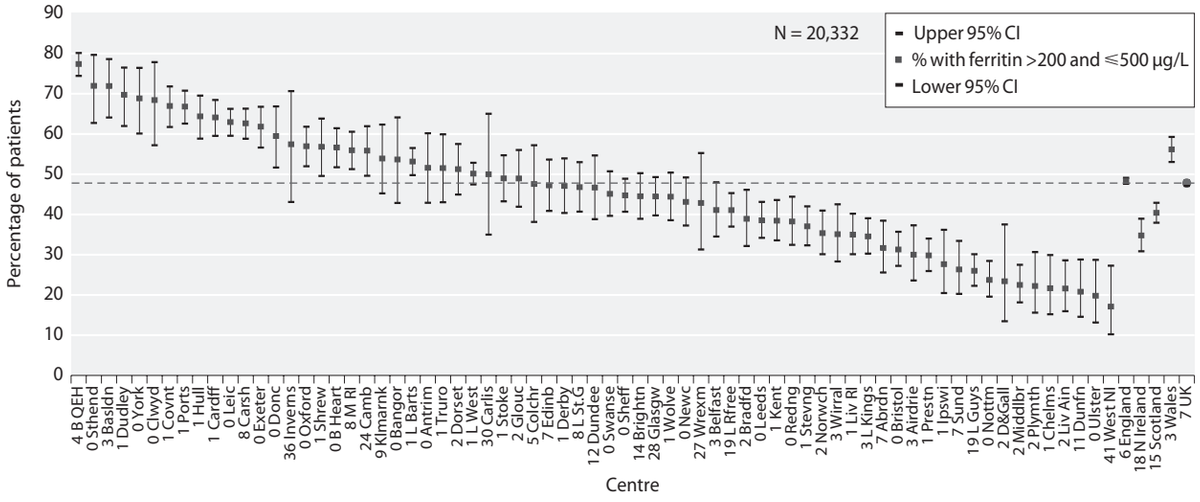

Fig. 10.21. Percentage of HD patients with ferritin >200 µg/L and ⩽500 µg/L by centre in 2012

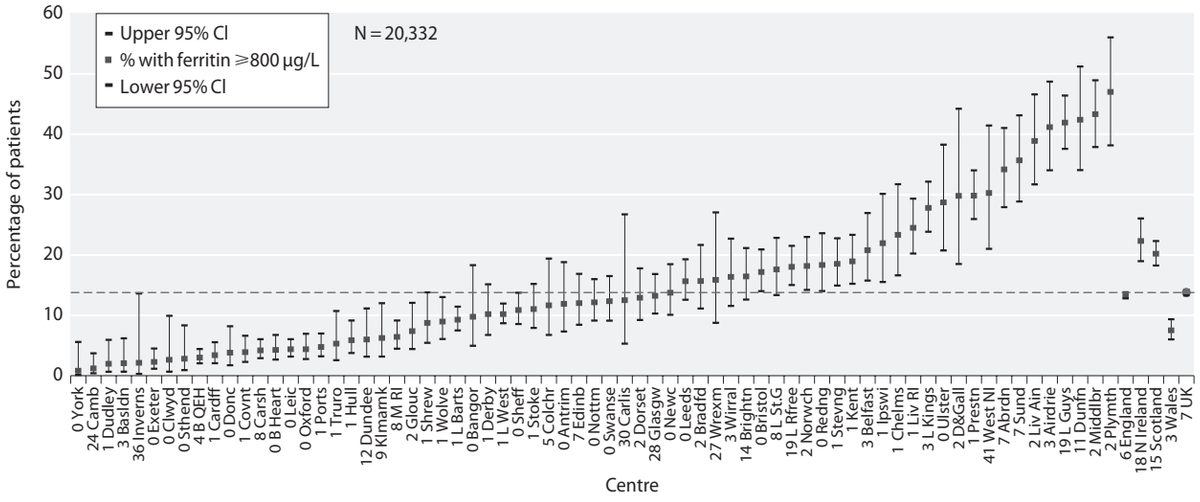

Fig. 10.22. Percentage of HD patients with ferritin ⩾800 µg/L by centre in 2012

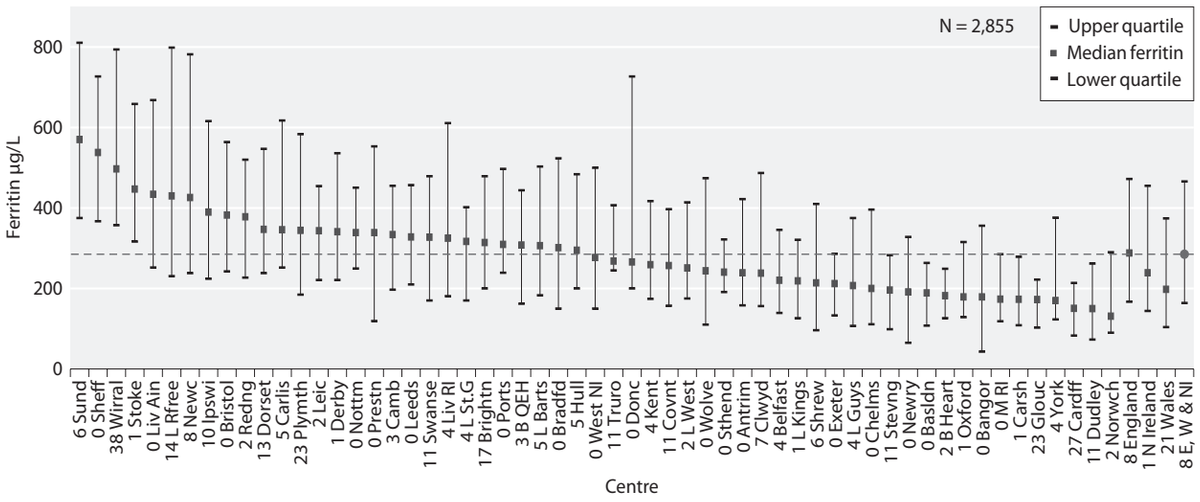

Fig. 10.23. Median ferritin in patients treated with PD by centre in 2012

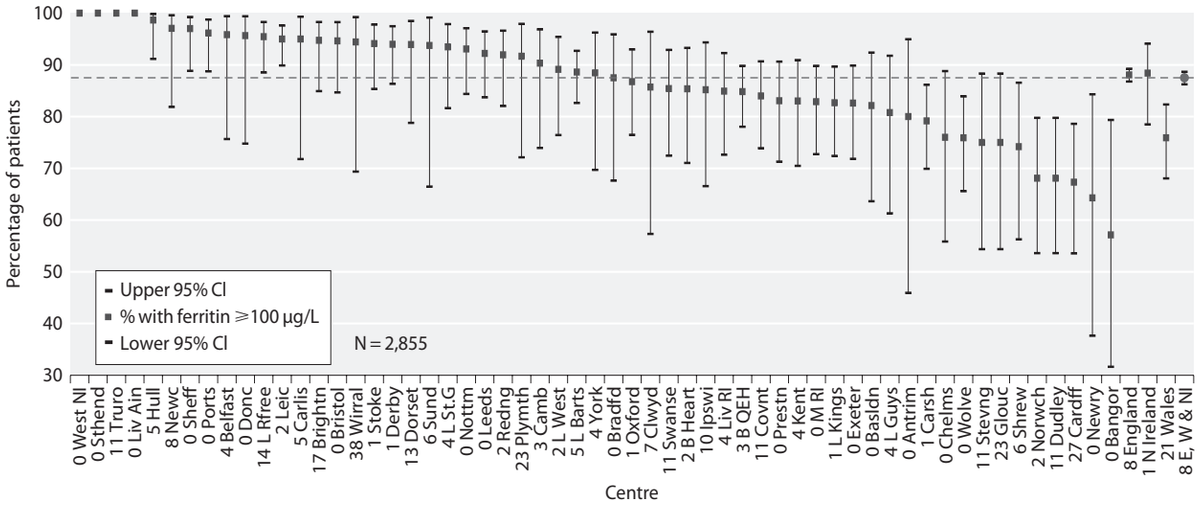

Fig. 10.24. Percentage of PD patients with ferritin ⩾100 µg/L by centre in 2012

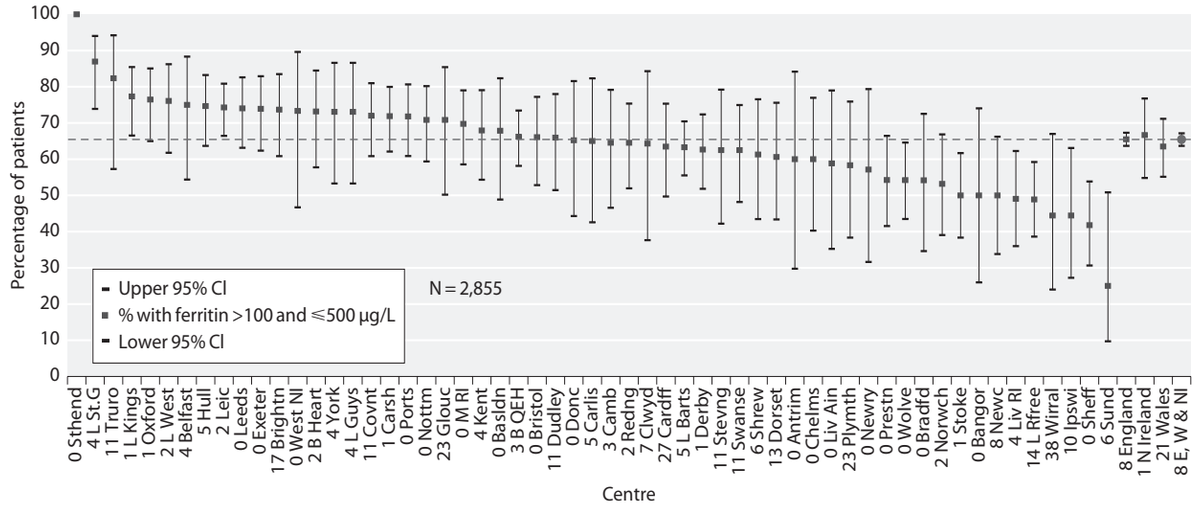

Fig. 10.25. Percentage of PD patients with ferritin >100 µg/L and ⩽500 µg/L by centre in 2012

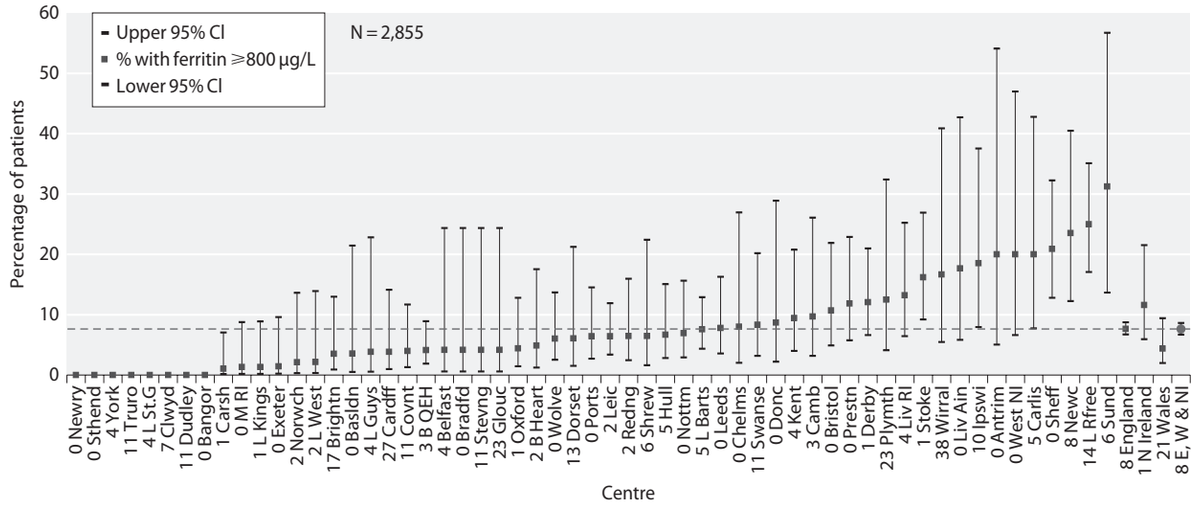

Fig. 10.26. Percentage of PD patients with ferritin ⩾800 µg/L by centre in 2012

who were receiving an ESA and had dose data available. There was no strong relationship in either figure.

It is known that not all patients treated with dialysis who have a Hb above 120 g/L are receiving ESA. It has been suggested that it may be inappropriate to include those patients not receiving ESA within the group not meeting this RA target. There are two reasons: firstly, the high Hb remains outside the control of the clinician, and secondly, the recent trials suggesting that it may be detrimental to achieve a high Hb in renal patients were based only upon patients treated with ESAs [13, 14].

Figures 10.29 and 10.30 show the percentages of HD and PD patients in each centre whose Hb lies above, within or below the RA guidelines of 100–120 g/L. These charts also show the proportion of patients with a Hb above the upper limit who were receiving, or were not receiving an ESA. These analyses are restricted to the centres with acceptable ESA returns as stipulated above. These figures show that 25% of HD patients had a Hb >120 g/L. Most of these patients (79%) were on ESAs. Whereas for PD, 30% of patients had a Hb >120 g/L, but only about 51% of these were on ESAs.

ESA prescription: age and modality associations

The proportion of patients on an ESA was higher for HD (87%) than PD (69%) and this difference was present and similar across all age groups (figure 10.31). The proportion of patients who maintained a Hb ⩾100 g/L without requiring ESA (by age group and modality) is shown in figure 10.32. This was highest in the 45–54 age group both for HD at 13.6% (95% CI: 12–15.5%) and PD at 33.8% (95% CI: 28–40%).

ESAs and time on renal replacement therapy

The percentage of patients on ESA by time on RRT and dialysis modality is shown in figure 10.33. This is a

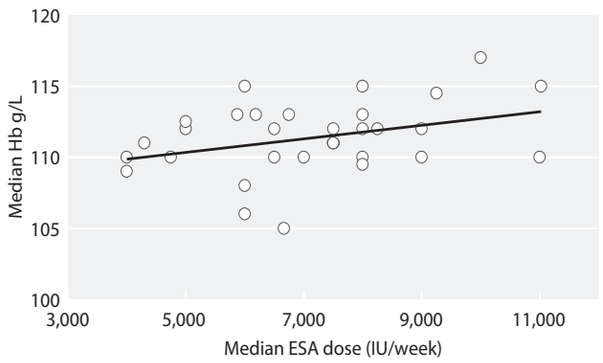

Fig. 10.27. Median Hb versus median ESA dose in HD patients on ESA, by centre in 2012

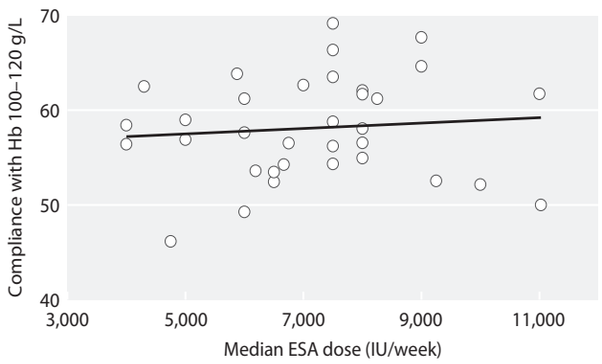

Fig. 10.28. Compliance with Hb 100–120 g/L versus median ESA dose in HD patients on ESA, by centre in 2012

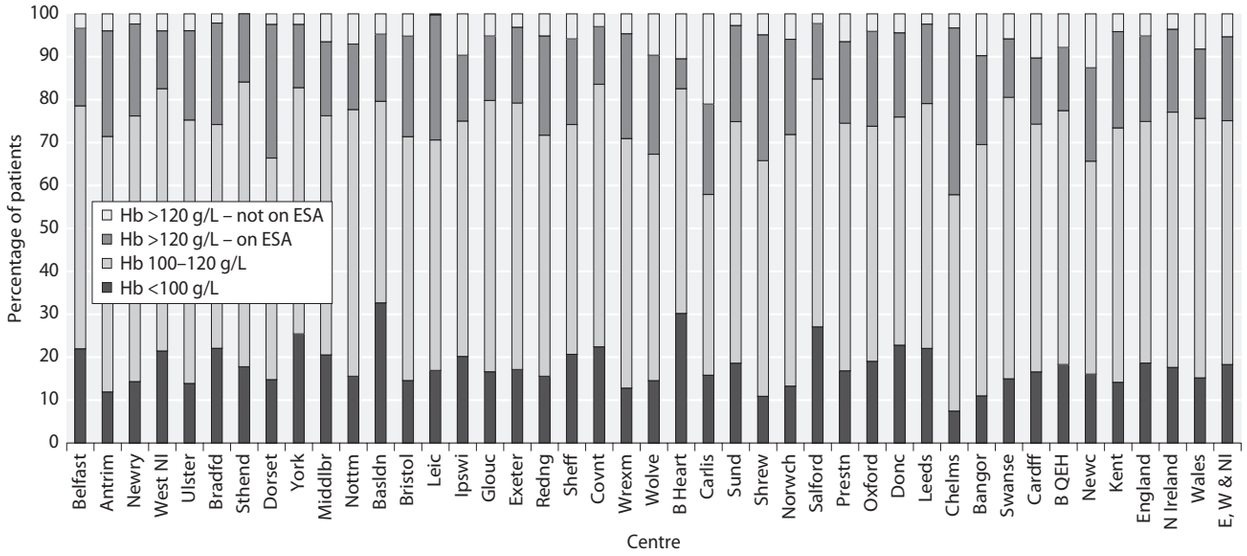

Fig. 10.29. Distribution of haemoglobin in patients treated with HD and the proportion of patients with Hb >120 g/L receiving ESA by centre in 2012

cross-sectional analysis at the final quarter of 2012. Patients who had previously changed RRT modality were included in this analysis. The proportion of PD patients requiring ESA rises with duration of RRT from 69% after 3–12 months, to 81% after 10 or more years. This almost certainly reflects loss of residual renal function. For at least the first 10 years on RRT, a greater percentage of HD patients are receiving ESA treatment than patients on PD for any given duration on RRT.

Resistance to ESA therapy

Figure 10.34 shows the frequency distribution of weekly ESA dose by treatment modality adjusted for weight. Data regarding prevalence of ESA resistance in the literature in the ERF population is very sparse. RA guidelines define resistance to ESA therapy as '***failure to reach the target Hb level despite SC epoetin dose >300 IU/kg/week (450 IU/kg/week IV epoetin) or darbepoetin dose >1.5 mcg/kg/week'.*** For the purposes

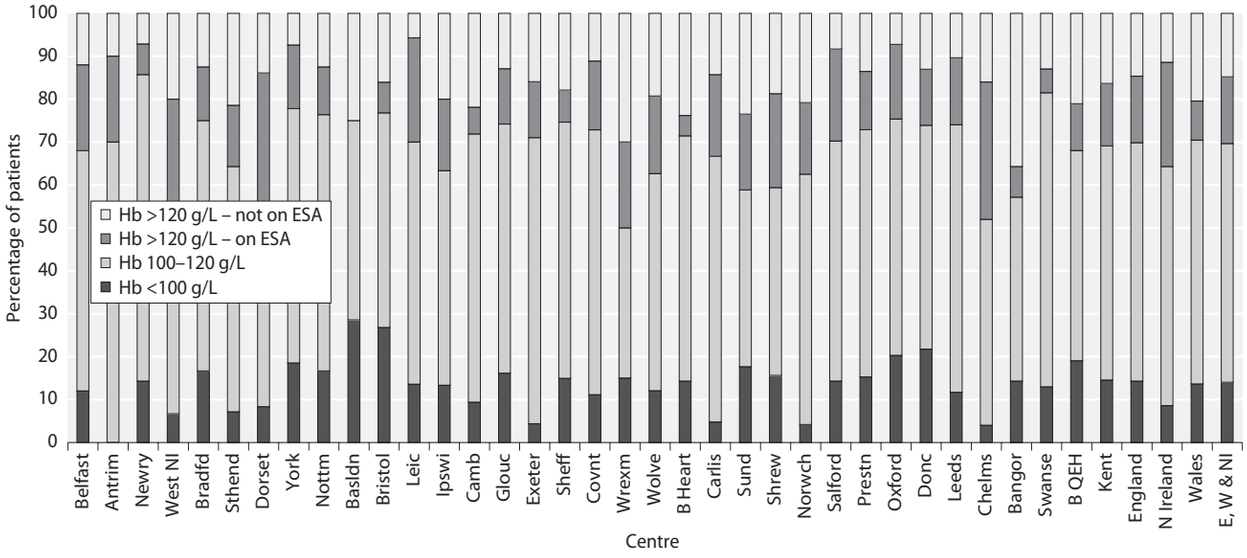

Fig. 10.30. Distribution of haemoglobin in patients treated with PD and the proportion of patients with Hb >120 g/L receiving ESA by centre in 2012

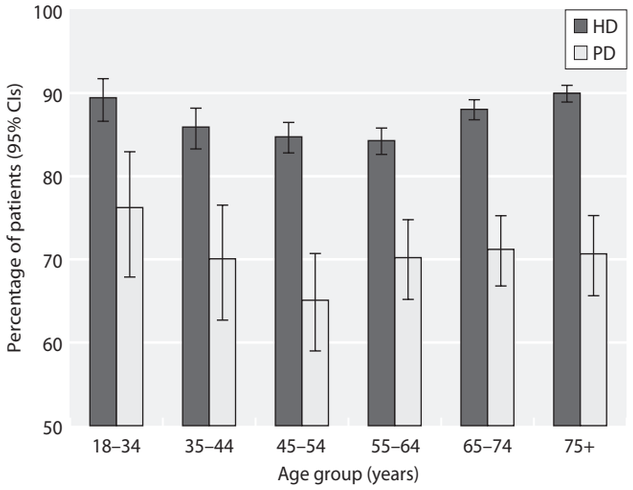

Fig. 10.31. Percentage of dialysis patients on ESA, by age group and treatment modality (2012)

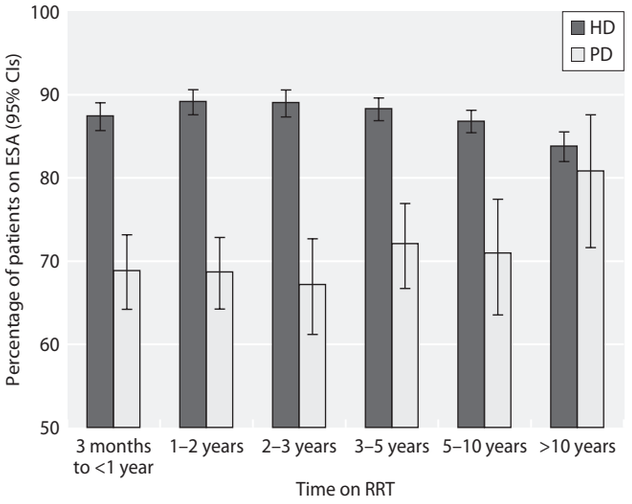

Fig. 10.33. Percentage of patients on ESA by time on RRT (2012)

of this analysis the centres were restricted to those with good completeness for weight (over 75%) and ESA dose data (33 centres for HD and 22 centres for PD). As per the above definition and assuming that HD patients largely receive ESA intravenously and PD patients receive ESA subcutaneously, the prevalence of high doses of ESA was 1.0% ($N = 72$) and 2.2% ($N = 12$) for HD and PD patients respectively. For these patients the dose range for HD was 453–772 IU/kg/week and for PD 312–535 IU/kg/week. For patients on HD with high ESA doses, 45% ($N = 32$) had Hb <100 g/L and 28% were within 100–120 g/L. For patients on PD with high ESA doses, 25% ($N = 3$) had a Hb <100 g/L and 67% were within 100–120 g/L. The percentage of patients with ESA resistance, defined by those failing to reach target Hb >100 g/L were 0.5% for HD and 0.6% for PD. Caution needs to be applied when interpreting these results as the numbers for the above calculations are small.

Success with guideline compliance

Compliance with current minimum standards by year (1998 to 2012) is shown in figure 10.35 for prevalent patients (by treatment modality).

The Renal Association guidelines state that centres should audit the '***Proportion of patients on renal replacement therapy with Hb level <100 g/L who are***

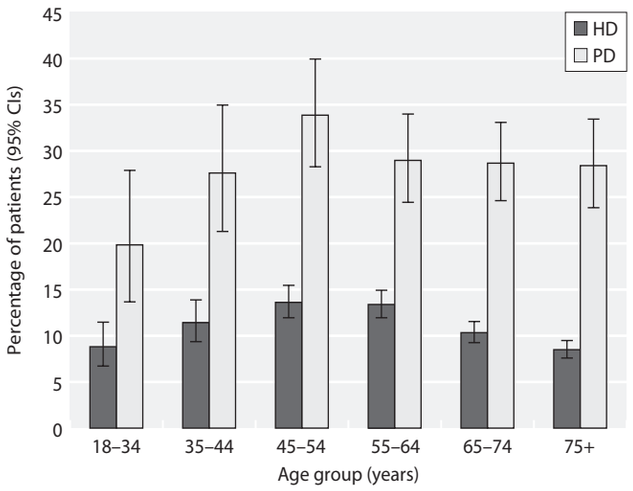

Fig. 10.32. Percentage of whole cohort (2012) who are not on ESA and have Hb ⩾100 g/L, by age group and treatment modality

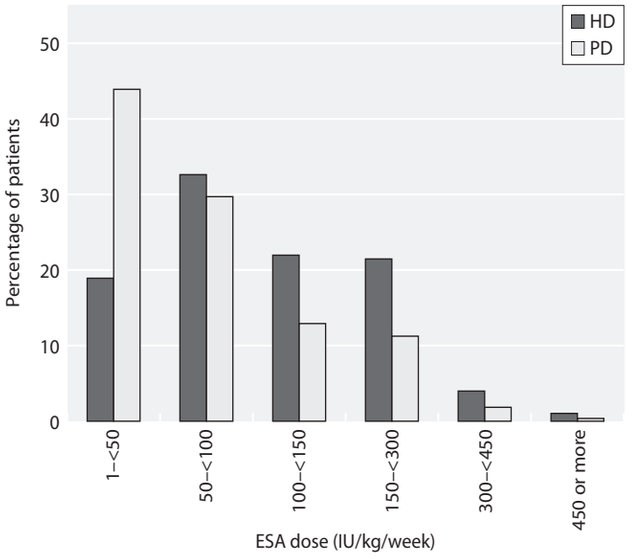

Fig. 10.34. Frequency distribution of mean weekly ESA dose corrected for weight in 2012

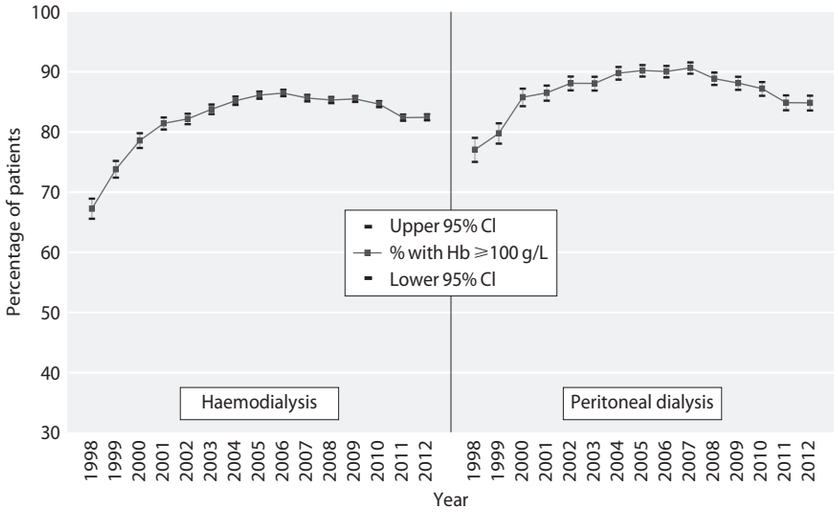

Fig. 10.35. Percentage of prevalent HD and PD patients (1998–2012) with Hb ⩾100 g/L

not prescribed an ESA'. Figure 10.36 shows the percentage of anaemic patients (Hb <100 g/L) receiving an ESA. A minority of patients had a Hb <100 g/L and were not receiving ESA therapy. Across the age groups this was between 7–10% for HD patients and 2–13% for PD patients. There are several potential explanations for this. Treatment with ESA may have been stopped in patients who were unresponsive or avoided in those with malignancy. Others may have been on ESA treatment but not had it recorded.

The Renal Association guideline states that centres should audit the '***Proportion of patients with serum ferritin levels <100 μg/L treated with an ESA'*** & '***The proportion of patients treated with an ESA with Hb >120 g/L'.*** Table 10.5 shows that the percentage of all patients treated with an ESA and having Hb >120 g/L ranged between 7–39% for HD and between 0–33% for PD. For HD, there was a small percentage of patients having ferritin levels <100 μg/L and being on an ESA (0–7%). The percentages were somewhat higher for PD (0–21%).

Renal Association guidelines state that '***Each renal unit should audit the type, route and frequency of administration and weekly dose of ESA prescribed***'. Table 10.6 shows the percentage completeness for type, route and frequency of administration for centres ($N = 40$) reporting ESA data. The completeness was generally good for drug type and dose but patchy for frequency and route of administration.

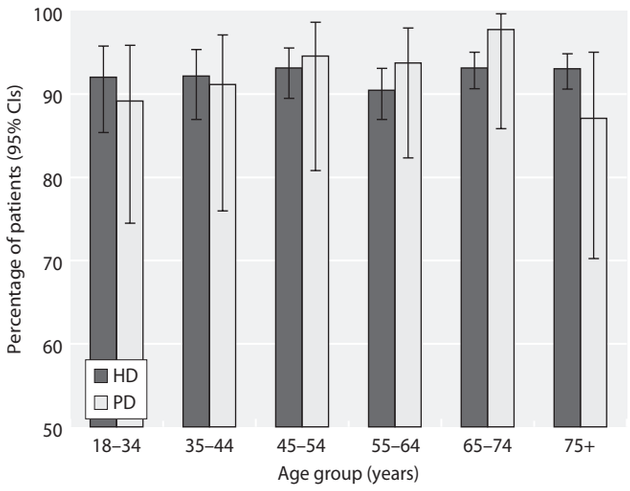

Fig. 10.36. Percentage of patients with Hb <100 g/L who were on ESA, by age group and treatment modality (2012)

Discussion

Anaemia is one of the major problems that contribute to high comorbidity and poor outcome in dialysis patients. Since the introduction of human recombinant erythropoietin for treating CKD-related anaemia over two decades ago, attention has shifted from treating severe anaemia in dialysis patients to preventing anaemia pre-dialysis and to correcting anaemia within defined target limits. Renal centres strive to meet the Renal Association standards in order to prevent adverse outcomes associated with low Hb such as impaired quality of life, increased hospitalisation, increased cardiovascular events and increased cardiovascular and all-cause mortality.

Table 10.5. Percentage of patients with serum ferritin levels <100 μg/L and on ESA and percentage of patients with Hb >120 g/L and on ESA by modality

	HD		PD	
Centre	% with Hb >120 g/L and on ESA	% with ferr <100 μg/L and on ESA	% with Hb >120 g/L and on ESA	% with ferr <100 μg/L and on ESA
England				
B Heart	7	1	5	6
B QEH	15	1	11	5
Basldn	16	6	0	4
Bradfd	24	4	13	5
Bristol	23	3	7	0
Camb			6	4
Carlis	21	4	19	6
Chelms	39	0	32	13
Covnt	13	3	16	6
Donc	20	0	13	0
Dorset	31	2	33	0
Exeter	18	7	13	7
Glouc	15	7	13	15
Ipswi	15	1	17	12
Kent	22	6	15	8
Leeds	19	2	16	4
Leic	29	5	24	2
Middlbr	17	3		
Newc	22	2		
Norwch	22	5	17	20
Nottm	15	0	11	1
Oxford	22	5	17	5
Prestn	19	2	14	14
Redng	23	2		
Salford	13		21	
Sheff	20	1	7	0
Shrew	29	2	22	10
Sthend	16	2	14	0
Sund	22	5	18	0
Wolve	23	1	18	14
York	15	1	15	4
N Ireland				
Antrim	25	1	20	10
Belfast	18	4	20	0
Newry	21		7	21
Ulster	21	1		
West NI	13	4	33	0
Wales				
Bangor	21	1	7	7
Cardff	15	3		
Swanse	14	2	6	6
Wrexm	24	2	20	
England	**20**	**3**	**16**	**6**
N Ireland	**19**	**3**	**24**	**7**
Wales	**16**	**3**	**9**	**5**
E, W & NI	**20**	**3**	**16**	**6**

Blank cells denote centres excluded from analyses due to poor completeness or small numbers with data

Table 10.6. Percentage completeness for type, dose, route and frequency of administration of ESA

	HD					PD				
Centre	*N* on ESA	% with drug type	% with dose	% with frequency	% with administration route	*N* on ESA	% with drug type	% with dose	% with frequency	% with administration route
England										
B Heart	307	100	100	0	0	20	100	100	0	0
B QEH	726	100	100	100	0	92	100	100	100	0
Basldn	137	100	99	100	100	17	100	100	100	100
Bradfd	181	100	91	0	0	20	100	100	0	0
Bristol	422	100	100	0	0	37	100	100	0	0
Camb						19	100	100	0	0
Carlis	39	100	100	0	0	14	100	100	0	0
Chelms	117	100	100	100	100	19	100	100	100	100
Covnt	305	100	99	0	0	57	100	98	0	0
Donc	144	100	100	100	100	16	100	100	100	94
Dorset	236	100	100	97	100	26	100	100	100	100
Exeter	327	100	100	0	0	50	100	100	0	0
Glouc	175	100	0	0	0	17	100	0	0	0
Ipswi	81	100	100	0	0	21	100	100	0	0
Kent	330	100	100	100	100	37	100	100	100	100
Leeds	427	100	90	0	0	60	100	100	0	0
Leic	782	100	98	0	0	115	100	93	0	0
Middlbr	242	100	100	0	0	6	100	100	0	0
Newc	180	100	100	0	0					
Norwch	275	100	100	100	100	34	100	100	97	100
Nottm	318	100	99	0	0	50	100	80	0	0
Oxford	360	100	100	0	0	56	100	100	0	0
Prestn	435	100	8	0	0	44	100	0	0	0
Redng	227	100	0	0	0					
Salford	236	100	97	100	0	69	100	96	100	0
Sheff	486	100	100	0	0	40	100	100	0	0
Shrew	162	100	99	87	94	20	100	100	100	100
Sthend	104	100	95	0	0	8	100	75	0	0
Sund	174	100	28	0	0	11	100	100	0	0
Wolve	230	100	100	0	0	52	100	100	0	0
York	113	100	100	0	0	19	100	100	0	0
N Ireland										
Antrim	116	100	100	100	100	8	100	100	100	100
Belfast	187	100	100	99	100	20	100	100	100	100
Newry	81	100	100	93	100	12	100	100	100	92
Ulster	94	100	100	100	100	6	100	100	100	100
West NI	119	100	100	98	100	10	100	100	100	100
Wales										
Bangor	65	100	96	0	0	7	100	100	0	0
Cardff	273	100	0	0	0					
Swanse	282	100	100	100	99	42	100	98	100	98
Wrexm	78	100	99	99	100	11	100	92	83	100
England	**8,278**	**100**	**88**	**28**	**17**	**1,046**	**100**	**92**	**31**	**16**
N Ireland	**597**	**100**	**100**	**98**	**100**	**56**	**100**	**100**	**100**	**98**
Wales	**698**	**100**	**61**	**51**	**51**	**60**	**100**	**97**	**85**	**87**
E, W & NI	**9,573**	**100**	**86**	**34**	**24**	**1,162**	**100**	**93**	**37**	**24**

Blank cells denote centres excluded from analyses due to poor completeness or small numbers with data

Haemoglobin outcomes for patients on HD and PD in the UK were largely compliant with the RA minimum standard of Hb $\geqslant$100 g/L (82% and 85% respectively). As would be anticipated, a greater proportion of prevalent patients (83%) than incident patients (51%) had a Hb $\geqslant$100 g/L in 2012. In the UK, the median Hb of patients on HD was 112 g/L with an IQR of 103–121 g/L, and the median Hb of patients on PD was 114 g/L with an IQR of 105–123 g/L.

Compliance with advice regarding iron stores as reflected by ferritin remained stable in the UK with 95% of HD patients and 88% of PD patients achieving a serum ferritin greater than 100 μg/L.

The analysis of ESA usage is limited by incomplete data returns. From the available data, 87% of HD patients and 69% of PD patients were on ESA treatment in England, Wales and Northern Ireland. The percentage of patients treated with an ESA and having Hb >120 g/L ranged between centres from 7–39% for HD and from 0–33% for PD. There was a small percentage of patients with ferritin levels <100 μg/L and receiving an ESA. There was substantial variation between centres in the average dose of ESA prescribed. Attainment of Hb targets correlates poorly with median ferritin and ESA usage.

Resistance to ESA has consistently been shown to be associated with an increased risk of death and cardiovascular events in CKD patients [14–17]. There is for the first time an attempt to describe the prevalence of ESA resistance in the UK and this was 0.5% and 0.6% for HD and PD patients respectively. Bearing in mind the limitations of relatively small numbers involved in the calculations, one possible reason that could explain the low prevalence is that this group of patients have poor survival. This again emphasises the need for better data returns and with improved completeness future analysis could look into whether this translates to poor patient outcomes for the UK dialysis population.

Conflicts of interest: none

References

1 KDIGO clinical practice guideline for anemia in chronic kidney disease. Summary of recommendations statements. Kidney International Supplements 2012;2:283–287

2 Department of Health Renal Team National Service Framework for Renal Services: Part One – Dialysis and transplantation, 2004, Department of Health: London

3 Renal Association. Treatment of adults and children with renal failure: standards and audit measures. 3rd Edition., 2002, Royal College of Physicians of London and the Renal Association: London

4 Locatelli F, et al. Anaemia management in patients with chronic kidney disease: a position statement by the Anaemia Working Group of European Renal Best Practice (ERBP). Nephrology Dialysis Transplantation 2009;24(2):348–354

5 National Institute for Health and Clinical Excellence (NICE). Anaemia management in people with chronic kidney disease (CG114), 2011

6 Renal Association Clinical Practice Guidelines Committee: Haemodialysis, 5th Edition. 2010. http://www.renal.org/clinical/guidelinessection/haemodialysis.aspx

7 Kidney Disease: Improving Global Outcomes (KDIGO) Anemia Work Group. KDIGO Clinical Practice Guideline for Anemia in Chronic Kidney Disease. Kidney inter 2012:2(suppl 1);279–335

8 Movilli E, et al. Predialysis versus postdialysis hematocrit evaluation during erythropoietin therapy. American journal of kidney diseases: the official journal of the National Kidney Foundation 2002:39(4);850–853

9 Kalantar-Zadeh K, et al. Diagnosis of iron deficiency anemia in renal failure patients during the post-erythropoietin era. American Journal of Kidney Diseases 1995;26(2):292–299

10 Eschbach JW, et al. Correction of the Anemia of End-Stage Renal Disease with Recombinant Human Erythropoietin. New England Journal of Medicine 1987:316(2);73–78

11 Singh AK, et al. Correction of Anemia with Epoetin Alfa in Chronic Kidney Disease. New England Journal of Medicine 2006:355(20);2085–2098

12 Drüeke TB, et al. Normalization of Hemoglobin Level in Patients with Chronic Kidney Disease and Anemia. New England Journal of Medicine 2006:355(20):2071–2084

13 Pfeffer MA, et al. A Trial of Darbepoetin Alfa in Type 2 Diabetes and Chronic Kidney Disease. New England Journal of Medicine 2009: 361(21);2019–2032

14 Gomez-Alamillo C, et al. Erythropoietin Resistance as Surrogate Marker of Graft and Patient Survival in Renal Transplantation: 3-Year Prospective Multicenter Study. Transplantation Proceedings 2010; 42(8):2935–2937

15 Chung S, et al. Relationship between erythropoietin resistance index and left ventricular mass and function and cardiovascular events in patients on chronic hemodialysis. Hemodialysis International 2012; 16(2):181–187

16 Panichi V, et al. Anaemia and resistance to erythropoiesis-stimulating agents as prognostic factors in haemodialysis patients: results from the RISCAVID study. Nephrology Dialysis Transplantation, 2011;26(8): 2641–2648

17 Solomon SD, et al. Erythropoietic Response and Outcomes in Kidney Disease and Type 2 Diabetes. New England Journal of Medicine 2010;363(12):1146–1155

UK Renal Registry 16th Annual Report: Chapter 11 Blood Pressure Profile of Prevalent Patients receiving Renal Replacement Therapy in 2012: National and Centre-specific Analyses

Anirudh Rao[a], David Pitcher[a], Ken Farrington[b]

[a]UK Renal Registry, Bristol, UK; [b]Lister Hospital, Stevenage, UK

Key Words
Diastolic blood pressure · Epidemiology · Established renal failure · Haemodialysis · Peritoneal dialysis · Pulse pressure · Systolic blood pressure · Transplant

Summary

- Data completeness was better for haemodialysis (HD) patients (75% for pre-HD measurements) than for peritoneal dialysis (PD) patients (51%) or transplant recipients (41%).
- In 2012, median pre- and post-HD systolic blood pressures (SBPs) were 140 mmHg and 128 mmHg respectively. The median SBP of patients on PD was 137 mmHg. Transplant recipients had a median SBP of 134 mmHg.
- In 2012, median diastolic blood pressures (DBPs) were 71 mmHg (pre-HD), 67 mmHg (post-HD), 78 mmHg (PD) and 79 mmHg (transplant).
- In England, Wales and Northern Ireland only 26% of PD patients achieved the Renal Association guideline of SBP <130 mmHg **and** DBP <80 mmHg.
- In England, Wales and Northern Ireland only 27% of transplant patients achieved the Renal Association guideline of SBP <130 mmHg **and** DBP <80 mmHg.

Introduction

The aetiology of hypertension in established renal failure is multifactorial and interpreting blood pressure (BP) values in this cohort of patients is challenging. In dialysis patients there is a complex interplay between volume overload with salt (and water) which may be appropriately addressed by dialysis, and vasoconstriction caused by neurohumoral mechanisms which may require additional treatment with antihypertensive drugs. These mechanisms lead to cardiovascular dysfunction and may be important in the observation of the 'U-shaped' mortality curve seen in relation to BP in dialysis patients [1, 2]. Original descriptions at the individual patient level were confounded by unmeasured case-mix, with comorbidity associated with both lower BP and lower survival. Similar patterns have now been reported at centre level [3]. It is possible that the association can be overcome by longer or more frequent sessions of dialysis and careful attention to dry-weight [4, 5]. Iatrogenic factors such as erythropoiesis stimulating agents (ESA) [6] in dialysis patients and ciclosporin [7] in transplant patients may also contribute to high BP. Further, BP in dialysis patients varies as much within individuals as it does between individuals [8]. The extent of this variability appears to be as important as the absolute value in predicting cardiovascular mortality in haemodialysis patients [9]. The optimal measure of BP therefore remains the subject of considerable controversy, with ambulatory BP predicting mortality better than pre- or post-dialysis BP [10]. There is some evidence to suggest that pre-dialysis systolic blood pressures (SBPs) >150–160 [11–13] are associated with excess mortality in haemodialysis patients and other data suggesting that very high SBP (>200) pre-dialysis seems to confer an adverse prognosis [14]. Conversely, lowering BP too aggressively may lead to intradialytic hypotension [15], which is an independent predictor of mortality [16, 17]. Data from a number of studies suggest excess mortality associated with pre-dialysis SBP <120 mmHg [14, 18].

The Renal Association guidelines updated in August 2010 and in operation during the period in which the audit data in this chapter were collected [19] stated:

Guideline 5.2 – CVD: Hypertension in dialysis patients

We suggest that pre- and post-dialysis blood pressure (measured after completion of dialysis, including washback) should be recorded and intra-dialytic blood pressure measurements should be made to facilitate good management of the HD session. (2D)

Guideline 5.4 – CVD: Hypertension in dialysis patients

It would be sensible to avoid sustained BP extremes and, in order to try to provide some guidance we suggest that systolic blood pressure during the inter-dialytic period on HD and for PD patients should not regularly exceed >160 mmHg. (2C)

Guideline 5.5 – CVD: Hypotension/Hypertension in dialysis patients

We suggest that systolic blood pressure should not routinely be treated with pharmacological agents with antihypertensive properties if SBP is regularly <120 mmHg pre dialysis.

Guideline 5.7 – CVD: Hypertension in dialysis patients

We suggest that hypertension on dialysis should be managed by ultrafiltration in the first instance. (2D)

Blood pressure in peritoneal dialysis patients should be <130/80 mmHg (Good Practice).

The target blood pressure for renal transplant patients is <130/80 mmHg (Good practice).

These guidelines are consistent with international guidelines [20, 21].

This chapter reports UK Renal Registry (UKRR) data completeness for BP for adult renal centres in England, Northern Ireland and Wales and presents centre level average BP attainment for patients on haemodialysis (HD), peritoneal dialysis (PD) and with a functioning kidney transplant at the end of December 2012.

Methods

All adult patients in England, Wales and Northern Ireland receiving renal replacement therapy (RRT) (HD, PD and transplant recipients) on 31st December 2012 were considered for inclusion in the analyses.

The method of data extraction employed is described in chapter 15 of the 11th UKRR Annual Report [22]. The UKRR extracts quarterly laboratory, clinical and demographic data for all patients receiving RRT in the 62 renal centres in England, Northern Ireland and Wales. Data on some variables from the nine Scottish renal centres are sent annually to the Scottish Renal Registry. However, BP measurements are only collected from the Scottish Registry

for HD patients and therefore PD and transplant patients from Scottish renal centres are excluded from all BP analyses.

Patients who had been on the same modality and at the same renal centre for three months and with a valid BP reading in either the fourth or the third quarter of 2012 were included. This included incident patients starting RRT during 2012 who were still alive on 31st December 2012. Analyses used the last recorded BP from quarter four, however, if this was missing, the last recorded BP from quarter three was used instead. BP data from quarter two were used for patients at renal centres in Scotland because BP data from quarters three and four were unavailable.

Analyses were performed for each RRT modality (HD, PD and transplant). Most UK renal centres manage HD, PD and transplant patients. However, Colchester had no PD patients and four centres (Bangor, Colchester, Liverpool Aintree, Wirral) had no transplant patients under their care.

All patients meeting the criteria above were included in the overall national analyses, but renal centres with less than 50% data completeness for any modality, or fewer than 20 patients with results, were excluded from the centre level analysis for that modality. The number preceding the centre name in each figure corresponds to the percentage of missing data for that centre.

Patients on HD were analysed both by pre-dialysis and post-dialysis BP. The BP components analysed included systolic blood pressure, diastolic blood pressure (DBP) and pulse pressure (PP). The data were analysed to produce summary statistics (mean, median, maximum, minimum). Standard deviation and quartile ranges were also calculated. Median BP and inter-quartile ranges (IQRs) are presented for each analysis as caterpillar plots. In addition, the percentage of HD patients with pre-dialysis systolic BP <120 mmHg, between 120–160 mmHg, >160 mmHg; PD and transplant patients attaining Renal Association standards for BP (***<130/80 mmHg***) in individual renal centres and each nation were calculated and are presented with 95% confidence intervals in caterpillar plots.

Chi-squared tests were used in the analyses of the 2012 BP data to test for statistically significant differences between renal centres and between nations. All statistical analyses were performed using SAS version 9.3.

Results

Data completeness

Data extracts were received from all 62 centres in England, Wales and Northern Ireland. Data completeness is summarised in table 11.1. Overall, completeness was very similar to that previously reported.

BP on each modality

Figure 11.1 gives the median and IQR for SBP, DBP and PP in prevalent HD patients (pre- and post-dialysis), PD and transplant patients.

In 2012, the median pre- and post-HD SBPs were 140 mmHg and 128 mmHg respectively. The median SBP of patients on PD was 137 mmHg. Transplant recipients had a median SBP of 134 mmHg. Median DBP was 71 mmHg (pre-HD), 67 mmHg (post-HD), 78 mmHg (PD) and 79 mmHg (transplant).

Relationship between the centre mean and the proportion above a threshold BP in that centre

As the distribution of BP in each centre approximates a normal distribution (data not shown), the population mean of each BP variable should predict the number of individuals above (or below) a predefined threshold or standard (Rose and Day 1990). As these assumptions were confirmed in the 13th UKRR Annual Report [23] only median BP data by centre are presented below.

Centre-specific analyses of BP in haemodialysis patients

Figures 11.2 and 11.3 illustrate the median and IQR pre-dialysis SBP and DBP in each centre supplying data on >50% of patients. The median HD pre-dialysis SBP and pre-dialysis DBP for the UK were 140 mmHg and 71 mmHg respectively. Figures 11.4 and 11.5 illustrate the equivalent analyses for post-dialysis BP.

There remains marked centre variation. The difference between the centres with the lowest and highest median SBP was >20 mmHg. Comparison with previous UKRR reports showed that in general, the same centres can be found at roughly the same place in the distribution from year to year.

Adherence to guidelines

Figures 11.6, 11.7 and 11.8 illustrate the percentages (with 95% confidence intervals (CIs)) of HD patients achieving SBP in the range 120–160 mmHg, <120 mmHg and >160 mmHg respectively. There was marked variation (45–80%) between centres achieving their pre-dialysis SBP readings in the range 120–160 mmHg. The vast majority of centres had greater than 50% of their patients falling in the range 120–160 mmHg. Thirty-five of the centres had greater than 20% of their patients with a pre-dialysis SBP <120 mmHg and there were also 35 centres who had greater than 20% of their patients with a pre-dialysis SBP >160 mmHg.

Centre-specific analyses of BP in peritoneal dialysis patients

Figures 11.9 and 11.10 illustrate the median and IQR SBP and DBP in each centre supplying data on >50% of eligible patients. Figure 11.11 gives the percentage of

Table 11.1. Percentage of patients by renal centre for whom BP readings were received by the UKRR, by modality

	% completed data			
Centre	Pre-HD	Post-HD	PD	Transplant
England				
B Heart	98	98	2	3
B QEH	94	93	84	93
Basldn	98	93	96	2
Bradfd	3	2	96	69
Brightn	54	68	0	0
Bristol	99	99	91	72
Camb	100	100	97	97
Carlis	100	100	5	0
Carsh	92	92	1	0
Chelms	100	98	96	94
Colchr	99	99	n/a	n/a
Covnt	100	100	95	81
Derby	99	95	99	83
Donc	100	95	91	100
Dorset	100	96	58	81
Dudley	95	93	47	16
Exeter	100	99	94	92
Glouc	100	100	90	89
Hull	97	97	89	25
Ipswi	100	100	0	0
Kent	98	98	98	85
L Barts	0	0	0	0
L Guys	0	0	0	0
L Kings	0	0	0	0
L Rfree	93	91	99	77
L St.G	59	60	0	0
L West	0	0	0	0
Leeds	100	97	99	96
Leic	97	96	81	48
Liv Ain	98	98	12	n/a
Liv RI	97	95	2	2
M RI	0	0	0	0
Middlbr	97	96	88	46
Newc	100	100	0	0
Norwch	95	90	4	41
Nottm	100	100	97	87
Oxford	96	95	43	16
Plymth	59	10	65	85
Ports	100	100	85	19
Prestn	20	0	0	0
Redng	95	100	0	0
Salford	97	97	0	0
Sheff	99	96	99	97
Shrew	99	99	0	1
Stevng	94	91	63	23
Sthend	99	99	0	61
Stoke	95	95	1	0
Sund	99	99	0	0
Truro	83	82	68	19
Wirral	94	93	14	n/a
Wolve	99	99	98	95
York	100	98	96	53
N Ireland				
Antrim	98	92	100	65
Belfast	94	87	16	45
Newry	99	98	71	86
Ulster	99	94	100	90
West NI	98	92	100	93
Scotland				
Abrdn	99	99	n/a	n/a
Airdrie	94	94	n/a	n/a
D & Gall	96	96	n/a	n/a
Dundee	99	96	n/a	n/a
Dunfn	96	95	n/a	n/a
Edinb	94	93	n/a	n/a
Glasgw	95	88	n/a	n/a
Inverns	96	95	n/a	n/a
Klmarnk	99	99	n/a	n/a
Wales				
Bangor	98	98	100	n/a
Cardff	4	29	51	98
Clwyd	100	92	0	0
Swanse	100	100	96	100
Wrexm	100	99	25	0
England	**73**	**71**	**50**	**37**
N Ireland	**97**	**91**	**64**	**60**
Scotland	**96**	**93**	**n/a**	**n/a**
Wales	**57**	**67**	**61**	**84**
UK	**75**	**74**	**51***	**41***

*UK % completeness for PD and transplant excludes Scotland

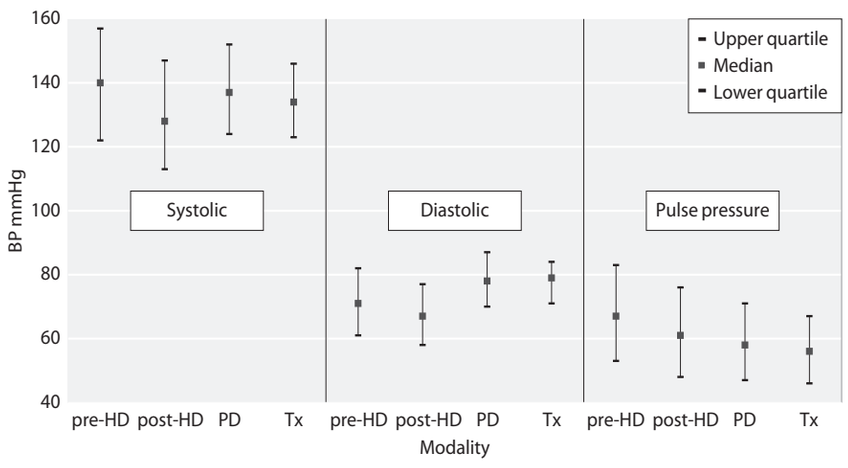

Fig. 11.1. Summary of BP achievements

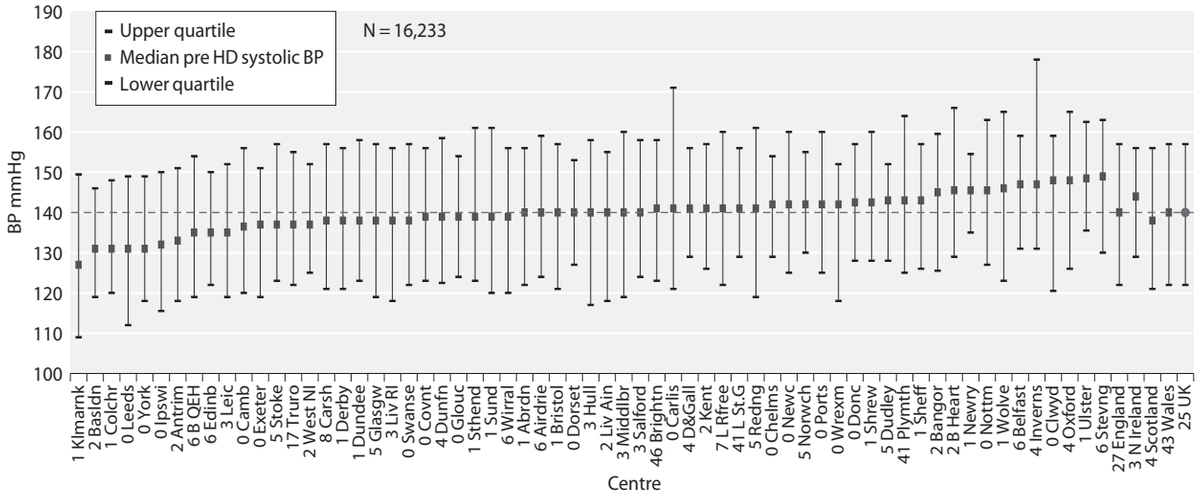

Fig. 11.2. Median systolic BP: pre-HD

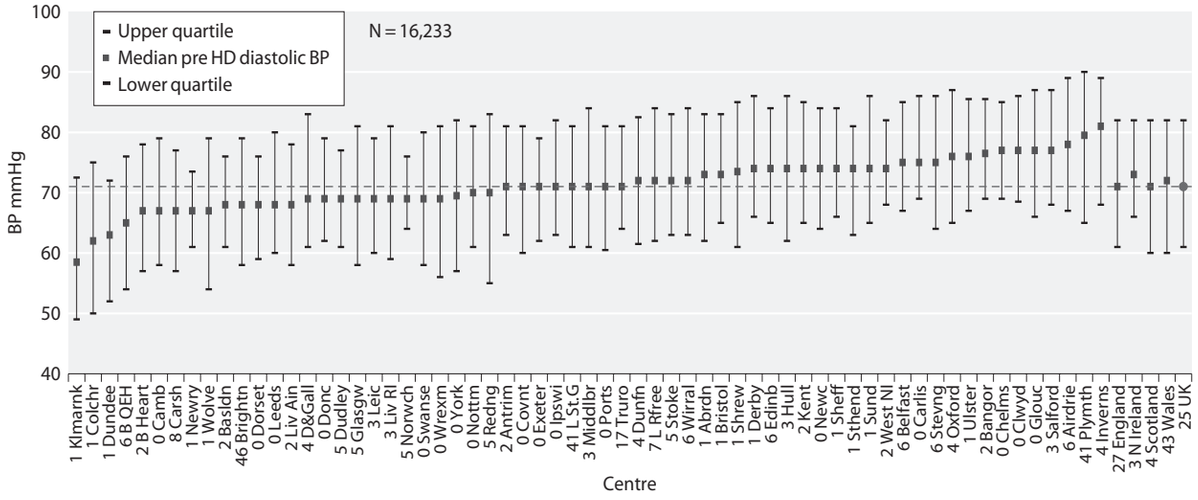

Fig. 11.3. Median diastolic BP: pre-HD

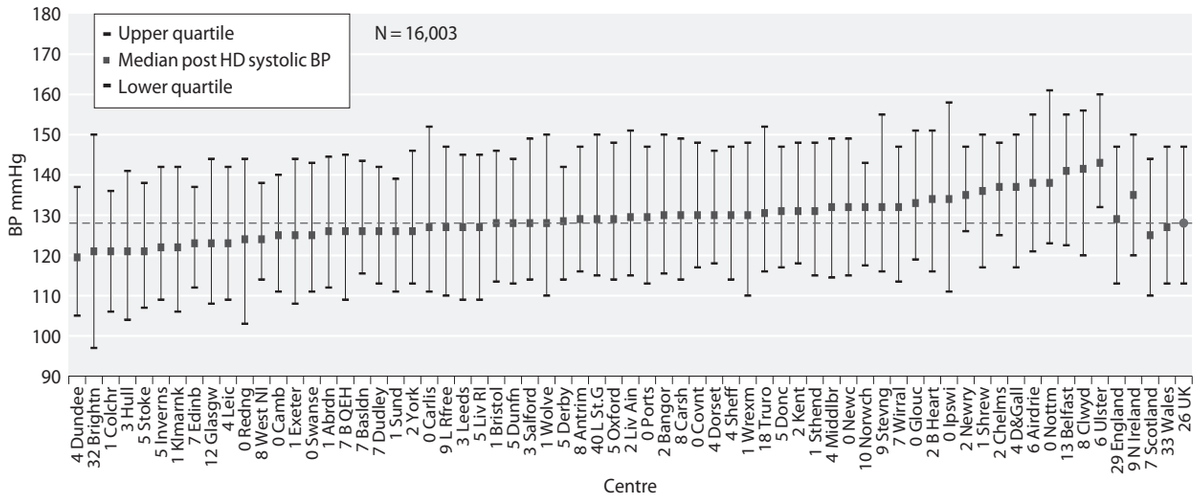

Fig. 11.4. Median systolic BP: post-HD

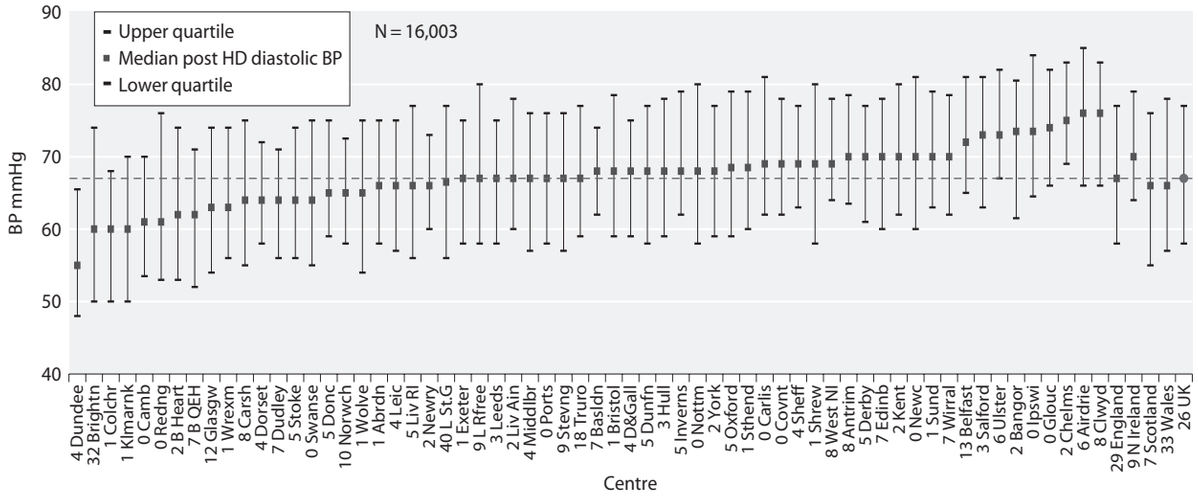

Fig. 11.5. Median diastolic BP: post-HD

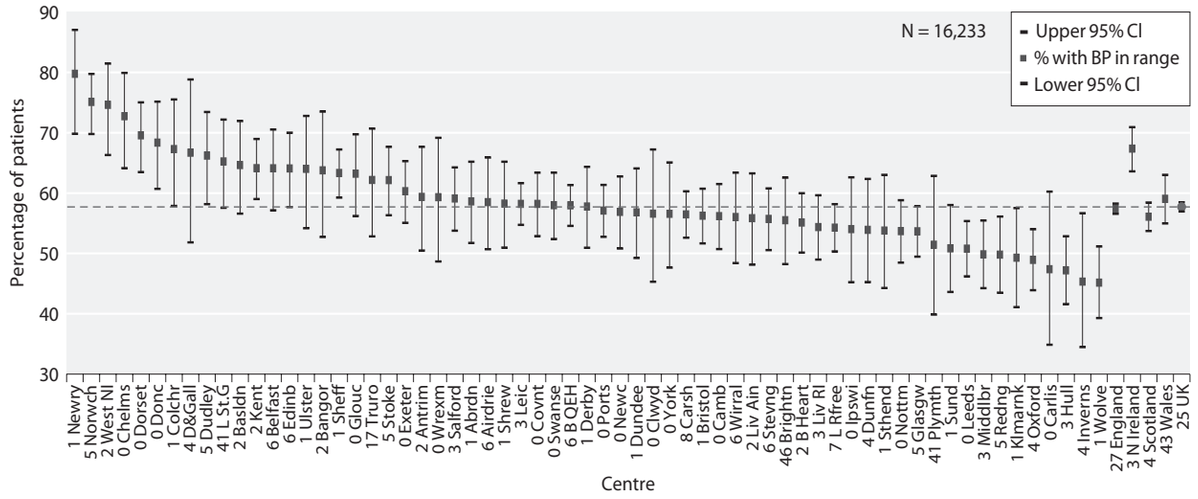

Fig 11.6. Percentage of patients achieving pre-dialysis SBP readings in the range 120–160 mmHg

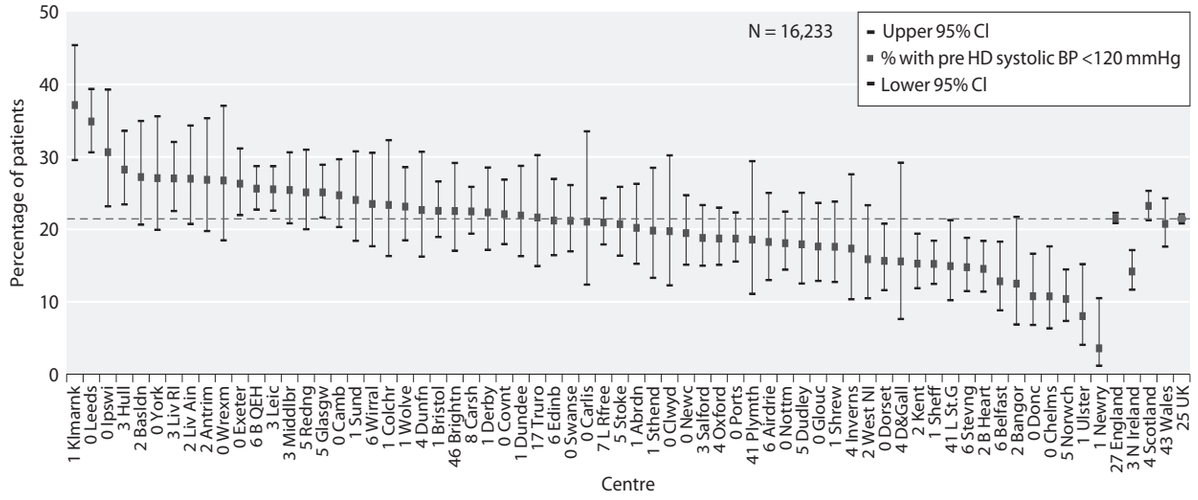

Fig 11.7. Percentage of patients with pre-dialysis SBP <120 mmHg

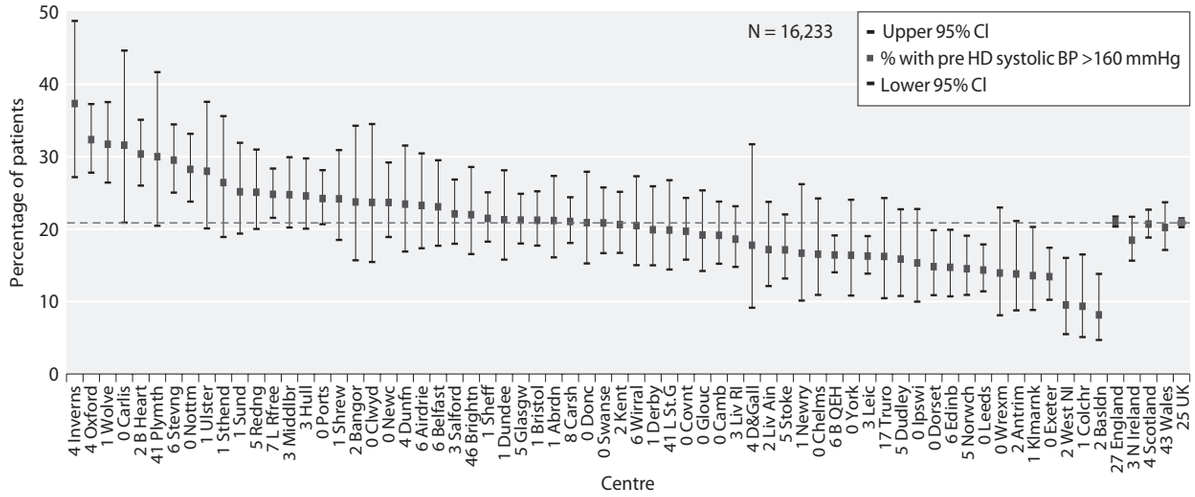

Fig 11.8. Percentage of patients with pre-dialysis SBP >160 mmHg

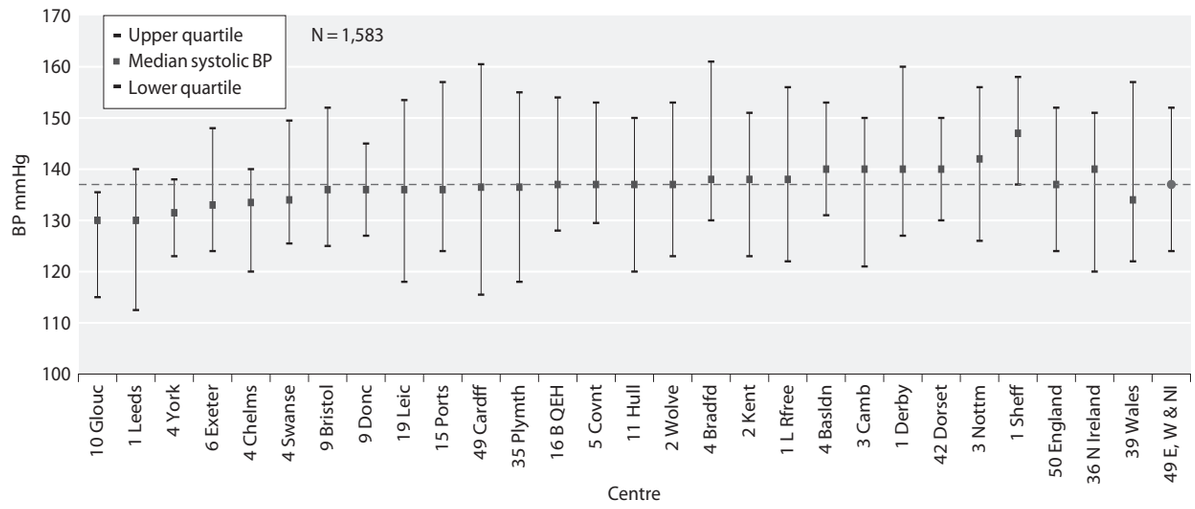

Fig. 11.9. Median systolic BP: PD

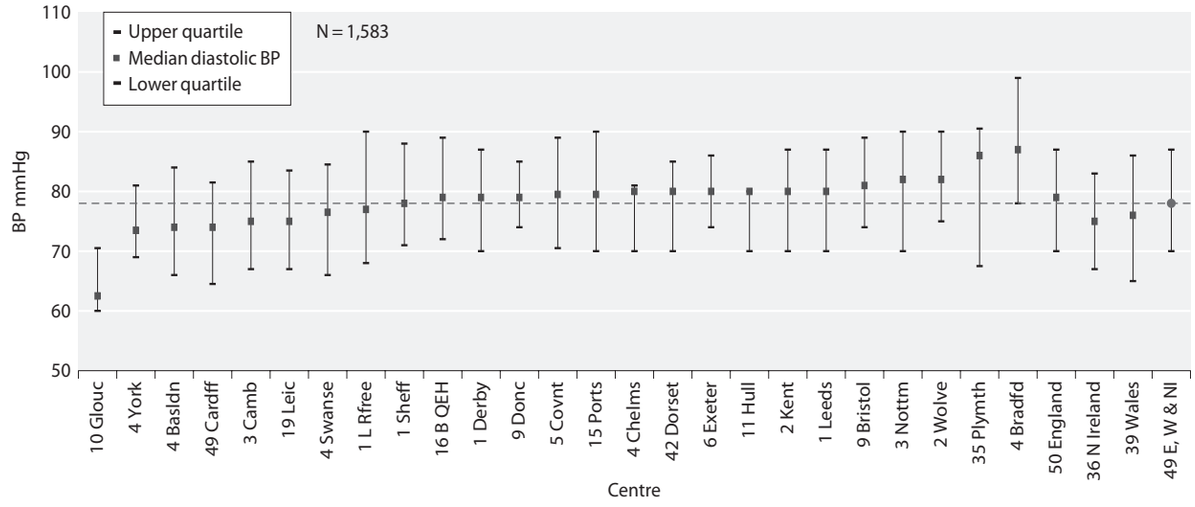

Fig. 11.10. Median diastolic BP: PD

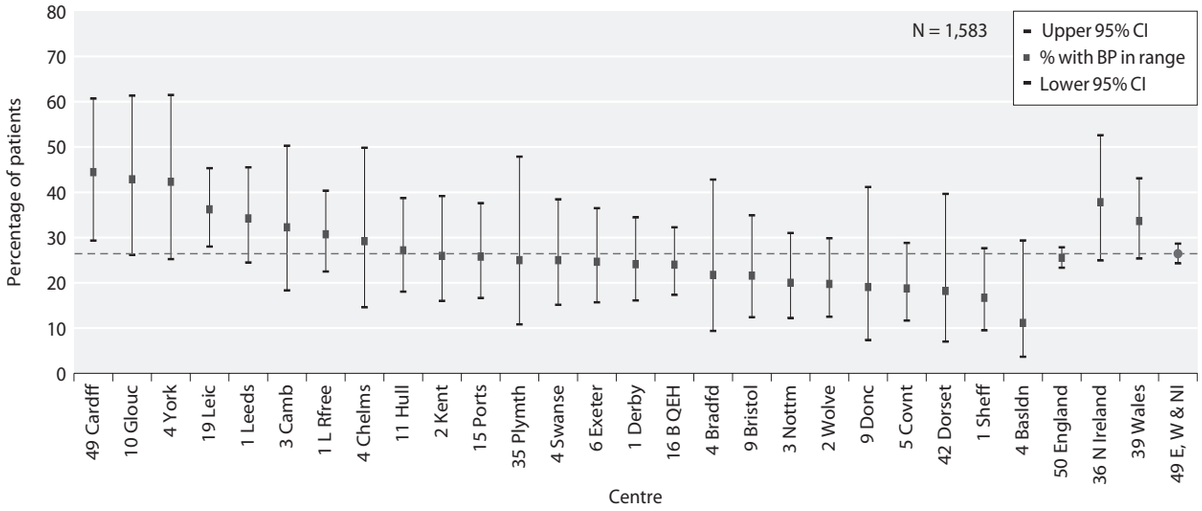

Fig. 11.11. Percentage of patients with BP <130 mmHg systolic and <80 mmHg diastolic: PD

patients meeting the audit standard of BP <130/80 mmHg.

The possibility of information bias in these analyses cannot be excluded since BP data are extracted from the routine clinical record.

Centre-specific analysis of BP in transplant patients

Figures 11.12 and 11.13 illustrate the median and IQR SBP and DBP in each centre supplying data on >50% of eligible patients and figure 11.14 illustrates the percentage of patients meeting the audit standard of BP <130/80 mmHg.

As with PD patients, the possibility of information bias in these analyses cannot be excluded.

Discussion

Blood pressure control amongst HD patients in the UK remained poor in 2012. Nearly half of centres had greater than 20% of their patients with pre-dialysis systolic BP <120 mmHg. There were also nearly half who had greater than 20% of their patients with pre-dialysis systolic BP >160 mmHg. There continues to be marked variation between centres in attainment of nationally agreed BP standards for those on PD and those with functioning kidney transplants.

High BP is common in HD patients and contributes to the observed excess of cardiovascular morbidity and mortality in these patients [24]. However, there is still

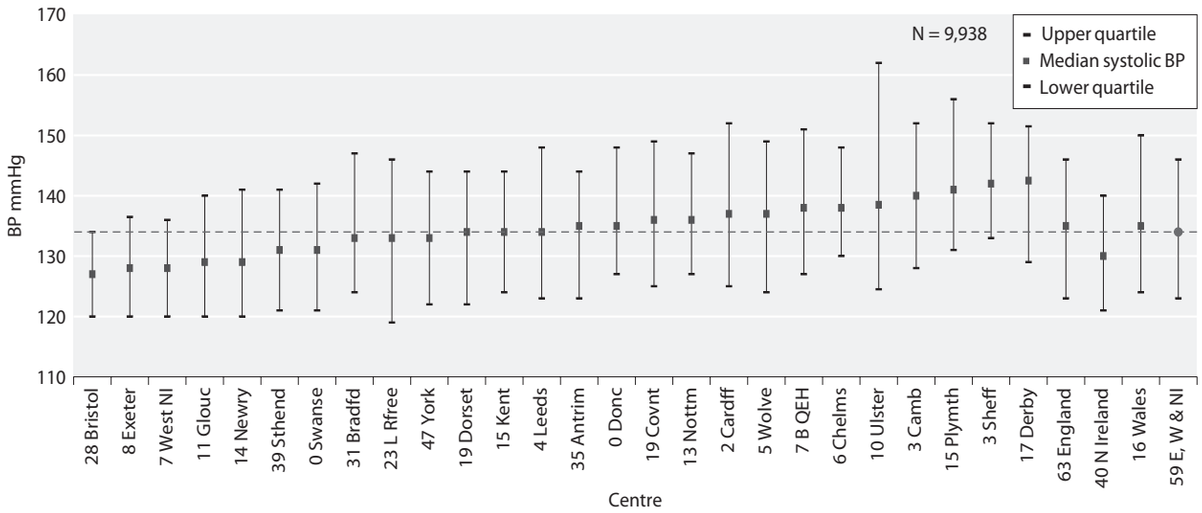

Fig. 11.12. Median systolic BP: transplant

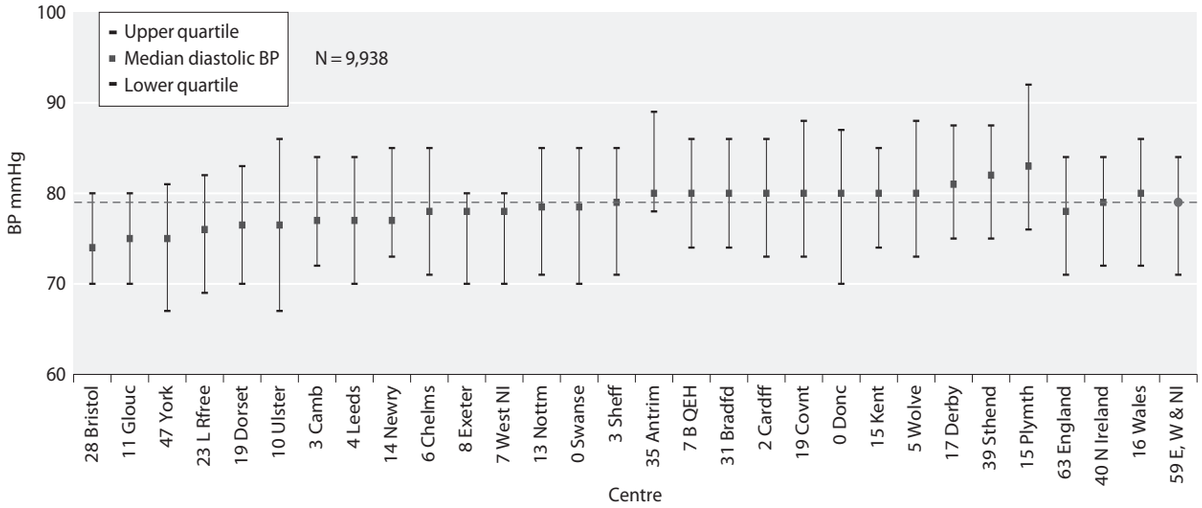

Fig. 11.13. Median diastolic BP: transplant

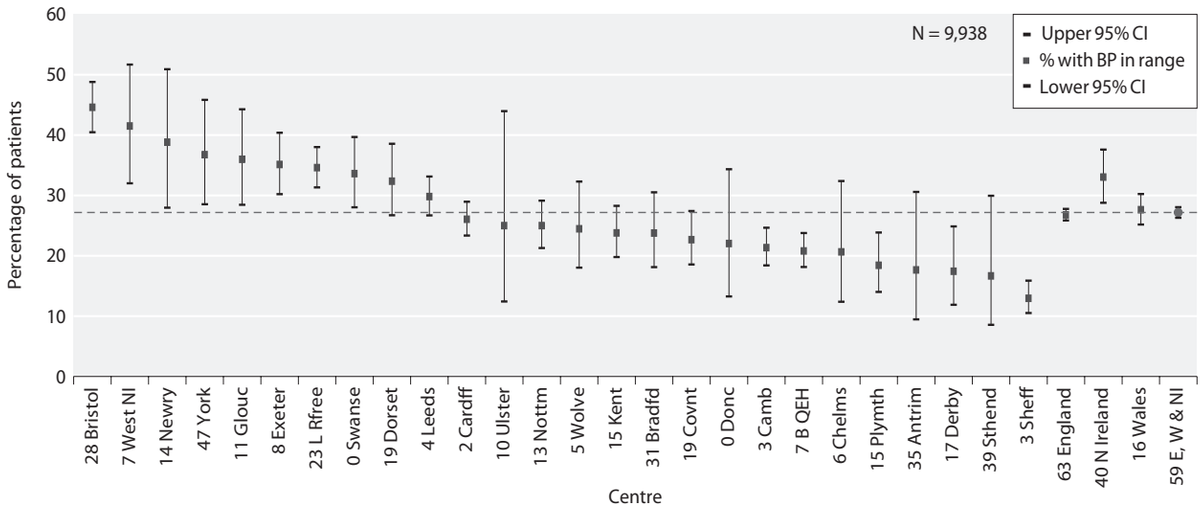

Fig. 11.14. Percentage of patients with BP <130 mmHg systolic and <80 mmHg diastolic: transplant

no clarity about how and when to measure BP, or about BP targets in the haemodialysis population.

Reliance upon immediate pre-dialysis and/or post-dialysis BP measurements alone to detect hypertension in patients undergoing haemodialysis may be misleading [25]. Pre-dialysis BP may substantially overestimate mean ambulatory inter-dialytic BP [26]. For pre-dialysis SBP the overestimate may range from 6–18 mmHg depending on the timing of the measurement and for DBP from 3–9 mmHg. In contrast, post-dialysis measurements underestimate mean systolic BP by approximately 4–14 mmHg for SBP and 1 mmHg for DBP. There are suggestions that post-dialysis BP may be more reflective of mean inter-dialytic BP [25, 26].

The utility of UKRR data could be enhanced by collection of data on intra-dialytic weight gain, the use of BP lowering drugs and the frequency of intra-dialytic hypotension. Future registry analyses should include systolic BP as an independent risk factor in models for predictors of death and variation in survival on dialysis.

Conflicts of interest: none

References

1 Kalantar-Zadeh K KR, Kopple JD. Reverse epidemiology of blood pressure in dialysis patients. Kidney Int. 2005;67(5):2067

2 Levin NW, Kotanko P, Eckardt KU, Kasiske BL, Chazot C, Cheung AK, Redon J, Wheeler DC, Zoccali C, London GM: Blood pressure in chronic kidney disease stage 5D-report from a Kidney Disease: Improving Global Outcomes controversies conference. Kidney Int. 2010;77:273–28
3 Robinson BM TL, Zhang J, Wolfe RA, Goodkin DA, Greenwood RN, Kerr PG, Morgenstern H, Li Y, Pisoni RL, Saran R, Tentori F, Akizawa T, Fukuhara S, Port FK. Blood pressure levels and mortality risk among hemodialysis patients in the Dialysis Outcomes and Practice Patterns Study. Kidney Int 2012;82(5):570–580
4 Chazot C, Vo-Van C, Deleaval P, Lorriaux C, Hurot JM, Mayor B, Jean G: Predialysis systolic blood pressure evolution in incident hemodialysis patients: effects of the dry weight method and prognostic value. Blood Purif. 2012;33:275–283
5 The FHN Trial Group. In-Center Hemodialysis Six Times per Week versus Three Times per Week. New England Journal of Medicine. 2010; 363:2287–2300
6 Krapf R, Hulter HN. Arterial Hypertension Induced by Erythropoietin and Erythropoiesis-Stimulating Agents (ESA). Clinical Journal of the American Society of Nephrology 2009;4(2):470–480
7 Oberbauer R, Kreis H, Johnson RW, Mota A, Claesson K, Ruiz JC, Wilczek H, Jamieson N, Henriques AC, Paczek L, Chapman J, Burke JT: Rapamune Maintenance Regimen Study Group: Long-term improvement in renal function with sirolimus after early cyclosporine withdrawal in renal transplant recipients: 2–year results of the Rapamune Maintenance Regimen Study. Transplantation 2003;76:364–370
8 Rohrscheib MR, Myers OB, Servilla KS, Adams CD, Miskulin D, Bedrick EJ, Hunt WC, Lindsey DE, Gabaldon D, Zager PG: Age-related blood pressure patterns and blood pressure variability among hemodialysis patients. Clin J Am Soc Nephrol 2008;3:1407–1414
9 Di Iorio B DML, Torraca S, Sirico ML, Guastaferro P, Chiuchiolo L, Nigro F, De Blasio A, Romano P, Pota A, Rubino R, Morrone L, Lopez T, Casino FG. Variability of blood pressure in dialysis patients: a new marker of cardiovascular risk. J Nephrol 2013;26(1):173–182
10 Agarwal R. Blood pressure and mortality among hemodialysis patients. Hypertension 2010;55(3):762–768
11 Zoccali C. Arterial pressure components and cardiovascular risk in end-stage renal disease. Nephrol. Dial. Transplant. 2003 Feb;18(2):249–252
12 Mazzuchi N, Carbonell E, Fernández-Cean J. Importance of blood pressure control in hemodialysis patient survival. Kidney Int. 2000 Nov;58(5):2147–2154
13 Tomita J, Kimura G, Inoue T, Inenaga T, Sanai T, Kawano Y, et al. Role of systolic blood pressure in determining prognosis of hemodialyzed patients. Am. J. Kidney Dis. 1995 Mar;25(3):405–412
14 Li Z, Lacson E, Lowrie EG, Ofsthun NJ, Kuhlmann MK, Lazarus JM, et al. The epidemiology of systolic blood pressure and death risk in hemodialysis patients. Am. J. Kidney Dis. 2006 Oct;48(4):606–615
15 Davenport A, Cox C, Thuraisingham R. Achieving blood pressure targets during dialysis improves control but increases intradialytic hypotension. Kidney Int. 2008 Mar;73(6):759–764
16 Shoji T, Tsubakihara Y, Fujii M, Imai E. Hemodialysis-associated hypotension as an independent risk factor for two-year mortality in hemodialysis patients. Kidney Int. 2004 Sep;66(3):1212–1220
17 Burton JO, Jefferies HJ, Selby NM, McIntyre CW. Hemodialysis-induced cardiac injury: determinants and associated outcomes. Clin J Am Soc Nephrol. 2009 May;4(5):914–920
18 Zager PG, Nikolic J, Brown RH, Campbell MA, Hunt WC, Peterson D, et al. "U" curve association of blood pressure and mortality in hemodialysis patients. Medical Directors of Dialysis Clinic, Inc. Kidney Int. 1998 Aug;54(2):561–569
19 Holt S, Goldsmith D: UK Renal Association Clinical Practice Guidelines Committee: 2010 RA Guidelines – Cardiovascular disease in CKD, 5th Edition. 2010. http://www.renal.org/Clinical/GuidelinesSection/CardiovascularDiseaseInCKD.aspx
20 Levin NW, Kotanko P, Eckardt KU, et al. Blood pressure in chronic kidney disease stage 5D-report from a Kidney Disease: Improving Global Outcomes controversies conference. Kidney Int 2010;77(4):273–284
21 KDIGO clinical practice guideline for the care of kidney transplant recipients. Am J Transplant 2009;9(suppl 3):S1–155
22 Ansell D, Tomson CR. UK Renal Registry 11th Annual Report (December 2008): Chapter 15 The UK Renal Registry, UKRR database, validation and methodology. Nephron Clin Pract 2009;111(suppl 1): c277–285
23 Webb L, Tomson CRV, Casula A, Farrington K: Registry 13th Annual Report (December 2010): Chapter 11 Blood Pressure Profile of Prevalent Patients receiving Renal Replacement Therapy in England, Wales and Northern Ireland in 2009: National and Centre-Specific Analyses. Nephron Clin Pract 2011;119(suppl 2):c215–c224
24 Foley RN, Parfrey PS, Harnett JD, Kent GM, Murray DC, Barre PE: Impact of hypertension on cardiomyopathy, morbidity and mortality in end-stage renal disease. Kidney Int 1996;49:1379–1385
25 Agarwal R, Peixoto, AJ, Santos SFF, Zoccali C. Pre- and post-dialysis blood pressures are imprecise estimates of interdialytic ambulatory blood pressure. Clin J Am Soc Nephrol 2006;1:389–398
26 Mitra S, Chandna SM, Farrington K. What is hypertension in chronic haemodialysis? The role of interdialytic blood pressure monitoring. Nephrol Dial Transplant. 1999;14(12):2915–21

UK Renal Registry 16th Annual Report: Chapter 12 Biochemical Variables amongst UK Adult Dialysis patients in 2012: National and Centre-specific Analyses

Johann Nicholas[a], Catriona Shaw[b], David Pitcher[b], Anne Dawnay[c]

[a]Royal Wolverhampton NHS Trust, UK; [b]UK Renal Registry, Bristol, UK; [c]University College London Hospitals, London, UK

Key Words
Bicarbonate · Biochemical variables · Calcium · Cholesterol · Dialysis · Haemodialysis · Parathyroid hormone · Peritoneal dialysis · Phosphate · Quality improvement

Summary

- 56% of HD patients and 61% of PD patients achieved the audit measure for phosphate.
- 32% of HD and 32% of PD patients had a serum phosphate above the audit standard range.
- 77% of HD and 78% of PD patients had adjusted calcium between 2.2–2.5 mmol/L.
- 58% of HD and 65% of PD patients had a serum PTH between 16–72 pmol/L.
- 16% of HD and 10% of PD patients had a serum PTH >72 pmol/L.
- Simultaneous control of all three parameters within current audit standards was achieved by 51% of HD and PD patients.
- 59% of HD and 80% of PD patients achieved the audit measure for bicarbonate.

Introduction

The UK Renal Registry (UKRR) collects routine biochemical data from clinical information systems in renal centres in England, Wales and Northern Ireland and receives data from Scotland via the Scottish Renal Registry. Annual cross sectional analyses are undertaken on some of these variables to determine centre level performance against national (Renal Association) clinical performance measures [1]. This enables UK renal centres to compare their own performance against each other and to the UK average performance [2]. Currently the 5th edition of the UK Renal Association clinical practice guidelines is in practice [1]. This edition commenced in a graded manner in 2009 and includes an expanded number of guideline modules compared to previous editions.

Audit measures for kidney disease increasingly include tighter specification limits in conjunction with a growing evidence base. Out of range observations (e.g. hyperphosphataemia and hypophosphataemia) need to be interpreted cautiously as they may relate to different clinical problems or population characteristics. These will therefore require different strategies to improve centre performance of clinical audit measures. To supplement these performance analyses, summary statistical data have been provided to enhance understanding of the population characteristics of each centre and longitudinal analyses demonstrate changes over time.

Methods

These analyses relate to biochemical variables in the prevalent dialysis cohort in England, Wales and Northern Ireland in 2012. Scotland is also included in analyses pertaining to phosphate control. The cohort studied were patients prevalent on dialysis treatment on 31st December 2012, excluding patients receiving dialysis for less than 90 days and those who had changed modality or renal centre in the last 90 days. Haemodialysis (HD) and peritoneal dialysis (PD) cohorts were analysed separately. A full definition of this cohort including inclusion and exclusion criteria is included in appendix B www.renalreg.com.

The biochemical variables analysed were phosphate, calcium, parathyroid hormone, bicarbonate and cholesterol. The method of data collection and validation by the UKRR has been described elsewhere [3]. For each quarter of 2012 the UKRR extracted biochemical data electronically from clinical information systems in UK dialysis centres. The UKRR does not collect data regarding different assay methods mainly because a single dialysis centre may process samples in several different laboratories. Scottish centres have only been included in analyses relating to phosphate control, with data for their prevalent dialysis cohort being supplied directly by the Scottish Renal Registry. The audit measure used for serum phosphate was 1.1–1.7 mmol/L in both the HD and PD cohorts [1, 3]. For centres providing adjusted calcium values, these data were analysed directly as it is these values on which clinical decisions within centres are based. For centres providing unadjusted calcium values, a formula in widespread use was used to calculate adjusted calcium [4]. The audit measure for adjusted calcium depends on a local reference range [1, 3]. The UKRR has used the RA guideline standard of adjusted calcium between 2.2–2.5 mmol/L as the audit measure for these analyses. There are also a variety of methods and reference ranges in use to measure parathyroid hormone (PTH). To enable some form of comparative audit the UKRR has used 2–9 times the median upper limit of the reference range (8 pmol/L) as the audit measure in line with the 5th edition of the Renal Association clinical practice guidelines that were current during 2012 and KDIGO 2009 guidance [3, 5]. This equates to a PTH of 16–72 pmol/L. The audit measure used for serum bicarbonate in the HD cohort was 18–24 mmol/L as per the updated haemodialysis guidelines and in the PD cohort was 22–30 mmol/L [1]. A summary of the current Renal Association audit measures and conversion factors to SI units are given in table 12.1.

Quarterly values were extracted from the database for the last two quarters for calcium, phosphate and bicarbonate; the last three quarters for PTH and the entire year for cholesterol. Patients who did not have these data were excluded from the analyses. Data completeness was analysed at centre and country level. All patients were included in analyses but centres with less than 50% completeness were excluded from plots showing centre level performance. Data were also excluded from plots when there were less than 20 patients with data both at centre or country level. These data were analysed to calculate summary

Table 12.1. Summary of clinical audit measures and conversion factors from SI units

Biochemical variable	Clinical audit measure	Conversion factor from SI units
Phosphate	HD Patients: 1.1–1.7 mmol/L PD Patients: 1.1–1.7 mmol/L	mg/dl = mmol/L × 3.1
Calcium (adjusted)	Normal range (ideally <2.5 mmol/L)	mg/dl = mmol/L × 4
Parathyroid hormone	2–9 times upper limit of normal	ng/L = pmol × 9.5
Bicarbonate	HD Patients: 18–24 mmol/L PD Patients: 22–30 mmol/L	mg/dl = mmol/L × 6.1
Cholesterol	No audit measure	mg/dl = mmol/L × 38.6

descriptive statistics (maximum, minimum, mean and median values in addition to standard deviation and quartile ranges). Where applicable, the percentage achieving the Renal Association standard or other surrogate clinical performance measure was also calculated.

The simultaneous control of all three components of bone and mineral disorder (BMD) parameters were analysed in combination. Thus, the control of none, one, two or three parameters, as well as an analysis of combinations of calcium-PTH, calcium-phosphate and phosphate-PTH were collated, with an emphasis on evaluating the effective management and prevention of severe hyperparathyroidism (maintaining PTH $\leqslant$72 pmol/L). For the purpose of this analysis, the corrected calcium standard of between 2.2–2.5 mmol/L, a phosphate level being maintained at or below 1.7 mmol/L and a PTH level being at or below 72 pmol/L, were evaluated in combination.

The analyses presented in this chapter are descriptive. As data are provided unadjusted for confounding factors and due to concerns regarding measurement error in many of the biochemical parameters, hypothesis testing was not utilised.

Centres report several biochemical variables with different levels of accuracy, leading to problems in comparative evaluation. For example, in the case of serum bicarbonate, data can be submitted as integer values but some centres submit data to one decimal place. All data has been rounded up in an attempt to make all centres more comparable.

The number preceding the centre name in each figure indicates the percentage of missing data for that centre. Funnel plot analysis was used to identify 'outlying centres' [6]. The percentage achieving each standard was plotted against centre size along with the upper and lower 95% and 99.9% limits. Centres can be identified on these plots by looking up the number of patients treated in each centre provided in the relevant table and finding this value on the x-axis. Longitudinal analyses were performed for some data to calculate overall changes in achievement of a performance measure annually from 2002 to 2012 and were recalculated for each previous year using the rounding procedure. All data were unadjusted for case-mix.

Results and discussions

Mineral and bone variables

Phosphate

In 2012 the following Renal Association clinical practice guideline regarding phosphate management was applicable:

Guideline 3.2 CKD-MBD: Serum phosphate in dialysis patients

'We suggest that serum phosphate in dialysis patients, measured before a "short-gap" dialysis session in haemodialysis patients, should be maintained between 1.1 and 1.7 mmol/L (2C)' [3]

The data completeness for serum phosphate across the UK was 96% for HD patients and 98% for PD patients although there was considerable variation between centres (tables 12.2 and 12.4). The individual centre means and standard deviations are shown in tables 12.2 and 12.4. Fifty-six percent (95% CI 55–57%) of HD patients and 61% (95% CI 59–63%) of PD patients achieved a phosphate level within the target range specified by the RA clinical audit measure (tables 12.3, 12.5). The proportion of HD patients with hyperphosphataemia was 32% and the proportion with hypophosphataemia was 12% (table 12.3, figures 12.1, 12.2). The proportion of PD patients with hyperphosphataemia was 32% and the proportion with hypophosphataemia was 7% (table 12.5, figures 12.3, 12.4). Longitudinal analysis showed a trend towards improved phosphate control for England, Northern Ireland and Wales combined between 2002 and 2012 that has plateaued in recent years (figure 12.5).

There was significant between centre variation in the proportion of patients below, within and above the phosphate range specified by the clinical performance measure (figures 12.1–12.4). Of note, the percentage of PD patients achieving the target decreased substantially from 2011 for Birmingham Heartlands (from 66% to 43%) and for Cambridge (from 72% to 47%). The same fall was not seen for HD patients at these centres. If the phosphate analyses for both HD and PD patients were conducted in the same laboratories for each centre, it suggests that this was not due to any change in laboratory methods.

Adjusted calcium

In 2012, the following Renal Association clinical practice guideline regarding calcium management was applicable:

Guideline 2.2 CKD-MBD: Serum calcium in dialysis patients (stage 5D)

'We suggest that serum calcium, adjusted for albumin concentration, should be maintained within the normal reference range for the laboratory used, measured before a "short-gap" dialysis session in haemodialysis patients. Ideally, adjusted serum calcium should be maintained between 2.2 and 2.5 mmol/L, with avoidance of hypercalcaemic episodes (2D)' [3]

The current guidelines are based upon adjusted serum calcium. A variety of formulae have been proposed to permit calculation of the 'adjusted' total calcium (i.e. an

Table 12.2. Summary statistics for phosphate in haemodialysis patients in 2012

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
England							
B Heart	100.0	401	1.7	0.6	1.6	1.3	2.0
B QEH	96.2	831	1.6	0.5	1.5	1.3	1.8
Basldn	97.3	146	1.4	0.4	1.4	1.2	1.7
Bradfd	98.4	186	1.4	0.6	1.3	1.0	1.7
Brightn	95.6	323	1.6	0.5	1.6	1.2	1.9
Bristol	100.0	461	1.6	0.5	1.5	1.3	1.9
Camb	95.7	310	1.5	0.4	1.5	1.2	1.8
Carlis	100.0	57	1.8	0.7	1.6	1.4	1.9
Carsh	93.4	652	1.6	0.5	1.5	1.3	1.9
Chelms	100.0	121	1.5	0.4	1.5	1.2	1.8
Colchr	92.6	100	1.6	0.4	1.6	1.3	1.8
Covnt	99.7	334	1.7	0.5	1.6	1.3	2.0
Derby	99.5	208	1.6	0.5	1.5	1.3	1.9
Donc	100.0	158	1.5	0.5	1.4	1.2	1.7
Dorset	99.6	243	1.6	0.5	1.5	1.2	1.9
Dudley	100.0	153	1.7	0.5	1.6	1.3	2.0
Exeter	100.0	351	1.5	0.5	1.5	1.2	1.8
Glouc	100.0	193	1.5	0.5	1.4	1.2	1.8
Hull	100.0	310	1.5	0.5	1.5	1.2	1.8
Ipswi	100.0	124	1.5	0.5	1.4	1.2	1.7
Kent	98.3	355	1.7	0.5	1.6	1.3	1.9
L Barts	99.8	844	1.6	0.5	1.6	1.3	1.9
L Guys	89.0	527	1.5	0.5	1.5	1.2	1.8
L Kings	99.8	459	1.5	0.4	1.4	1.2	1.7
L Rfree	84.4	564	1.5	0.5	1.5	1.2	1.8
L St.G	96.3	261	1.5	0.5	1.5	1.2	1.8
L West	98.6	1,323	1.5	0.5	1.5	1.2	1.8
Leeds	100.0	454	1.6	0.5	1.5	1.2	1.9
Leic	99.8	799	1.7	0.5	1.6	1.3	2.0
Liv Ain	98.2	163	1.5	0.5	1.4	1.1	1.8
Liv RI	99.4	343	1.5	0.5	1.4	1.1	1.8
M RI	92.2	437	1.6	0.5	1.5	1.2	1.9
Middlbr	99.4	310	1.6	0.5	1.5	1.3	1.9
Newc	100.0	262	1.6	0.5	1.5	1.3	1.9
Norwch	100.0	303	1.6	0.5	1.6	1.3	1.9
Nottm	99.7	354	1.5	0.5	1.5	1.2	1.8
Oxford	100.0	389	1.6	0.5	1.6	1.3	1.9
Plymth	100.0	119	1.5	0.5	1.4	1.2	1.8
Ports	99.8	509	1.7	0.5	1.6	1.4	2.0
Prestn	99.6	494	1.7	0.5	1.6	1.3	1.9
Redng	100.0	251	1.5	0.4	1.5	1.2	1.8
Salford	88.1	304	1.5	0.6	1.5	1.1	1.8
Sheff	99.8	561	1.6	0.5	1.6	1.3	1.8
Shrew	99.5	183	1.6	0.6	1.5	1.2	1.8
Stevng	99.2	377	1.7	0.5	1.6	1.3	1.9
Sthend	100.0	107	1.6	0.5	1.6	1.3	1.9
Stoke	86.1	253	1.5	0.5	1.4	1.2	1.8
Sund	0.0	0					
Truro	99.3	133	1.5	0.5	1.4	1.2	1.8
Wirral	97.7	173	1.5	0.5	1.5	1.2	1.8
Wolve	98.9	267	1.5	0.6	1.4	1.1	1.8
York	100.0	122	1.5	0.5	1.4	1.1	1.7
N Ireland							
Antrim	100.0	126	1.4	0.5	1.3	1.1	1.7
Belfast	99.0	206	1.5	0.5	1.5	1.2	1.8
Newry	100.0	85	1.7	0.5	1.6	1.3	2.0
Ulster	100.0	101	1.6	0.4	1.5	1.3	1.7
West NI	100.0	129	1.7	0.5	1.6	1.3	1.9

Table 12.2. Continued

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
Scotland							
Abrdn	94.4	202	1.5	0.5	1.4	1.1	1.8
Airdrie	93.8	165	1.5	0.5	1.4	1.1	1.9
D & Gall	95.8	46	1.5	0.5	1.5	1.2	1.8
Dundee	98.8	169	1.6	0.5	1.6	1.4	1.9
Dunfn	95.0	133	1.7	0.5	1.7	1.4	2.0
Edinb	94.0	235	1.7	0.5	1.6	1.3	1.9
Glasgw	86.0	498	1.6	0.5	1.6	1.3	1.9
Inverns	74.0	54	1.8	0.6	1.8	1.4	2.1
Klmarnk	88.7	125	1.4	0.5	1.4	1.0	1.7
Wales							
Bangor	100.0	82	1.6	0.4	1.5	1.3	1.9
Cardff	99.3	445	1.6	0.5	1.5	1.2	1.8
Clwyd	100.0	76	1.6	0.6	1.5	1.3	1.9
Swanse	100.0	308	1.5	0.5	1.4	1.2	1.8
Wrexm	100.0	86	1.3	0.4	1.3	1.1	1.6
England	**96.4**	**17,662**	**1.6**	**0.5**	**1.5**	**1.2**	**1.8**
N Ireland	**99.7**	**647**	**1.6**	**0.5**	**1.5**	**1.2**	**1.8**
Scotland	**90.8**	**1,627**	**1.6**	**0.5**	**1.5**	**1.2**	**1.9**
Wales	**99.7**	**997**	**1.5**	**0.5**	**1.5**	**1.2**	**1.8**
UK	**96.2**	**20,933**	**1.6**	**0.5**	**1.5**	**1.2**	**1.8**

Blank cells denote no data returned

Table 12.3. Percentage of haemodialysis patients within, below and above the range specified in the RA audit measure for phosphate (1.1–1.7 mmol/L) in 2012

Centre	*N*	% phos 1.1–1.7 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	% phos >1.7 mmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
England									
B Heart	401	52.4	47.5	57.2	11.0	36.7	−3.7	−10.5	3.2
B QEH	831	58.1	54.7	61.4	11.0	30.9	−1.4	−6.1	3.4
Basldn	146	62.3	54.2	69.8	17.1	20.6	7.9	−3.7	19.4
Bradfd	186	50.5	43.4	57.7	25.8	23.7	1.4	−8.9	11.7
Brightn	323	55.1	49.6	60.5	9.9	35.0	0.9	−6.9	8.7
Bristol	461	53.8	49.2	58.3	10.0	36.2	−2.0	−8.5	4.4
Camb	310	65.2	59.7	70.3	9.7	25.2	0.3	−7.1	7.7
Carlis	57	52.6	39.8	65.1	8.8	38.6	−0.8	−19.1	17.4
Carsh	652	58.7	54.9	62.5	8.9	32.4	−3.2	−8.5	2.1
Chelms	121	65.3	56.4	73.2	8.3	26.5	7.9	−4.5	20.3
Colchr	100	71.0	61.4	79.0	4.0	25.0	9.0	−4.0	22.0
Covnt	334	56.6	51.2	61.8	6.0	37.4	−4.7	−12.2	2.8
Derby	208	55.8	49.0	62.4	9.6	34.6	−2.2	−12.0	7.6
Donc	158	64.6	56.8	71.6	12.7	22.8	2.5	−8.2	13.2
Dorset	243	54.7	48.4	60.9	14.0	31.3	−11.6	−20.5	−2.8
Dudley	153	52.9	45.0	60.7	7.2	39.9	1.5	−10.1	13.0
Exeter	351	58.1	52.9	63.2	12.5	29.3	−3.4	−10.8	4.0
Glouc	193	59.1	52.0	65.8	14.5	26.4	−9.8	−19.4	−0.1
Hull	310	60.0	54.4	65.3	13.6	26.5	−1.7	−9.4	6.0
Ipswi	124	59.7	50.8	67.9	16.1	24.2	6.0	−6.4	18.3
Kent	355	53.5	48.3	58.7	9.0	37.5	−3.1	−10.4	4.3
L Barts	844	51.4	48.1	54.8	12.0	36.6	0.6	−4.2	5.4
L Guys	527	59.0	54.8	63.1	14.0	26.9	4.0	−2.2	10.1
L Kings	459	64.1	59.6	68.3	13.5	22.4	2.4	−3.9	8.8
L Rfree	564	56.9	52.8	61.0	14.5	28.6	0.8	−5.0	6.6

Table 12.3. Continued

Centre	*N*	% phos 1.1–1.7 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	% phos >1.7 mmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
L St.G	261	55.2	49.1	61.1	18.8	26.1	2.8	−5.7	11.2
L West	1,323	57.9	55.2	60.5	15.0	27.1	3.4	−0.4	7.2
Leeds	454	51.1	46.5	55.7	15.6	33.3	−4.6	−11.0	1.9
Leic	799	52.4	49.0	55.9	8.5	39.1	−8.8	−13.7	−3.9
Liv Ain	163	56.4	48.7	63.9	18.4	25.2	−5.7	−16.5	5.2
Liv RI	343	53.6	48.4	58.9	19.0	27.4	−0.6	−8.0	6.7
M RI	437	51.0	46.4	55.7	15.1	33.9	−2.8	−9.6	4.0
Middlbr	310	55.5	49.9	60.9	11.3	33.2	−2.7	−10.7	5.3
Newc	262	56.5	50.4	62.4	10.3	33.2	2.3	−6.4	11.0
Norwch	303	59.4	53.8	64.8	6.6	34.0	−1.8	−9.7	6.0
Nottm	354	57.9	52.7	63.0	15.3	26.8	−5.6	−12.7	1.4
Oxford	389	54.5	49.5	59.4	10.0	35.5	2.1	−5.0	9.2
Plymth	119	60.5	51.5	68.9	14.3	25.2	0.3	−12.0	12.7
Ports	509	52.1	47.7	56.4	9.0	38.9	5.2	−1.1	11.4
Prestn	494	51.6	47.2	56.0	9.9	38.5	−2.9	−9.1	3.4
Redng	251	58.2	52.0	64.1	14.3	27.5	−5.7	−14.2	2.9
Salford	304	53.0	47.3	58.5	21.1	26.0	2.5	−5.6	10.5
Sheff	561	59.5	55.4	63.5	8.6	31.9	−0.8	−6.6	4.9
Shrew	183	54.1	46.8	61.2	16.4	29.5	1.5	−8.9	11.9
Stevng	377	56.5	51.4	61.4	6.9	36.6	4.8	−2.3	11.9
Sthend	107	46.7	37.5	56.2	13.1	40.2	5.5	−7.6	18.6
Stoke	253	57.7	51.5	63.7	13.0	29.3	−3.9	−12.2	4.3
Truro	133	57.1	48.6	65.3	16.5	26.3	−3.0	−14.7	8.7
Wirral	173	56.7	49.2	63.8	14.5	28.9	−1.4	−12.0	9.2
Wolve	267	54.3	48.3	60.2	18.7	27.0	2.9	−5.4	11.2
York	122	59.0	50.1	67.4	16.4	24.6	4.2	−8.4	16.8
N Ireland									
Antrim	126	57.1	48.4	65.5	22.2	20.6	4.7	−7.7	17.1
Belfast	206	51.5	44.7	58.2	17.0	31.6	−2.5	−12.1	7.2
Newry	85	50.6	40.1	61.0	10.6	38.8	−1.4	−15.9	13.0
Ulster	101	68.3	58.6	76.6	7.9	23.8	3.0	−10.0	15.9
West NI	129	53.5	44.9	61.9	7.8	38.8	−3.2	−15.2	8.8
Scotland									
Abrdn	202	56.9	50.0	63.6	17.3	25.7	2.5	−7.3	12.3
Airdrie	165	49.1	41.5	56.7	23.6	27.3	−4.7	−15.6	6.2
D & Gall	46	56.5	42.1	70.0	13.0	30.4	−1.0	−22.0	20.0
Dundee	169	52.1	44.6	59.5	10.7	37.3	−4.5	−15.1	6.1
Dunfn	133	56.4	47.9	64.6	2.3	41.4	−2.7	−14.5	9.1
Edinb	235	54.5	48.1	60.7	7.7	37.9	−2.9	−11.9	6.1
Glasgw	498	51.6	47.2	56.0	11.9	36.6	−4.8	−11.0	1.4
Inverns	54	38.9	26.9	52.4	9.3	51.9	−5.6	−22.9	11.8
Klmarnk	125	52.8	44.1	61.4	25.6	21.6	−4.2	−16.3	7.9
Wales									
Bangor	82	64.6	53.8	74.2	4.9	30.5	−0.1	−14.6	14.4
Cardff	445	58.7	54.0	63.1	10.6	30.8	3.2	−3.3	9.7
Clwyd	76	54.0	42.7	64.8	11.8	34.2	−2.0	−18.9	14.9
Swanse	308	62.3	56.8	67.6	10.7	27.0	−0.3	−7.9	7.2
Wrexm	86	59.3	48.7	69.1	23.3	17.4	17.8	3.0	32.7
England	**17,662**	**56.2**	**55.5**	**56.9**	**12.4**	**31.4**	**−0.7**	**−1.7**	**0.3**
N Ireland	**647**	**55.5**	**51.6**	**59.3**	**13.9**	**30.6**	**−0.2**	**−5.6**	**5.2**
Scotland	**1,627**	**52.7**	**50.2**	**55.1**	**13.2**	**34.1**	**−3.2**	**−6.6**	**0.2**
Wales	**997**	**60.0**	**56.9**	**63.0**	**11.3**	**28.7**	**2.5**	**−1.8**	**6.8**
UK	**20,933**	**56.1**	**55.4**	**56.8**	**12.4**	**31.5**	**−0.7**	**−1.7**	**0.2**

Table 12.4. Summary statistics for phosphate in peritoneal dialysis patients in 2012

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
England							
B Heart	100.0	42	1.7	0.4	1.75	1.5	2
B QEH	98.0	146	1.6	0.5	1.5	1.2	1.8
Basldn	96.4	27	1.5	0.4	1.4	1.2	1.8
Bradfd	95.8	23	1.7	0.4	1.7	1.4	2
Brightn	94.2	65	1.6	0.4	1.6	1.2	1.9
Bristol	100.0	56	1.8	0.5	1.7	1.5	2
Camb	100.0	32	1.5	0.4	1.45	1.05	1.8
Carlis	100.0	21	1.6	0.4	1.4	1.3	1.7
Carsh	97.9	95	1.6	0.4	1.5	1.3	1.8
Chelms	100.0	25	1.5	0.4	1.5	1.2	1.8
Colchr							
Covnt	91.7	77	1.4	0.3	1.4	1.2	1.6
Derby	100.0	84	1.5	0.4	1.4	1.2	1.7
Donc	100.0	23	1.7	0.4	1.6	1.3	1.9
Dorset	92.1	35	1.5	0.3	1.5	1.2	1.7
Dudley	100.0	53	1.8	0.4	1.8	1.5	2.2
Exeter	98.6	68	1.6	0.4	1.6	1.3	1.8
Glouc	96.8	30	1.6	0.4	1.6	1.3	1.8
Hull	96.2	76	1.7	0.4	1.6	1.4	1.9
Ipswi	100.0	30	1.6	0.4	1.55	1.3	1.8
Kent	98.2	54	1.7	0.5	1.6	1.4	1.9
L Barts	98.8	165	1.6	0.5	1.5	1.2	1.8
L Guys	96.3	26	1.5	0.4	1.5	1.3	1.7
L Kings	100.0	76	1.6	0.4	1.5	1.3	1.8
L Rfree	99.0	101	1.6	0.4	1.5	1.4	1.8
L St.G	97.9	47	1.5	0.3	1.5	1.3	1.7
L West	100.0	47	1.5	0.4	1.4	1.2	1.7
Leeds	100.0	77	1.7	0.4	1.7	1.4	1.9
Leic	97.9	140	1.6	0.4	1.6	1.3	1.8
Liv Ain	100.0	17					
Liv RI	98.2	54	1.5	0.4	1.45	1.2	1.7
M RI	100.0	76	1.7	0.4	1.65	1.4	1.9
Middlbr	87.5	7					
Newc	86.5	32	1.7	0.3	1.7	1.45	2
Norwch	100.0	48	1.5	0.4	1.5	1.3	1.75
Nottm	100.0	72	1.6	0.5	1.6	1.3	1.85
Oxford	100.0	69	1.7	0.5	1.6	1.3	1.9
Plymth	93.6	29	1.6	0.4	1.5	1.2	1.8
Ports	100.0	78	1.6	0.4	1.5	1.4	1.8
Prestn	98.3	58	1.7	0.4	1.7	1.4	2
Redng	100.0	63	1.5	0.4	1.5	1.3	1.7
Salford	93.3	84	1.6	0.5	1.6	1.3	1.9
Sheff	100.0	67	1.7	0.4	1.6	1.4	1.9
Shrew	97.0	32	1.8	0.5	1.6	1.45	1.95
Stevng	100.0	27	1.5	0.3	1.5	1.4	1.7
Sthend	100.0	14					
Stoke	100.0	69	1.6	0.5	1.7	1.3	1.9
Sund	100.0	17					
Truro	100.0	19					
Wirral	72.4	21	1.6	0.3	1.5	1.4	1.6
Wolve	97.6	81	1.6	0.5	1.5	1.3	1.9
York	100.0	27	1.7	0.4	1.6	1.4	2
N Ireland							
Antrim	100.0	10					
Belfast	100.0	25	1.5	0.4	1.6	1.2	1.8
Newry	100.0	14					
Ulster	100.0	6					
West NI	100.0	15					

Table 12.4. Continued

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
Scotland							
Abrdn	100.0	20	1.7	0.3	1.75	1.4	1.9
Airdrie	100.0	10					
D & Gall	92.9	13					
Dundee	94.7	18					
Dunfn	95.0	19					
Edinb	100.0	35	1.7	0.5	1.7	1.2	2.1
Glasgw	100.0	40	1.7	0.4	1.7	1.4	1.9
Inverns	86.7	13					
Klmarnk	100.0	40	1.6	0.3	1.6	1.4	1.85
Wales							
Bangor	100.0	14					
Cardff	98.6	70	1.5	0.4	1.45	1.2	1.7
Clwyd	100.0	15					
Swanse	98.2	53	1.5	0.4	1.5	1.3	1.7
Wrexm	95.0	19					
England	**97.8**	**2,802**	**1.6**	**0.4**	**1.6**	**1.3**	**1.8**
N Ireland	**100.0**	**70**	**1.6**	**0.4**	**1.6**	**1.2**	**1.8**
Scotland	**97.7**	**208**	**1.7**	**0.4**	**1.6**	**1.4**	**1.9**
Wales	**98.3**	**171**	**1.5**	**0.4**	**1.5**	**1.3**	**1.8**
UK	**97.9**	**3,251**	**1.6**	**0.4**	**1.6**	**1.3**	**1.8**

Blank cells denote centres excluded from analyses due to low patient numbers or poor data completeness

Table 12.5. Percentage of peritoneal dialysis patients within, below and above the range specified in the RA audit measure for phosphate (1.1–1.7 mmol/L) in 2012

Centre	*N*	% phos 1.1–1.7 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	% phos >1.7 mmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
England									
B Heart	42	42.9	28.9	58.0	7.1	50.0	−22.9	−44.2	−1.7
B QEH	146	67.8	59.8	74.9	6.9	25.3	4.1	−6.8	15.0
Basldn	27	59.3	40.3	75.8	11.1	29.6	0.9	−26.1	28.0
Bradfd	23	56.5	36.3	74.8	0.0	43.5	1.0	−26.6	28.6
Brightn	65	49.2	37.4	61.2	10.8	40.0	−16.4	−33.2	0.4
Bristol	56	53.6	40.6	66.1	1.8	44.6	−2.4	−20.6	15.8
Camb	32	46.9	30.6	63.9	25.0	28.1	−25.0	−48.3	−1.7
Carlis	21	76.2	54.0	89.7	0.0	23.8	n/a	n/a	n/a
Carsh	95	64.2	54.1	73.2	5.3	30.5	0.1	−13.7	13.8
Chelms	25	52.0	33.1	70.4	16.0	32.0	2.0	−26.6	30.6
Covnt	77	76.6	65.9	84.8	9.1	14.3	9.1	−5.0	23.2
Derby	84	63.1	52.3	72.7	16.7	20.2	−2.5	−16.6	11.5
Donc	23	56.5	36.3	74.8	8.7	34.8	−19.7	−46.9	7.6
Dorset	35	65.7	48.8	79.4	11.4	22.9	−9.3	−29.6	11.0
Dudley	53	43.4	30.8	56.9	1.9	54.7	−3.5	−22.9	15.8
Exeter	68	63.2	51.2	73.8	10.3	26.5	−5.6	−21.9	10.7
Glouc	30	63.3	45.1	78.4	6.7	30.0	7.1	−17.3	31.4
Hull	76	61.8	50.5	72.0	2.6	35.5	0.5	−15.0	16.0
Ipswi	30	63.3	45.1	78.4	6.7	30.0	3.3	−21.3	27.9
Kent	54	53.7	40.5	66.5	11.1	35.2	−16.8	−34.3	0.8
L Barts	165	58.2	50.5	65.5	11.5	30.3	−13.6	−24.1	−3.2
L Guys	26	73.1	53.3	86.6	7.7	19.2	23.1	−2.1	48.3
L Kings	76	63.2	51.8	73.2	9.2	27.6	−1.1	−16.7	14.5
L Rfree	101	62.4	52.6	71.3	7.9	29.7	−7.6	−21.4	6.2

Table 12.5. Continued

Centre	*N*	% phos 1.1–1.7 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	% phos >1.7 mmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
L St.G	47	74.5	60.2	84.9	2.1	23.4	11.7	−6.5	29.9
L West	47	70.2	55.8	81.5	8.5	21.3	4.6	−16.4	25.6
Leeds	77	58.4	47.2	68.9	3.9	37.7	−5.8	−20.9	9.4
Leic	140	63.6	55.3	71.1	7.9	28.6	3.4	−8.0	14.8
Liv RI	54	72.2	58.9	82.5	5.6	22.2	0.3	−16.4	17.0
M RI	76	52.6	41.5	63.5	6.6	40.8	−3.7	−19.8	12.4
Newc	32	56.3	39.0	72.1	0.0	43.8	−2.3	−25.2	20.6
Norwch	48	60.4	46.1	73.1	14.6	25.0	−12.5	−31.2	6.2
Nottm	72	52.8	41.3	64.0	9.7	37.5	0.1	−16.1	16.3
Oxford	69	55.1	43.3	66.3	5.8	39.1	3.9	−12.1	19.8
Plymth	29	62.1	43.6	77.6	6.9	31.0	1.0	−22.8	24.7
Ports	78	65.4	54.2	75.1	2.6	32.1	12.8	−2.5	28.1
Prestn	58	58.6	45.7	70.5	1.7	39.7	−4.3	−22.4	13.7
Redng	63	68.3	55.9	78.5	7.9	23.8	−1.2	−16.9	14.5
Salford	84	54.8	44.1	65.0	7.1	38.1	−0.6	−15.2	14.1
Sheff	67	58.2	46.2	69.4	3.0	38.8	−17.7	−34.1	−1.3
Shrew	32	62.5	44.9	77.3	0.0	37.5	−6.7	−31.1	17.7
Stevng	27	81.5	62.5	92.1	7.4	11.1	23.8	−0.2	47.8
Stoke	69	55.1	43.3	66.3	7.3	37.7	−14.5	−30.5	1.5
Wirral	21	76.2	54.0	89.7	4.8	19.1	20.2	−6.5	46.8
Wolve	81	59.3	48.3	69.4	7.4	33.3	−0.4	−16.7	15.8
York	27	55.6	36.9	72.8	3.7	40.7	−4.4	−32.9	24.1
N Ireland									
Belfast	25	48.0	29.6	66.9	16.0	36.0	−23.4	−49.2	2.3
Scotland									
Abrdn	20	50.0	29.4	70.6	0.0	50.0	−4.6	−34.8	25.7
Edinb	35	45.7	30.2	62.1	8.6	45.7	−2.9	−26.2	20.5
Glasgw	40	52.5	37.3	67.3	5.0	42.5	−2.7	−26.5	21.1
Klmarnk	40	65.0	49.2	78.1	5.0	30.0	0.5	−21.9	22.9
Wales									
Cardff	70	64.3	52.5	74.6	11.4	24.3	1.3	−13.7	16.2
Swanse	53	69.8	56.3	80.6	7.6	22.6	2.5	−15.6	20.5
England	**2,802**	**60.9**	**59.0**	**62.6**	**7.5**	**31.7**	**−2.3**	**−4.8**	**0.3**
N Ireland	**70**	**62.9**	**51.0**	**73.3**	**5.7**	**31.4**	**−7.9**	**−23.7**	**7.9**
Scotland	**208**	**54.3**	**47.5**	**61.0**	**4.8**	**40.9**	**1.2**	**−8.9**	**11.2**
Wales	**171**	**66.7**	**59.3**	**73.3**	**8.2**	**25.2**	**0.9**	**−8.9**	**10.8**
UK	**3,251**	**60.8**	**59.1**	**62.5**	**7.3**	**31.9**	**−2.1**	**−4.5**	**0.3**

estimation of the expected total calcium were the serum albumin normal) from the total calcium and albumin concentration, but there are no data to support the use of mathematical corrections of serum calcium amongst patients with ERF. This topic was discussed in considerable detail in the 2009 report and most of the shortcomings remain. However the ongoing restructuring of pathology into a smaller number of services together with harmonisation should increase measurement uniformity across laboratories and hence renal centres. UK laboratories are still in the process of adopting the guidelines to harmonise albumin-adjusted calcium reference ranges to 2.2–2.6 mmol/L using method-specific adjustment equations normalised to a mean calcium of 2.4 mmol/L. Until this process is complete, differences between laboratories in the reported adjusted calcium are likely to continue.

Meanwhile, centres must work with their laboratories to ensure that the calcium results are adjusted correctly for the methods in use. These problems must be borne in mind when trying to interpret the following figures that compare serum adjusted calcium achieved in different renal centres. These issues raise the question as to whether these comparisons between centres of achievement of the calcium guidelines are of value, and also raises questions about the guidelines themselves.

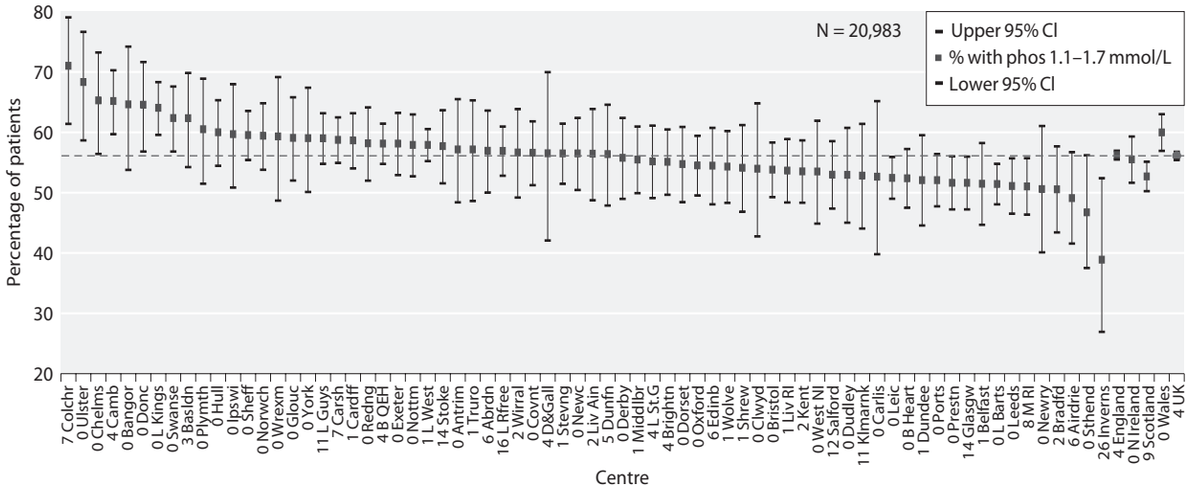

Fig. 12.1. Percentage of haemodialysis patients with phosphate within the range specified by the RA clinical audit measure (1.1–1.7 mmol/L) by centre in 2012

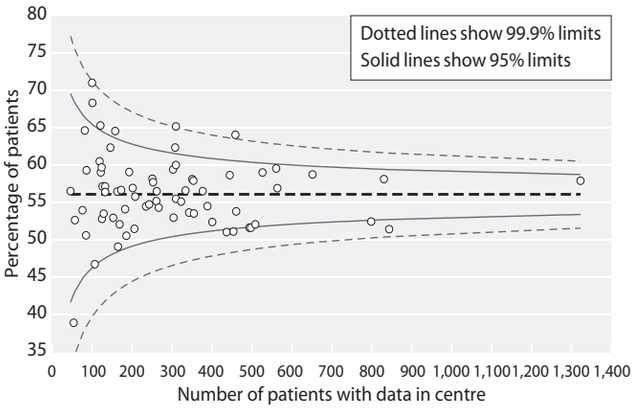

Fig. 12.2. Funnel plot of percentage of haemodialysis patients with phosphate within the range specified by the RA clinical audit measure (1.1–1.7 mmol/L) by centre in 2012

To try and better understand the varation in current laboratory assays utilised and practice in adjustment formulae applied it is proposed to undertake a short survey of all renal centres in 2013.

The audit measure for calcium in the current Renal Association clinical practice guidelines does not specify a lower limit for calcium and advises that adjusted calcium should ideally be within the normal range as per earlier guidance. Previously the UKRR used 2.2–2.5 mmol/L as the audit measure for adjusted calcium and in the absence of any change in guidance has maintained this range in this report to allow consistency. The data for adjusted calcium was 97% complete for HD patients and 98% complete for PD patients overall, although there was between centre variation (tables 12.6,

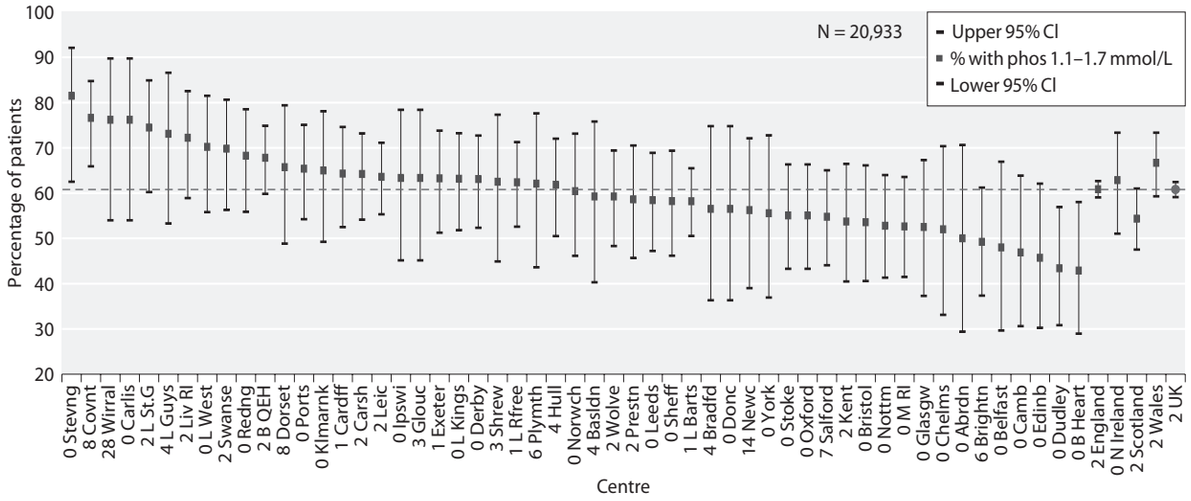

Fig. 12.3. Percentage of peritoneal dialysis patients with phosphate within the range specified by the RA clinical audit measure (1.1–1.7 mmol/L) by centre in 2012

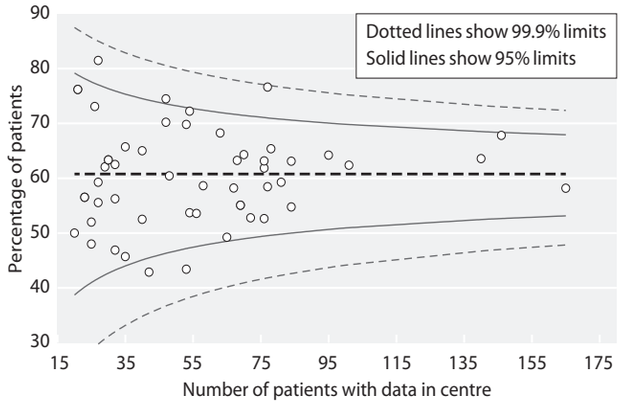

Fig. 12.4. Funnel plot of percentage of peritoneal dialysis patients with phosphate within the range specified by the RA clinical audit measure (1.1–1.7 mmol/L) by centre in 2012

12.8). Seventy-seven percent (95% CI 76–77%) of HD patients and 78% (95% CI 77–80%) of PD patients achieved adjusted calcium between 2.2–2.5 mmol/L (tables12.7, 12.9), not significantly different from 2011. The proportion of HD patients with hypercalcaemia was 12% and the proportion with hypocalcaemia was 11%. For peritoneal dialysis patients the proportion of patients with hypercalcaemia was 16% and the proportion with hypocalcaemia was 6% (tables 12.7, 12.9, figures 12.6–12.9). The changes in the percentages above, below and within range for the period 2002 to 2012 for England, Northern Ireland and Wales combined are shown in figure 12.10. The percentage of patients achieving the audit standard for calcium appears to have plateaued for both HD and PD patients in recent years. However, centres should be aware that achievement of the audit standard can mask population shifts in concentration. This can be illustrated by data from the Royal Free for HD patients: in 2011 30% had an adjusted calcium <2.2 mmol/L, 65% were within range, and 5% were >2.5 mmol/L; in 2012 4% had an adjusted calcium <2.2 mmol/L, 77% were within range and 19% were >2.5 mmol/L (date not shown). A similar pattern was observed in PD patients. However, the figures for unadjusted calcium remained stable. This shift can be attributed to a change in the equation used to adjust calcium that was introduced on July 6th 2012 before the UKRR collection of data in the last two quarters. The new equation increased adjusted calcium values by approximately 0.2 mmol/L. It has since been recognised that the new equation was over-adjusting calcium results and a revised equation has been introduced from 17th October 2013.

Similar to that seen in earlier phosphate analyses, there was significant between centre variation in unadjusted analyses for the proportion of patients below, within and above the range specified by the clinical performance measure (figures 12.6–12.10). There was greater variation in the proportion of patients within range for adjusted calcium than phosphate, most notably for HD patients. The funnel plot shows a greater number of centres outlying the 3SD limit indicating over dispersion in the

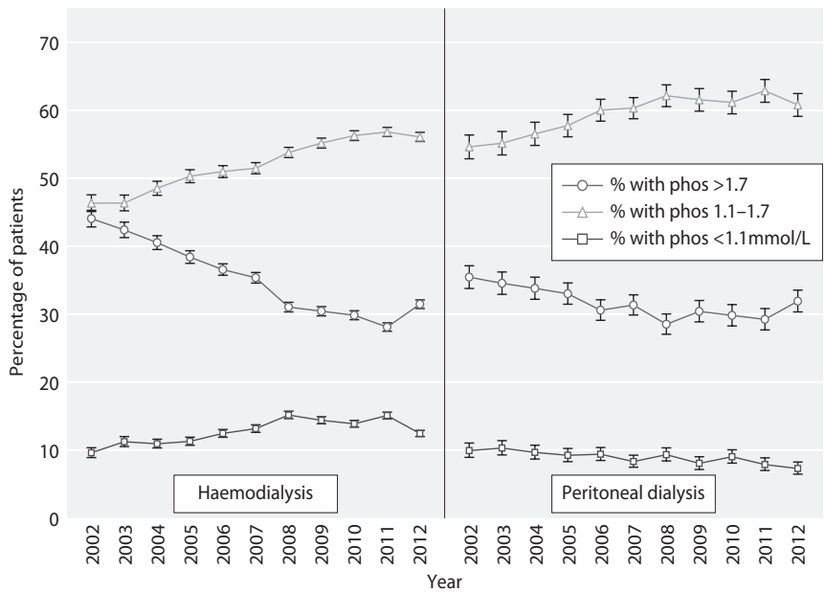

Fig. 12.5. Longitudinal change in percentage of patients with phosphate below, within and above the 2010 RA standard by dialysis modality 2000–2012

Table 12.6. Summary statistics for adjusted calcium in haemodialysis patients in 2012

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
England							
B Heart[a]	100.0	401	2.5	0.2	2.5	2.4	2.6
B QEH	96.8	836	2.2	0.2	2.2	2.1	2.3
Basldn	98.0	147	2.4	0.2	2.4	2.3	2.5
Bradfd	98.4	186	2.4	0.2	2.4	2.3	2.5
Brightn	67.2	227	2.3	0.2	2.3	2.2	2.4
Bristol	100.0	461	2.4	0.2	2.4	2.3	2.5
Camb	95.1	308	2.3	0.1	2.3	2.2	2.4
Carlis	100.0	57	2.3	0.2	2.3	2.2	2.4
Carsh	93.3	651	2.4	0.2	2.3	2.2	2.5
Chelms	100.0	121	2.3	0.1	2.3	2.2	2.4
Colchr	92.6	100	2.4	0.1	2.4	2.3	2.5
Covnt	100.0	335	2.3	0.2	2.3	2.2	2.4
Derby	99.5	208	2.5	0.2	2.4	2.4	2.5
Donc	100.0	158	2.4	0.1	2.3	2.3	2.5
Dorset	99.6	243	2.4	0.2	2.3	2.2	2.4
Dudley	100.0	153	2.3	0.2	2.3	2.2	2.4
Exeter	100.0	351	2.3	0.2	2.3	2.2	2.4
Glouc	100.0	193	2.4	0.1	2.4	2.3	2.5
Hull	100.0	310	2.3	0.2	2.4	2.2	2.4
Ipswi	100.0	124	2.4	0.2	2.4	2.3	2.5
Kent	98.9	357	2.4	0.2	2.4	2.3	2.5
L Barts	99.8	844	2.3	0.2	2.3	2.1	2.4
L Guys	89.0	527	2.3	0.2	2.3	2.2	2.4
L Kings	99.8	459	2.3	0.1	2.3	2.2	2.4
L Rfree[a]	84.4	564	2.4	0.2	2.4	2.3	2.5
L St.G	96.7	262	2.3	0.2	2.3	2.2	2.4
L West[b]	91.6	1,229	2.4	0.2	2.4	2.3	2.5
Leeds	100.0	454	2.4	0.2	2.4	2.3	2.5
Leic	99.8	799	2.4	0.2	2.4	2.3	2.5
Liv Ain	98.2	163	2.4	0.2	2.3	2.3	2.5
Liv RI	99.4	343	2.4	0.2	2.3	2.3	2.5
M RI	92.2	437	2.4	0.2	2.4	2.3	2.5
Middlbr	99.4	310	2.3	0.2	2.3	2.2	2.4
Newc	100.0	262	2.3	0.2	2.3	2.2	2.4
Norwch	100.0	303	2.4	0.2	2.4	2.3	2.6
Nottm	99.7	354	2.4	0.2	2.4	2.3	2.5
Oxford	100.0	389	2.4	0.2	2.4	2.3	2.5
Plymth	100.0	119	2.4	0.2	2.4	2.3	2.5
Ports	99.8	509	2.4	0.2	2.4	2.3	2.5
Prestn	99.6	494	2.3	0.2	2.3	2.2	2.4
Redng	100.0	251	2.3	0.2	2.3	2.2	2.4
Salford	88.4	305	2.4	0.2	2.4	2.3	2.5
Sheff	99.8	561	2.3	0.2	2.3	2.2	2.4
Shrew	100.0	184	2.3	0.2	2.3	2.2	2.4
Stevng	99,0	376	2.4	0.2	2.4	2.3	2.5
Sthend	100.0	107	2.4	0.2	2.4	2.3	2.5
Stoke	85.0	250	2.4	0.2	2.4	2.3	2.5
Sund	99.5	183	2.4	0.2	2.4	2.2	2.5
Truro	99.3	133	2.4	0.2	2.3	2.2	2.4
Wirral	97.7	173	2.4	0.2	2.4	2.3	2.5
Wolve	99.6	269	2.4	0.2	2.4	2.3	2.5
York	100.0	122	2.4	0.1	2.4	2.3	2.5
N Ireland							
Antrim	99.2	125	2.4	0.1	2.4	2.3	2.5
Belfast	99.0	206	2.3	0.2	2.3	2.2	2.4
Newry	100.0	85	2.4	0.2	2.4	2.3	2.4
Ulster	100.0	101	2.4	0.2	2.4	2.3	2.5
West NI	100.0	129	2.3	0.2	2.3	2.2	2.4

Table 12.6. Continued

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
Wales							
Bangor	100.0	82	2.4	0.2	2.4	2.3	2.5
Cardff[b]	99.3	445	2.4	0.2	2.4	2.3	2.5
Clwyd	100.0	76	2.3	0.2	2.3	2.2	2.4
Swanse	100.0	308	2.3	0.2	2.3	2.2	2.4
Wrexm	100.0	86	2.4	0.1	2.4	2.3	2.5
England	**96.4**	**17,662**	**2.4**	**0.2**	**2.4**	**2.2**	**2.5**
N Ireland	**99.5**	**646**	**2.4**	**0.2**	**2.4**	**2.3**	**2.4**
Wales	**99.7**	**997**	**2.3**	**0.2**	**2.3**	**2.2**	**2.5**
E, W & NI	**96.7**	**19,305**	**2.4**	**0.2**	**2.4**	**2.2**	**2.5**

Blank cells denote centres excluded from analyses due to low patient numbers or poor data completeness
[a]London Royal Free and Birmingham Heartlands had changes in their calcium assay/albumin adjustment calculations in 2012
[b]These centres supplied uncorrected calcium and were corrected using the formula: adjusted calcium = unadjusted calcium + [(40-albumin) × 0.02]

Table 12.7. Percentage of haemodialysis patients within, below and above the range for adjusted calcium (2.2–2.5 mmol/L) in 2012

Centre	*N*	% adjusted Ca 2.2–2.5 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca <2.2 mmol/L	% adjusted Ca >2.5 mmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
England									
B Heart	401	57.9	53.0	62.6	4.0	38.2	−15.8	−22.2	−9.4
B QEH	836	70.7	67.5	73.7	26.8	2.5	−2.3	−6.6	2.1
Basldn	147	82.3	75.3	87.7	6.1	11.6	3.2	−6.0	12.5
Bradfd	186	73.1	66.3	79.0	3.8	23.1	−4.3	−13.1	4.6
Brightn	227	78.4	72.6	83.3	15.4	6.2	3.9	−4.1	11.8
Bristol	461	76.6	72.5	80.2	4.8	18.7	1.9	−3.7	7.5
Camb	308	87.3	83.1	90.6	6.5	6.2	6.7	1.0	12.4
Carlis	57	79.0	66.5	87.6	15.8	5.3	−2.1	−16.7	12.5
Carsh	651	81.6	78.4	84.4	9.4	9.1	2.6	−1.7	7.0
Chelms	121	84.3	76.7	89.8	9.9	5.8	−4.4	−13.1	4.3
Colchr	100	87.0	78.9	92.3	0.0	13.0	11.0	0.3	21.7
Covnt	335	77.6	72.8	81.8	10.8	11.6	9.0	2.3	15.7
Derby	208	77.4	71.2	82.6	2.4	20.2	1.3	−7.0	9.7
Donc	158	86.7	80.5	91.2	5.1	8.2	−0.2	−7.7	7.3
Dorset	243	84.8	79.7	88.8	7.4	7.8	4.1	−2.8	10.9
Dudley	153	78.4	71.2	84.2	12.4	9.2	6.8	−3.2	16.8
Exeter	351	76.1	71.3	80.2	14.0	10.0	−6.1	−12.1	0.0
Glouc	193	86.5	81.0	90.7	5.2	8.3	0.7	−6.2	7.7
Hull	310	76.8	71.8	81.1	13.6	9.7	−4.4	−10.9	2.0
Ipswi	124	79.8	71.9	86.0	7.3	12.9	3.0	−7.3	13.3
Kent	357	70.3	65.4	74.8	5.3	24.4	−4.0	−10.6	2.6
L Barts	844	66.7	63.5	69.8	26.0	7.4	−2.1	−6.6	2.4
L Guys	527	73.8	69.9	77.4	14.8	11.4	2.5	−3.0	8.0
L Kings	459	81.9	78.1	85.2	14.8	3.3	−3.4	−8.3	1.5
L Rfree	564	77.0	73.3	80.2	3.9	19.2	11.7	6.4	16.9
L St.G	262	80.5	75.3	84.9	11.1	8.4	−2.4	−8.9	4.2
L West*	1,229	71.4	68.8	73.8	9.1	19.5	−3.9	−7.4	−0.4
Leeds	454	79.5	75.6	83.0	5.7	14.8	2.8	−2.6	8.1
Leic	799	79.0	76.0	81.7	9.1	11.9	−2.0	−6.0	1.9
Liv Ain	163	79.8	72.9	85.2	6.8	13.5	−2.3	−11.0	6.5
Liv RI	343	80.8	76.2	84.6	7.6	11.7	5.8	−0.3	11.9
M RI	437	74.8	70.6	78.7	5.5	19.7	0.0	−6.0	5.9
Middlbr	310	76.1	71.1	80.6	17.7	6.1	4.7	−2.4	11.8

Table 12.7. Continued

Centre	*N*	% adjusted Ca 2.2–2.5 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca <2.2 mmol/L	% adjusted Ca >2.5 mmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
Nottm	354	83.1	78.8	86.6	3.1	13.8	2.1	−3.5	7.6
Oxford	389	78.9	74.6	82.7	8.2	12.9	−1.6	−7.3	4.1
Plymth	119	87.4	80.1	92.3	4.2	8.4	12.6	2.9	22.3
Ports	509	80.0	76.3	83.2	5.5	14.5	−0.2	−5.2	4.8
Prestn	494	75.1	71.1	78.7	18.6	6.3	−2.7	−8.0	2.7
Redng	251	80.5	75.1	84.9	15.5	4.0	−2.5	−9.2	4.3
Salford	305	71.5	66.2	76.3	6.2	22.3	−3.8	−10.8	3.3
Sheff	561	77.7	74.1	81.0	13.6	8.7	1.1	−3.8	6.0
Shrew	184	71.7	64.8	77.8	22.8	5.4	−1.3	−10.5	8.0
Stevng	376	80.1	75.7	83.8	5.1	14.9	1.0	−4.8	6.7
Sthend	107	76.6	67.7	83.7	9.4	14.0	3.0	−8.4	14.3
Stoke	250	78.0	72.4	82.7	8.4	13.6	−0.1	−7.1	7.0
Sund	183	77.1	70.4	82.6	10.4	12.6	4.6	−4.7	13.8
Truro	133	73.7	65.6	80.5	12.8	13.5	−4.6	−14.7	5.6
Wirral	173	81.5	75.0	86.6	12.1	6.4	−1.2	−9.4	7.0
Wolve	269	76.6	71.2	81.3	7.4	16.0	−0.9	−7.9	6.1
York	122	91.0	84.5	94.9	2.5	6.6	7.5	−1.5	16.4
N Ireland									
Antrim	125	84.0	76.5	89.4	1.6	14.4	2.0	−7.3	11.4
Belfast	206	82.0	76.2	86.7	13.1	4.9	−0.3	−7.7	7.1
Newry	85	84.7	75.4	90.9	9.4	5.9	6.7	−4.4	17.9
Ulster	101	81.2	72.4	87.7	6.9	11.9	3.0	−8.1	14.1
West NI	129	83.7	76.3	89.1	7.8	8.5	1.6	−7.5	10.7
Wales									
Bangor	82	82.9	73.2	89.6	1.2	15.9	−7.7	−17.9	2.6
Cardff*	445	73.3	69.0	77.2	11.0	15.7	−5.4	−11.0	0.2
Clwyd	76	73.7	62.7	82.4	21.1	5.3	7.6	−8.0	23.2
Swanse	308	75.3	70.2	79.8	18.2	6.5	0.4	−6.3	7.1
Wrexm	86	88.4	79.7	93.6	5.8	5.8	10.6	−0.7	21.9
England	**17,662**	**76.5**	**75.9**	**77.2**	**10.9**	**12.6**	**0.0**	**−0.9**	**0.9**
N Ireland	**646**	**83.0**	**79.9**	**85.7**	**8.4**	**8.7**	**2.0**	**−2.1**	**6.2**
Wales	**997**	**76.0**	**73.3**	**78.6**	**12.7**	**11.2**	**−1.6**	**−5.3**	**2.1**
E, W & NI	**19,305**	**76.7**	**76.1**	**77.3**	**10.9**	**12.4**	**0.0**	**−0.8**	**0.9**

*These centres supplied uncorrected calcium and were corrected using the formula: adjusted calcium = unadjusted calcium + [(40-albumin) × 0.02]

Table 12.8. Summary statistics for adjusted calcium in peritoneal dialysis patients in 2012

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
England							
B Heart	100.0	42	2.5	0.2	2.4	2.3	2.6
B QEH	98.7	147	2.3	0.1	2.3	2.2	2.4
Basldn	96.4	27	2.4	0.2	2.5	2.3	2.6
Bradfd	100.0	24	2.4	0.2	2.4	2.3	2.4
Brightn	94.2	65	2.4	0.8	2.3	2.2	2.4
Bristol	100.0	56	2.5	0.1	2.4	2.4	2.5
Camb	100.0	32	2.4	0.1	2.3	2.3	2.4
Carlis	100.0	21	2.3	0.1	2.3	2.2	2.3
Carsh	97.9	95	2.4	0.2	2.3	2.3	2.5
Chelms	100.0	25	2.4	0.1	2.4	2.3	2.5
Colchr[a]							
Covnt	95.2	80	2.3	0.2	2.3	2.2	2.4
Derby	100.0	84	2.5	0.2	2.5	2.4	2.6
Donc	100.0	23	2.4	0.2	2.4	2.2	2.5

Table 12.8. Continued

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
Dorset	73.7	28	2.4	0.1	2.4	2.3	2.5
Dudley	100.0	53	2.4	0.2	2.4	2.3	2.5
Exeter	98.6	68	2.3	0.1	2.3	2.2	2.4
Glouc	96.8	30	2.4	0.2	2.4	2.3	2.4
Hull	96.2	76	2.5	0.1	2.4	2.4	2.5
Ipswi	100.0	30	2.4	0.1	2.4	2.3	2.5
Kent	98.2	54	2.5	0.2	2.5	2.4	2.6
L Barts	98.8	165	2.3	0.2	2.3	2.2	2.4
L Guys	96.3	26	2.4	0.1	2.35	2.3	2.5
L Kings	100.0	76	2.3	0.1	2.2	2.2	2.3
L Rfree	99.0	101	2.5	0.2	2.4	2.3	2.5
L St.G	97.9	47	2.4	0.1	2.4	2.4	2.5
L West[b]	100.0	47	2.5	0.1	2.5	2.4	2.6
Leeds	100.0	77	2.4	0.2	2.4	2.3	2.5
Leic	97.9	140	2.4	0.2	2.4	2.3	2.5
Liv Ain	100.0	17					
Liv RI	98.2	54	2.4	0.2	2.3	2.2	2.4
M RI	100.0	76	2.5	0.2	2.5	2.35	2.6
Middlbr	87.5	7					
Newc	86.5	32	2.3	0.1	2.3	2.3	2.4
Norwch	100.0	48	2.5	0.1	2.5	2.4	2.6
Nottm	100.0	72	2.4	0.2	2.4	2.3	2.5
Oxford	100.0	69	2.4	0.2	2.4	2.3	2.5
Plymth	96.8	30	2.4	0.1	2.4	2.4	2.5
Ports	100.0	78	2.4	0.2	2.4	2.3	2.5
Prestn	98.3	58	2.4	0.2	2.4	2.3	2.5
Redng	100.0	63	2.3	0.1	2.3	2.3	2.4
Salford	93.3	84	2.5	0.2	2.45	2.4	2.6
Sheff	100.0	67	2.4	0.1	2.3	2.3	2.4
Shrew	97.0	32	2.3	0.2	2.3	2.2	2.4
Stevng	100.0	27	2.4	0.2	2.4	2.3	2.5
Sthend	100.0	14					
Stoke	87.0	60	2.4	0.2	2.5	2.3	2.5
Sund	100.0	17					
Truro	100.0	19					
Wirral	72.4	21	2.4	0.2	2.3	2.3	2.4
Wolve	98.8	82	2.4	0.2	2.4	2.3	2.5
York	100.0	27	2.4	0.1	2.4	2.4	2.5
N Ireland							
Antrim	100.0	10					
Belfast	100.0	25	2.3	0.2	2.3	2.2	2.4
Newry	100.0	14					
Ulster	100.0	6					
West NI	100.0	15					
Wales							
Bangor	100.0	14					
Cardff[b]	98.6	70	2.4	0.2	2.4	2.3	2.5
Clwyd	100.0	15					
Swanse	98.2	53	2.3	0.2	2.3	2.2	2.4
Wrexm	95.0	19					
England	**97.5**	**2,793**	**2.4**	**0.2**	**2.4**	**2.3**	**2.5**
N Ireland	**100.0**	**70**	**2.4**	**0.2**	**2.4**	**2.3**	**2.5**
Wales	**98.3**	**171**	**2.4**	**0.2**	**2.4**	**2.3**	**2.5**
E, W & NI	**97.6**	**3,034**	**2.4**	**0.2**	**2.4**	**2.3**	**2.5**

Blank cells denote centres excluded from the analysis due to low patient numbers
[a]No PD patients
[b]These centres supplied uncorrected calcium and were corrected using the formula: adjusted calcium = unadjusted calcium + [(40-albumin) × 0.02]

Table 12.9. Percentage of peritoneal dialysis patients within, below and above the range for adjusted calcium (2.2–2.5 mmol/L) in 2012

Centre	*N*	% adjusted Ca 2.2–2.5 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca <2.2 mmol/L	% adjusted Ca >2.5 mmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
England									
B Heart	42	71.4	56.1	83.0	0.0	28.6	−7.5	−26.4	11.3
B QEH	147	79.6	72.3	85.4	15.0	5.4	1.5	−7.8	10.9
Basldn	27	66.7	47.3	81.7	3.7	29.6	0.0	−25.9	25.9
Bradfd	24	79.2	58.7	91.1	8.3	12.5	8.8	−14.9	32.5
Brightn	65	81.5	70.2	89.2	6.2	12.3	−4.4	−17.1	8.3
Bristol	56	76.8	64.0	86.0	1.8	21.4	12.4	−4.1	28.9
Camb	32	90.6	74.7	96.9	0.0	9.4	9.4	−7.5	26.3
Carlis	21	81.0	58.9	92.7	19.1	0.0	n/a	n/a	n/a
Carsh	95	80.0	70.8	86.9	10.5	9.5	−7.0	−17.5	3.6
Chelms	25	88.0	68.7	96.1	4.0	8.0	−7.5	−22.9	8.0
Covnt	80	81.3	71.2	88.4	10.0	8.8	7.2	−5.8	20.2
Derby	84	65.5	54.7	74.8	1.2	33.3	−13.7	−26.7	−0.7
Donc	23	82.6	61.8	93.3	4.4	13.0	−3.1	−24.6	18.4
Dorset	28	89.3	71.6	96.5	0.0	10.7	23.4	5.3	41.5
Dudley	53	81.1	68.4	89.5	1.9	17.0	−4.6	−19.0	9.8
Exeter	68	82.4	71.4	89.7	14.7	2.9	5.3	−8.6	19.2
Glouc	30	86.7	69.4	94.9	6.7	6.7	5.4	−12.8	23.6
Hull	76	76.3	65.5	84.5	0.0	23.7	1.6	−12.1	15.4
Ipswi	30	76.7	58.5	88.5	6.7	16.7	−3.3	−24.2	17.5
Kent	54	55.6	42.2	68.1	1.9	42.6	−13.3	−30.9	4.3
L Barts	165	75.8	68.6	81.7	14.6	9.7	1.9	−7.7	11.6
L Guys	26	88.5	69.7	96.2	7.7	3.9	13.5	−6.7	33.7
L Kings	76	76.3	65.5	84.5	21.1	2.6	−9.4	−22.0	3.2
L Rfree	101	73.3	63.8	81.0	2.0	24.8	−3.0	−15.7	9.7
L St.G	47	87.2	74.4	94.2	0.0	12.8	8.8	−6.0	23.6
L West*	47	63.8	49.3	76.2	0.0	36.2	−1.8	−23.2	19.6
Leeds	77	85.7	76.0	91.9	2.6	11.7	5.5	−6.2	17.1
Leic	140	77.9	70.2	84.0	5.0	17.1	−5.5	−14.7	3.8
Liv RI	54	79.6	66.8	88.4	7.4	13.0	0.7	−14.4	15.8
M RI	76	65.8	54.5	75.5	2.6	31.6	−4.6	−19.7	10.4
Newc	32	84.4	67.5	93.3	9.4	6.3	8.8	−9.4	27.0
Norwch	48	64.6	50.2	76.7	0.0	35.4	−16.3	−33.9	1.3
Nottm	72	81.9	71.3	89.2	2.8	15.3	13.0	−0.8	26.8
Oxford	69	78.3	67.0	86.5	4.4	17.4	−1.0	−14.1	12.1
Plymth	30	83.3	65.7	92.9	0.0	16.7	2.3	−16.1	20.6
Ports	78	78.2	67.7	86.0	1.3	20.5	−4.3	−16.7	8.1
Prestn	58	82.8	70.8	90.5	6.9	10.3	−4.3	−17.5	8.9
Redng	63	93.7	84.3	97.6	4.8	1.6	7.5	−2.5	17.5
Salford	84	64.3	53.5	73.8	0.0	35.7	−7.0	−20.7	6.7
Sheff	67	92.5	83.3	96.9	3.0	4.5	14.8	2.0	27.5
Shrew	32	71.9	54.2	84.7	18.8	9.4	10.3	−14.0	34.7
Stevng	27	85.2	66.5	94.3	0.0	14.8	−11.0	−26.3	4.3
Stoke	60	73.3	60.8	83.0	6.7	20.0	10.3	−6.0	26.5
Wirral	21	76.2	54.0	89.7	4.8	19.1	−4.6	−28.3	19.1
Wolve	82	82.9	73.2	89.6	6.1	11.0	2.3	−10.5	15.0
York	27	85.2	66.5	94.3	3.7	11.1	n/a	n/a	n/a
N Ireland									
Belfast	25	64.0	44.0	80.1	20.0	16.0	−7.4	−32.6	17.8
Wales									
Cardff*	70	80.0	69.0	87.8	8.6	11.4	6.1	−6.9	19.1
Swanse	53	81.1	68.4	89.5	11.3	7.6	−0.5	−15.6	14.6
England	**2,793**	**78.0**	**76.4**	**79.5**	**6.1**	**15.9**	**0.3**	**−1.8**	**2.5**
N Ireland	**70**	**71.4**	**59.8**	**80.8**	**8.6**	**20.0**	**−7.0**	**−21.6**	**7.5**
Wales	**171**	**81.3**	**74.7**	**86.5**	**8.8**	**9.9**	**4.7**	**−3.8**	**13.1**
E, W & NI	**3,034**	**78.1**	**76.5**	**79.5**	**6.3**	**15.7**	**0.4**	**−1.7**	**2.5**

*These centres supplied uncorrected calcium and were corrected using the formula: adjusted calcium = unadjusted calcium + [(40-albumin) × 0.02]

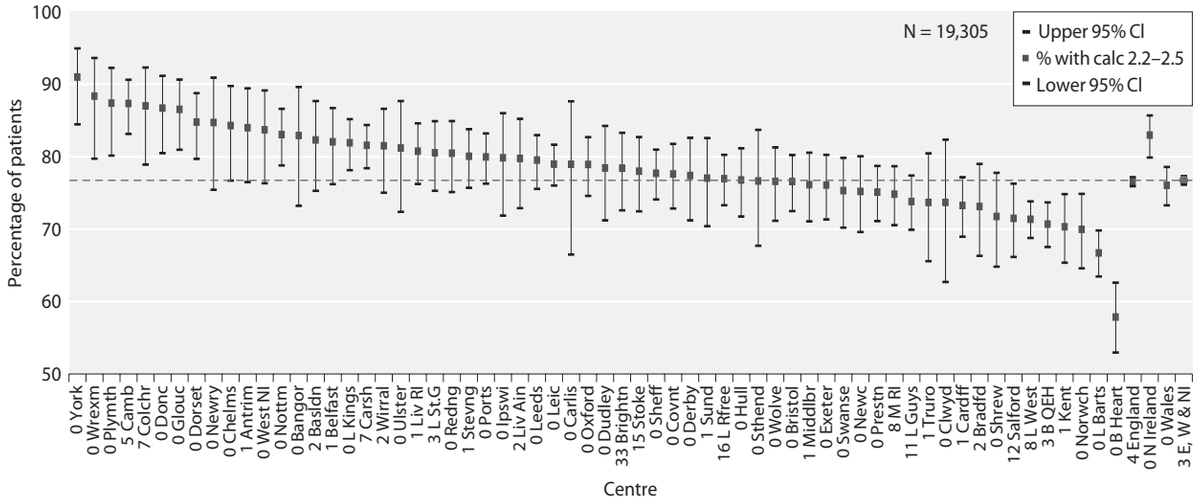

Fig. 12.6. Percentage of haemodialysis patients with adjusted calcium within range (2.2–2.5 mmol/L) by centre in 2012

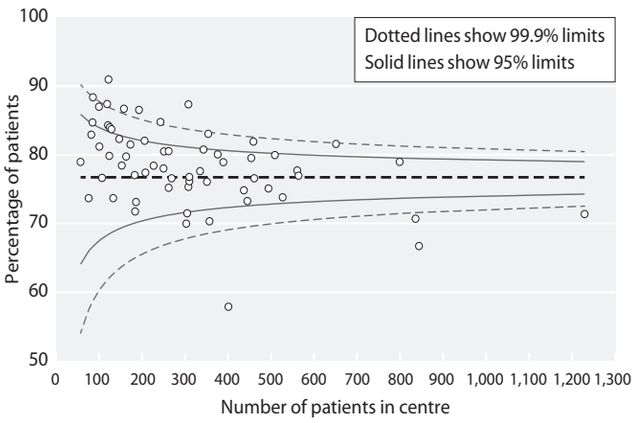

Fig. 12.7. Funnel plot of percentage of haemodialysis patients with adjusted calcium within range (2.2–2.5 mmol/L) by centre in 2012

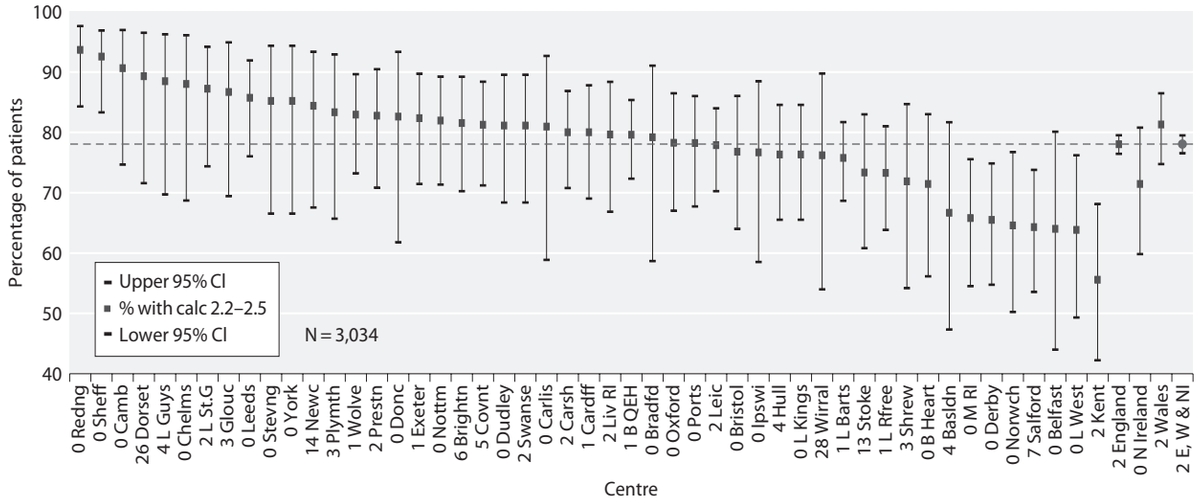

Fig. 12.8. Percentage of peritoneal dialysis patients with adjusted calcium within range (2.2–2.5 mmol/L) by centre in 2012

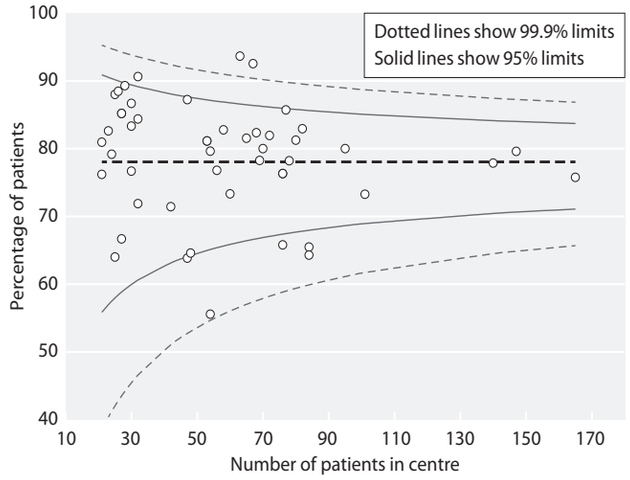

Fig. 12.9. Funnel plot of percentage of peritoneal dialysis patients with adjusted calcium within range (2.2–2.5 mmol/L) by centre in 2012

data, possibly due to differences in calcium adjustment factors between centres.

Parathyroid hormone

At the beginning of 2012 the following RA guideline for PTH applied:

Guideline 4.2.1 CKD-MBD: Target range of serum PTH in patients on dialysis

'We suggest that the target range for parathyroid hormone measured using an intact PTH assay should be between 2 and 9 times the upper limit of normal for the assay used (2C)' [3]

The data for parathyroid hormone were 83% complete for both HD and PD patients overall, although there was between centre variation (tables 12.10, 12.12). Fifty-eight percent (95% CI 57–58%) of HD patients and 65% (95% CI 63–67%) of PD patients achieved a parathyroid hormone between 16–72 pmol/L (tables 12.11, 12.13). In 2010, when the PTH standard target was 16–32 pmol/L, 28% (95% CI 27–29%) of HD patients and 31% (95% CI 29–32%) of PD patients achieved the RA standard.

In 2012, the proportion of HD patients with a parathyroid hormone above the upper limit of the range (>72 pmol/L) was 16% and the proportion with parathyroid hormone below the lower limit of the range was 27%. The proportion of PD patients with parathyroid hormone above the upper limit of the range was 10% and the proportion below the lower limit of the range was 25% (tables 12.11, 12.13, figures 12.11–12.14). Again there was significant between centre variation in unadjusted analyses for the proportion of patients below, within and above the range specified by the clinical performance measure.

A significant contributor to centre variation will be the assay used to measure PTH. This has been demonstrated by a study undertaken by the Scottish Clinical Biochemistry Managed Diagnostic Network in association with the Scottish Renal Registry. Analysis of samples from 106 haemodialysis patients by six different PTH immunoassays in common use showed a 1.2- to 2.7-fold variation in results in spite of similar reference ranges for each method [7]. Since current guidelines refer to multiples of the upper reference limit, 53% of

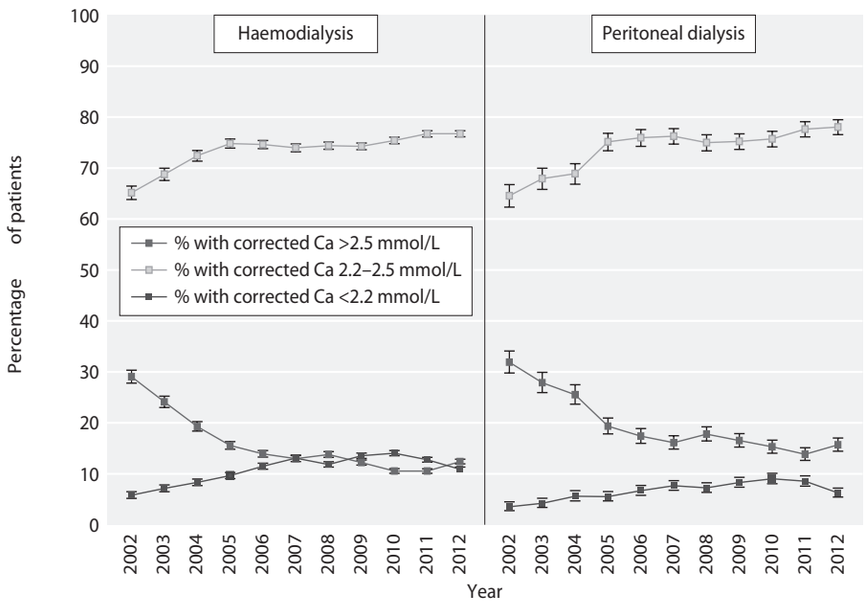

Fig. 12.10. Longitudinal change in percentage of patients with adjusted calcium <2.2 mmol/L, 2.2–2.5 mmol/L and >2.5 mmol/L by dialysis modality 2002–2012

Table 12.10. Summary statistics for PTH in haemodialysis patients in 2012

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
England							
B Heart	96.0	385	49.4	43.7	37	20	61
B QEH	0.2	2					
Basldn	97.3	146	43.0	44.9	33	16	55
Bradfd	97.9	185	31.3	35.8	17	8	43
Brightn	80.2	271	42.0	41.5	31	12	58
Bristol	98.1	452	41.4	49.6	27	14	48
Camb	68.5	222	45.5	72.3	29	17	46
Carlis	100.0	57	26.3	29.8	18	11	30
Carsh	0.4	3					
Chelms	99.2	120	41.5	32.1	33	19	54
Colchr	95.4	103	33.3	35.5	23	12	37
Covnt	98.8	331	42.2	42.6	30	16	54
Derby	98.6	206	33.1	27.9	26	16	43
Donc	99.4	157	43.6	35.4	35	21	55
Dorset	99.2	242	27.7	33.6	19	9	34
Dudley	96.1	147	50.4	53.8	31	14	62
Exeter	99.2	348	22.0	22.9	14	7	29
Glouc	99.5	192	35.9	33.1	28	15	48
Hull	98.4	305	45.3	47.0	31	16	59
Ipswi	100.0	124	36.6	31.8	30	14	46
Kent	98.3	355	44.2	37.3	38	19	57
L Barts	98.6	834	51.1	47.9	37	20	66
L Guys	77.0	456	48.3	48.0	34	16	62
L Kings	96.5	444	46.3	44.4	32.5	15	66
L Rfree	80.5	538	37.8	39.2	28	14	50
L St.G	92.3	250	57.6	53.7	42	22	74
L West	75.5	1,013	62.8	62.4	43	20	87
Leeds	98.7	448	39.9	38.5	28	14	54
Leic	98.5	789	42.4	45.4	28	11	57
Liv Ain	95.2	158	28.4	33.2	19	7	37
Liv RI	97.1	335	37.8	36.4	28	11	50
M RI	90.1	427	47.6	45.5	34	14	66
Middlbr	93.3	291	52.6	48.4	38	22	67
Newc	99.6	261	37.7	36.4	28	14	50
Norwch	94.4	286	36.9	33.4	29	15	46
Nottm	99.4	353	45.9	49.9	31	17	56
Oxford	98.5	383	51.5	42.2	41	19	70
Plymth	96.6	115	28.5	29.9	19	9	39
Ports	94.7	483	42.2	52.1	25	10	51
Prestn	1.4	7					
Redng	100.0	251	37.6	37.6	30	16	47
Salford	84.9	293	34.7	32.1	25	12	46
Sheff	96.8	544	42.2	42.0	31	17	54
Shrew	99.5	183	37.1	40.0	19	10	48
Stevng	98.2	373	45.4	42.5	38	19	57
Sthend	90.7	97	55.6	59.2	37	20	57
Stoke	87.8	258	51.1	43.2	39.5	23	64
Sund	97.8	180	46.8	50.9	30	14	60
Truro	97.8	131	25.7	37.1	16	6	31
Wirral	96.6	171	38.3	35.5	31	15	48
Wolve	97.0	262	32.5	40.0	21	10	40
York	96.7	118	26.2	29.2	18.5	7	36
N Ireland							
Antrim	100.0	126	33.2	31.5	23	15	42
Belfast	97.1	202	37.1	43.2	23.5	13	48
Newry	100.0	85	25.3	27.3	16	9	30
Ulster	100.0	101	22.5	23.3	16	9	28
West NI	100.0	129	36.0	29.4	29	15	47

Table 12.10. Continued

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
Wales							
Bangor	98.8	81	25.2	24.5	19	10	31
Cardff	96.7	433	37.3	30.6	29	19	47
Clwyd	100.0	76	32.4	31.6	24.5	14	41
Swanse	72.7	224	40.1	37.0	30.5	16	52
Wrexm	96.5	83	18.4	15.6	19	4	29
England	**82.3**	**15,085**	**43.4**	**45.4**	**30**	**15**	**56**
N Ireland	**99.1**	**643**	**32.3**	**34.1**	**22**	**13**	**41**
Wales	**89.7**	**897**	**34.7**	**31.6**	**27**	**15**	**44**
E, W & NI	**83.2**	**16,625**	**42.5**	**44.4**	**29**	**14**	**54**

Blank cells denote centres excluded from analyses due to low patient numbers or poor data completeness

Table 12.11. Percentage of haemodialysis patients within, below and above the range for PTH (16–72 pmol/L) in 2012

Centre	*N*	% PTH 16–72 pmol/L	Lower 95% CI	Upper 95% CI	% PTH <16 pmol/L	% PTH >72 pmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
England									
B Heart	385	63.9	59.0	68.5	16.6	19.5	10.4	3.5	17.3
Basldn	146	62.3	54.2	69.8	23.3	14.4	−0.4	−11.7	11.0
Bradfd	185	43.8	36.8	51.0	46.0	10.3	−6.5	−16.8	3.8
Brightn	271	53.5	47.6	59.4	29.9	16.6	6.4	−1.8	14.7
Bristol	452	57.5	52.9	62.0	28.1	14.4	1.3	−5.2	7.8
Camb	222	66.7	60.2	72.6	23.9	9.5	1.5	−7.3	10.3
Carlis	57	57.9	44.8	69.9	36.8	5.3	14.8	−3.3	32.9
Chelms	120	68.3	59.5	76.0	18.3	13.3	12.2	−0.1	24.5
Colchr	103	50.5	40.9	60.0	37.9	11.7	−7.7	−21.4	6.1
Covnt	331	61.6	56.3	66.7	24.2	14.2	5.5	−2.0	13.0
Derby	206	68.9	62.3	74.9	24.8	6.3	1.2	−8.0	10.4
Donc	157	71.3	63.8	77.9	15.3	13.4	6.9	−3.5	17.3
Dorset	242	52.1	45.8	58.3	41.3	6.6	2.3	−6.8	11.4
Dudley	147	51.0	43.0	59.0	27.2	21.8	11.3	−0.4	23.1
Exeter	348	41.7	36.6	46.9	53.5	4.9	−1.8	−9.3	5.7
Glouc	192	64.1	57.0	70.5	25.5	10.4	6.7	−3.2	16.5
Hull	305	57.7	52.1	63.1	24.3	18.0	5.2	−2.8	13.1
Ipswi	124	59.7	50.8	67.9	29.0	11.3	−3.4	−15.6	8.7
Kent	355	67.3	62.3	72.0	15.5	17.2	−2.6	−9.4	4.3
L Barts	834	59.4	56.0	62.6	19.2	21.5	−3.7	−8.4	1.1
L Guys	456	55.3	50.7	59.8	24.6	20.2	5.4	−1.1	11.9
L Kings	444	53.6	49.0	58.2	25.5	21.0	3.8	−2.8	10.5
L Rfree	538	59.7	55.5	63.7	28.6	11.7	0.3	−5.6	6.3
L St.G	250	56.0	49.8	62.0	18.4	25.6	0.1	−8.6	8.7
L West	1,013	50.5	47.5	53.6	19.2	30.3	0.5	−3.9	4.9
Leeds	448	55.6	50.9	60.1	28.4	16.1	−0.8	−7.3	5.6
Leic	789	50.2	46.7	53.7	31.7	18.1	−1.3	−6.2	3.7
Liv Ain	158	50.0	42.3	57.7	43.7	6.3	−2.8	−15.0	9.4
Liv RI	335	55.5	50.2	60.8	32.2	12.2	2.9	−4.5	10.3
M RI	427	51.8	47.0	56.5	26.2	22.0	−7.1	−14.0	−0.3
Middlbr	291	62.2	56.5	67.6	16.5	21.3	2.8	−5.3	10.9
Newc	261	60.5	54.5	66.3	27.2	12.3	0.5	−8.0	9.1
Norwch	286	61.5	55.8	67.0	26.2	12.2	−0.3	−8.4	7.8
Nottm	353	60.1	54.9	65.0	23.0	17.0	6.0	−1.1	13.2
Oxford	383	58.2	53.2	63.1	18.0	23.8	−2.9	−9.9	4.1
Plymth	115	52.2	43.1	61.1	40.0	7.8	6.8	−6.0	19.6

Table 12.11. Continued

Centre	*N*	% PTH 16–72 pmol/L	Lower 95% CI	Upper 95% CI	% PTH <16 pmol/L	% PTH >72 pmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
Ports	483	47.0	42.6	51.5	36.2	16.8	3.1	−3.4	9.5
Redng	251	65.7	59.7	71.4	24.7	9.6	−3.1	−11.4	5.2
Salford	293	55.3	49.6	60.9	33.5	11.3	8.9	0.7	17.1
Sheff	544	63.6	59.5	67.5	22.1	14.3	3.6	−2.2	9.3
Shrew	183	49.7	42.5	56.9	35.0	15.3	−8.6	−18.8	1.7
Stevng	373	66.0	61.0	70.6	15.6	18.5	−0.6	−7.4	6.1
Sthend	97	66.0	56.0	74.7	15.5	18.6	5.0	−8.2	18.3
Stoke	258	66.7	60.7	72.2	14.3	19.0	3.8	−4.2	11.8
Sund	180	54.4	47.1	61.6	27.8	17.8	−1.8	−12.4	8.8
Truro	131	45.0	36.7	53.6	48.1	6.9	−1.0	−12.9	11.0
Wirral	171	64.9	57.5	71.7	25.2	9.9	−3.5	−14.5	7.6
Wolve	262	52.7	46.6	58.7	38.9	8.4	9.3	0.9	17.6
York	118	48.3	39.4	57.3	45.8	5.9	4.1	−8.8	16.9
N Ireland									
Antrim	126	67.5	58.8	75.1	25.4	7.1	1.1	−10.6	12.8
Belfast	202	57.4	50.5	64.1	32.2	10.4	−4.6	−14.2	4.9
Newry	85	45.9	35.6	56.5	48.2	5.9	−8.1	−22.5	6.3
Ulster	101	47.5	38.0	57.2	48.5	4.0	8.5	−5.1	22.2
West NI	129	66.7	58.1	74.3	25.6	7.8	−10.2	−21.0	0.6
Wales									
Bangor	81	56.8	45.9	67.1	40.7	2.5	−1.5	−16.6	13.5
Cardff	433	71.1	66.7	75.2	18.2	10.6	5.7	−0.5	11.9
Clwyd	76	61.8	50.5	72.0	29.0	9.2	17.0	0.2	33.8
Swanse	224	63.0	56.4	69.0	24.1	13.0	2.5	−6.4	11.4
Wrexm	83	51.8	41.1	62.3	48.2	0.0	3.1	−12.3	18.4
England	**15,085**	**57.0**	**56.2**	**57.8**	**26.5**	**16.5**	**1.9**	**0.7**	**3.0**
N Ireland	**643**	**58.2**	**54.3**	**61.9**	**34.2**	**7.6**	**−3.0**	**−8.3**	**2.3**
Wales	**897**	**65.2**	**62.0**	**68.3**	**25.4**	**9.4**	**4.6**	**0.1**	**9.1**
E, W & NI	**16,625**	**57.5**	**56.7**	**58.2**	**26.8**	**15.8**	**1.8**	**0.8**	**2.9**

Table 12.12. Summary statistics for PTH in peritoneal dialysis patients in 2012

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
England							
B Heart	76.2	32	52.6	31.5	44.5	33.0	65.5
B QEH	0.0	0					
Basldn	96.4	27	35.4	25.3	29.0	19.0	49.0
Bradfd	91.7	22	45.6	51.1	27.0	14.0	57.0
Brightn	88.4	61	32.2	30.9	23.0	14.0	37.0
Bristol	94.6	53	34.9	33.3	25.0	14.0	44.0
Camb	100.0	32	32.2	27.6	29.5	14.5	38.5
Carlis	95.2	20	30.6	24.0	26.5	13.5	38.0
Carsh	0.0	0					
Chelms	100.0	25	36.2	16.3	37.0	24.0	51.0
Colchr*							
Covnt	92.9	78	28.3	28.3	19.5	12.0	34.0
Derby	98.8	83	28.2	23.6	25.0	15.0	33.0
Donc	100.0	23	42.3	36.4	32.0	19.0	65.0
Dorset	73.7	28	28.2	20.0	26.0	16.5	38.0
Dudley	86.8	46	20.9	16.9	17.5	9.0	28.0

Table 12.12. Continued

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
Exeter	98.6	68	23.8	23.9	17.0	10.0	29.0
Glouc	80.7	25	23.1	18.5	19.0	8.0	34.0
Hull	88.6	70	25.7	27.5	18.0	10.0	32.0
Ipswi	96.7	29	53.5	46.4	37.0	23.0	78.0
Kent	90.9	50	35.7	27.3	29.0	19.0	48.0
L Barts	88.6	148	34.5	26.1	27.0	14.0	46.0
L Guys	96.3	26	37.5	19.2	39.5	25.0	49.0
L Kings	98.7	75	45.4	37.5	37.0	17.0	70.0
L Rfree	69.6	71	42.1	47.0	33.0	18.0	46.0
L St.G	89.6	43	37.4	29.7	30.0	22.0	46.0
L West	97.9	46	37.0	31.1	29.0	17.0	44.0
Leeds	100.0	77	46.5	34.8	37.0	26.0	57.0
Leic	95.8	137	37.3	35.6	26.0	12.0	52.0
Liv Ain	94.1	16					
Liv RI	96.4	53	28.0	22.2	20.0	13.0	39.0
M RI	97.4	74	43.5	33.8	35.5	21.0	62.0
Middlbr	75.0	6					
Newc	86.5	32	33.9	22.8	27.5	22.0	45.0
Norwch	89.6	43	28.5	24.3	21.0	13.0	40.0
Nottm	98.6	71	50.9	45.5	38.0	21.0	66.0
Oxford	95.7	66	51.0	36.5	40.0	25.0	66.0
Plymth	90.3	28	28.7	40.1	12.5	9.5	29.5
Ports	98.7	77	41.1	35.3	31.0	18.0	53.0
Prestn	15.3	9					
Redng	96.8	61	33.9	42.7	24.0	15.0	37.0
Salford	93.3	84	37.0	35.3	26.5	15.5	45.0
Sheff	79.1	53	33.2	22.1	31.0	19.0	42.0
Shrew	93.9	31	37.2	37.4	29.0	19.0	48.0
Stevng	92.6	25	31.9	29.7	29.0	10.0	38.0
Sthend	92.9	13					
Stoke	94.2	65	58.7	52.2	40.0	26.0	68.0
Sund	100.0	17					
Truro	94.7	18					
Wirral	62.1	18					
Wolve	94.0	78	28.6	18.4	27.0	15.0	40.0
York	92.6	25	29.9	23.2	22.0	13.0	49.0
N Ireland							
Antrim	100.0	10					
Belfast	92.0	23	27.4	18.3	21.0	15.0	38.0
Newry	100.0	14					
Ulster	100.0	6					
West NI	100.0	15					
Wales							
Bangor	100.0	14					
Cardff	98.6	70	43.8	31.9	37.0	20	61
Clwyd	73.3	11					
Swanse	92.6	50	29.3	20.9	26.0	16	36
Wrexm	95.0	19					
England	**82.3**	**2,358**	**36.3**	**33.2**	**27.0**	**15**	**47**
N Ireland	**97.1**	**68**	**26.0**	**17.9**	**21.5**	**12.5**	**37.5**
Wales	**94.3**	**164**	**34.5**	**26.2**	**29.5**	**17**	**46**
E, W & NI	**83.3**	**2,590**	**35.9**	**32.5**	**27.0**	**15**	**47**

Blank cells denote centres excluded from analyses due to small numbers or poor data completeness
*No PD patients

Table 12.13. Percentage of peritoneal dialysis patients within, below and above the range for PTH (16–72 pmol/L) in 2012

Centre	*N*	% PTH 16–72 pmol/L	Lower 95% CI	Upper 95% CI	% PTH <16 pmol/L	% PTH >72 pmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
England									
B Heart	32	75.0	57.4	87.0	3.1	21.9	−0.7	−21.1	19.7
Basldn	27	81.5	62.5	92.1	14.8	3.7	27.3	2.6	52.1
Bradfd	22	54.6	34.1	73.5	27.3	18.2	10.1	−17.9	38.1
Brightn	61	63.9	51.3	74.9	27.9	8.2	2.0	−15.0	19.0
Bristol	53	60.4	46.8	72.5	30.2	9.4	4.2	−14.2	22.7
Camb	32	65.6	47.9	79.8	25.0	9.4	−6.3	−28.9	16.4
Carlis	20	60.0	38.0	78.6	35.0	5.0	n/a	n/a	n/a
Chelms	25	88.0	68.7	96.1	12.0	0.0	28.0	3.0	53.0
Covnt	78	60.3	49.1	70.5	32.1	7.7	14.3	−1.4	30.0
Derby	83	73.5	63.0	81.9	25.3	1.2	−1.3	−14.2	11.7
Donc	23	65.2	44.3	81.6	21.7	13.0	−4.8	−32.7	23.2
Dorset	28	67.9	48.9	82.4	25.0	7.1	4.0	−19.4	27.3
Dudley	46	52.2	38.0	66.1	45.7	2.2	−6.9	−27.4	13.6
Exeter	68	50.0	38.3	61.7	47.1	2.9	0.9	−16.6	18.3
Glouc	25	56.0	36.6	73.7	40.0	4.0	7.6	−18.6	33.8
Hull	70	54.3	42.6	65.5	38.6	7.1	3.6	−13.0	20.2
Ipswi	29	58.6	40.4	74.8	13.8	27.6	−8.1	−32.7	16.6
Kent	50	64.0	50.0	76.0	24.0	12.0	−13.1	−30.0	3.9
L Barts	148	63.5	55.5	70.9	26.4	10.1	−4.5	−15.3	6.3
L Guys	26	80.8	61.3	91.8	15.4	3.9	14.1	−9.3	37.5
L Kings	75	58.7	47.3	69.2	21.3	20.0	3.5	−12.9	19.8
L Rfree	71	67.6	55.9	77.4	22.5	9.9	10.1	−5.2	25.5
L St.G	43	69.8	54.6	81.6	18.6	11.6	5.9	−13.5	25.4
L West	46	69.6	55.0	81.1	19.6	10.9	0.8	−20.0	21.7
Leeds	77	66.2	55.0	75.9	14.3	19.5	−7.8	−22.1	6.4
Leic	137	59.9	51.4	67.7	27.0	13.1	4.2	−7.6	16.0
Liv RI	53	64.2	50.5	75.8	32.1	3.8	−9.5	−26.8	7.7
M RI	74	73.0	61.8	81.9	13.5	13.5	3.4	−11.4	18.2
Newc	32	75.0	57.4	87.0	18.8	6.3	8.3	−12.7	29.4
Norwch	43	51.2	36.6	65.6	41.9	7.0	5.0	−16.6	26.6
Nottm	71	63.4	51.6	73.7	14.1	22.5	2.3	−13.6	18.2
Oxford	66	65.2	53.0	75.6	10.6	24.2	4.4	−11.4	20.1
Plymth	28	39.3	23.3	58.0	53.6	7.1	−16.6	−41.2	8.0
Ports	77	67.5	56.4	77.0	22.1	10.4	8.4	−7.1	23.9
Redng	61	68.9	56.3	79.2	26.2	4.9	1.2	−14.7	17.2
Salford	84	61.9	51.1	71.6	25.0	13.1	10.8	−3.9	25.4
Sheff	53	73.6	60.2	83.7	18.9	7.6	2.5	−15.3	20.3
Shrew	31	67.7	49.7	81.7	19.4	12.9	−5.0	−29.8	19.9
Stevng	25	52.0	33.1	70.4	36.0	12.0	−29.8	−55.2	−4.5
Stoke	65	67.7	55.5	77.9	10.8	21.5	9.9	−6.7	26.5
Wolve	78	71.8	60.9	80.7	25.6	2.6	2.4	−12.8	17.7
York	25	64.0	44.0	80.1	28.0	8.0	−6.0	−33.5	21.5
N Ireland									
Belfast	23	65.2	44.3	81.6	30.4	4.4	15.2	−11.6	42.1
Wales									
Cardff	70	65.7	53.9	75.8	17.1	17.1	3.9	−11.1	18.9
Swanse	50	72.0	58.1	82.7	24.0	4.0	16.7	−2.2	35.6
England	**2,358**	**64.4**	**62.5**	**66.3**	**25.1**	**10.5**	**2.3**	**−0.4**	**5.0**
N Ireland	**68**	**64.7**	**52.7**	**75.1**	**33.8**	**1.5**	**4.7**	**−11.7**	**21.2**
Wales	**164**	**68.3**	**60.8**	**75.0**	**23.2**	**8.5**	**8.0**	**−2.2**	**18.1**
E, W & NI	**2,590**	**64.7**	**62.8**	**66.5**	**25.2**	**10.1**	**2.7**	**0.1**	**5.3**

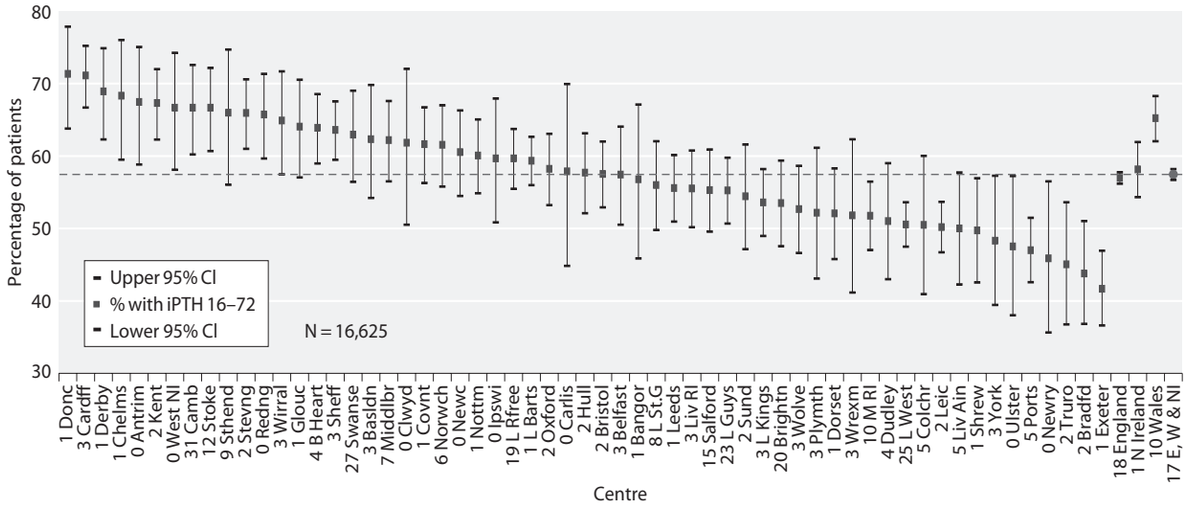

Fig. 12.11. Percentage of haemodialysis patients with PTH within range (16–72 pmol/L) by centre in 2012

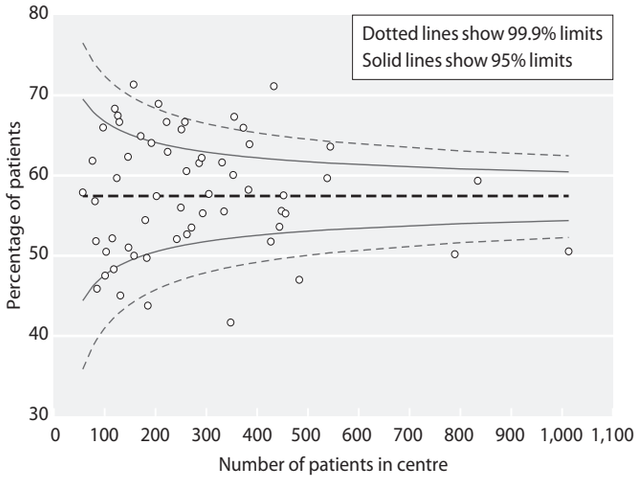

Fig. 12.12. Funnel plot of percentage of haemodialysis patients with PTH within range (16–72 pmol/L) by centre in 2012

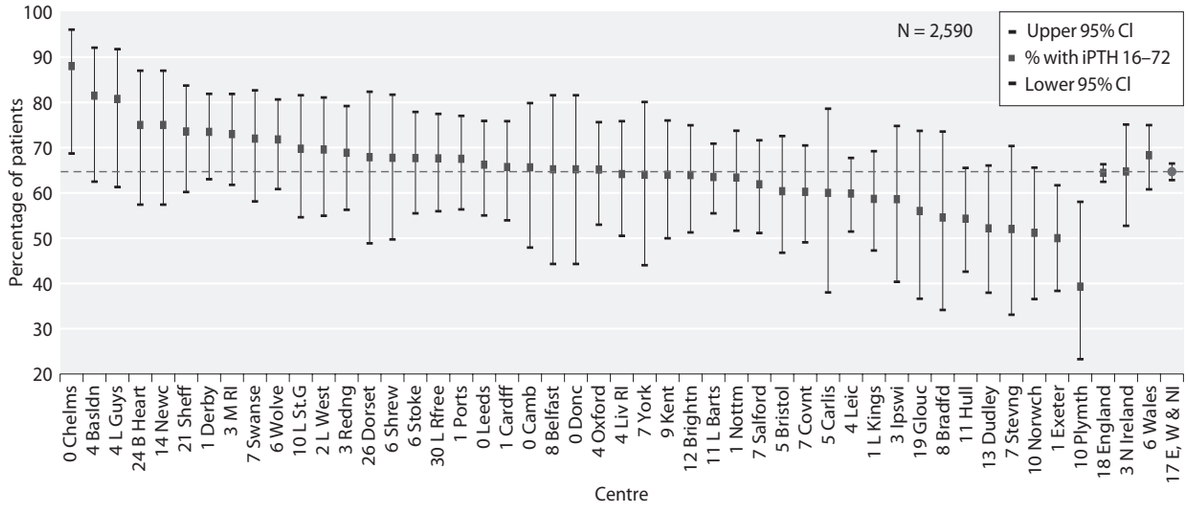

Fig. 12.13. Percentage of peritoneal dialysis patients with PTH within range (16–72 pmol/L) by centre in 2012

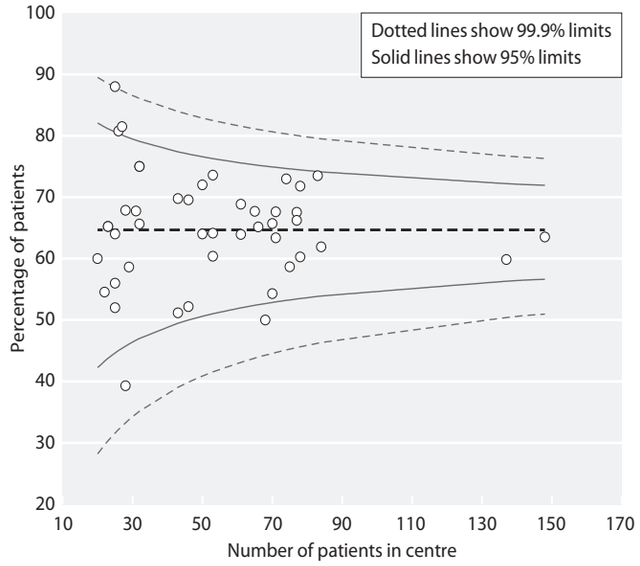

Fig. 12.14. Funnel plot of percentage of peritoneal dialysis patients with PTH within range (16–72 pmol/L) by centre in 2012

patients were classified differently by different methods with implications for treatment e.g. with Cinacalcet. In an excellent accompanying editorial, Garrett and Goldsmith [8] also highlighted the high biological variability of PTH and its poor ability to predict skeletal or patient outcomes. Whether more accurate and specific assays would improve this or whether PTH will be supplanted by other markers such as bone specific alkaline phosphatase that also have greater pre-analytical stability remains to be determined [9].

Improvement of PTH assays to achieve consensus results within CKD patients requires manufacturers to consider two principal factors: adoption of a common reference preparation for standardisation, such as the WHO international standard 95/646, and selection of pairs of antibodies that do not detect PTH fragments such as 7–84 that accumulate in CKD. Meanwhile Almond et al. [7] and a recent editorial review [10] urge adoption of assay-specific action limits for PTH in CKD patients. However this approach raises a number of difficult governance issues. There is already evidence that the manufacturers of the major diagnostic platforms used throughout the world have started to respond. The Roche assay used by Almond et al. [7] was PTH (intact) that was not standardised and cross-reacted with PTH 7–84. Roche have recently launched the more expensive PTH (1–84) that is standardised against the WHO international standard 95/646 and has $\leqslant$0.1% cross-reactivity with both PTH (1–34) and PTH (7–84) (information supplied by Roche Diagnostics).

Simultaneous control of corrected calcium, phosphate and PTH in preventing severe hyperparathyroidism

Data points to perform the bone mineral disease (BMD) combination analyses were available from 58 HD and 45 PD centres, covering 16,300 HD and 2,377 PD patients, from England, Wales and Northern Ireland. The ranges used for this audit were adjusted calcium 2.2–2.5 mmol/L, phosphate $\leqslant$1.7 mmol/L, and PTH $\leqslant$72 pmol/L.

Tables 12.14 and 12.15 identify each centre and detail the numbers of patients who had received HD and PD and the results of the BMD combination analyses.

Figures 12.15 and 12.16, demonstrate the caterpillar plots of all centres and the percentage achievement of

Table 12.14. Percentage of haemodialysis patients within the ranges specified for the simultaneous combinations of control of bone and mineral disorder parameters in preventing severe hyperparathyroidism in 2012

		Number of parameters			
Centre	*N*	None	One	Two	Three
England					
B Heart	385	5.2	23.1	36.1	35.6
Basldn	145	0.7	7.6	35.9	55.9
Bradfd	185	0.5	15.7	28.1	55.7
Brightn	206	2.4	15.5	33.5	48.5
Bristol	452	1.5	16.6	36.9	44.9
Camb	214	0.9	8.4	29.0	61.7
Carlis	57	1.8	10.5	38.6	49.1
Chelms	120	0.8	12.5	27.5	59.2
Colchr	98	0.0	7.1	36.7	56.1
Covnt	331	2.1	15.7	36.9	45.3
Derby	206	1.0	12.1	36.9	50.0
Donc	157	1.3	5.7	34.4	58.6

Table 12.14. Continued

Centre	*N*	Number of parameters			
		None	One	Two	Three
Dorset	241	0.4	10.4	30.3	58.9
Dudley	147	3.4	17.0	40.1	39.5
Exeter	348	1.7	6.9	38.8	52.6
Glouc	192	0.5	7.3	34.4	57.8
Hull	305	3.6	11.1	35.4	49.8
Ipswi	124	0.0	8.9	37.9	53.2
Kent	351	2.6	18.8	39.9	38.7
L Barts	834	4.1	19.3	41.1	35.5
L Guys	452	3.5	13.1	36.3	47.1
L Kings	444	1.8	11.5	33.1	53.6
L Rfree	531	2.4	10.9	34.5	52.2
L St.G	249	2.0	13.3	38.2	46.6
L West	1,007	3.1	17.5	44.1	35.4
Leeds	448	2.2	15.0	33.5	49.3
Leic	789	2.3	16.9	37.3	43.6
Liv Ain	158	1.9	7.0	31.0	60.1
Liv RI	335	1.8	8.7	36.1	53.4
M RI	426	2.6	17.1	39.0	41.3
Middlbr	291	2.1	17.9	38.5	41.6
Newc	261	2.3	12.6	37.9	47.1
Norwch	286	2.8	13.3	41.6	42.3
Nottm	353	2.0	13.0	28.9	56.1
Oxford	383	3.1	17.0	36.0	43.9
Plymth	115	1.7	7.0	27.8	63.5
Ports	483	2.5	14.1	40.0	43.5
Redng	251	2.4	7.2	35.1	55.4
Salford	292	2.1	12.3	34.6	51.0
Sheff	544	1.3	14.0	36.6	48.2
Shrew	182	2.2	15.4	35.7	46.7
Stevng	370	1.9	16.2	37.6	44.3
Sthend	97	3.1	18.6	38.1	40.2
Stoke	236	1.3	12.7	41.1	44.9
Truro	131	0.0	11.5	35.1	53.4
Wirral	171	0.6	13.5	29.2	56.7
Wolve	261	1.1	8.8	37.2	52.9
York	118	0.0	7.6	24.6	67.8
N Ireland					
Antrim	125	0.8	7.2	27.2	64.8
Belfast	202	1.5	12.4	31.2	55.0
Newry	85	2.4	7.1	38.8	51.8
Ulster	101	0.0	6.9	32.7	60.4
West NI	129	1.6	12.4	33.3	52.7
Wales					
Bangor	81	0.0	8.6	33.3	58.0
Cardff	432	1.9	12.7	37.0	48.4
Clwyd	76	1.3	11.8	42.1	44.7
Swanse	224	1.8	12.1	35.3	50.9
Wrexm	83	0.0	1.2	25.3	73.5
England	**14,762**	**2.2**	**14.0**	**36.7**	**47.1**
N Ireland	**642**	**1.2**	**9.8**	**32.1**	**56.9**
Wales	**896**	**1.5**	**11.0**	**35.6**	**51.9**
E, W & NI	**16,300**	**2.2**	**13.7**	**36.4**	**47.8**

Target range: adjusted calcium 2.2–2.5 mmol/L; phosphate $\leqslant$ 1.7 mmol/L; PTH $\leqslant$ 72 pmol/L

Table 12.15. Percentage of peritoneal dialysis patients within the ranges specified for the simultaneous combinations of control of bone and mineral disorder parameters in preventing severe hyperparathyroidism in 2012

		Number of parameters			
Centre	*N*	None	One	Two	Three
England					
B Heart	32	3.1	25.0	40.6	31.3
Basldn	27	0.0	14.8	37.0	48.1
Bradfd	21	4.8	14.3	38.1	42.9
Brightn	61	0.0	9.8	44.3	45.9
Bristol	53	0.0	13.2	49.1	37.7
Camb	32	0.0	3.1	40.6	56.3
Carlis	20	0.0	20.0	10.0	70.0
Chelms	25	0.0	8.0	28.0	64.0
Covnt	76	1.3	2.6	28.9	67.1
Derby	83	1.2	7.2	37.3	54.2
Donc	23	0.0	21.7	21.7	56.5
Dorset	22	0.0	9.1	13.6	77.3
Dudley	46	0.0	6.5	60.9	32.6
Exeter	68	0.0	4.4	38.2	57.4
Glouc	25	0.0	8.0	32.0	60.0
Hull	69	1.4	10.1	42.0	46.4
Ipswi	29	6.9	10.3	37.9	44.8
Kent	48	2.1	18.8	47.9	31.3
L Barts	147	0.7	13.6	34.7	51.0
L Guys	25	0.0	4.0	28.0	68.0
L Kings	75	1.3	17.3	33.3	48.0
L Rfree	71	1.4	15.5	35.2	47.9
L St.G	43	0.0	4.7	37.2	58.1
L West	46	0.0	13.0	43.5	43.5
Leeds	77	2.6	14.3	35.1	48.1
Leic	136	2.9	11.0	32.4	53.7
Liv RI	53	0.0	7.5	32.1	60.4
M RI	74	4.1	20.3	35.1	40.5
Newc	32	0.0	12.5	40.6	46.9
Norwch	43	2.3	9.3	44.2	44.2
Nottm	71	2.8	15.5	39.4	42.3
Oxford	66	4.5	15.2	42.4	37.9
Plymth	27	0.0	7.4	44.4	48.1
Ports	77	1.3	13.0	35.1	50.6
Redng	61	0.0	6.6	23.0	70.5
Salford	83	1.2	24.1	34.9	39.8
Sheff	53	0.0	9.4	37.7	52.8
Shrew	31	3.2	9.7	45.2	41.9
Stevng	25	0.0	8.0	24.0	68.0
Stoke	57	5.3	22.8	28.1	43.9
Wolve	77	0.0	5.2	41.6	53.2
York	25	0.0	16.0	36.0	48.0
N Ireland					
Belfast	23	0.0	17.4	43.5	39.1
Wales					
Cardff	69	2.9	8.7	33.3	55.1
Swanse	50	0.0	6.0	34.0	60.0
England	**2,235**	**1.4**	**12.1**	**36.6**	**49.9**
N Ireland	**23**	**0.0**	**17.4**	**43.5**	**39.1**
Wales	**119**	**1.7**	**7.6**	**33.6**	**57.1**
E, W & NI	**2,377**	**1.4**	**11.9**	**36.5**	**50.1**

Target range: adjusted calcium 2.2–2.5 mmol/L; phosphate $\leqslant$ 1.7 mmol/L; PTH $\leqslant$ 72 pmol/L

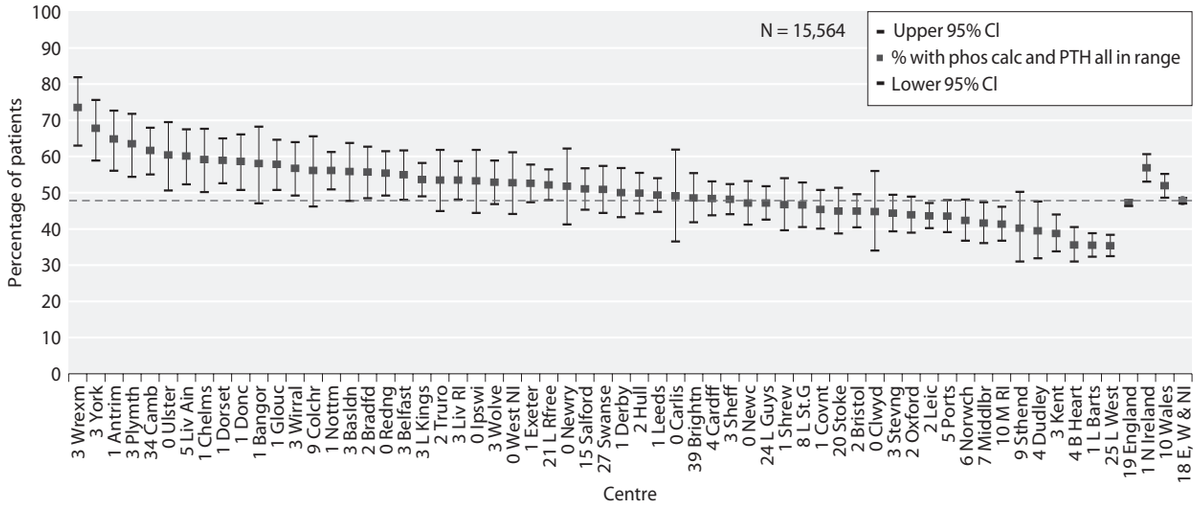

Fig. 12.15. Percentage of HD patients achieving simultaneous control of all three BMD parameters in preventing severe hyperparathyroidism by centre in 2012

simultaneous control of all three BMD parameters for HD and PD patients.

Control of none of the parameters of BMD was found in 2.2% of HD patients and 1.4% of PD patients; of one parameter in 13.7% of HD and 11.9% of PD patients; of two parameters in 36.4% of HD and 36.5% of PD patients; and of all three parameters in 47.8% of HD and 50.1% of PD patients (tables 12.14, 12.15).

The details of single parameters alone and combinations of adjusted calcium, phosphate and PTH are detailed in table 12.16 (aggregate information has been presented as a percentage measure for all centres with valid data).

Figures 12.17 and 12.18 are funnel plots of all centres who contributed data to these analyses based on the size of the centre and the percentage of patients achieving the control of all three BMD parameters. In HD patients, there was a negative trend observed between centre size and the simultaneous control of all three BMD parameters as identified in this analysis. No such trend was observed in PD patients, perhaps because PD centres are all of a small size.

Mineral and bone variables

There are convincing observational data that hyperphosphataemia is associated with increased mortality in

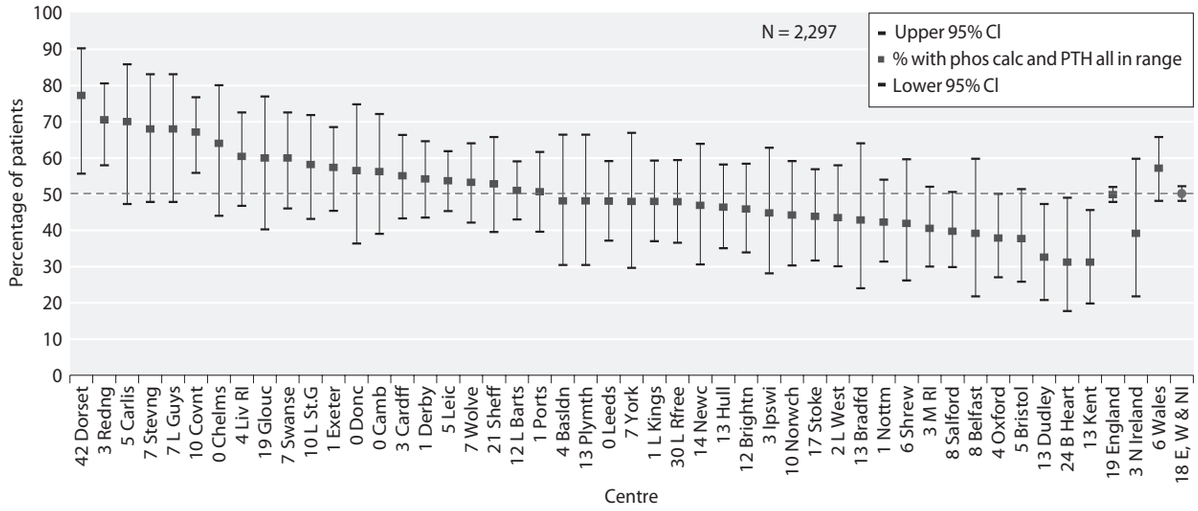

Fig. 12.16. Percentage of PD patients achieving simultaneous control of all three BMD parameters in preventing severe hyperparathyroidism by centre in 2012

Table 12.16. Average control of BMD parameters in preventing severe hyperparathyroidism across renal centres in 2012

	HD			PD		
BMD combination of parameters	Avg (%)	Min (%)	Max (%)	Avg (%)	Min (%)	Max (%)
None	1.8	0.0	5.2	1.3	0.0	6.9
One	12.2	1.2	23.1	11.9	2.6	25.0
Two	35.2	24.6	44.1	36.1	10.0	60.9
Three	50.8	35.4	73.5	50.8	31.3	77.3
Adj.Ca alone	4.2	0.0	9.1	4.0	0.0	13.0
Phosphate alone	2.1	0.0	7.3	1.8	0.0	6.5
PTH alone	5.8	1.0	13.0	6.2	0.0	15.0
Adj.Ca and phosphate	5.1	0.0	17.3	3.3	0.0	10.3
Adj.Ca and PTH	18.4	10.3	29.4	20.4	5.0	47.8
Phosphate and PTH	11.8	6.1	17.4	12.4	0.0	30.4

Adj.Ca = adjusted calcium
Avg = average

dialysis patients but the data linking calcium and parathyroid hormone to patient survival are less clear [11–15]. A recent cohort study has demonstrated that simultaneous achievement of all three audit measures does appear to be associated with better outcomes [16].

The UKRR has consistently demonstrated between centre variation in achievement of audit measures for bone and mineral parameters but little is understood about the causes of this 'centre effect'. The complexity of the clinical processes required to manage mineral and bone disorders is probably further confounded by case-mix. In the future, with centres moving to newer IT systems, medications used in the management of bone and mineral diseases may become available to aid in better analyses of these parameters.

Finally, it is important to consider data quality and the potential for measurement bias particularly in light of the variability in assay methods for parathyroid hormone as discussed above. However, detecting these centre level differences is an important step in understanding the factors associated with exceptional performance.

Bicarbonate

In 2012 the following Renal Association clinical practice guidelines regarding bicarbonate management were applicable:

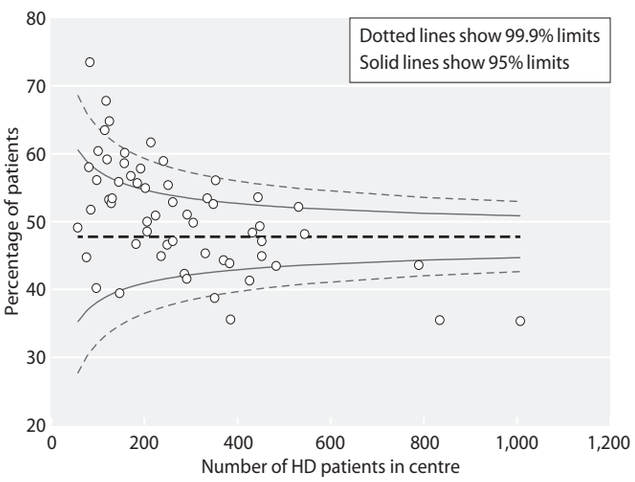

Fig. 12.17. Funnel plot for percentage of HD patients achieving simultaneous control of all three BMD parameters in preventing severe hyperparathyroidism by centre in 2012

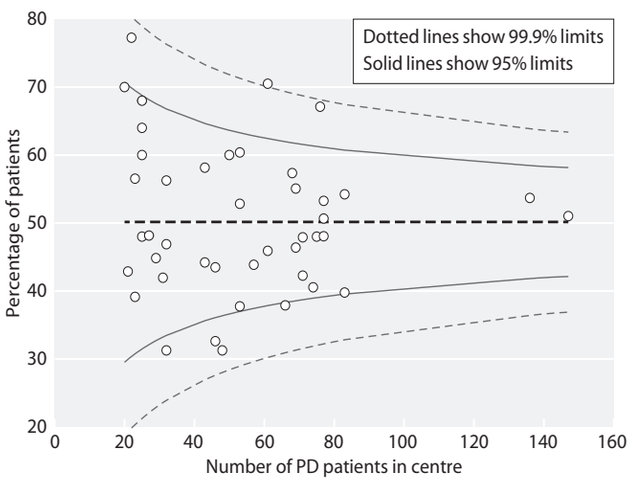

Fig. 12.18. Funnel plot for percentage of PD patients achieving simultaneous control of all three BMD parameters in preventing severe hyperparathyroidism by centre in 2012

Haemodialysis Guideline 6.3: Pre-dialysis serum bicarbonate concentrations

'We suggest that pre-dialysis serum bicarbonate concentrations, measured with minimum delay after venepuncture, should be between 18 and 24 mmol/l. (2C)' [17]

Peritoneal Dialysis Guideline 6.2 – PD: Metabolic factors

'We recommend that plasma bicarbonate should be maintained within the normal range' [18]

Citing evidence for reduced risk of adverse events, the haemodialysis module of the 5th edition of the Renal Association clinical practice guidelines published in December 2009 [1, 17–18] recommended a target range for serum bicarbonate of 18–24 mmol/L, a reduction from the previous guideline range of 20–26 mmol/L.

Bicarbonate data were 91% complete for both HD and PD patients (tables 12.17, 12.19). A lower bicarbonate RA target range in haemodialysis patients was introduced in 2010. The proportion of patients achieving the audit measure was 59% in 2012 (95% CI 58–60%) (table 12.18); the mean bicarbonate was 24 mmol/L (table 12.17). The proportion achieving the standard in

Table 12.17. Summary statistics for serum bicarbonate in haemodialysis patients by centre in 2012

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
England							
B Heart	93.8	376	21.8	3.0	22	20	24
B QEH	96.2	831	23.6	2.6	24	22	25
Basldn	96.7	145	23.2	3.2	24	22	25
Bradfd	98.4	186	24.0	3.2	24	22	26
Brightn	90.8	307	23.2	3.1	23	21	25
Bristol	100.0	461	22.7	2.4	23	21	24
Camb	94.8	307	23.7	2.2	24	22	25
Carlis	100.0	57	22.0	3.0	22	20	25
Carsh	92.8	648	23.4	3.9	24	21	26
Chelms	100.0	121	21.9	2.0	22	21	23
Colchr	92.6	100	24.6	1.7	25	23	26
Covnt	98.5	330	24.5	3.3	24	22	27
Derby	99.5	208	22.1	2.7	22	20	24
Donc	100.0	158	23.1	3.1	23	21	25
Dorset	99.6	243	22.8	2.8	23	21	24
Dudley	100.0	153	23.7	2.7	24	22	25
Exeter	100.0	351	21.0	2.6	21	19	23
Glouc	100.0	193	24.0	2.6	24	22	26
Hull	100.0	310	22.0	2.3	22	21	23
Ipswi	100.0	124	23.0	2.8	23	21	25
Kent	99.5	359	21.8	2.7	22	20	23
L Barts	66.4	562	22.4	3.1	22	21	24
L Guys	71.6	424	22.3	3.0	22	20	24
L Kings	99.8	459	26.5	2.2	26	25	28
L Rfree	82.9	554	23.1	2.9	23	21	25
L St.G	97.4	264	26.6	2.8	26.5	25	28.5
L West	65.6	880	19.2	2.7	19	17	21
Leeds	100.0	454	22.3	3.6	22	20	25
Leic	99.5	797	24.8	3.7	24	22	27
Liv Ain	98.2	163	24.0	2.9	24	22	26
Liv RI	99.4	343	27.3	2.9	28	26	29
M RI	92.2	437	24.1	3.1	24	22	26
Middlbr	99.4	310	27.2	3.2	27	25	29
Newc	100.0	262	25.0	3.2	26	24	27
Norwch	99.3	301	24.0	2.9	24	22	26
Nottm	94.4	335	25.1	3.0	25	23	27
Oxford	100.0	389	23.5	3.2	24	22	25
Plymth	100.0	119	25.6	2.6	26	24	27

Table 12.17. Continued

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
Ports	99.8	509	22.9	2.8	23	21	25
Prestn	98.8	490	23.3	3.0	23	21	25
Redng	100.0	251	24.5	2.4	24	23	26
Salford	9.0	31					
Sheff	99.8	561	24.8	3.2	25	23	27
Shrew	100.0	184	24.5	2.9	24	22	26
Stevng	97.9	372	23.3	3.1	23	21	25
Sthend	100.0	107	25.1	3.6	25	23	27
Stoke	33.3	98					
Sund	99.5	183	26.5	3.1	27	25	29
Truro	99.3	133	21.5	2.4	21	20	23
Wirral	97.7	173	24.3	2.8	25	22	26
Wolve	98.9	267	21.9	2.6	22	20	24
York	100.0	122	23.6	2.7	23	22	25
N Ireland							
Antrim	97.6	123	23.6	2.8	23	22	25
Belfast	99.0	206	23.8	2.4	24	22	25
Newry	100.0	85	22.4	2.8	22	20	24
Ulster	100.0	101	23.3	2.9	23	22	25
West NI	100.0	129	24.1	2.7	24	22	26
Wales							
Bangor	100.0	82	24.9	3.4	25	23	27
Cardff	96.0	430	22.8	4.0	22	20	25
Clwyd	100.0	76	22.6	2.7	23	21	24
Swanse	100.0	308	24.5	2.9	24	23	26
Wrexm	100.0	86	21.4	2.1	22	20	23
England	**90.1**	**16,502**	**23.5**	**3.5**	**23**	**21**	**26**
N Ireland	**99.2**	**644**	**23.6**	**2.7**	**23**	**22**	**25**
Wales	**98.2**	**982**	**23.4**	**3.5**	**23**	**21**	**26**
E, W & NI	**90.8**	**18,128**	**23.5**	**3.5**	**23**	**21**	**26**

Blank cells denote centres excluded from analyses due to poor data completeness

Table 12.18. Percentage of haemodialysis patients within, below and above the range for bicarbonate (18–24 mmol/L) by centre in 2012

Centre	*N*	% bicarb 18–24 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb <18 mmol/L	% bicarb >24 mmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
England									
B Heart	376	78.5	74.0	82.3	5.9	15.7	52.7	46.5	59.0
B QEH	831	62.1	58.7	65.3	0.8	37.1	8.8	4.0	13.5
Basldn	145	69.0	61.0	76.0	3.5	27.6	−7.2	−17.6	3.3
Bradfd	186	51.1	43.9	58.2	2.7	46.2	−4.9	−15.1	5.4
Brightn	307	64.2	58.7	69.3	3.9	31.9	1.8	−5.9	9.6
Bristol	461	75.5	71.4	79.2	3.0	21.5	25.0	19.0	31.1
Camb	307	64.8	59.3	70.0	0.7	34.5	0.5	−7.0	8.0
Carlis	57	63.2	50.0	74.6	8.8	28.1	−2.4	−19.9	15.1
Carsh	648	52.9	49.1	56.8	6.5	40.6	−8.3	−13.7	−2.9
Chelms	121	86.8	79.5	91.7	2.5	10.7	25.0	14.3	35.8
Colchr	100	42.0	32.7	51.9	0.0	58.0	27.0	15.1	38.9
Covnt	330	53.3	47.9	58.7	1.8	44.9	18.8	11.3	26.2
Derby	208	76.9	70.7	82.2	2.9	20.2	23.2	14.1	32.3
Donc	158	67.7	60.1	74.6	1.3	31.0	1.1	−9.4	11.5

Table 12.18. Continued

Centre	*N*	% bicarb 18–24 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb <18 mmol/L	% bicarb >24 mmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
Dorset	243	74.1	68.2	79.2	1.2	24.7	11.0	2.6	19.4
Dudley	153	58.8	50.9	66.3	2.0	39.2	3.2	−8.3	14.7
Exeter	351	82.1	77.7	85.7	9.1	8.8	12.7	6.3	19.1
Glouc	193	58.0	51.0	64.8	0.5	41.5	3.4	−6.6	13.4
Hull	310	86.1	81.8	89.6	2.3	11.6	3.7	−2.1	9.4
Ipswi	124	70.2	61.6	77.6	0.8	29.0	35.7	24.1	47.4
Kent	359	81.9	77.6	85.5	3.9	14.2	6.4	0.4	12.4
L Barts	562	71.7	67.8	75.3	5.7	22.6	25.2	20.1	30.3
L Guys	424	75.0	70.7	78.9	4.3	20.8	13.0	6.4	19.6
L Kings	459	17.0	13.8	20.7	0.0	83.0	−13.3	−18.9	−7.8
L Rfree	554	69.7	65.7	73.4	2.5	27.8	0.1	−5.4	5.5
L St.G	264	20.1	15.7	25.3	0.0	79.9	−9.3	−16.6	−2.0
L West	880	71.7	68.6	74.6	25.3	3.0	−2.9	−7.1	1.2
Leeds	454	63.7	59.1	68.0	8.8	27.5	−10.5	−16.4	−4.5
Leic	797	47.8	44.4	51.3	2.6	49.6	−3.1	−8.0	1.8
Liv Ain	163	57.1	49.4	64.4	0.0	42.9	−6.3	−17.1	4.4
Liv RI	343	13.4	10.2	17.4	0.6	86.0	−45.5	−51.8	−39.3
M RI	437	54.9	50.2	59.5	2.1	43.0	−7.1	−13.8	−0.4
Middlbr	310	20.3	16.2	25.2	0.0	79.7	−2.7	−9.4	4.0
Newc	262	32.1	26.7	38.0	3.1	64.9	12.9	5.4	20.4
Norwch	301	57.8	52.2	63.3	0.7	41.5	1.9	−6.1	9.9
Nottm	335	39.1	34.0	44.4	1.5	59.4	10.4	3.4	17.3
Oxford	389	61.4	56.5	66.2	2.8	35.7	14.7	7.7	21.6
Plymth	119	28.6	21.2	37.3	0.0	71.4	−50.5	−61.3	−39.6
Ports	509	70.9	66.8	74.7	3.1	25.9	−0.5	−6.2	5.2
Prestn	490	60.8	56.4	65.0	3.1	36.1	0.9	−5.2	7.1
Redng	251	49.8	43.7	56.0	0.8	49.4	−3.9	−12.6	4.9
Sheff	561	46.5	42.4	50.7	0.7	52.8	−2.2	−8.1	3.6
Shrew	184	50.5	43.4	57.7	0.0	49.5	−9.1	−19.4	1.1
Stevng	372	68.8	63.9	73.3	1.6	29.6	10.5	3.7	17.4
Sthend	107	36.5	27.9	46.0	1.9	61.7	−11.8	−24.7	1.1
Sund	183	20.2	15.0	26.7	1.6	78.1	17.1	10.7	23.5
Truro	133	82.7	75.3	88.2	4.5	12.8	37.8	27.3	48.3
Wirral	173	47.4	40.1	54.8	0.6	52.0	1.2	−9.6	11.9
Wolve	267	78.3	72.9	82.8	3.8	18.0	3.1	−3.9	10.1
York	122	62.3	53.4	70.4	1.6	36.1	20.6	8.1	33.0
N Ireland									
Antrim	123	63.4	54.6	71.4	1.6	35.0	41.6	30.3	52.9
Belfast	206	63.6	56.8	69.9	0.5	35.9	10.4	0.9	19.9
Newry	85	72.9	62.6	81.3	3.5	23.5	32.1	18.6	45.7
Ulster	101	71.3	61.7	79.3	2.0	26.7	5.0	−7.8	17.7
West NI	129	53.5	44.9	61.9	1.6	45.0	−14.4	−26.1	−2.7
Wales									
Bangor	82	47.6	37.0	58.3	1.2	51.2	14.6	−0.1	29.3
Cardff	430	64.0	59.3	68.4	5.8	30.2	−0.2	−6.6	6.1
Clwyd	76	77.6	66.9	85.6	2.6	19.7	−0.3	−14.5	13.8
Swanse	308	51.0	45.4	56.5	1.6	47.4	16.1	8.5	23.7
Wrexm	86	89.5	81.1	94.5	3.5	7.0	0.4	−8.9	9.7
England	**16,502**	**58.5**	**57.8**	**59.3**	**3.9**	**37.6**	**4.1**	**3.0**	**5.1**
N Ireland	**644**	**64.0**	**60.2**	**67.6**	**1.6**	**34.5**	**13.3**	**8.0**	**18.6**
Wales	**982**	**61.8**	**58.7**	**64.8**	**3.7**	**34.5**	**7.0**	**2.7**	**11.3**
E, W & NI	**18,128**	**58.9**	**58.2**	**59.6**	**3.8**	**37.3**	**4.5**	**3.5**	**5.6**

Table 12.19. Summary statistics for serum bicarbonate in peritoneal dialysis patients by centre in 2012

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
England							
B Heart	97.6	41	21.2	2.6	21	20	23
B QEH	92.0	137	24.2	3.5	25	22	26
Basldn	96.4	27	27.6	3.9	27	24	30
Bradfd	95.8	23	26.3	2.5	27	24	28
Brightn	79.7	55	25.3	3.5	26	22	28
Bristol	100.0	56	22.5	2.7	23	21	24
Camb	93.8	30	27.8	3.4	29	25	30
Carlis	100.0	21	22.3	3.8	23	21	24
Carsh	90.7	88	26.7	3.5	27	25	29
Chelms	100.0	25	24.7	3.4	26	23	27
Colchr*							
Covnt	89.3	75	26.2	2.8	26	24	28
Derby	100.0	84	24.3	3.1	25	22	26
Donc	100.0	23	25.5	3.4	26	22	29
Dorset	68.4	26	24.5	3.5	25	23	28
Dudley	98.1	52	27.3	3.1	28	26	29
Exeter	100.0	69	21.7	3.1	22	20	24
Glouc	93.6	29	25.2	2.9	26	23	26
Hull	94.9	75	26.1	3.0	27	25	28
Ipswi	100.0	30	28.2	3.1	29	26	31
Kent	98.2	54	23.9	2.8	23	22	26
L Barts	97.6	163	23.9	2.7	24	22	26
L Guys	96.3	26	23.8	2.7	24	22	26
L Kings	98.7	75	27.1	2.9	27	25	29
L Rfree	81.4	83	26.6	3.0	27	25	29
L St.G	97.9	47	27.5	2.6	28	26	29
L West	100.0	47	21.5	2.7	22	20	24
Leeds	100.0	77	26.0	3.1	26	24	29
Leic	96.5	138	26.8	3.7	27	25	29
Liv Ain	100.0	17					
Liv RI	98.2	54	25.8	3.4	26	24	28
M RI	98.7	75	26.0	3.2	26	24	28
Middlbr	87.5	7					
Newc	86.5	32	24.1	2.5	24	23	26
Norwch	100.0	48	22.9	3.2	23	21	24
Nottm	55.6	40	28.6	3.2	28	26	31
Oxford	76.8	53	25.1	3.6	25	24	27
Plymth	93.6	29	25.2	2.3	26	24	27
Ports	98.7	77	25.6	2.6	26	24	27
Prestn	98.3	58	24.8	3.7	26	22	28
Redng	100.0	63	27.8	2.6	28	26	29
Salford	11.1	10					
Sheff	100.0	67	26.0	3.3	26	24	28
Shrew	97.0	32	26.5	3.3	27	25	29
Stevng	96.3	26	26.0	2.5	26	25	27
Sthend	100.0	14					
Stoke	98.6	68	26.9	3.5	27	25	29
Sund	100.0	17					
Truro	94.7	18					
Wirral	75.9	22	25.1	2.2	25	24	27
Wolve	97.6	81	24.6	2.7	25	23	26
York	100.0	27	26.3	2.5	27	24	29

Table 12.19. Continued

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
N Ireland							
Antrim	30.0	3					
Belfast	96.0	24	25.4	3.3	25	23	28
Newry	57.1	8					
Ulster	100.0	6					
West NI	86.7	13					
Wales							
Bangor	100.0	14					
Cardff	93.0	66	26.5	3.9	26	23	30
Clwyd	100.0	15					
Swanse	100.0	54	25.6	3.3	27	24	28
Wrexm	95.0	19					
England	**91.2**	**2,611**	**25.4**	**3.5**	**26**	**23**	**28**
N Ireland	**77.1**	**54**	**24.6**	**2.9**	**24**	**23**	**27**
Wales	**96.6**	**168**	**25.9**	**3.4**	**26**	**24**	**28**
E, W & NI	**91.2**	**2,833**	**25.4**	**3.5**	**26**	**23**	**28**

Blank cells denote low patient numbers or poor data completeness
*No PD patients

PD patients was 80% (CI 78–81%) (table 12.20). Collectively there was significant inter-centre variation for both HD and PD (tables 12.18, 12.20, figures 12.19, 12.20). There was even greater between centre variation in the proportion of patients with bicarbonate values above and below the specified range for the audit measure (tables 12.18, 12.20). The UKRR has previously conducted a limited survey into the possible underlying causes of this variation. The study predominantly looked at measures of sample processing and of dialysis treatment. It did not adjust for case-mix and was unable to detect any significant differences between centres.

Table 12.20. Percentage of peritoneal dialysis patients within, below and above the range for bicarbonate (22–30 mmol/L) by centre in 2012

Centre	*N*	% bicarb 22–30 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb <22 mmol/L	% bicarb >30 mmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
England									
B Heart	41	41.5	27.6	56.9	58.5	0.0	−47.7	−65.8	−29.6
B QEH	137	72.3	64.2	79.1	24.1	3.7	−8.4	−18.4	1.5
Basldn	27	74.1	54.7	87.1	3.7	22.2	−21.8	−40.1	−3.4
Bradfd	23	100.0	0.0	100.0	0.0	0.0	22.2	6.5	37.9
Brightn	55	80.0	67.4	88.6	14.6	5.5	1.3	−13.4	16.1
Bristol	56	62.5	49.3	74.1	37.5	0.0	−27.3	−42.2	−12.5
Camb	30	76.7	58.5	88.5	6.7	16.7	−4.6	−24.9	15.7
Carlis	21	57.1	36.0	76.0	42.9	0.0	24.0	24.0	24.0
Carsh	88	80.7	71.1	87.6	8.0	11.4	4.5	−7.6	16.7
Chelms	25	76.0	55.8	88.8	24.0	0.0	−14.9	−35.5	5.7
Covnt	75	86.7	77.0	92.7	8.0	5.3	1.1	−9.9	12.2
Derby	84	82.1	72.5	88.9	15.5	2.4	−3.3	−14.1	7.5
Donc	23	78.3	57.2	90.7	17.4	4.4	−17.0	−36.1	2.2
Dorset	26	73.1	53.3	86.6	23.1	3.9	−1.3	−23.2	20.6
Dudley	52	84.6	72.1	92.1	3.9	11.5	5.5	−9.7	20.6
Exeter	69	55.1	43.3	66.3	44.9	0.0	−30.2	−44.9	−15.5
Glouc	29	86.2	68.5	94.7	6.9	6.9	−7.5	−22.6	7.6
Hull	75	90.7	81.7	95.5	8.0	1.3	2.8	−7.1	12.8
Ipswi	30	73.3	55.0	86.1	0.0	26.7	−16.7	−35.8	2.5
Kent	54	79.6	66.8	88.4	20.4	0.0	10.8	−5.0	26.6
L Barts	163	79.1	72.2	84.7	20.3	0.6	−8.0	−16.3	0.2
L Guys	26	76.9	57.2	89.3	23.1	0.0	−5.2	−26.8	16.3

Table 12.20. Continued

Centre	*N*	% bicarb 22–30 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb <22 mmol/L	% bicarb >30 mmol/L	Change in % within range from 2011	95% LCL change	95% UCL change
L Kings	75	81.3	70.9	88.6	1.3	17.3	−15.8	−25.5	−6.2
L Rfree	83	83.1	73.5	89.8	9.6	7.2	−0.6	−12.0	10.8
L St.G	47	87.2	74.4	94.2	4.3	8.5	18.6	2.7	34.5
L West	47	53.2	39.1	66.8	46.8	0.0	−18.7	−39.8	2.4
Leeds	77	81.8	71.6	88.9	11.7	6.5	−7.1	−18.1	3.9
Leic	138	79.0	71.4	85.0	5.8	15.2	3.1	−6.9	13.0
Liv RI	54	83.3	71.0	91.1	7.4	9.3	−0.9	−14.6	12.8
M RI	75	86.7	77.0	92.7	6.7	6.7	−0.6	−11.6	10.3
Newc	32	81.3	64.1	91.3	18.8	0.0	−0.3	−18.6	18.0
Norwch	48	68.8	54.4	80.2	29.2	2.1	2.8	−16.1	21.6
Nottm	40	75.0	59.5	86.0	0.0	25.0	0.0	0.0	0.0
Oxford	53	86.8	74.8	93.6	9.4	3.8	22.0	6.3	37.6
Plymth	29	89.7	72.4	96.6	10.3	0.0	0.5	−14.5	15.4
Ports	77	93.5	85.3	97.3	3.9	2.6	5.7	−3.6	14.9
Prestn	58	81.0	68.9	89.2	17.2	1.7	1.4	−13.3	16.1
Redng	63	82.5	71.2	90.1	0.0	17.5	7.5	−6.2	21.2
Sheff	67	80.6	69.4	88.4	9.0	10.5	2.8	−11.8	17.4
Shrew	32	81.3	64.1	91.3	9.4	9.4	−2.8	−22.5	17.0
Stevng	26	92.3	73.9	98.1	3.9	3.9	0.3	−14.5	15.1
Stoke	68	75.0	63.4	83.9	8.8	16.2	19.8	4.0	35.5
Wirral	22	95.5	73.9	99.4	4.6	0.0	28.8	8.0	49.6
Wolve	81	86.4	77.1	92.3	13.6	0.0	−0.7	−11.9	10.5
York	27	96.3	77.9	99.5	3.7	0.0	1.3	−10.6	13.2
N Ireland									
Belfast	24	83.3	63.1	93.6	12.5	4.2	15.5	−7.4	38.3
Wales									
Cardff	66	74.2	62.4	83.4	9.1	16.7	−6.9	−20.2	6.4
Swanse	54	83.3	71.0	91.1	13.0	3.7	7.8	−7.8	23.4
England	**2,611**	**79.2**	**77.6**	**80.7**	**14.2**	**6.6**	**−2.2**	**−4.4**	**0.0**
N Ireland	**54**	**87.0**	**75.2**	**93.7**	**11.1**	**1.9**	**8.1**	**−5.8**	**22.0**
Wales	**168**	**81.0**	**74.3**	**86.2**	**10.1**	**8.9**	**−1.4**	**−9.5**	**6.8**
E, W & NI	**2,833**	**79.5**	**77.9**	**80.9**	**13.9**	**6.6**	**−1.9**	**−4.0**	**0.1**

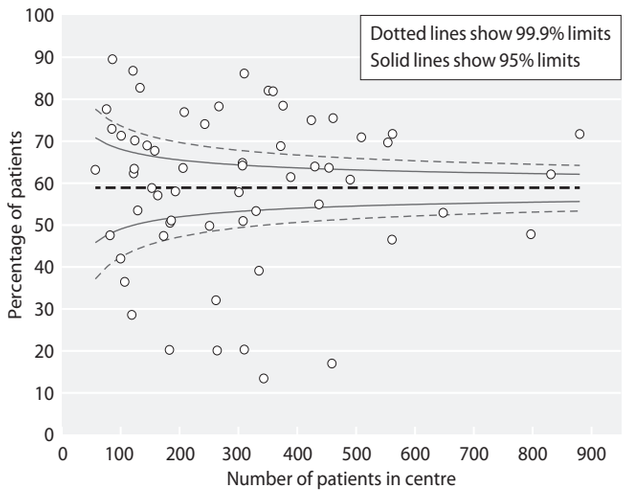

Fig. 12.19. Funnel plot for percentage of haemodialysis patients within the range for bicarbonate (18–24 mmol/L) by centre in 2012

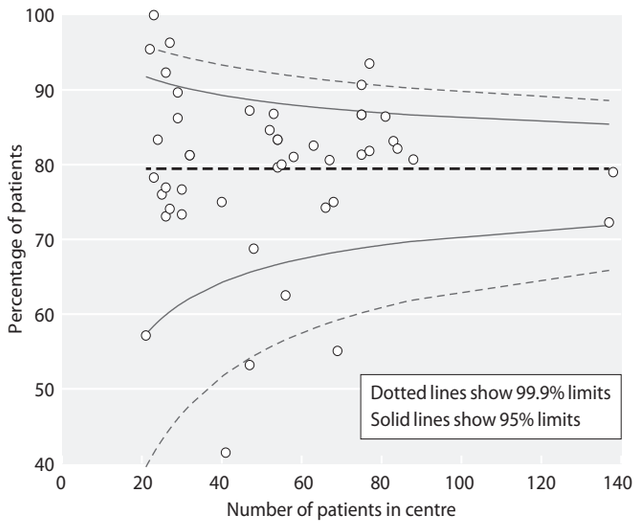

Fig. 12.20. Funnel plot for percentage of peritoneal dialysis patients within the range for bicarbonate (22–30 mmol/L) by centre in 2012

However, it is possible that there may be unmeasured processes including dialysis and oral bicarbonate prescription that might account for the variation observed [19].

Total cholesterol

There is no audit standard for total cholesterol in the Renal Association clinical practice guidelines. Current guidance on lipid management states:

'We recommend that statins (or 3 hydroxy-3 methylglutaryl-coenzyme A reductase inhibitors) should be considered for primary prevention in all CKD Stages 1–4 and transplant patients with a 10-year risk of cardiovascular disease, calculated as >20% according to the Joint British Societies' Guidelines – JBS2 (British Hypertension Society British Cardiac Society 2005).

We recommend that a total cholesterol of <4 mmol/L or a 25% reduction from baseline, or a fasting low density lipoprotein (LDL)-cholesterol of <2 mmol/L or a 30% reduction from baseline, should be achieved, whichever is the greatest reduction in all patients.

Statins should not be withdrawn from patients in whom they were previously indicated and should continue to be prescribed when such patients start renal replacement therapy (RRT) or change modality.' [20]

Total cholesterol data were 82% complete for HD patients and 78% complete for PD patients. As there are no specific audit measures for total cholesterol, summary data are presented for each dialysis centre (tables 12.21, 12.22, figures 12.21, 12.22). There are a number of case-mix factors (comorbidity, inflammation,

Table 12.21. Summary statistics for total cholesterol in haemodialysis patients by centre in 2012

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
England							
B Heart	98.8	396	4.2	1.1	4.1	3.3	4.8
B QEH	93.8	810	4.0	1.1	3.8	3.2	4.6
Basldn	98.0	147	3.9	1.0	3.7	3.2	4.6
Bradfd	91.5	173	3.8	1.0	3.7	3.1	4.4
Brightn	32.8	111					
Bristol	94.8	437	4.1	1.1	3.9	3.4	4.7
Camb	83.3	270	3.8	1.1	3.6	3.0	4.5
Carlis	100.0	57	4.2	1.2	4.1	3.3	5.0
Carsh	85.8	599	4.1	1.1	3.9	3.4	4.8
Chelms	88.4	107	3.6	0.9	3.5	2.9	4.1
Colchr	50.9	55	3.8	1.1	3.7	2.9	4.5
Covnt	0.3	1					
Derby	95.7	200	4.2	1.1	4.0	3.4	4.9
Donc	97.5	154	3.8	0.9	3.7	3.1	4.4
Dorset	91.4	223	3.9	1.0	3.9	3.2	4.6
Dudley	89.5	137	3.7	1.0	3.6	3.0	4.3
Exeter	96.6	339	3.9	1.0	3.8	3.2	4.5
Glouc	95.9	185	4.0	1.1	4.0	3.3	4.6
Hull	23.6	73					
Ipswi	90.3	112	3.8	1.0	3.6	3.1	4.3
Kent	92.0	332	4.0	1.1	3.9	3.2	4.7
L Barts	94.1	796	4.1	1.1	4.0	3.4	4.9
L Guys	39.5	234					
L Kings	89.8	413	3.8	0.9	3.7	3.1	4.4
L Rfree	61.8	413	4.1	1.2	3.9	3.3	4.7
L St.G	90.4	245	4.0	1.1	3.9	3.3	4.6
L West	83.5	1,120	3.6	0.9	3.5	2.9	4.2
Leeds	98.5	447	3.8	0.9	3.7	3.2	4.4
Leic	95.3	763	3.8	1.0	3.8	3.1	4.4
Liv Ain	88.6	147	4.0	1.1	3.8	3.1	4.8
Liv RI	96.5	333	3.8	1.1	3.8	3.0	4.5
M RI	91.1	432	4.0	1.1	3.8	3.2	4.7
Middlbr	80.8	252	4.3	1.1	4.2	3.5	4.9
Newc	100.0	262	3.8	1.0	3.7	3.1	4.3
Norwch	95.7	290	4.0	1.0	3.9	3.2	4.6

Table 12.21. Continued

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
Nottm	99.2	352	4.0	1.0	3.9	3.3	4.7
Oxford	54.2	211	3.8	1.0	3.6	2.9	4.5
Plymth	90.8	108	3.8	0.9	3.7	3.1	4.3
Ports	67.1	342	4.0	1.2	3.9	3.1	4.8
Prestn	75.2	373	3.9	1.0	3.8	3.1	4.5
Redng	96.4	242	3.8	1.0	3.7	3.1	4.3
Salford	49.3	170					
Sheff	90.9	511	4.1	1.1	4.0	3.3	4.8
Shrew	96.7	178	4.0	1.0	3.9	3.3	4.5
Stevng	20.0	76					
Sthend	94.4	101	3.8	1.1	3.8	3.1	4.5
Stoke	90.8	267	3.7	0.9	3.7	3.0	4.2
Sund	98.4	181	3.8	1.0	3.7	3.2	4.3
Truro	98.5	132	4.0	1.1	3.9	3.2	4.7
Wirral	91.5	162	3.8	1.1	3.6	3.0	4.4
Wolve	98.5	266	4.3	1.1	4.2	3.5	4.9
York	98.4	120	4.2	1.1	4.1	3.4	4.9
N Ireland							
Antrim	98.4	124	3.7	1.1	3.5	3.0	4.3
Belfast	82.7	172	3.8	1.0	3.7	3.1	4.5
Newry	100.0	85	3.5	0.8	3.5	3.1	3.8
Ulster	100.0	101	3.8	1.1	3.6	3.1	4.6
West NI	100.0	129	3.7	0.8	3.7	3.1	4.2
Wales							
Bangor	95.1	78	4.2	1.1	3.9	3.5	5.0
Cardff	95.3	427	4.1	1.1	4.0	3.3	4.8
Clwyd	97.4	74	3.9	1.0	3.8	3.3	4.4
Swanse	99.0	305	4.0	1.2	3.8	3.2	4.7
Wrexm	67.4	58	4.0	1.3	4.0	3.2	4.8
England	**81.1**	**14,857**	**3.9**	**1.1**	**3.8**	**3.2**	**4.6**
N Ireland	**94.1**	**611**	**3.7**	**1.0**	**3.6**	**3.1**	**4.3**
Wales	**94.2**	**942**	**4.0**	**1.1**	**3.9**	**3.3**	**4.7**
E, W & NI	**82.2**	**16,410**	**3.9**	**1.1**	**3.8**	**3.2**	**4.6**

Blank cells denote poor data completeness

Table 12.22. Summary statistics for total cholesterol in peritoneal dialysis patients by centre in 2012

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
England							
B Heart	95.2	40	5.0	1.2	4.9	4.2	5.7
B QEH	96.0	143	4.6	1.2	4.5	3.8	5.3
Basldn	96.4	27	4.5	1.5	4.4	3.4	5.2
Bradfd	87.5	21	4.0	0.9	4.1	3.3	4.7
Brightn	18.8	13					
Bristol	82.1	46	5.3	1.5	5.0	4.4	6.4
Camb	100.0	32	4.6	1.1	4.5	3.8	5.3
Carlis	95.2	20	4.4	0.8	4.4	3.8	4.9
Carsh	21.7	21					
Chelms	88.0	22	4.6	1.2	4.4	3.6	5.3
Colchr*							
Covnt	0.0	0					
Derby	86.9	73	4.9	1.5	4.6	3.6	5.9
Donc	52.2	12					
Dorset	65.8	25	5.1	1.5	4.7	4.0	5.6

Table 12.22. Continued

Centre	% completeness	Patients with data *N*	Mean	SD	Median	Lower quartile	Upper quartile
Dudley	60.4	32	4.3	1.1	4.4	3.4	5.0
Exeter	95.7	66	4.7	1.3	4.6	4.0	5.4
Glouc	83.9	26	4.6	1.0	4.4	4.0	5.0
Hull	25.3	20					
Ipswi	96.7	29	4.5	1.1	4.5	3.7	5.6
Kent	87.3	48	4.6	1.4	4.7	3.5	5.4
L Barts	100.0	167	4.7	1.3	4.6	3.8	5.3
L Guys	55.6	15					
L Kings	98.7	75	4.5	1.3	4.3	3.6	5.1
L Rfree	81.4	83	4.9	1.8	4.6	3.6	5.6
L St.G	97.9	47	4.4	1.2	4.4	3.4	5.4
L West	100.0	47	4.6	1.1	4.4	3.6	5.5
Leeds	90.9	70	4.3	0.9	4.1	3.5	4.9
Leic	96.5	138	4.5	1.2	4.4	3.6	5.1
Liv Ain	94.1	16					
Liv RI	94.6	52	4.6	1.5	4.3	3.5	5.1
M RI	98.7	75	4.4	1.4	4.2	3.6	5.2
Middlbr	37.5	3					
Newc	89.2	33	4.8	1.4	4.8	3.8	5.4
Norwch	100.0	48	4.9	1.4	4.7	3.9	5.6
Nottm	88.9	64	4.6	1.3	4.4	3.6	5.2
Oxford	58.0	40	4.7	1.5	4.4	3.7	5.4
Plymth	61.3	19					
Ports	97.4	76	4.6	1.2	4.4	3.8	5.1
Prestn	86.4	51	4.4	1.2	4.0	3.6	4.7
Redng	71.4	45	4.3	1.5	4.0	3.4	4.9
Salford	85.6	77	4.6	1.3	4.5	3.9	5.4
Sheff	50.8	34	4.7	1.1	4.6	3.9	5.3
Shrew	81.8	27	4.7	1.3	4.5	3.7	5.6
Stevng	44.4	12					
Sthend	78.6	11					
Stoke	100.0	69	4.0	1.1	4.0	3.1	4.8
Sund	70.6	12					
Truro	79.0	15					
Wirral	58.6	17					
Wolve	81.9	68	5.4	1.6	5.2	4.3	6.6
York	88.9	24	5.4	1.4	5.4	4.4	6.1
N Ireland							
Antrim	100.0	10					
Belfast	96.0	24	5.2	1.3	5.0	4.5	5.8
Newry	100.0	14					
Ulster	100.0	6					
West NI	100.0	15					
Wales							
Bangor	100.0	14					
Cardff	57.8	41	4.8	1.2	4.8	3.9	5.6
Clwyd	86.7	13					
Swanse	79.6	43	4.8	1.4	4.5	3.9	5.3
Wrexm	60.0	12					
England	**78.4**	**2,246**	**4.6**	**1.3**	**4.5**	**3.7**	**5.3**
N Ireland	**98.6**	**69**	**4.6**	**1.2**	**4.6**	**3.8**	**5.1**
Wales	**70.7**	**123**	**4.8**	**1.3**	**4.7**	**4.0**	**5.5**
E, W & NI	**78.4**	**2,438**	**4.7**	**1.3**	**4.5**	**3.7**	**5.3**

Blank cells denote low patient numbers or poor data completeness
*No PD patients

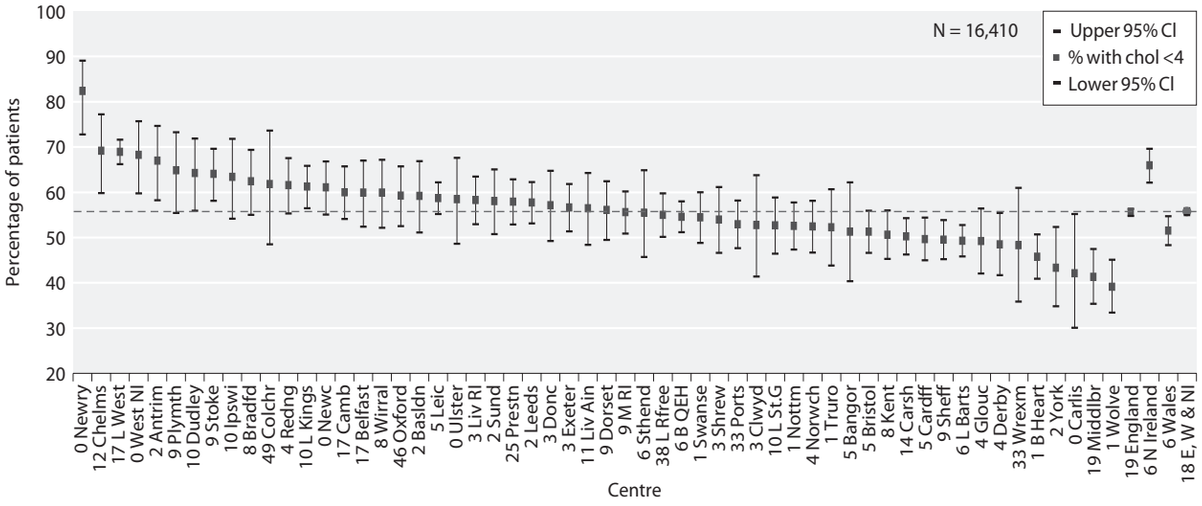

Fig. 12.21. Median total cholesterol in haemodialysis patients by centre in 2012

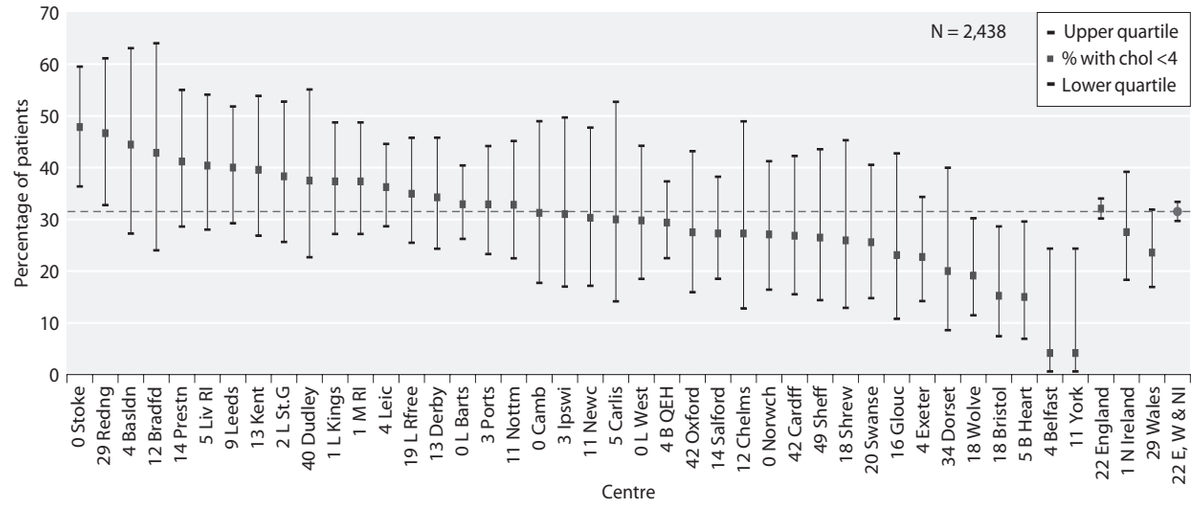

Fig. 12.22. Median total cholesterol in peritoneal dialysis patients by centre in 2012

malnutrition) which may account for any inter-centre variation in addition to differences in prescription of lipid lowering medication and other therapies known to influence serum lipid concentration such as steroids or sevelamer as examples.

Conflicts of interest: none

References

1 Renal Association. Clinical Practice Guidelines. 5th Edition. http://www.renal.org/Clinical/GuidelinesSection/Guidelines.aspx

2 Ansell D, Feehally J, Feest T, Tomson C, Williams AJ, Warwick G: U.K. Renal registry report 2007. Chapter 9. Management of biochemical variables. UK Renal Registry, Bristol, UK 2007

3 Steddon S, Sharpes E. Renal Association Clinical Practice Guideline. CKD-Mineral and Bone Disorders 2010 http://www.renal.org/Clinical/GuidelinesSection/CKD-MBD.aspx

4 Morton AR, Garland JS, Holden RM: Is the calcium correct? Measuring serum calcium in dialysis patients. Semin Dial;23:283–289

5 Kidney Disease: Improving Global Outcomes (KDIGO) CKD–MBD Work Group. KDIGO clinical practice guideline for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease–mineral and bone disorder (CKD–MBD). Kidney International 2009; 76(suppl 113):S1–S130
6 Spiegelhalter DJ: Funnel plots for comparing institutional performance. Statistics in Medicine 2005;24:1185–1202
7 Almond A, Ellis AR, Walker SW: Current parathyroid hormone immunoassays do not adequately meet the needs of patients with chronic kidney disease. Ann Clin Biochem 2011;49:63–67
8 Garrett G, Goldsmith DJA: Parathyroid hormone measurements, guidelines statements and clinical treatments: a real world cautionary tale. Ann Clin Biochem 2011;49:4–6
9 Gardham C, Stevens PE, Delaney MP, LeRoux M, Coleman A, Lamb EJ: Variability of parathyroid hormone and other markers of bone mineral metabolism in patients receiving haemodialysis. Clin J Am Soc Nephrol 2010;5:1261–1267
10 Sturgeon CM, Sprague SM, Metcalfe W: Variation in parathyroid hormone immunoassay results – a critical governance issue in the management of chronic kidney disease. Nephrol Dial Transplant 2011;26: 3440–3445
11 Kalantar-Zadeh K, Kuwae N, Regidor DL, Kovesdy CP, Kilpatrick RD, Shinaberger CS, McAllister CJ, Budoff MJ, Salusky IB, Kopple JD: Survival predictability of time-varying indicators of bone disease in maintenance hemodialysis patients. Kidney Int 2006;70:771–780
12 Melamed ML, Eustace JA, Plantinga L, Jaar BG, Fink NE, Coresh J, Klag MJ, Powe NR: Changes in serum calcium, phosphate, and pth and the risk of death in incident dialysis patients: A longitudinal study. Kidney Int 2006;70:351–357
13 Noordzij M, Korevaar JC, Boeschoten EW, Dekker FW, Bos WJ, Krediet RT: The kidney disease outcomes quality initiative (k/doqi) guideline for bone metabolism and disease in ckd: Association with mortality in dialysis patients. Am J Kidney Dis 2005;46:925–932
14 Stevens LA, Djurdjev O, Cardew S, Cameron EC, Levin A: Calcium, phosphate, and parathyroid hormone levels in combination and as a function of dialysis duration predict mortality: Evidence for the complexity of the association between mineral metabolism and outcomes. J Am Soc Nephrol 2004;15:770–779
15 Block GA, Klassen PS, Lazarus JM, Ofsthun N, Lowrie EG, Chertow GM: Mineral metabolism, mortality, and morbidity in maintenance hemodialysis. J Am Soc Nephrol 2004;15:2208–2218
16 Danese MD, Belozeroff V, Smirnakis K, Rothman KJ: Consistent control of mineral and bone disorder in incident hemodialysis patients. Clin J Am Soc Nephrol 2008;2:2
17 Mactier R, Hoenich N, Breen C. Renal Association Clinical Practice Guideline Haemodialysis 2009 http://www.renal.org/Clinical/GuidelinesSection/Haemodialysis.aspx
18 Woodrow G, Davies S. Renal Association Clinical Practice Guideline Peritoneal Dialysis 2010 http://www.renal.org/Clinical/GuidelinesSection/PeritonealDialysis.aspx
19 Ansell DF, T.G. (eds): Renal registry 7th annual report. Chapter 6: Adequacy of haemodialysis and serum bicarbonate, 2004, pp 59–86
20 Holt S, Goldsmith D. Renal Association Clinical Practice Guidelines Cardiovascular Disease in CKD 2010 http://www.renal.org/Clinical/GuidelinesSection/CardiovascularDiseaseInCKD.aspx

UK Renal Registry 16th Annual Report: Chapter 13 Clinical, Haematological and Biochemical Parameters in Patients Receiving Renal Replacement Therapy in Paediatric Centres in the UK in 2012: National and Centre-specific Analyses

Rishi Pruthi[a], Heather Maxwell[b], Anna Casula[a], Fiona Braddon[a], Malcolm Lewis[c], Catherine O'Brien[d], Jelena Stojanovic[e], Yincent Tse[f], Carol Inward[g], Manish D Sinha[e]

[a]UK Renal Registry, Bristol, UK; [b]Royal Hospital for Sick Children (Yorkhill), Glasgow, UK; [c]Manchester Children's Hospital, Manchester, UK; [d]Birmingham Children's Hospital, Birmingham, UK; [e]Evelina Childrens Hospital, London, UK; [f]Royal Victoria Infirmary, Newcastle, UK; [g]Bristol Royal Hospital for Children, Bristol, UK

Key Words
Biochemical variables · Children · Dialysis · ERF · Haemoglobin · Height · Quality improvement · Transplant · Weight

Summary

- Median weight z-score for children on dialysis was −1.1 whereas children with a functioning transplant had a near normal weight (median z-score 0.1).
- Median height z-score for children on dialysis was −2.0 and for children with a functioning transplant −1.3.
- 76% of transplant patients, 57% of haemodialysis patients and 56% of peritoneal dialysis patients had a systolic blood pressure within the 90th percentile standard.
- 92% of transplant patients, 74% of HD patients and 83% of PD patients had a haemoglobin within or above the age appropriate standard.
- 50% of HD patients and 56% of PD patients achieved the audit standard for phosphate.

Introduction

This report focuses on the following variables for the prevalent paediatric dialysis and transplantation cohort on 31st December 2012:

1. The completeness of data returns to the renal registry
2. The anthropometric characteristics in children with established renal failure (ERF)
3. Blood pressure control in children with ERF
4. Anaemia control in children with ERF
5. Key biochemical findings in this population.

Analyses of prevalent paediatric patients aged <16 years receiving renal replacement therapy for the year 2012 and for the period 2001 to 2012 inclusive are reported. A single dataset was collected for each patient per year during this time period. Due to low numbers of patients in each cohort, no incident cohort analyses have been undertaken. Centre specific data for each paediatric nephrology centre in the UK has also been provided.

Methods

There were 13 centres providing care for children requiring renal replacement therapy in the UK, ten of which also provided surgical renal transplant services. All 13 centres provided outpatient and inpatient follow up for children who had received kidney transplants. Centres are listed in table 13.1 and appendix K.

Table 13.1. Paediatric renal centres, their abbreviations and IT systems

Paediatric centre	Abbreviation	Renal IT system
Belfast*	Blfst_P	Mediqal
Birmingham	Bham_P	Proton
Bristol	Brstl_P	Proton
Cardiff	Cardf_P	Proton
Glasgow	Glasg_P	Filemaker
Leeds	Leeds_P	Proton
Liverpool	Livpl_P	None
London Evelina	L Eve_P	Filemaker
London Great Ormond Street	L GOSH_P	Filemaker
Manchester	Manch_P	Filemaker
Newcastle	Newc_P	Clinical Vision
Nottingham	Nottm_P	Proton
Southampton	Soton_P	Bespoke

*New system installed, although paper submission received in 2012

Data collection

The data presented in this report relate to the annual census date of 31st December 2012.

Those paediatric centres with access to renal IT systems submitted encrypted electronic data directly to the UK Renal Registry (UKRR). Those centres without access, sent paper (Belfast and Liverpool) or electronic returns (Filemaker systems in table 13.1) in the original BAPN database format which were then entered into the original BAPN database as in previous years. Complete transfer to the UKRR encrypted database is still awaited.

Governance, reporting and standardisation

Information governance, reporting and standardisation were all performed in an identical manner to previous analyses to allow comparison [1]. Where the value of clinical parameters in childhood varies with age and size, data are presented as z-scores.

Anthropometry

The reference range for height (Ht), weight (Wt) and body mass index (BMI) in childhood varies with gender and age. BMI was calculated using the formula BMI = Wt (kg)/ Ht $(m)^2$. Height and weight were adjusted for age. To account for discrepancies in linear growth secondary to renal disease, BMI was expressed according to height-age, rather than chronological age. The International Obesity Taskforce (IOTF) definition proposed by Cole *et al* [2] was used to define overweight and obesity; z-scores were calculated based on the British 1990 reference data for height and weight [3].

Blood pressure (BP)

The reference range for blood pressure varies with gender, age and height. The data is therefore presented as z-scores based on data from the fourth report of the National High Blood Pressure Education Programme (NHBPEP) working group in the United States [4].

Laboratory values

Haemoglobin (Hb), ferritin (Ferr), calcium (Ca) and phosphate (Phos) were analysed using age related laboratory reference ranges as in table 13.2. Data analysis is presented for each centre individually and at a national level for each variable.

Statistical analyses

Data were analysed to calculate summary statistics (maximum, minimum, mean and median values in addition to standard deviation and quartile ranges). Where applicable, the percentage achieving the audit standard was also calculated. If a patient had missing data, they were excluded from the relevant analyses.

Longitudinal analyses of attainment of standards over time were also performed. These were based on a single data point per ERF patient per year collected as described previously. Cautious interpretation of these analyses is required due to changing audit standards over time and

Table 13.2. Summary of relevant biochemical clinical audit measures

	Age			
Parameter	<1 year	1–<6 years	6–12 years	>12 years
Haemoglobin (g/L), NICE guideline CG 114	Maintain 95–115 for <2 years	Maintain 100–120 for >2 years	100–120	100–120
Ferritin (μg/L)	200–500	200–500	200–500	200–500
Corrected calcium (mmol/L)	2.24–2.74	2.19–2.69	2.19–2.69	2.15–2.55
Phosphate (mmol/L)	1.10–1.95	1.05–1.75	1.05–1.75	1.05–1.75
eGFR ml/min/1.73 m^2 (transplant patients)	Estimated GFR (eGFR) as per Schwartz formula: (height × k)/ plasma creatinine The value for k is that in use at the reporting centre			
Parathyroid hormone (individual centre units)	Within twice the normal range Levels may be maintained within normal range if growing appropriately			

variable data returns for previous years. All analyses were done using SAS 9.3.

Standards

Standards are from the treatment of adults and children with renal failure, Renal Association 2002 guidelines [5] unless otherwise stated.

Anthropometry

'Height and weight should be monitored at each clinic visit. Measures of supine length or standing head circumference should be measured during each visit up to two years of age and 6 monthly up to 5 years of age. All measurements should be plotted on European reference growth charts for healthy children.'

Blood pressure

'Blood pressure varies throughout childhood and should be maintained within 2 standard deviations of the mean for normal children of the same height and sex. Systolic blood pressure during PD or post-HD should be maintained at <90th percentile for age, gender and height.'

The analyses of blood pressure in this report present the achievement of blood pressures at or below the 90th percentile.

Anaemia

Guidance on the management of anaemia in adults and children with chronic kidney disease was updated and published by the National Institute for Clinical Excellence (NICE) in February 2011 (Clinical Guideline 114) [6]. The recommendation in this guidance is that in children with chronic kidney disease, treatment should maintain stable haemoglobin levels between 100 and 120 g/L in children above 2 years of age and between 95 and 115 g/L in children below 2 years of age. These NICE standards have been adopted for this report.

Calcium, phosphate and parathyroid hormone (PTH) levels

Phosphate and calcium should be kept within the normal range [5]. For analyses of calcium and phosphate, the age related ranges as described previously have been used [1]. PTH levels should be kept less than twice the upper limit of normal.

Results

Data completeness

Tables 13.3 and 13.4 show the completeness of data returns for transplant and dialysis patients for 2012.

In 2012, overall completeness was good, with virtually all data variables showing a significant rise in completeness compared to 2011, maintaining the improvement noted in data returns over recent years. The only exception were data returns for cholesterol which continued to remain poor with four centres reporting on data for <50% patients, it is planned that analysis of this data will be included in next year's report.

Height, weight and BMI

Figures 13.1 and 13.4 show that children receiving renal replacement therapy were short for their age; those on dialysis were significantly shorter that those with renal transplants. The overall median z-score was −1.3 in the transplanted group and −2.0 in the dialysis group, $p < 0.0001$.

Children with a functioning kidney transplant had a median weight z-score of 0.1, (figure 13.2), whilst those on dialysis had a significantly lower weight z-score than

Table 13.3. Percentage data completeness for transplant patients <16 years old by centre for each variable and total number of patients per centre in 2012

Centre	Transplant patients *N*	Height	Weight	BMI	Systolic BP	Hb	Creat	Ferr	EPO	IV iron	Chol	HCO_3	PTH	Ca	Phos
Bham_P	59	100.0	100.0	100.0	100.0	100.0	100.0	50.9	8.5	8.5	78.0	100.0	88.1	100.0	100.0
Blfst_P*	21	95.2	100.0	95.2	100.0	100.0	100.0	19.1	100.0	76.2	61.9	100.0	9.5	100.0	100.0
Brstl_P	35	94.3	97.1	94.3	97.1	100.0	100.0	68.6	100.0	100.0	74.3	100.0	80.0	100.0	100.0
Cardf_P	17	100.0	100.0	100.0	100.0	100.0	100.0	94.1	100.0	100.0	47.1	100.0	100.0	100.0	100.0
Glasg_P	27	100.0	100.0	100.0	100.0	100.0	100.0	85.2	100.0	100.0	37.0	100.0	100.0	100.0	100.0
L Eve_P	62	98.4	100.0	98.4	100.0	100.0	100.0	100.0	100.0	100.0	75.8	100.0	96.8	100.0	100.0
L GOSH_P	113	93.8	96.5	93.8	93.8	100.0	94.7	99.1	94.7	97.4	8.9	98.2	96.5	100.0	100.0
Leeds_P	57	96.5	98.3	96.5	98.3	100.0	100.0	35.1	96.5	96.5	93.0	93.0	35.1	98.3	93.0
Livpl_P	21	95.2	95.2	95.2	95.2	95.2	95.2	81.0	90.5	90.5	85.7	95.2	85.7	95.2	95.2
Manch_P	30	96.7	100.0	96.7	100.0	100.0	100.0	80.0	100.0	100.0	73.3	100.0	100.0	100.0	100.0
Newc_P	24	100.0	100.0	100.0	100.0	100.0	100.0	87.5	100.0	100.0	83.3	100.0	91.7	100.0	100.0
Nottm_P	54	92.6	96.3	92.6	94.4	98.2	98.2	85.2	100.0	100.0	24.1	98.2	57.4	98.2	98.2
Soton_P	14	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
UK	**534**	**96.4**	**98.3**	**96.4**	**97.6**	**99.6**	**98.5**	**77.3**	**88.0**	**87.6**	**56.2**	**98.5**	**80.5**	**99.4**	**98.9**

*Belfast do not routinely measure PTH in transplant patients

that of healthy children with a median of −1.1 (figure 13.5), $p < 0.0001$.

Body mass index in children, reported here based on 'height age', with a functioning transplant in 2012 showed inter-centre variation with a median z-score of 1.0 (figure 13.3) which was significantly higher than the median BMI z-score in those on dialysis which was 0.40 (figure 13.6), $p = <0.0001$. This is also highlighted in figure 13.7 which shows that 42.3% of transplanted children are either overweight or obese, compared to 25.7% of children on dialysis.

An analysis was performed excluding patients with syndromes and those born prematurely whose growth might be compromised. Table 13.5 shows that 27.7% of patients with a functioning transplant had a height <2SD, whilst the proportion below the normal range was even greater amongst those on haemodialysis (50.0%) and those on peritoneal dialysis (41.2%),

Table 13.4. Percentage data completeness for dialysis patients <16 years old by centre for each variable and total number of patients per centre in 2012

Centre	Dialysis patients *N*	Height	Weight	BMI	Systolic BP	Hb	Ferr	EPO	IV iron	Chol	HCO_3	PTH	Ca	Phos
Bham_P	21	100.0	100.0	100.0	100.0	100.0	90.5	4.8	4.8	90.5	100.0	100.0	100.0	100.0
Blfst_P	6	83.3	100.0	83.3	83.3	100.0	66.7	100.0	100.0	50.0	83.3	100.0	100.0	100.0
Brstl_P	5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	80.0	80.0	100.0	100.0	100.0	100.0
Cardf_P	3	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0
Glasg_P	13	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	53.9	100.0	100.0	100.0	100.0
L Eve_P	12	91.7	91.7	91.7	91.7	100.0	91.7	100.0	100.0	25.0	100.0	100.0	100.0	100.0
L GOSH_P	25	100.0	100.0	100.0	100.0	100.0	88.0	96.0	100.0	72.0	100.0	100.0	100.0	100.0
Leeds_P	8	87.5	100.0	87.5	100.0	100.0	100.0	100.0	100.0	87.5	100.0	100.0	100.0	100.0
Livpl_P	4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	75.0	100.0	100.0	100.0	100.0
Manch_P	22	95.5	100.0	95.5	95.5	100.0	95.5	100.0	100.0	13.6	95.5	100.0	100.0	100.0
Newc_P	3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Nottm_P	15	93.3	100.0	93.3	100.0	100.0	93.3	100.0	100.0	66.7	100.0	100.0	100.0	100.0
Soton_P	8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	62.5	100.0	87.5	100.0	100.0
UK	**145**	**96.6**	**99.3**	**96.6**	**97.9**	**100.0**	**93.1**	**85.5**	**85.5**	**50.0**	**98.6**	**99.3**	**100.0**	**100.0**

Blank cell denotes data items which could not be sent by centre due to technical reasons

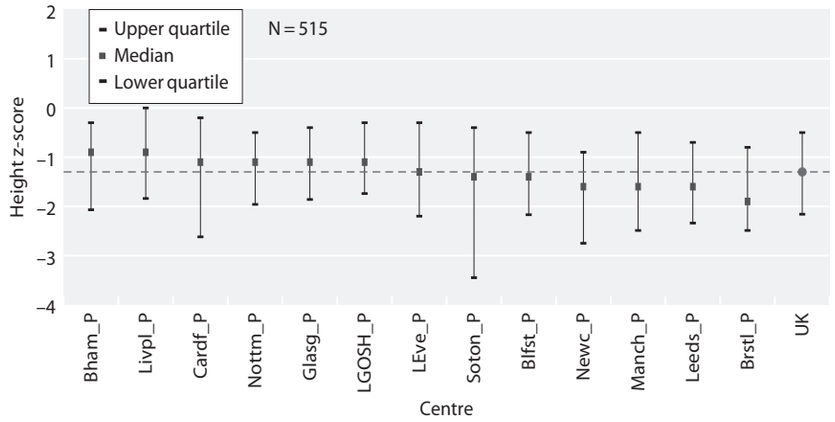

Fig. 13.1. Median height z-scores for transplant patients <16 years in 2012

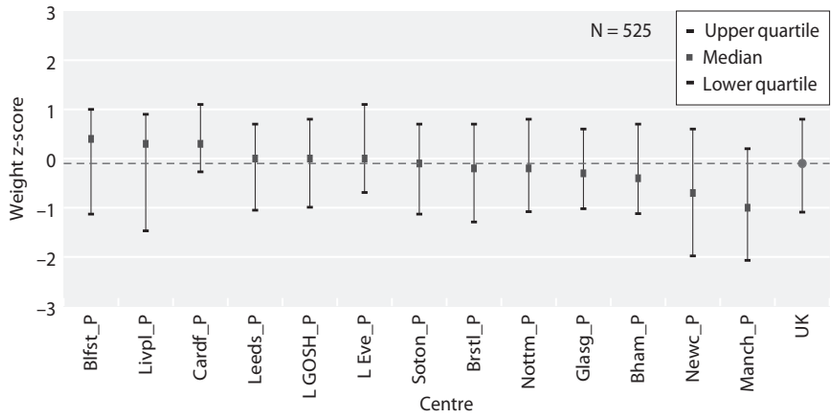

Fig. 13.2. Median weight z-scores for transplant patients <16 years in 2012

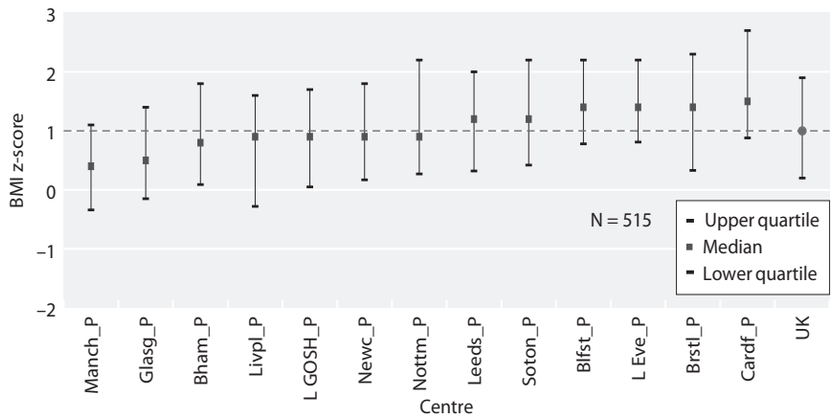

Fig. 13.3. Median BMI z-scores for transplant patients <16 years in 2012

$p < 0.01$. Analysis by age showed that amongst dialysis and transplanted patients the greatest proportion of children with a height <2SD was in the 2–4.99 years age group.

Figure 13.8 shows the use of growth hormone in all ERF children under 16 years with a height under 2SD in the UK between 2001 and 2012. There has been little change during this time in the overall use of growth hormone with a significant proportion of children under 16 years with a height under 2SD not receiving growth hormone. Only 29.2% of dialysis patients with a height below the normal range and 11.9% with a functioning transplant who were short received growth hormone treatment.

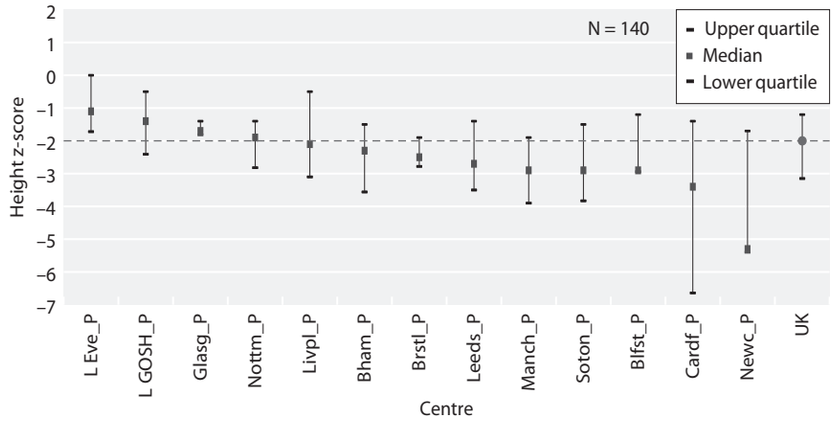

Fig. 13.4. Median height z-scores for dialysis patients <16 years in 2012

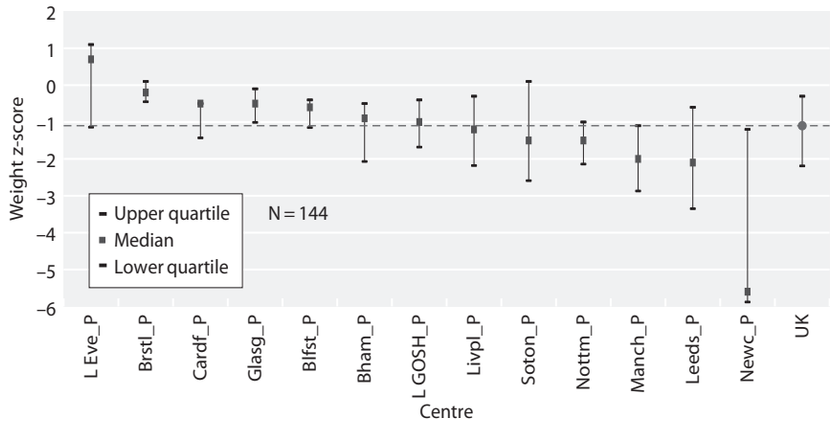

Fig. 13.5. Median weight z-scores for dialysis patients <16 years in 2012

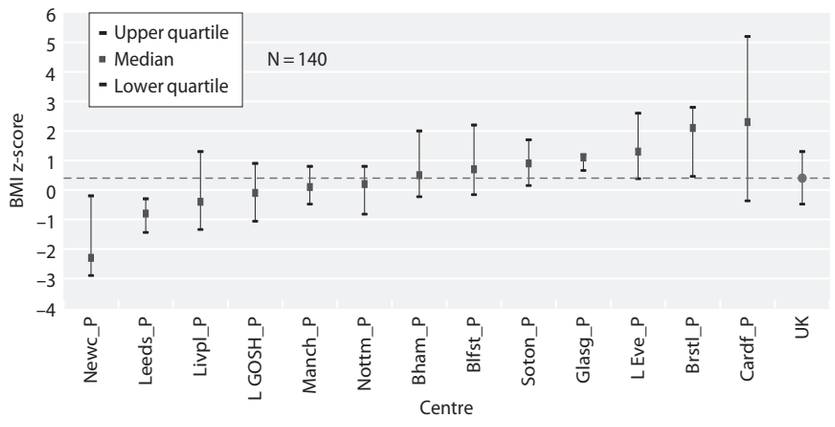

Fig. 13.6. Median BMI z-scores for dialysis patients <16 years in 2012

Blood pressure

Analyses of blood pressure levels have shown that blood pressure was higher in children receiving renal replacement therapy than in healthy children (figures 13.9, 13.10). There was wide inter-centre variation in systolic blood pressure, particularly in dialysis patients. The UK median z-score was 1.0 for dialysis patients and 0.40 for transplant patients.

For children with a functioning kidney transplant, 76.3% had a systolic BP <90th percentile which was slightly lower than last year when 81.1% of such children achieved the target (table 13.6). In comparison, 56.7% of children on haemodialysis had a systolic BP <90th percentile whilst 56.2% of children receiving peritoneal dialysis achieved this (table 13.6). The results for haemodialysis and peritoneal dialysis were slightly worse than

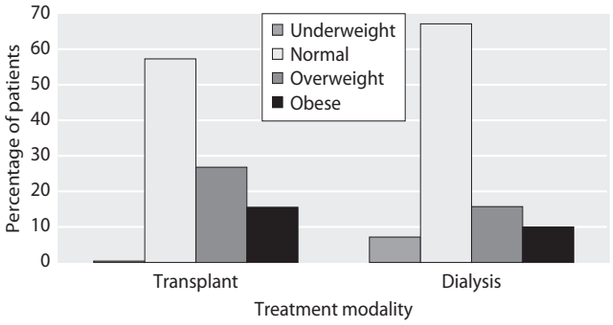

Fig. 13.7. BMI categorisation in children <16 years by modality in 2012

those achieved in the previous year (66.7% and 66.2% respectively) although absolute numbers were small. When analysing data by age, blood pressure control was slightly worse in the 0–4.99 year age group for dialysis patients with little difference noted amongst transplanted age groups.

Haemoglobin

The analyses in this report show that many children receiving dialysis were anaemic, with 25.7% of haemodialysis and 17.3% of peritoneal dialysis patients having a haemoglobin level below the standard (table 13.7).

Table 13.5. Percentage of patients aged 2–16 years old with height under 2SDs in 2012*

	Transplant patients		Haemodialysis patients		Peritoneal dialysis patients	
Centre	Patients with data (*N*)	% <2SD	Patients with data (*N*)	% <2SD	Patients with data (*N*)	% <2SD
Bham_P	57	26.3	10	80.0	10	40.0
Blfst_P	14	42.9	2	50.0	2	50.0
Brstl_P	24	41.7	2	50.0	2	50.0
Cardf_P	16	37.5	1	100.0	1	0.0
Glasg_P	25	8.0	3	33.3	6	33.3
L Eve_P	54	27.8	5	0.0	4	50.0
L GOSH_P	95	21.1	10	40.0	5	20.0
Leeds_P	40	27.5	2	50.0	3	33.3
Livpl_P	18	22.2	2	50.0	1	100.0
Manch_P	20	35.0	5	80.0	7	42.9
Newc_P	21	33.3	1	100.0	1	0.0
Nottm_P	39	30.8	4	25.0	6	50.0
Soton_P	10	50.0	3	33.3	3	66.7
UK	**433**	**27.7**	**50**	**50.0**	**51**	**41.2**
Age group						
2–4.99 years	40	35.0	9	77.8	11	54.6
5–11.99 years	203	30.05	23	47.83	20	45.0
12–15.99 years	190	23.68	18	38.89	20	30.0

*Preterm children and patients with a syndromic diagnosis were excluded from analyses

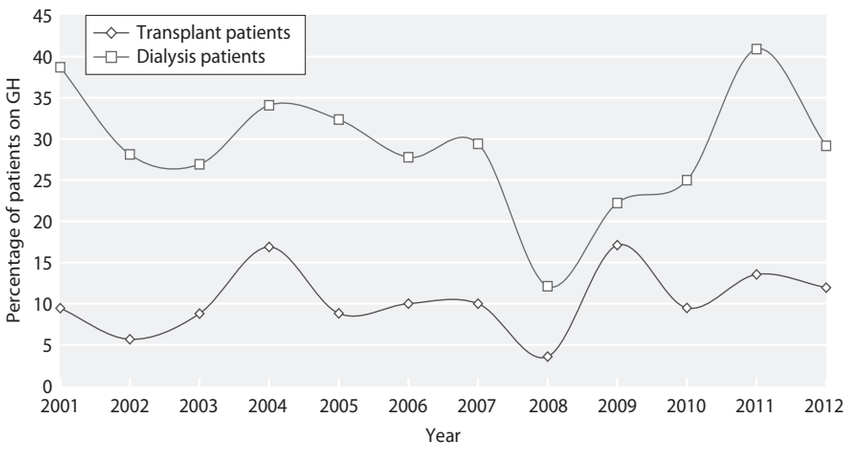

Fig. 13.8. Use of growth hormone in children <16 years with a height under 2SD in the UK between 2001 and 2012

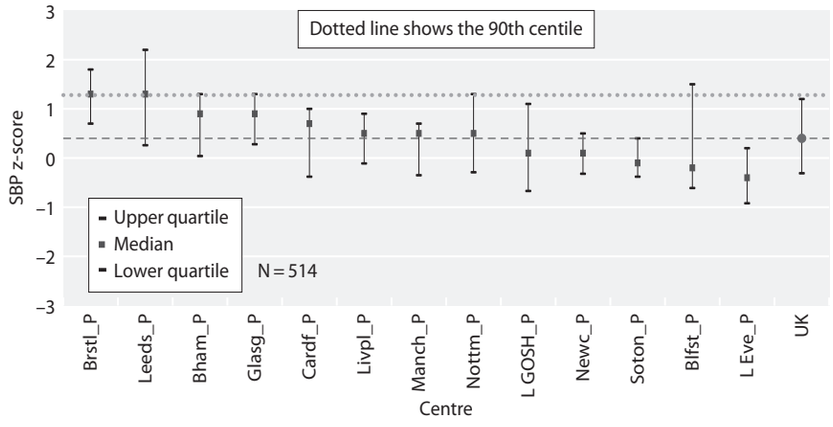

Fig. 13.9. Median systolic blood pressure z-scores for transplant patients <16 years in 2012

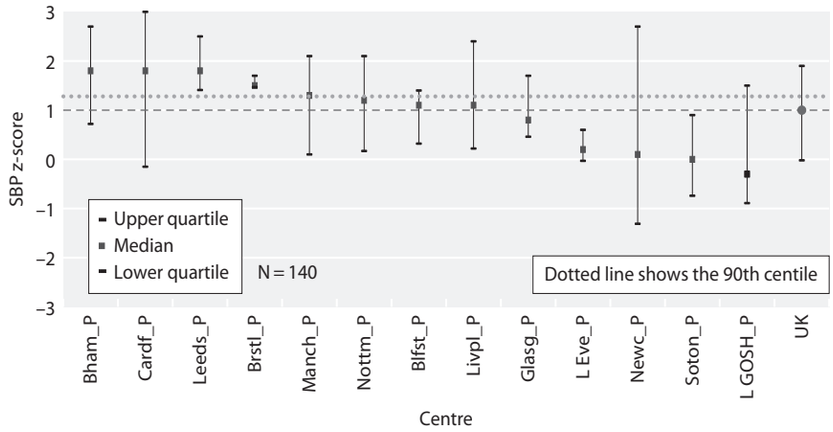

Fig. 13.10. Median systolic blood pressure z-scores for dialysis patients <16 years in 2012

Table 13.6. Percentage of patients <16 years achieving the standards for systolic blood pressure in 2012

	Transplant patients		Haemodialysis patients		Peritoneal dialysis patients	
Centre	Patients with data (*N*)	Below 90th percentile	Patients with data (*N*)	Below 90th percentile	Patients with data (*N*)	Below 90th percentile
Bham_P	59	67.8	11	54.6	10	20.0
Blfst_P	20	75.0	2	50.0	3	66.7
Brstl_P	33	57.6	3	33.3	2	0.0
Cardf_P	17	76.5	2	0.0	1	100.0
Glasg_P	27	74.1	4	50.0	9	77.8
L Eve_P	61	95.1	7	100.0	4	75.0
L GOSH_P	106	84.0	15	66.7	10	80.0
Leeds_P	55	49.1	3	33.3	4	0.0
Livpl_P	20	85.0	2	50.0	2	50.0
Manch_P	29	79.3	7	57.1	14	42.9
Newc_P	24	87.5	2	50.0	1	100.0
Nottm_P	49	75.5	4	0.0	10	70.0
Soton_P	14	92.9	5	80.0	3	100.0
UK	**514**	**76.3**	**67**	**56.7**	**73**	**56.2**
Age group						
0–4.99 years	49	73.5	20	45.0	29	51.7
5–11.99 years	239	73.6	28	53.6	23	52.2
12–15.99 years	226	79.7	19	73.7	21	66.7

Table 13.7. Percentage of patients <16 years old achieving the haemoglobin standard in 2012

	Transplant patients			Haemodialysis patients			Peritoneal dialysis patients		
Centre	Patients with data (*N*)	% achieving standard	% lower then standard	Patients with data (*N*)	% achieving standard	% lower then standard	Patients with data (*N*)	% achieving standard	% lower then standard
Bham_P	59	91.5	8.5	11	72.7	27.3	10	80.0	20.0
Blfst_P	21	90.5	9.5	3	100.0	0.0	3	100.0	0.0
Brstl_P	35	94.3	5.7	3	33.3	66.7	2	50.0	50.0
Cardf_P	17	94.1	5.9	2	50.0	50.0	1	100.0	0.0
Glasg_P	27	96.3	3.7	4	100.0	0.0	9	88.9	11.1
L Eve_P	62	95.2	4.8	8	100.0	0.0	4	75.0	25.0
L GOSH_P	113	90.3	9.7	15	93.3	6.7	10	90.0	10.0
Leeds_P	57	87.7	12.3	3	33.3	66.7	5	40.0	60.0
Livpl_P	20	95.0	5.0	2	50.0	50.0	2	100.0	0.0
Manch_P	30	93.3	6.7	7	71.4	28.6	15	86.7	13.3
Newc_P	24	91.7	8.3	2	0.0	100.0	1	100.0	0.0
Nottm_P	53	88.7	11.3	5	80.0	20.0	10	80.0	0.0
Soton_P	14	92.9	7.1	5	40.0	60.0	3	100.0	0.0
UK	**532**	**91.7**	**8.3**	**70**	**74.3**	**25.7**	**75**	**82.7**	**17.3**
Age group									
0–4.99 years	50	88.0	12.0	22	54.6	45.5	29	86.2	13.8
5–11.99 years	245	91.4	8.6	28	75.0	25.0	24	83.3	16.7
12–15.99 years	237	92.8	7.2	20	95.0	5.0	22	77.3	22.7

This compared to only 8.3% of patients with a functioning transplant having haemoglobin below the standard.

Analysis by age showed that the proportion of children on haemodialysis with haemoglobin below the standard was greatest for those under five years although this was not statistically significant.

Figure 13.11 shows that the percentage of dialysis patients achieving or exceeding the treatment standards for haemoglobin has increased over the last decade, with little change noted in transplanted patients. Attainment of ferritin standards are more difficult to interpret because of a higher proportion of historical missing data.

The attainment of the haemoglobin standard in transplant patients was assessed for different levels of graft function (figure 13.12) and with the use of MMF as immunosuppressant therapy (figure 13.13). Figure 13.12 demonstrates that haemoglobin standard attainment was worse for patients with transplant dysfunction with only 79.5% of patients with an eGFR of <45 achieving or exceeding the standard for haemoglobin compared to 95.4% of patients with an eGFR of >60. As for the impact of MMF, figure 13.12 shows that patients using

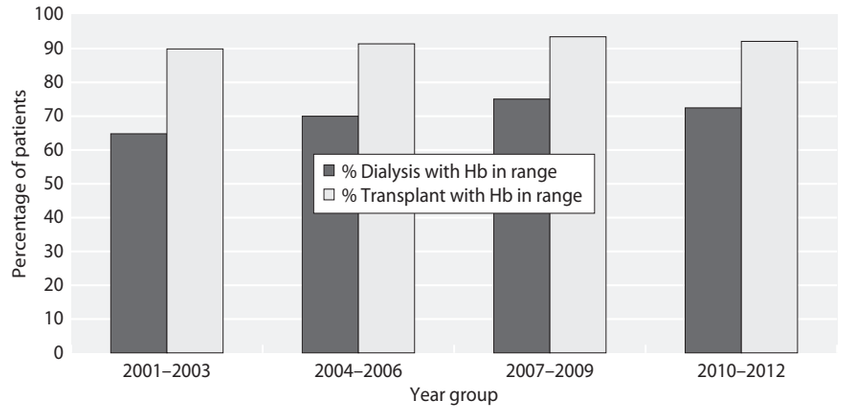

Fig. 13.11. The percentage of patients <16 years achieving the treatment standard for haemoglobin between 2001–2012, by treatment modality

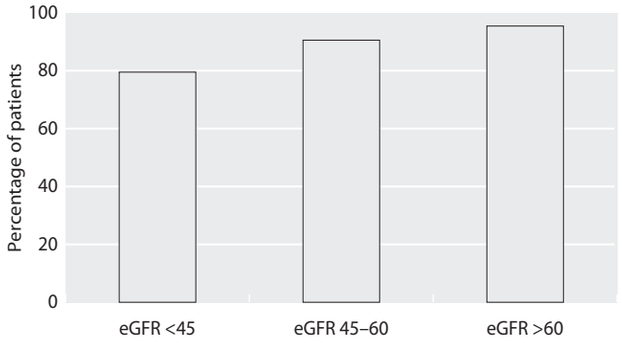

Fig. 13.12. The achievement of haemoglobin treatment standards in paediatric transplant patients <16 years, by the level of graft function
This figures combines all data from 2001–2012.

MMF as immunosuppressant therapy were more likely to have haemoglobin concentrations below the standard, which was statistically significant $p < 0.001$. Whilst this was noted between 2001–2006, this was not seen between 2007–2012, although during this time period there was a marked rise in missing data for MMF (48% missing data, compared to 14% during earlier years) making it difficult to draw any significant conclusions.

Regarding the use of erythropoietin (ESA) and IV iron, figure 13.14 shows that there has been little change in the use of these agents in transplanted patients over the last decade; in dialysis patients the use of ESA appears to have stabilised following the initial fall below 90% first observed in 2009. The use of IV iron in dialysis patients showed a small increase over last year. Table 13.8 shows that the majority of patients on dialysis (with a haemoglobin above or below range) were on ESA with little change over time.

Phosphate, calcium, PTH and bicarbonate

In 2012 in the UK as a whole, 50% of haemodialysis patients and 56% of peritoneal dialysis patients had a phosphate within the target range (table 13.9). The

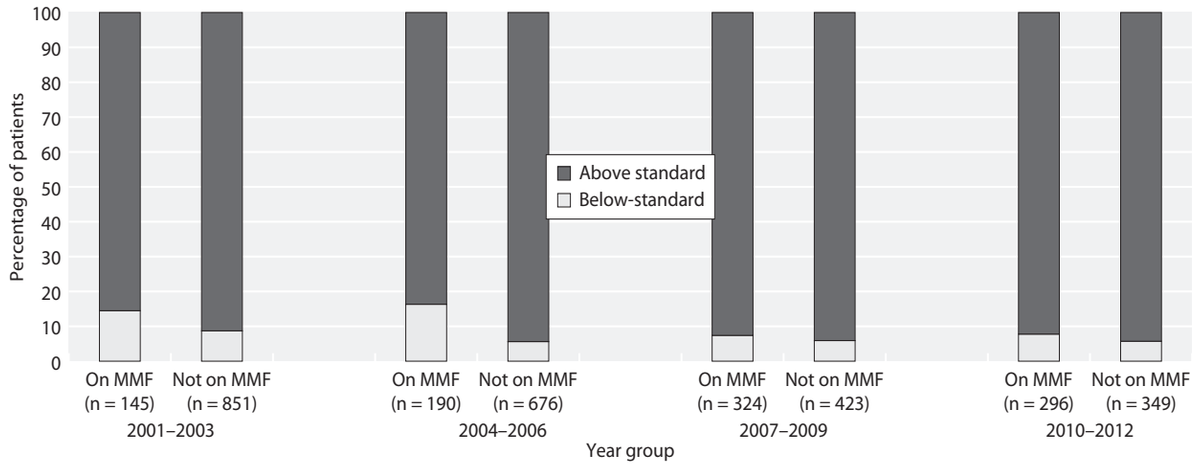

Fig. 13.13. The achievement of haemoglobin treatment standards in paediatric transplant patients <16 years, by use of MMF between 2001–2012

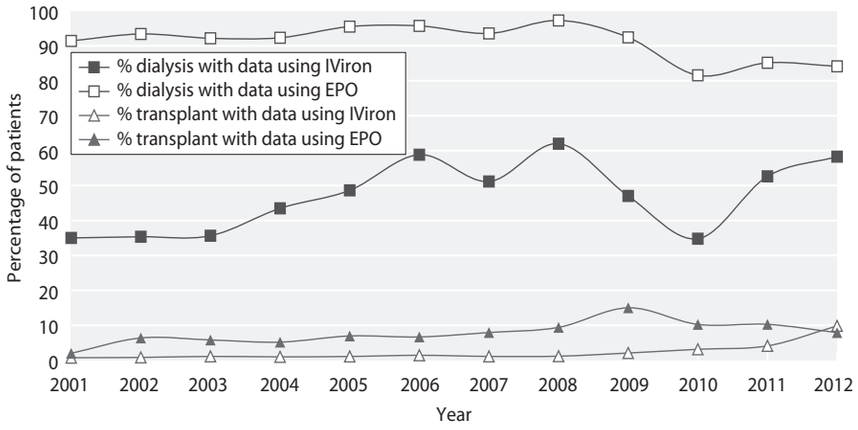

Fig. 13.14. The use of erythropoietin and IV iron in paediatric patients <16 years between 2001 and 2012 by treatment modality

Table 13.8. Proportion of paediatric RRT patients on ESA, by haemoglobin attainment, across time

Time period	Hb below standard % on ESA	Hb above standard % on ESA
Transplant patients		
2001–2003	15.2	3.8
2004–2006	23.2	4.2
2007–2009	23.2	6.6
2010–2012	21.3	6.4
Dialysis patients		
2001–2003	92.7	89.9
2004–2006	98.9	93.0
2007–2009	95.7	90.6
2010–2012	82.0	86.8

achievement of the standard for calcium was better with 80% of children on dialysis (haemodialysis and peritoneal dialysis) having a calcium level within the target range (table 13.10). As for PTH, only 43.5% of children on HD and 30.7% on PD had a PTH within the target range with wide inter-centre variation (table 13.11). In comparison, 84.2% of patients with a functioning transplant achieved a PTH within the target range. Caution should be exercised in the interpretation of these analyses as these analyses represent measurements performed once per year per patient. Further, there are differences between assays used at different centres which may further complicate interpretation of results. No significant age related differences were observed.

For the first time this year, data are presented on the bicarbonate levels achieved in children on dialysis and those transplanted (table 13.12). It is important to highlight that some centres reported having normal ranges extending below 20 mmol/L. It was observed that more children were acidotic (bicarbonate level <20 mmol/L) on haemodialysis (18.8%) as compared to peritoneal dialysis (2.7%), this perhaps reflects the timing of blood testing performed. Transplanted patients had the highest percentage (92.1%) of patients with a bicarbonate in range (20–30 mmol/L) with 7.2% of patients having a bicarbonate <20 mmol/L. No significant age related differences were observed.

Discussion

This year 92% of data returns were submitted electronically with most centres now having electronic systems, albeit currently without the facility for automatic data extraction. As this is developed over the coming years, it will allow downloads of data at multiple time points

Table 13.9. Achievement of the phosphate standard in dialysis patients <16 years in 2012

	Haemodialysis patients				Peritoneal dialysis patients			
Centre	Patients with data (*N*)	% within standard	% below standard	% above standard	Patients with data (*N*)	% within standard	% below standard	% above standard
Bham_P	11	36.4	18.2	45.5	10	50.0	0.0	50.0
Blfst_P	3	33.3	33.3	33.3	3	0.0	33.3	66.7
Brstl_P	3	33.3	66.7	0.0	2	50.0	0.0	50.0
Cardf_P	2	0.0	50.0	50.0	1	100.0	0.0	0.0
Glasg_P	4	25.0	0.0	75.0	9	55.6	0.0	44.4
L Eve_P	8	25.0	12.5	62.5	4	100.0	0.0	0.0
L GOSH_P	15	66.7	13.3	20.0	10	50.0	20.0	30.0
Leeds_P	3	66.7	0.0	33.3	5	60.0	0.0	40.0
Livpl_P	2	100.0	0.0	0.0	2	50.0	0.0	50.0
Manch_P	7	57.1	14.3	28.6	15	66.7	0.0	33.3
Newc_P	2	100.0	0.0	0.0	1	100.0	0.0	0.0
Nottm_P	5	80.0	20.0	0.0	10	50.0	0.0	50.0
Soton_P	5	40.0	20.0	40.0	3	33.3	0.0	66.7
UK	**70**	**50.0**	**17.1**	**32.9**	**75**	**56.0**	**4.0**	**40.0**
Age group								
0–4.99 years	22	54.6	22.7	22.7	29	55.2	0.0	44.8
5–11.99 years	28	50.0	17.9	32.1	24	50.0	8.3	41.7
12–15.99 years	20	45.0	10.0	45.0	22	63.6	4.6	31.8

Table 13.10. Achievement of the adjusted calcium standard in dialysis patients <16 years in 2012

	Haemodialysis patients				Peritoneal dialysis patients			
Centre	Patients with data (*N*)	% within standard	% below standard	% above standard	Patients with data (*N*)	% within standard	% below standard	% above standard
Bham_P	11	54.6	0.0	45.5	10	80.0	0.0	20.0
Blfst_P	3	66.7	0.0	33.3	3	33.3	0.0	66.7
Brstl_P	3	66.7	0.0	33.3	2	100.0	0.0	0.0
Cardf_P	2	100.0	0.0	0.0	1	100.0	0.0	0.0
Glasg_P	4	50.0	25.0	25.0	9	66.7	0.0	33.3
L Eve_P	8	87.5	12.5	0.0	4	75.0	0.0	25.0
L GOSH_P	15	100.0	0.0	0.0	10	90.0	0.0	10.0
Leeds_P	3	66.7	33.3	0.0	5	100.0	0.0	0.0
Livpl_P	2	100.0	0.0	0.0	2	50.0	0.0	50.0
Manch_P	7	71.4	14.3	14.3	15	80.0	13.3	6.7
Newc_P	2	100.0	0.0	0.0	1	100.0	0.0	0.0
Nottm_P	5	100.0	0.0	0.0	10	80.0	0.0	20.0
Soton_P	5	80.0	20.0	0.0	3	100.0	0.0	0.0
UK	**70**	**80.0**	**7.1**	**12.9**	**75**	**80.0**	**2.7**	**17.3**
Age group								
0–4.99 years	22	86.4	9.1	4.6	29	79.3	3.5	17.2
5–11.99 years	28	85.7	3.6	10.7	24	83.3	0.0	16.7
12–15.99 years	20	65.0	10.0	25.0	22	77.3	4.6	18.2

per year for each patient allowing more meaningful analyses. The recently updated NEW paediatric dataset is now being issued to system providers so that it can be incorporated in software upgrades.

The data for each section are discussed below, but often the results throw up as many questions as they answer. There are several areas where more detailed analysis may help to identify obstacles as to why there

Table 13.11. Percentage of patients <16 years achieving the PTH standard in 2012

	Transplant patients			Haemodialysis patients			Peritoneal dialysis patients		
Centre	Patients with data (*N*)	% achieving standard	% above standard	Patients with data (*N*)	% achieving standard	% above standard	Patients with data (*N*)	% achieving standard	% above standard
Bham_P	52	61.5	38.5	11	36.4	63.6	10	20.0	80.0
Blfst_P				3	33.3	66.7	3	100.0	0.0
Brstl_P	28	82.1	17.9	3	100.0	0.0	2	50.0	50.0
Cardf_P	17	82.4	17.7	2	50.0	50.0	1	0.0	100.0
Glasg_P	27	96.3	3.7	4	0.0	100.0	9	33.3	66.7
L Eve_P	60	90.0	10.0	8	50.0	50.0	4	25.0	75.0
L GOSH_P	109	84.4	15.6	15	53.3	46.7	10	50.0	50.0
Leeds_P				3	33.3	66.7	5	40.0	60.0
Livpl_P	18	100.0	0.0	2	50.0	50.0	2	100.0	0.0
Manch_P	30	93.3	6.7	7	42.9	57.1	15	6.7	93.3
Newc_P	22	100.0	0.0	2	0.0	100.0	1	0.0	100.0
Nottm_P	31	83.9	16.1	5	60.0	40.0	10	30.0	70.0
UK	**430**	**84.2**	**15.8**	**69**	**43.5**	**56.5**	**75**	**30.7**	**69.3**
Age group									
0–4.99 years	45	91.1	8.9	22	22.7	77.3	29	37.9	62.1
5–11.99 years	192	83.9	16.2	27	63.0	37.0	24	33.3	66.7
12–15.99 years	193	82.9	17.1	20	40.0	60.0	22	18.2	81.8

*Blank cells denote modalities where data completeness was <50%

Table 13.12. Centre analysis of bicarbonate levels (mmol/L) in patients under 16years old by treatment modality, in 2012

	Transplant patients				Haemodialysis patients				Peritoneal dialysis patients			
Centre	Patients with data (*N*)	% <20	% 20–30	% >30	Patients with data (*N*)	% <20	% 20–30	% >30	Patients with data (*N*)	% <20	% 20–30	% >30
Bham_P	59	8.5	89.8	1.7	11	18.2	81.8	0.0	10	0.0	80.0	20.0
Blfst_P	21	0.0	100.0	0.0	2	0.0	100.0	0.0	3	0.0	100.0	0.0
Brstl_P	35	2.9	97.1	0.0	3	33.3	66.7	0.0	2	0.0	100.0	0.0
Cardf_P	17	23.5	76.5	0.0	2	0.0	100.0	0.0	1	0.0	100.0	0.0
Glasg_P	27	37.0	63.0	0.0	4	100.0	0.0	0.0	9	22.2	66.7	11.1
L Eve_P	62	6.5	93.6	0.0	8	25.0	75.0	0.0	4	0.0	100.0	0.0
L GOSH_P	113	2.7	96.5	0.9	15	13.3	80.0	6.7	10	0.0	90.0	10.0
Leeds_P	53	0.0	100.0	0.0	3	0.0	100.0	0.0	5	0.0	80.0	20.0
Livpl_P	20	40.0	60.0	0.0	2	0.0	100.0	0.0	2	0.0	100.0	0.0
Manch_P	30	3.3	93.3	3.3	7	28.6	71.4	0.0	14	0.0	85.7	14.3
Newc_P	24	8.3	91.7	0.0	2	0.0	100.0	0.0	1	0.0	100.0	0.0
Nottm_P	53	0.0	98.1	1.9	5	0.0	80.0	20.0	10	0.0	70.0	30.0
Soton_P	14	0.0	100.0	0.0	5	0.0	100.0	0.0	3	0.0	100.0	0.0
UK	**528**	**7.2**	**92.1**	**0.8**	**69**	**18.8**	**78.3**	**2.9**	**74**	**2.7**	**83.8**	**13.5**
Age group												
0–4.99 years	50	12.0	88.0	0.0	22	13.6	86.4	0.0	29	3.5	72.4	24.1
5–11.99 years	244	6.6	92.2	1.2	27	18.5	77.8	3.7	23	4.4	87.0	8.7
12–15.99 years	234	6.8	92.7	0.4	20	25.0	70.0	5.0	22	0.0	95.5	4.6

<20 mmol/L was defined as being acidotic, although it is worth noting some centres report having normal ranges extending below 20

has been little apparent change in the attainment of many standards over the last few years.

Anthropometry

Children on renal replacement therapy are short for their age. Excluding children and young people with syndromes and those born prematurely, who are more likely to be short, just over a quarter of transplant patients, 50% of HD patients and 41% of PD patients had a height that was below the normal range. The figures would be lower if all children on RRT were included. Children aged less than five years who were on dialysis seemed to be most affected. Growth in the pre-school years is faster than in later years and so it is not surprising that dialysis at this age can have a deleterious effect on growth. It is a sobering thought that nearly half of children on dialysis have a height below the normal range. Whilst transplantation improves the situation, a quarter remain short.

The cross-sectional data presented here are little different from previous reports; indeed there appears to have been little change since 1999 which is disappointing [7]. There may be a number of reasons for this. Over the last few years, there has been an increase in the number of infants and young children receiving RRT. Children with ERF for a significant part of their childhood are more likely to have impaired growth than those who have had better health for part of their childhood and may be part of the explanation.

There have been initiatives to try and improve growth, such as using rhGH, improved nutrition and avoiding the use of steroids post transplant. Just under a third of dialysis patients, and 11.9% of transplant patients, who were short for their age, were on growth hormone treatment. The low uptake of rhGH within the UK ERF population where overall 32.8% of patients have a height below the normal range, remains disappointing. However in the transplant group it is important to remember that these data are cross-sectional and although some children are short, they may be growing at a rate above normal and therefore would not fall into the category for whom rhGH is appropriate.

The use of steroids post-transplant can affect growth and varies from centre to centre. It would be interesting to compare those centres which avoid steroids to those where steroids are used as standard post-transplant. Furthermore, it may be that many different factors not included here have an influence on growth and that further in depth studies will highlight these. There is therefore scope to increase the use of rhGH in these

patients. An analysis evaluating final adult height may add to our understanding. The proportion of short transplanted children varied by centre and it would be interesting to see if this relates to the centres' likelihood of using steroids post transplant.

In this report for the first time, BMI based on height-age as opposed to their chronological age is reported which is more appropriate given a cohort of children who have growth restriction. Overweight and obesity are also defined as per IOTF definitions. These definitions are different to those used in previous reports and likely to account for the small differences in reported data. Overall, little change in weight SDs and BMI SDs since 1999 in both transplanted children and those on dialysis were observed. Recent reports from the ERA-EDTA Registry [8] highlight the high prevalence rates of excess weight in UK children following renal transplantation. Furthermore, a report from the BAPN analysing the longitudinal change in BMI following transplantation highlights rates of excessive weight (overweight and obese) significantly worse than the background UK childhood population [9]. These data together highlight the need for urgent work to understand factors that lead to excess weight gain in this high risk cohort for adverse cardiovascular outcomes.

Blood pressure

There is an increasing body of evidence supporting the role of optimal blood pressure control in the management of CKD [10, 11]. There is also an increasing awareness of the importance of cardiovascular morbidity in paediatric patients with CKD and ERF. Despite this, there remains scope for improvement in BP control. As BP changes during childhood, it is important to manage blood pressure using percentiles in the clinic rather than using the absolute measurements alone. The authors hope that it may be possible at some point to include the degree of proteinuria for transplant patients in the analysis.

There was a wide range of median systolic BP scores in different centres and it might be helpful to reflect on the different strategies in each centre and their effect on outcomes. It is hoped that the clinical application of recently developed guidelines by the BAPN for the management of hypertension following transplantation would help in improving blood pressure control [12]. Once again the authors would highlight that these data reflect single measurements per year often performed using BP instruments that employ different techniques.

Anaemia

A significant proportion of dialysis patients (25.7% HD, 17.3% PD) were anaemic; this is little changed from previous reports. The proportion of transplant patients with a haemoglobin within the recommended range however has improved and is due to the change in standard used.

For transplant patients, the chances of a haemoglobin level below the standard were greater with reduced GFR and with the use of MMF. This highlights the importance of calculating GFR for transplant patients, rather than using creatinine alone. A lower GFR should highlight the need to check that the haemoglobin is within the recommended range. Since 2000, the proportion of patients with a haemoglobin within range who were on MMF has increased and remained stable in this year's report.

Whilst there are indicators to help identify those transplant patients at risk of anaemia, it is more difficult to highlight those at risk within the dialysis populations. As expected patients on HD seem more at risk and the risk of anaemia may be higher for those aged less than five years. Of those with a haemoglobin below range, over 90% of patients were on ESAs, although the proportion on IV iron or with a low ferritin was less clear. Of transplant patients with a low haemoglobin, 21% were on ESAs compared with 15% between 2001–2003.

It is important to highlight here that it is beyond the scope of the registry to be able to report on dose adjustments that would likely improve understanding of these data. It would be helpful to study dialysis patients in more detail to see if there are any factors which help identify those children at highest risk of anaemia. Detailed data on ferritin and IV iron would be needed for this subgroup of patients. The results of the national audit on anaemia in the UK paediatric ERF population may help to shed some further light on this.

Biochemistry

The numbers of paediatric patients on dialysis were small but phosphate control appears to be worse in patients on HD than in patients on PD. Results for calcium were little different between the dialysis groups, whilst patients on PD had worse PTH concentrations than those on haemodialysis. Data were less complete for PTH in the transplant group which might imply that the complications of reduced GFR might sometimes be overlooked in this group of patients. It would be useful to include vitamin D (calcidiol) concentrations in the parameters studied. Moving to multiple time point

reporting of data in future reports will allow better interpretation of biochemistry results. A higher proportion of subjects on HD were acidotic compared to those on PD, with the best results in transplanted patients.

Summary

In summary, continued efforts are being made to move towards universal electronic reporting from UK paediatric centres. Whilst this is ongoing, most centres are moving to using electronic systems which incorporate an electronic patient record. These improved electronic platforms have the additional potential to display percentiles and SDs and it may be that these functionalities will help make clinicians aware of patient's results and achievement of targeted clinical standards. Automatic calculations of e.g. eGFR in transplant patients may help to point out that some patients have lower GFRs that make them susceptible to anaemia. The likelihood of complete electronic reporting in the near future with plans for quarterly reporting in the format of the recently finalised NEW paediatric dataset will undoubtedly improve quality of data and their reporting, allowing improvements in patient care.

Conflicts of interest: none

References

1 Hussain F, Castledine C, Schalkwyk DV, Sinha MD, Lewis MA, Inward C. UK Renal Registry 12th Annual Report (December 2009): Chapter 12 Clinical, Haematological and Biochemical Parameters in Patients receiving Renal Replacement Therapy in Paediatric Centres in the UK in 2008: national and centre-specific analyses. Nephron Clin Pract 2010;115(suppl 1):c289–c308

2 TJ Cole, KM Flegal, D Nicholls, AA Jackson. Body Mass Index cut offs to define thinness in children and adolescents: international study. BMJ 2007;335(7612):194

3 Freeman JV CT, Chinn S et al. Cross sectional stature and weight reference curves for the UK, 1990. Arch Dis Child 1995;73:17–24.

4 National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents.The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents. Pediatrics 2004;114(2):555–76.

5 BAPN clinical standards http://www.bapn.org/clinical_standards.html.

6 NICE clinical guideline 114. Anaemia management in people with chronic kidney disease. London: National Institute for Health and Clinical Excellence, 2011.

7 Pruthi R, Sinha MD, Casula A, Tse Y, Maxwell H, O'Brien C, Lewis M, Inward C. UK Renal Registry 14th Annual Report (December 2010): Chapter 5 Demography of the UK Paediatric Renal Replacement Therapy Population in 2010. Nephron Clin Prac 2012;120(suppl 1): c93–c103

8 Bonthuis M, van Stralen KJ, Verrina E, Groothoff JW, Alonso Melgar A, Edefonti A, Fischbach M, Mendes P, Molchanova EA, Paripovic D, Peco-Antic A, Printza N, Rees L, Rubik J, Stefanidis CJ, Sinha MD, Zagozdzon I, Jager KJ, Schaefer F. Underweight, overweight and obesity in paediatric dialysis and renal transplant patients. Nephrol Dial Transplant. 2013; doi: 10.1093/ndt/gft259. [Epub ahead of print]

9 Plumb LA, Pitcher D, Tse Y, Shield JP, Inward C, Sinha MD on behalf of the British Association for Paediatric Nephrology. Longitudinal changes in Body Mass Index following renal transplantation in UK children. Nephrol Dial Transplant. 2013; doi: 10.1093/ndt/gft395. [Epub ahead of print]

10 Strict blood-pressure control and progression of renal failure in children, ESCAPE Trial Group, N Engl J Med. 2009;361(17):1639–50

11 Sinha MD, Gilg JA, Kerecuk L, Reid CJD; on behalf of the British Association for Paediatric Nephrology. Progression to hypertension in non-hypertensive children following renal transplantation. Nephron Dial Transp 2012;27(7):2990–2996

12 BAPN Standards for Hypertension in Paediatric Renal Transplant Recipients. http://www.bapn.org/assets/clinical_standards/BAPN%20standards%20for%20Hypertension%20in%20Renal%20Transplant%20Recipients.pdf (last accessed 22nd September 2013)

UK Renal Registry 16th Annual Report: Chapter 14 2012 Multisite Dialysis Access Audit in England, Northern Ireland and Wales and 2011 PD One Year Follow-up: National and Centre-specific Analyses

Victoria Briggs[a], David Pitcher[b], Catriona Shaw[b], Richard Fluck[c], Martin Wilkie[a]

[a]Sheffield Teaching Hospitals NHS Foundation Trust, UK; [b]UK Renal Registry, Bristol, UK; [c]Derby Hospitals Foundation Trust, UK

Key Words

Access · Chronic kidney disease · Diabetes · Dialysis · End stage renal disease · Established renal failure · Haemodialysis · Peritoneal dialysis · Prevalence · Primary Care Trust · Renal replacement therapy · Transplantation · Treatment modality

Summary

- Data are presented from the first combined vascular and peritoneal dialysis access audit.
- In 2012, 51 centres in England, Wales and Northern Ireland (representing 82% of all centres) returned data on first access from 3,720 incident haemodialysis (HD) patients and 1,018 incident peritoneal dialysis (PD) patients.
- Of the incident HD patients, 38.3% started therapy on an arteriovenous fistula (AVF), 36.9% on a tunnelled line (TL), 23.5% on non-tunnelled line (NTL) and 1.2% by means of arteriovenous graft (AVG).
- Referral time had an influence on PD catheter insertion technique: of patients starting PD within 90 days of initial referral, 50.6% underwent percutaneous PD catheter insertion. This contrasts with patients known to renal services in excess of 90 days, 32.4% of whom underwent percutaneous PD catheter insertion.
- Initial surgical assessment was a key determinant of the likelihood of AVF formation; 70.4% of patients assessed by a surgeon at least three months before commencing dialysis started on an AVF. By contrast, only 9.7% of patients not surgically assessed at least three months before commencing dialysis used an AVF as first dialysis access.
- Length of time known to nephrology services and likelihood of commencing dialysis using either an AVF or a PD catheter are strongly associated. For patients presenting late, 84.6% started on a line (TL/NTL). Amongst patients known to the centre for at least a year only 33.9% started via a line.
- Data on PD catheter failure rates at one year were poorly completed. Of 44 centres who reported data on PD patients in 2011, only 28 completed the one year follow up request, returning data on a total of 649 patients.
- For centres returning data on one year peritoneal dialysis outcomes, the majority of centres maintained >50% of patients on PD at one year, however only five centres maintained >80% on PD at one year.
- Further enhancement of data fields, improved data completeness and accuracy of returns will be essential to improve the quality of future audits.
- Further work is required to define optimal dialysis access care pathways that are comprehensive, high quality and responsive to patient needs.

Introduction

This report represents the first combined vascular and peritoneal dialysis access audit in England, Wales and Northern Ireland. Previously, vascular and peritoneal dialysis access audits have been published separately [1, 2, 3].

Dialysis access (regardless of modality) should be timely, minimise complications and maintain functionality for as long as it is required. Both haemodialysis (HD) and peritoneal dialysis (PD) require good functional access in order for the renal replacement technique to be successful.

The Department of Health National service framework for Renal Services 2004 [4] states that by 2014:

'All children, young people and adults approaching established renal failure are to receive timely preparation for renal replacement therapy so the complications and progression of their disease are minimised, and their choice of clinically appropriate treatment options is maximised.'

'All children, young people and adults with established renal failure are to have timely and appropriate surgery for permanent vascular or peritoneal dialysis access, which is monitored and maintained to achieve its maximum longevity.'

Previously reported vascular access and peritoneal access audits [1, 2, 3] have therefore been performed with the intention of providing clinically useful information relating to timely and appropriate access interventions in order to achieve permanent access based on these recommendations and quality requirements. The core principal of these audits has been to highlight the performance variation of renal centres across England, Wales and Northern Ireland and explore factors that may contribute to the provision of excellent quality vascular and peritoneal access.

High quality vascular access represents a key modifiable risk factor for patients on dialysis and is an important measure of clinical care [5]. Whilst it is possible to postulate plausible factors that influence access provision, such as variation in patient demographics and physician attitudes, the exact reasons for such variations are unknown. Audit is essential to define relevant issues relating to HD access formation and PD catheter insertion, and to understand practice variation with the aim of standardising the provision of a high-quality service to all patients who require it. Determination of the type of access first used for dialysis, investigation of operational effectiveness (surgical referral, conversion rates between access types) and documentation of complications continue to be the main endpoints of this joint access audit.

There is substantial evidence to suggest that prompt permanent vascular access is clinically advantageous. Indeed, current best practice indicates that vascular access should be in place by a minimum of six months before starting treatment [6]. Observational data has repeatedly demonstrated a strong association between the use of central venous catheters and increased mortality and morbidity [2, 7]. Similarly, patients presenting late commencing dialysis via a PD catheter rather than a tunnelled line are also less likely to experience bacteraemia [8].

Whilst this, in part, may reflect late presentation and co-morbidity, studies attempting to correct for this have identified an independent effect of access on patient outcomes [7, 9]. Permanent vascular access delivers a higher, more effective dialysis dose, and those with venous catheters may require an increase in frequency and duration of dialysis to compensate. Permanent vascular access will also remain functional for much longer than a venous catheter, requiring fewer hospital admissions with attendant health economic benefits [7, 9].

The provision of high quality PD access is equally important. The National Institute of Health and Clinical Excellence (NICE) has recommended that PD should be offered as a first-line therapy for the majority of patients with established renal failure (ERF) on the basis of equivalent outcomes with haemodialysis [10]. Despite this guidance, PD is only used for 20% of UK dialysis patients. Furthermore, the UK Renal Registry (UKRR) 2012 annual report documents a 10–fold national variation in PD utilisation between otherwise similar renal clinical centres [11].

The term established renal failure used within this chapter is synonymous with the terms end stage renal failure and end stage renal disease, which are in more widespread international usage. Patients have disliked the term 'end stage' which reflects the inevitable outcome of this disease.

The PD audit work was supported by funding from the Healthcare Quality Improvement Partnership (HQIP).

Methods

All adult renal centres in England, Wales and Northern Ireland were contacted regarding vascular and peritoneal access for all

incident dialysis patients in 2012. Data were collected using Microsoft Excel spreadsheets circulated by the UK Renal Registry. Of 62 centres contacted, data were received from 51 centres. Data fields were refined from the audit performed in 2011 based on the quality of the returned questionnaires and the feedback received from centres.

Patients who were identified by the renal centres as having acute kidney injury (AKI) in the free text fields or patients who were reported to have recovered renal function within three months were categorised as having AKI for the purposes of this audit and excluded ($n = 367/5{,}105$). The remaining records received were validated against the UKRR database to confirm that the population collected at each centre for the audit was the same as, or representative of, the incident population at that centre as collected via the usual UKRR methodology. Data checks were made by cross-referencing with the UKRR database. Any patients identified from the UKRR as not incident to dialysis between 1st January 2012 and 31st December 2012 were excluded. The cross-referencing also enabled ascertainment of information on mortality within three months of commencing dialysis.

Centres who reported data on PD patients in the 2011 vascular and peritoneal access audit were asked to complete a one year follow up of their PD patients. Additional information was requested on the date of PD catheter failure, the reason for catheter failure, the number of catheters used during the year, and the modality in use at one year after starting PD.

Patients starting HD were grouped by type of first vascular access: arteriovenous fistula (AVF), arteriovenous graft (AVG), tunnelled dialysis line (TL), non-tunnelled dialysis line (NTL). Patients starting PD were categorised by the insertion technique: laparoscopic, peritoneoscopic, open surgery, percutaneous. Access at three months was defined as the type of access in use at three months after starting dialysis. If a patient was no longer receiving dialysis at three months then the reason was recorded instead, for example died or transplanted. Referral time was defined as the number of days between the date of first being seen by a renal physician and the date of commencing dialysis. A patient was classified as presenting late if they had a referral time of less than 90 days. In the analyses involving whether or a not a patient had received surgical assessment at least three months before starting dialysis, patients were excluded if they were categorised as a late presenter.

Access failure was defined as the access no longer being usable for treatment. Data about the date and cause of access failure were collected. Access failure was censored for death, transplantation, withdrawal from renal replacement therapy (RRT) and elective switching of access type. It was the intention to only capture access failures relating to the first type of access. If the reason recorded for access failure was incompatible with the first type of access recorded then the data was not included in this analysis.

Separate or combined analyses have been performed for incident HD patients and incident PD patients as appropriate. Due to the exploratory nature of the audit the analyses have been limited to descriptive statistics of frequencies, percentages and unadjusted associations between variables. If a centre had more than 50% missing returns for a particular data field, then all patients from the centre were excluded from analyses involving that data field. The data were analysed using SAS 9.3.

Results

Data completeness

Fifty-one centres returned data on first dialysis access on 3,720 incident HD patients and 1,018 incident PD patients. The UKRR incident patient data for the same year were 3,818 HD and 1,035 PD, thus there were access returns on 97% of HD and 98% of PD patients.

Forty-one patients were excluded from all the analyses due to missing RRT start date or first access type. Figure 14.1 illustrates the data completeness for key variables.

Variations in first dialysis access

Patient demographics

The median patient age when starting RRT was 67 years in the HD cohort and 59 years for patients commencing PD. Overall, 62.6% of the patients were male, 37.4% female; the proportional distribution of the sexes was similar for both the HD and PD subgroups.

A significant proportion of patients starting dialysis had diabetes (43.0%), however diabetes associated nephropathy was the primary renal disease (PRD) in only 26.1% (table 14.1). There was however, a large volume of missing data relating to diabetes status (1,144 patients on HD (31.1%) and 204 patients on PD (20.1%)).

Table 14.2 presents HD and PD patient subgroups stratified by age, gender, dichotomised body mass index (BMI) (<30 or $\geqslant 30$), PRD, referral time (<90 or $\geqslant 90$ days) and surgical assessment status.

There was an apparent association between the access modality (HD *vs.* PD), referral time (<90 days *vs.* $\geqslant 90$ days) and surgical assessment status in excess of three months prior to dialysis start. The following observations can be made:

For HD:

- AVF was the initial access for 38.3% of patients, with 1.2% on an AVG, 36.9% on a tunnelled line and 23.5% on a non-tunnelled line.
- Patients aged 60 or over were more likely to initiate RRT on an AVF (40.7%) when compared to patients <60 years (33.9%). Similarly, older patients were less likely to start on a tunnelled line (33.3% vs. 43.7%).
- Patients with polycystic kidney disease (PKD) as primary renal diagnosis were most likely to start on an AVF (65.5%).
- Patients who had been seen by a surgeon at least three months before starting dialysis were more

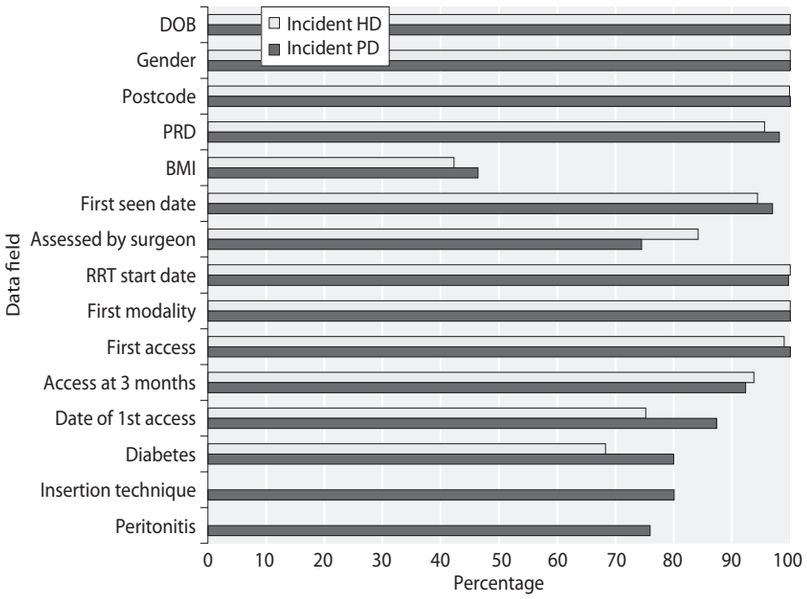

Fig. 14.1. Data completeness for key variables, stratified by first modality HD = haemodialysis; PD = peritoneal dialysis; DOB = date of birth; PRD = primary renal diagnosis; BMI = body mass index

likely to start on an AVF than those not assessed (67.7% *vs*. 5.6%).

- Of those referred at least 90 days prior to commencing dialysis, 50.1% started on an AVF compared to only 4.3% of those starting more acutely.

For PD:

- PD catheters were placed in 44.4% of patients by using open surgical techniques, 18.1% using laparoscopic techniques, 34.6% using percutaneous techniques and only 3.0% inserted using a peritoneoscope.
- Patients who were assessed by a surgeon at least three months before starting dialysis were more likely to undergo laparoscopic placement (24.4% *vs*. 5.9% for non-surgical assessment) and were less likely to have open surgical placement (36.8% *vs*. 55.6%) or percutaneous catheter placement (33.4% *vs*. 37.6%).

Table 14.1. Patient demographics

		Total $N = 4,697$	HD $N = 3,682$	PD $N = 1,015$
		Med (IQR)	**Med (IQR)**	**Med (IQR)**
	Age	65 (52, 75)	67 (54, 76)	59 (47, 71)
	BMI	27 (24, 32)	27 (23, 32)	27 (24, 31)
		***N* (%)**	***N* (%)**	***N* (%)**
Gender	Female	1,759 (37.4)	1,372 (37.3)	387 (38.1)
	Male	2,938 (62.6)	2,310 (62.7)	628 (61.9)
Diabetes	Missing	1,348 (28.7)	1,144 (31.1)	204 (20.1)
	Yes	2,018 (43.0)	1,503 (40.8)	515 (50.7)
	No	1,331 (28.3)	1,035 (28.1)	296 (29.2)
PRD	Diabetes	1,227 (26.1)	980 (26.6)	247 (24.3)
	Glomerulonephritis	610 (13.0)	446 (12.1)	164 (16.2)
	Hypertension	374 (8.0)	289 (7.8)	85 (8.4)
	Other	784 (16.7)	654 (17.8)	130 (12.8)
	Polycystic kidney	257 (5.5)	171 (4.6)	86 (8.5)
	Pyelonephritis	274 (5.8)	209 (5.7)	65 (6.4)
	Renovascular disease	298 (6.3)	251 (6.8)	47 (4.6)
	Uncertain aetiology	693 (14.8)	521 (14.1)	172 (16.9)
	Missing	180 (3.8)	161 (4.4)	19 (1.9)

IQR = interquartile range; BMI = body mass index; PRD = primary renal diagnosis; HD = haemodialysis; PD = peritoneal dialysis

Table 14.2. Patient characteristics stratified by type of first dialysis access

Variable		HD *N*	% of HD patients				PD *N**	% of PD patients			
			AVF	AVG	TL	NTL		Open surgery	Laparo-scopic	Peritoneo-scopic	Percuta-neous
	Total patients	**3,682**	1,412	46	1,358	866	**813**	361	147	24	281
	%		38.3	1.2	36.9	23.5		44.4	18.1	3.0	34.6
Age at first dialysis	<60	**1,269**	33.9	1.1	43.7	21.4	**421**	43.7	18.3	3.3	34.7
	⩾60	**2,413**	40.7	1.3	33.3	24.7	**392**	45.2	17.9	2.6	34.4
BMI (kg/m^2)	⩽30	**1,056**	42.8	1.3	32.9	23.0	**263**	58.9	11.8	7.2	22.1
	>30	**432**	53.2	2.3	29.6	14.8	**97**	76.3	8.2	3.1	12.4
PRD	Diabetes	**980**	41.4	1.7	39.3	17.6	**202**	44.1	18.8	1.0	36.1
	GN	**446**	39.5	0.2	37.0	23.3	**131**	44.3	17.6	4.6	33.6
	Hypertension	**289**	48.4	1.0	34.9	15.6	**64**	42.2	25.0	4.7	28.1
	Other	**654**	21.4	1.1	42.2	35.3	**111**	46.8	18.0	3.6	31.5
	PKD	**171**	65.5	1.2	25.7	7.6	**72**	45.8	9.7	4.2	40.3
	Pyelo	**209**	40.2	3.3	35.9	20.6	**45**	42.2	11.1	2.2	44.4
	RVD	**251**	37.8	0.0	33.9	28.3	**41**	46.3	24.4	4.9	24.4
	Uncertain	**521**	43.6	1.2	33.2	22.1	**133**	45.9	14.3	2.3	37.6
Referral time (days)	<90	**853**	4.3	0.6	48.5	46.5	**85**	22.4	23.5	3.5	50.6
	⩾90	**2,538**	50.1	1.3	33.6	15.0	**720**	47.4	17.4	2.9	32.4
Assessed by surgeon	No	**1,435**	5.6	0.3	53.5	40.6	**306**	55.6	5.9	1.0	37.6
	Yes	**1,690**	67.7	2.0	21.4	8.9	**386**	36.8	24.4	5.4	33.4

*PD patients with missing insertion technique are excluded
Patients from centres with more than 50% missing data for a variable are excluded from the table for that variable
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line; GN = glomerulonephritis; BMI = body mass index; PRD = primary renal diagnosis; GN = glomerulonephritis; PKD = polycystic kidney disease; Pyelo = pyelonephritis; RVD = reno-vascular disease

- Referral time had an influence on PD catheter insertion technique; 50.6% of patients referred less than 90 days before starting dialysis underwent percutaneous insertion compared to 32.4% of patients known longer to the service. These data were reversed for general surgical insertion: 22.4% of patients who presented late versus 47.4% of patients who did not present late.

The proportional distribution of HD access modality was similar for different primary renal disease diagnoses (figure 14.2). Of note, patients with polycystic kidney disease were more likely to start HD on an AVF. This likely results from the opportunity for timely access preparation as these patients are often known to renal services for many years before dialysis is required and indeed there is also evidence of a higher transplantation rate amongst this group [12]. Where no primary renal diagnosis was available (either missing or coded as uncertain aetiology), the numbers of patients starting dialysis with a tunnelled or non-tunnelled dialysis venous catheter were higher, suggesting that this may represent a cohort of patients who present later and in whom a PRD cannot be ascertained.

Patients with body mass index (BMI) >30kg/m^2 were more likely to undergo open surgical placement (76.3%) than those with BMI ⩽30kg/m^2 (58.9%) (figure 14.3). The percutaneous approach was nearly half as likely to be used in patients in the higher BMI category (12.4%) compared with those with a lower BMI (22.1%). Equally, peritoneoscopic placement in the higher BMI category was 50% less likely than in the lower BMI group (3.1% vs. 7.2%). It should be noted that the analysis was limited due to a high proportion of missing data for BMI.

Patients aged less than 60 at the point of commencing RRT were less likely than older patients to start dialysis using an AVF (33.9% vs. 40.7%) (figure 14.4). The reason for this is unknown but may reflect patient engagement with renal services or varying progression of chronic kidney disease in the older population [13, 14, 15]. Similarly, utility of non-tunnelled lines was lower in younger dialysis patients (21.4% *vs.* 24.7%) in contrast to the use of tunnelled lines which were more common in those aged less than 60 (43.7% *vs.* 33.3%).

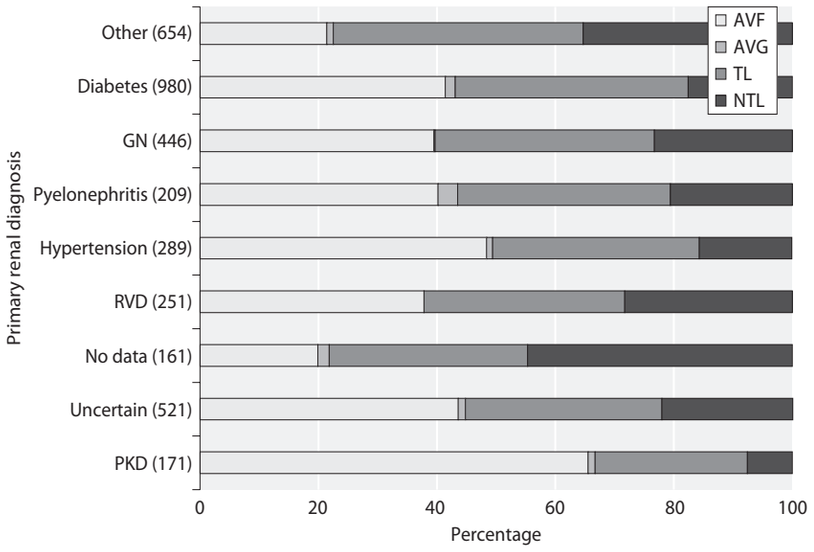

Fig. 14.2. Type of haemodialysis access stratified by primary renal disease
Number of patients in each primary renal diagnosis group in brackets
Primary renal diagnosis groups sorted by percentage of tunnelled lines
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line; GN = glomerulonephritis; RVD = reno-vascular disease; PKD = polycystic kidney disease

First dialysis access and renal centre

Large variations were apparent between centres when considering patients commencing dialysis via an AVF (figure 14.5). At one end of the spectrum was Ulster who reported a total of 27 patients with 7.4% starting on an AVF, 0% on an AVG, 48.1% starting on a tunnelled line, 33.3% using a non-tunnelled line and 11.1% PD catheter. In contrast, Liverpool Aintree reported a total of 57 patients with 54.4% using an AVF, 3.5% on an AVG, 5.3% using a tunnelled line, 15.8% on a non-tunnelled line and 21% on a PD catheter.

Use of a PD catheter as first access varied between 44.4% (Wolverhampton) and 0% (Colchester) (figure 14.5). Centres that had high usage of AVFs as starting access were also more likely to start patients on a PD catheter. There was some evidence ($p = 0.02$) that the proportion of HD patients starting on an AVF increased as the proportion of dialysis patients starting on PD increased. This may indicate variation in local processes for access planning and delivery.

The current audit question asked centres to report which type of access was used for the first ever dialysis session. The problem with this audit question is that

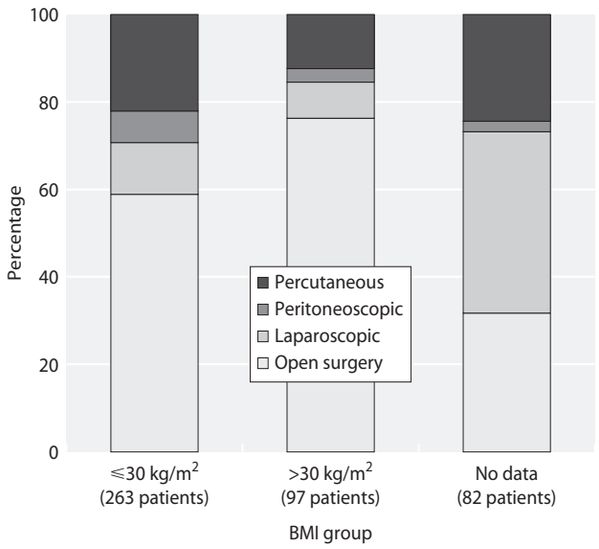

Fig. 14.3. Method of PD catheter insertion stratified by body mass index
BMI = body mass index
All patients from centres with more than 50% missing data for BMI were excluded

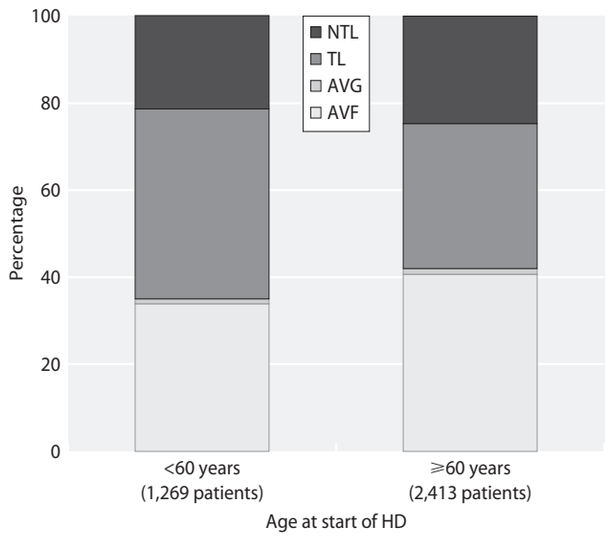

Fig. 14.4. Type of haemodialysis access stratified by age group
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line

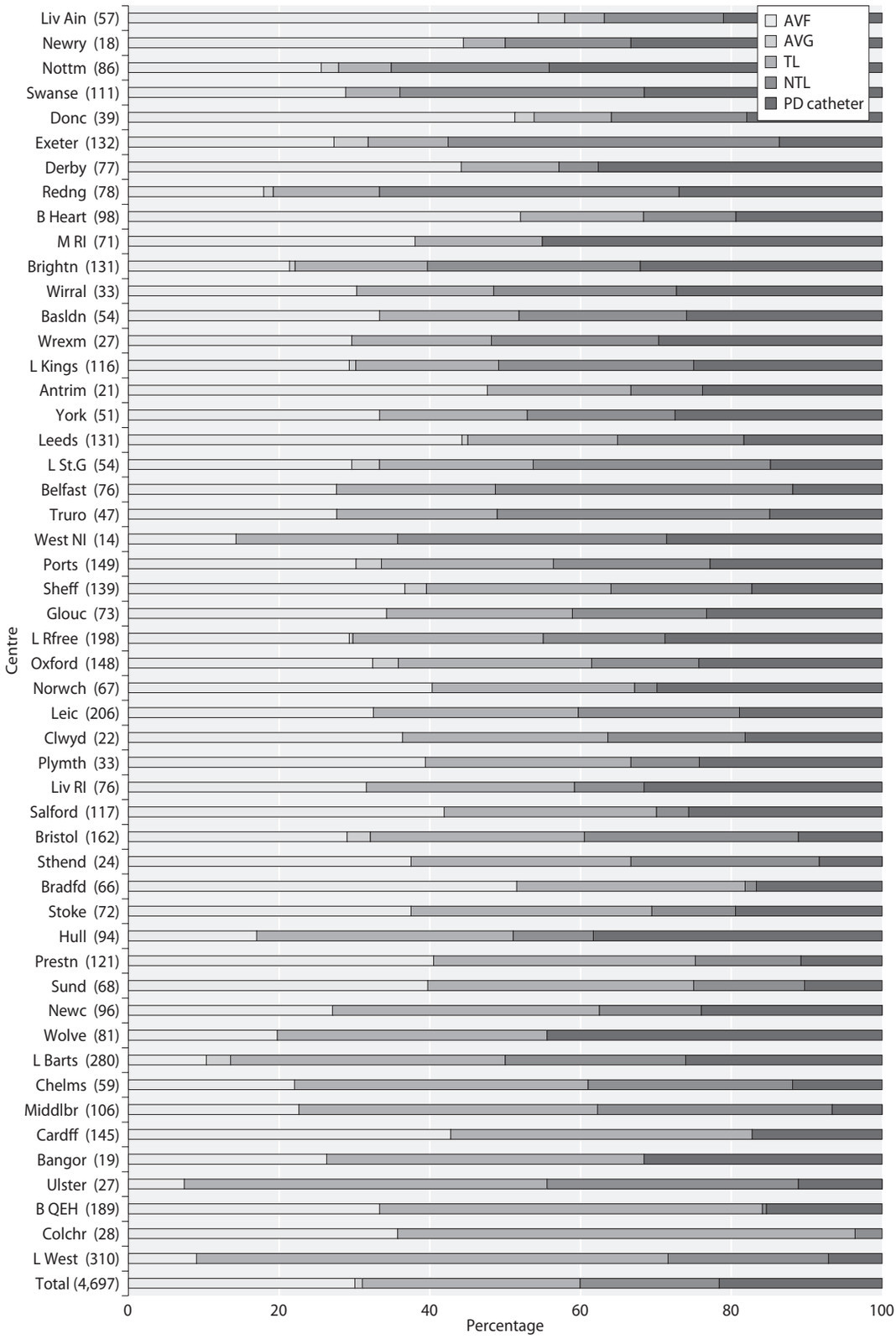

Fig. 14.5. Type of first dialysis access stratified by centre
Centres are ordered by the percentage of patients using a tunnelled line
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line; PD = peritoneal dialysis

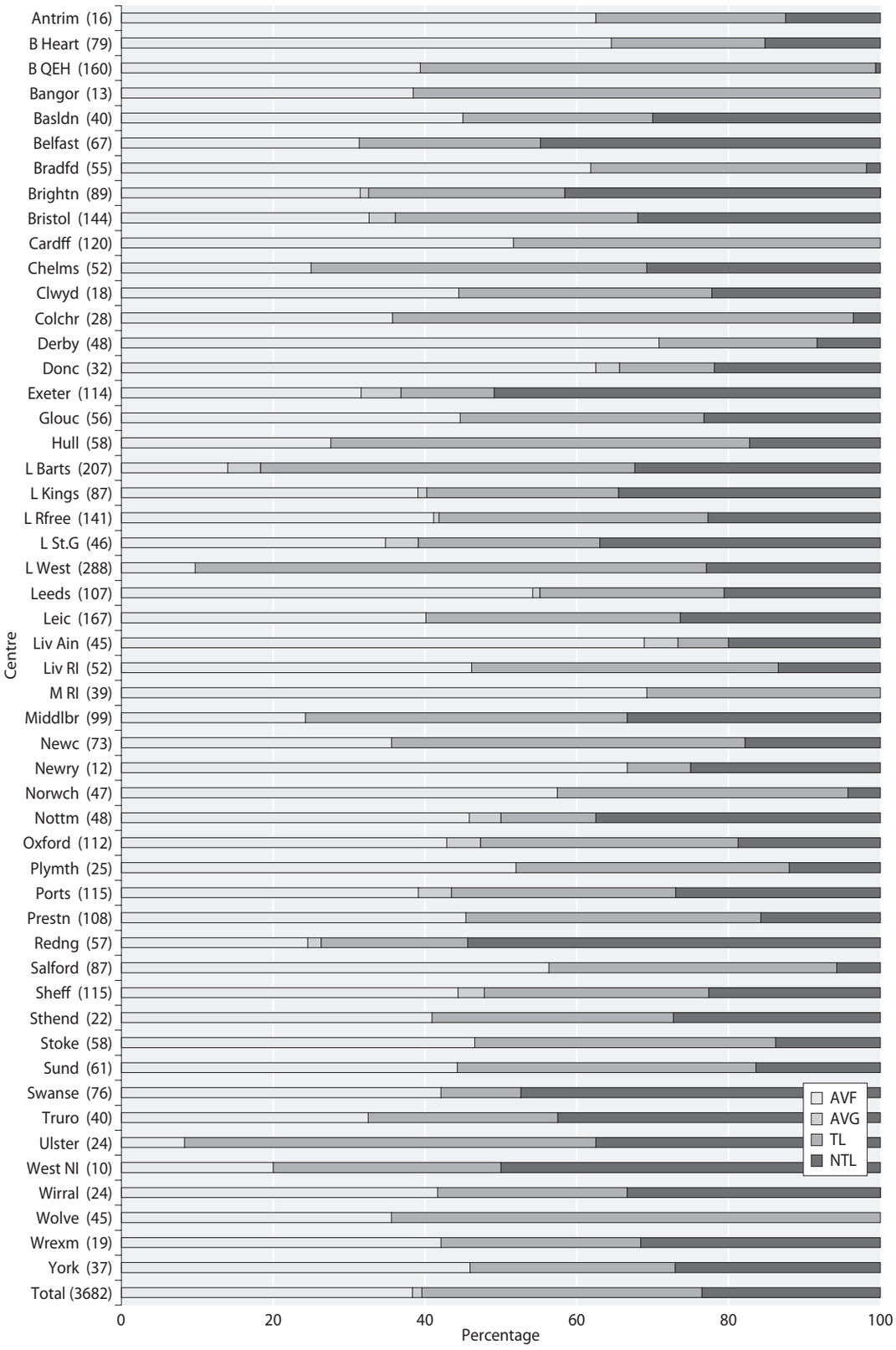

Fig. 14.6. Type of first access for haemodialysis stratified by centre
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line

Fig. 14.7. PD catheter insertion technique stratified by centre

many centres use a non-tunnelled line for a few days while either a tunnelled line for HD or a PD catheter is placed, and therefore in retrospect the access used for the fourth dialysis session may provide a better description of the dialysis access selected for patients presenting late.

Consideration of haemodialysis access separately from the PD group revealed wide variation in the use of AVFs for first HD (figure 14.6). This was demonstrated with the range being from 8.3% in Ulster to 70.8% in Derby (38.3% of HD patients at all centres). Central venous lines were clearly the main form of access where an AVF was not available. The centres with highest tunnelled line use were London West (67.3%), Wolverhampton (64.4%), Bangor (61.5%), and Colchester (60.7%). Two centres reported non-tunnelled lines as the starting form of access in more than 50% of HD patients (Reading 54.4%, Exeter 58.9%). It will be important to understand the variations in practice patterns that lie behind these statistics which were not provided by current data.

Eighteen centres reported less than 10 patients using PD catheters for first dialysis in 2012 (figure 14.7). For a total of 1,015 first PD catheters the insertion techniques were 35.6% open surgical, 14.5% laparoscopic, 2.4% peritoneoscopic and 27.7% percutaneous. Insertion technique was not reported for the remaining 19.9%. There seems to be a strong tendency for many centres to rely on one single approach to PD catheter placement, it is notable that 22 centres reported using a single technique for all of their patients. This is important if evidence were to suggest a benefit to offering an individualised technique (e.g. percutaneous approach for low BMI patients without previous surgery, or an open surgical approach for more complex patients). Only 19 centres reported using the percutaneous technique at all and these were Antrim, Birmingham Heartlands, Bangor, Belfast, Brighton, Derby, Gloucester, Leicester, London Kings, London West, Liverpool Aintree, Liverpool Royal Infirmary, Plymouth, Portsmouth, Reading, Salford, Southend, Stoke and Wolverhampton. Amongst these centres were some of those with the highest proportion of patients using a PD catheter as first access (Wolverhampton 44%, Derby 34%, Brighton 32%, Liverpool RI 26%, Salford 25%, Antrim 24%, London Kings 22%). Of the 20 centres with the lowest PD usage as first access only three used the percutaneous approach.

First dialysis access and referral time

Figure 14.8 shows first access for centres providing data for patients presenting late (known to renal services for <90days). Amongst the 977 patients for whom data were reported, 43.1% started dialysis on a tunnelled line, 41.5% on a non-tunnelled line, 11.0% using a PD catheter with only 4.0% having first access documented as an AVF. There was, however, wide variation amongst centres and clearly an understanding of practice patterns could lead to potential improvements in access service provision. There may also be reporting differences which need to be explored. Non-tunnelled haemodialysis lines are often used as a bridge to a more definitive form of access and it would be important to know what access was used at the end of the first week. As discussed above, revision of the question used in the audit to investigate the access used for the fourth rather than the first dialysis session in patients presenting late may provide more valuable information.

Only 13 centres reported that more than 15% of patients presenting late had a peritoneal dialysis catheter inserted for use as first dialysis access. As the large part of the remainder of patients presenting late start dialysis using a tunnelled vascular line, the centres that were able to make use of PD catheters for patients presenting late had a lower requirement for tunnelled or non-tunnelled lines. However, the number of patients presenting late reported in some centres was extremely small and it is difficult to make firm observations about clinical pathways for the development of dialysis access in this cohort.

Figure 14.9 combines PD and HD access data to demonstrate the association between referral time to renal services and the type of access used for the first treatment. A strong relationship is seen between being known to the renal centre for more than a year and the likelihood of commencing dialysis using either an AVF or a PD catheter. For patients presenting late, 84.6% start on some form of central venous line; however, amongst patients known to the centre for a year or more this percentage falls to 33.9%. Amongst HD patients there was a strong relationship between being known to the centre for more than a year and the use of AVF in preference to a venous line. Figure 14.9 demonstrates that as the time known to renal services increases, the proportion of patients starting dialysis on a line falls, whilst the proportion starting with an AVF or PD catheter increases. The number of patients starting dialysis with an AVG appears to remain the same regardless of the referral time, but numbers are very small.

First dialysis access and surgical assessment

Figure 14.10 shows the variation in centres according to whether PD catheters were inserted at least two

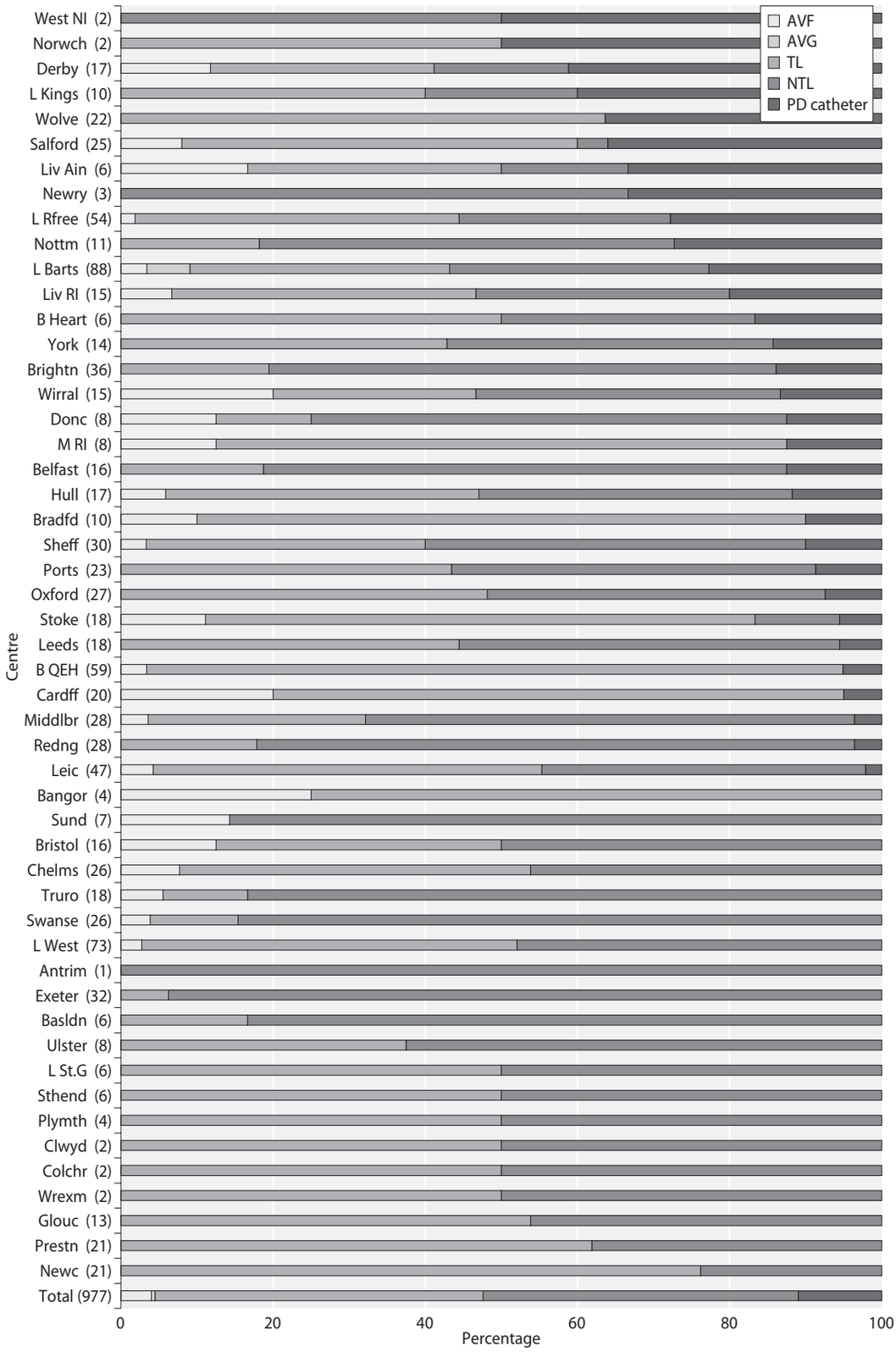

Fig. 14.8. Type of access for the first dialysis in patients presenting to a nephrologist <90 days prior to dialysis start
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line; PD = peritoneal dialysis

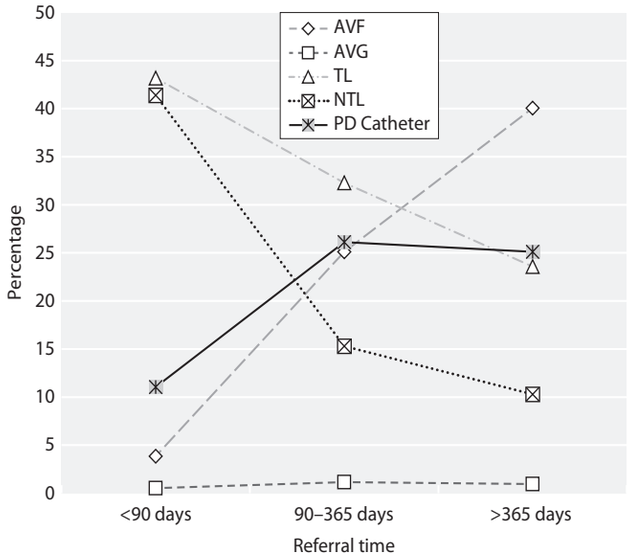

Fig. 14.9. Type of first dialysis access stratified by referral time AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line; PD = peritoneal dialysis

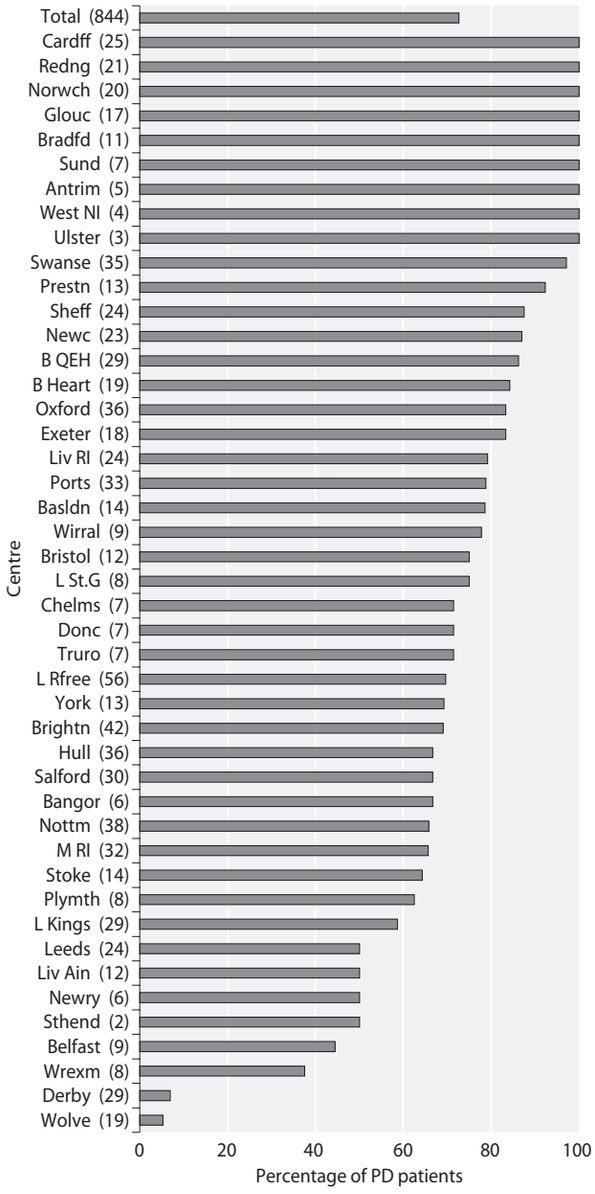

Fig. 14.10. Percentage of patients with PD catheter insertion >2 weeks before starting dialysis

weeks prior to commencing dialysis. Renal Association Peritoneal Access Clinical Guidelines state that [16]:

'Whenever possible, catheter insertion should be performed at least 2 weeks before starting peritoneal dialysis. Small dialysate volumes in the supine position can be used if dialysis is required earlier.'

This guideline was intended to reduce the risk of dialysate leakage following catheter insertion, however it may actually have resulted in patients being less likely to use the PD catheter for early start PD and therefore possibly be exposed to the hazards of a central venous line. It will be important to understand the association between early use and catheter outcomes. This has been explored in previous publications demonstrating a modest increase in dialysate leakage can be mitigated by careful preventative management [17]. It is quite possible that this guideline has been a disincentive to using PD for patients presenting late or for acute kidney injury and revision should be considered in the next iteration of the guideline.

From figure 14.11 it is clear that PD patients seen by a surgeon at least three months prior to starting RRT were more likely to have a laparoscopic insertion. Of those receiving surgical assessment at least three months prior to commencing dialysis, 24.4% underwent laparoscopic insertion *vs.* 5.9% of those who did not. Indeed, patients who underwent surgical assessment at least three months prior to starting PD were less likely to have catheter placement via open surgical technique than those who did not, possibly because such patients were more likely to have the laparoscopic approach. There does not appear from this data to be a relationship between surgical assessment and percutaneous catheter placement.

This relationship was very different from that between surgical assessment and AVF formation (see the next section). It is quite possible that the time required to plan PD catheter placement is less than that required

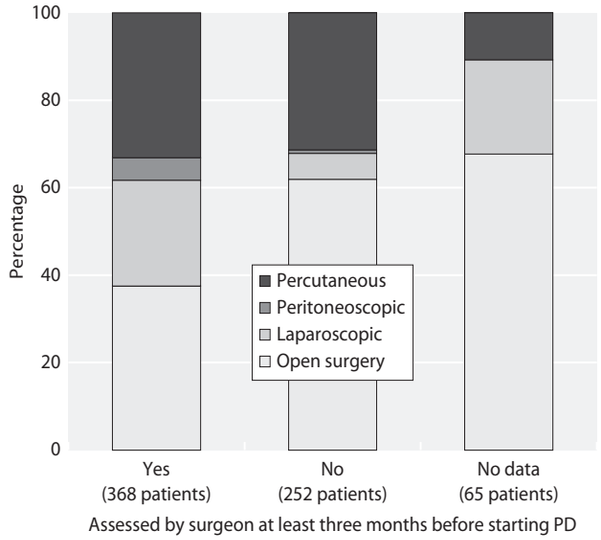

Fig. 14.11. PD catheter insertion technique stratified by surgical assessment

for AVF formation where vein mapping may be necessary.

Figure 14.12 highlights the proportion of patients who had been referred for surgical assessment at least three months prior to starting dialysis. Six renal centres were excluded because they returned data regarding surgical assessment or first seen date on fewer than half of their patients (Clwyd, London Barts, Leicester, Manchester Royal Infirmary, Norwich, Plymouth). There was considerable variation between the remaining renal centres. Overall, the proportion referred to a surgeon was highest in York (92.0%) and Middlesbrough (91.7%). Out of 2,246 patients with a referral time to nephrological services of more than 90 days, 67% per cent had been referred to a surgeon at least three months prior to dialysis start.

A detailed understanding of factors that prevent patients from being assessed for access in a timely fashion is required. These may reflect organisational factors or clinical uncertainty around the need for dialysis.

Figure 14.13 demonstrates a strong relationship between being assessed by a surgeon at least three months before starting dialysis and the likelihood of starting on an AVF. This relationship was much stronger than that between surgical assessment and method of PD catheter placement. This suggests that the role of surgical assessment is more important in relation to AVF placement. Of those assessed by a surgeon at least three months prior to starting dialysis, 70.4% started dialysis on an

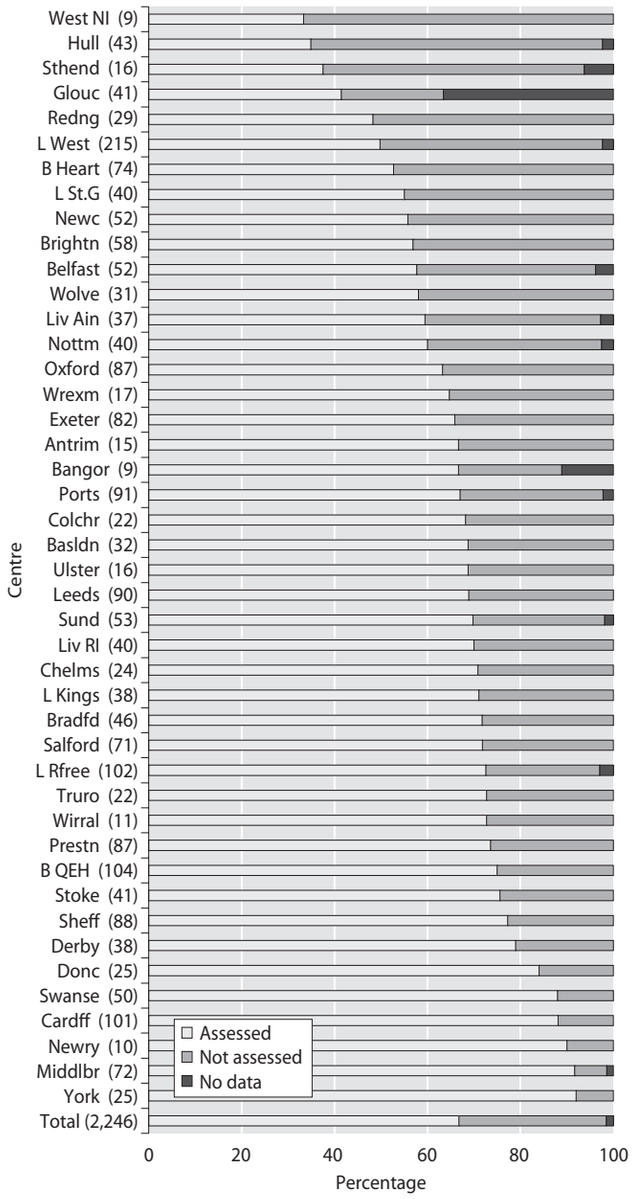

Fig. 14.12. Frequency of surgical assessment more than three months prior to starting dialysis

AVF whereas of those who were not seen by a surgeon only 9.7% did. Clearly, timely surgical assessment is a key component of the clinical pathway to fistula placement.

If data from figures 14.11 to 14.13 are considered together, the importance of timely referral for surgical assessment (if haemodialysis is the selected modality) is clear. Without such assessment, patients are more likely to require temporary haemodialysis access such as a tunnelled or non-tunnelled dialysis catheter.

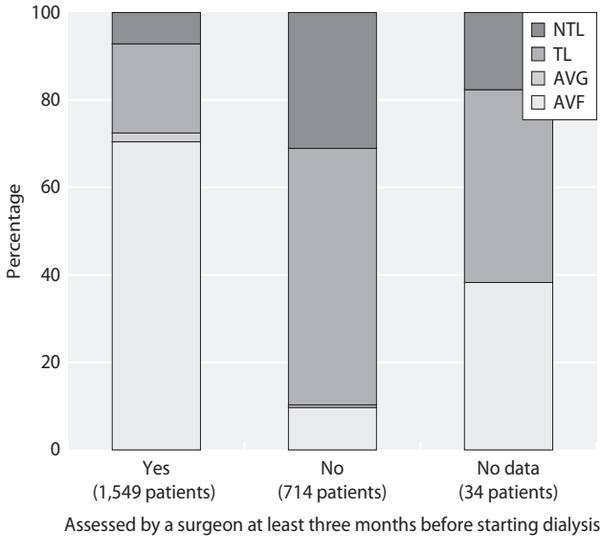

Fig. 14.13. Type of haemodialysis access stratified by surgical assessment
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line

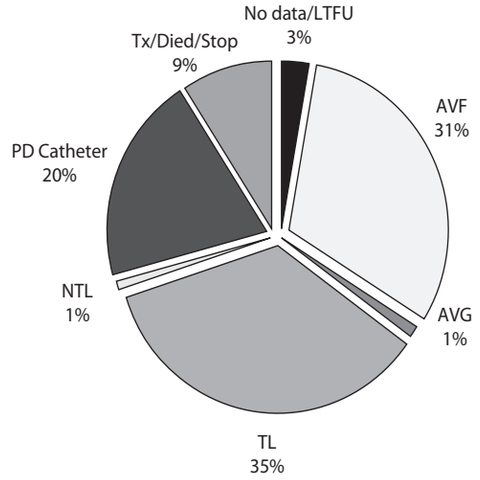

Fig. 14.14. Type of dialysis access at three months
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line; PD = peritoneal dialysis; Tx = transplanted; LTFU = lost to follow up

Dialysis access at three months after starting RRT

The type of access used three months after starting dialysis gives an important insight into the responsiveness of the access formation pathway. Table 14.3 expresses the proportion of patients still dialysing using a particular form of access as a percentage of the access they originally started dialysis with. For example, 87.2% of patients starting dialysis with an AVF were still using this at three months and 83.4% of patients starting on PD remained on this modality at three months. Of patients starting dialysis via a tunnelled line, the majority continued to use this form of access at three months (72.6%) and of 864 patients who commenced dialysis via a non-tunnelled line, 502 (58.1%) were dialysing through a tunnelled line at three months. This may suggest that obtaining definitive access for HD within three months of starting treatment remains a challenge.

Figures 14.14 and 14.15 demonstrate the differences in access outcomes in aggregate and stratified by centre respectively. By three months, 30.9% of patients were dialysing using an AVF (range 7.5% London Barts to 59.6% Liverpool Aintree); 0.9% were using an AVG (0% many sites to 6.1% Exeter); 34.5% tunnelled lines (5.3% Liverpool Aintree to 77.7% London West); 1.3% non-tunnelled lines; and 19.7% were using a PD catheter (0% Plymouth to 48.1% Wolverhampton).

The majority (59.8%) of patients presenting late were being dialysed using tunnelled lines at three months after dialysis start (figure 14.16). The between centre range was from 0% in three centres (Clwyd, Newry,

Table 14.3. Type of dialysis access at 3 months stratified by first access type

Access in use at first dialysis (*N*)	Access in use at three months								
	AVF	AVG	TL	NTL	PD catheter	Transplanted	Died	Stopped/LTFU	No data
AVF (1,358)	**87.2**	0.3	3.7	0.0	0.9	0.9	4.6	0.1	2.4
AVG (46)	2.2	**71.7**	6.5	0.0	2.2	0.0	6.5	0.0	10.9
TL (1,328)	11.0	0.2	**72.6**	0.4	2.7	1.3	8.4	0.3	3.2
NTL (864)	8.4	0.1	58.1	**6.4**	5.2	0.0	16.4	0.3	5.0
PD (963)	0.4	0.1	5.7	0.0	**83.4**	2.4	2.5	0.2	5.3

AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line; PD = peritoneal dialysis; LTFU = lost to follow up

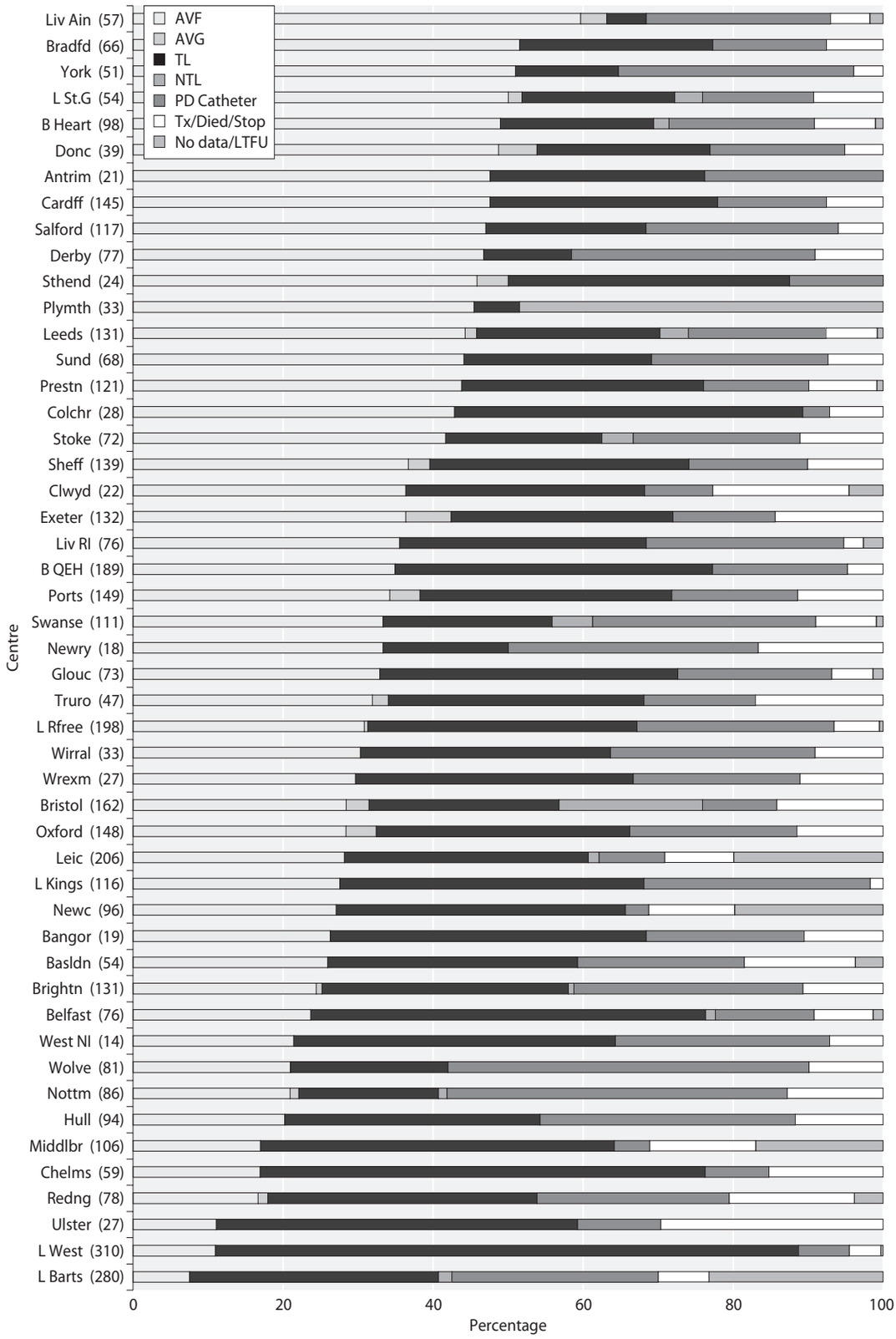

Fig. 14.15. Type of dialysis access at three months stratified by centre
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line; PD = peritoneal dialysis; Tx = transplanted; LTFU = lost to follow up

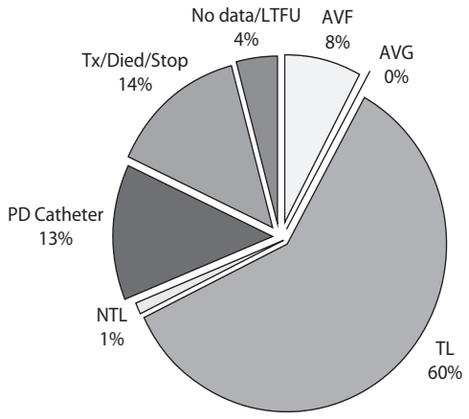

Fig. 14.16. Type of dialysis access at three months in patients referred to renal services less than 90 days before starting dialysis AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line; PD = peritoneal dialysis; Tx = transplanted; LTFU = lost to follow up

Sunderland) to 93.1% at London West (figure 14.17). Amongst patients presenting late, only 8.0% were using an AVF at three months (individual centres ranged from 0% in 16 centres to 75% in Plymouth). PD catheters were used by 12.7% of patients (range 0% in 14 centres to 85.7% in Sunderland). These percentages must be interpreted with caution as reported numbers of patients presenting late tended to be low in many centres.

Figure 14.18 shows comparative access failure for the different access types within three months. This was defined as a documented date of failure/discontinuation recorded within three months of starting dialysis unless a centre comment indicated that it was a planned discontinuation. Failure rates were generally less than 5%, apart from AVGs where it was closer to 15%. There were deficiencies in the way that failure was recorded in this audit, however it is interesting that for most forms of access the failure rates are rather similar at three months.

Numbers of access failures reported were small, however it can be seen from figure 14.19 that there was relatively poor reporting of the reason for failures. This may reflect local documentation procedure. Infectious causes were reported as contributing to 26.1% of access failures of tunnelled lines and 12.1% of non-tunnelled lines, and stenosis was reported as contributing to 22.7% of AVF failures. Steal syndrome was also a common reason for failure in AVF and AVG (29.5% and 28.6% respectively). This data should be regarded as provisional and would benefit from further detailed exploration in future audit.

Reported causes of access failures amongst peritoneal dialysis patients are not included here as the numbers reported were too low to make firm conclusions.

2011 PD access audit one-year follow-up

Centres who reported on PD patients in the 2011 vascular and peritoneal access audits were asked to complete a one year follow up of their PD patients. The additional information requested was the date of catheter failure, the reason for catheter failure, the number of catheters used during the year, and the modality in use at one year after starting PD. Of 44 centres who reported data on PD patients in 2011, 28 completed the one year follow up request returning data on 649 (70.9%) patients.

The reported numbers were too low to draw firm conclusions. Unsurprisingly the principal causes of catheter failure were flow or infection related (figure 14.20).

Figure 14.21 is a funnel plot which graphically displays the unadjusted percentage of PD patients experiencing a catheter failure within one year of commencement of RRT across multiple renal centres according to Speigelhalter's method [18]. PD catheter failure was censored for transplantation, elective transfer to HD or death. The bold dotted line represents the mean one-year catheter failure (23.0%). The 95% (solid lines) and 99.9% (dotted lines) binomial control limits (essentially corresponding to 2 and 3 standard deviations) were superimposed to indicate possible outlier thresholds for 'alert' and 'alarm' [19]. The results have to be cautiously interpreted due to the extent of and variation in missing data, small numbers of patients in some centres and non-adjustment for any patient related factors.

Of the centres for which data were available ($n = 28$), no outlier centres were identified with failure rates above the upper 95% 'alert' or 99.9% 'alarm' limits for PD catheter failures. Such data is suggestive of the absence of outlier centres with abnormally poor one year catheter survival rates relative to the other centres. Contrastingly, four renal centres reported one-year catheter failure rates *below* the 95% control limit. Furthermore, of these, one centre reported a one-year catheter failure rate of zero. This centre was thus considered as an 'alarm' outlier raising questions over data integrity or accuracy.

Of note, although the overall mean one-year catheter failure rate was similar to that which was recommended in the guidelines issued by the ISPD/RA [16, 20] (23% vs. 20%), reported failure rates of as low as 10% raise questions of whether such modest targets should be revised to improve practice [21].

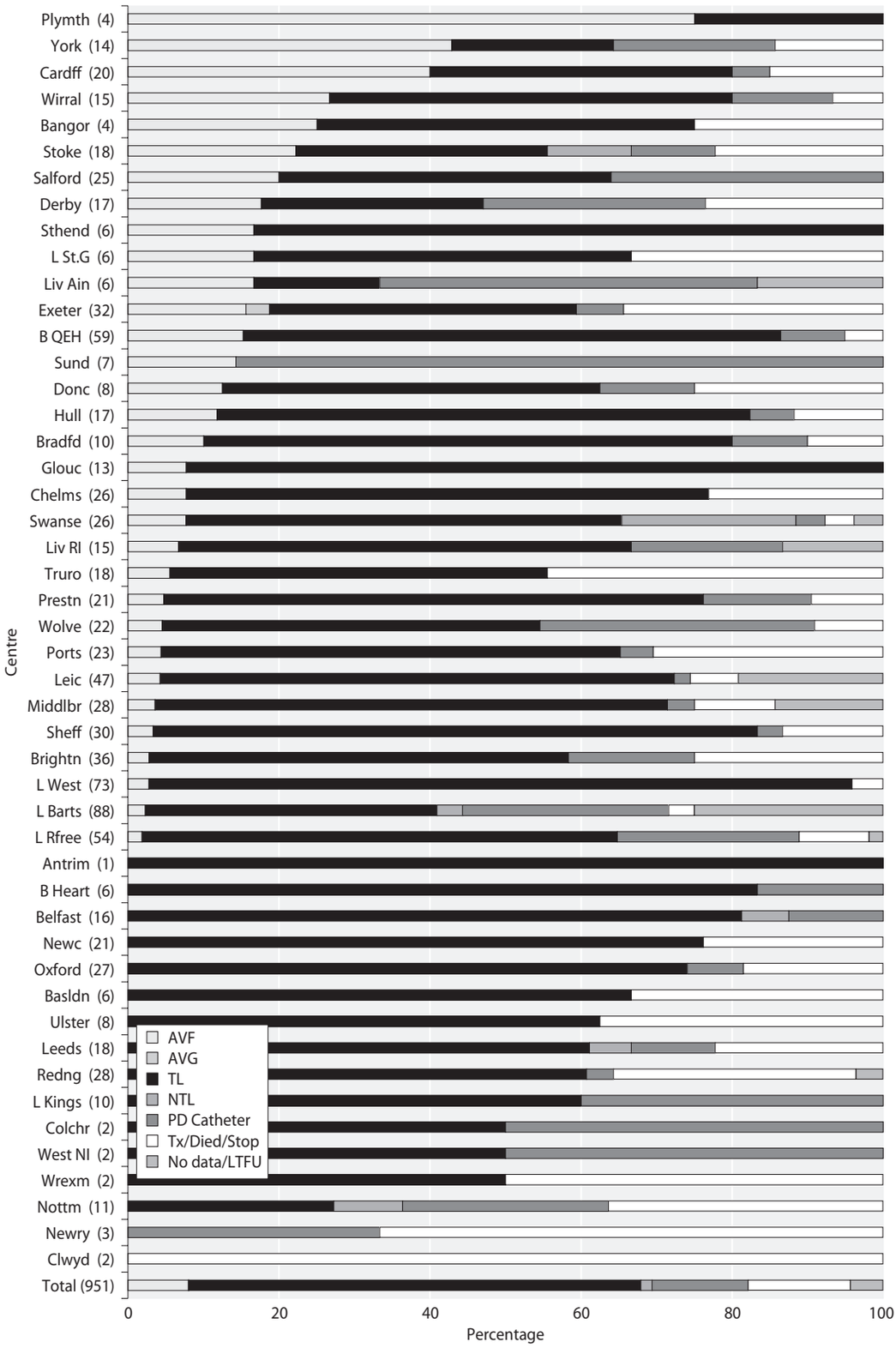

Fig. 14.17. Type of dialysis access at three months in patients referred to renal services less than 90 days before starting dialysis, stratified by centre
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line; PD = peritoneal dialysis; Tx = transplanted; LTFU = lost to follow up

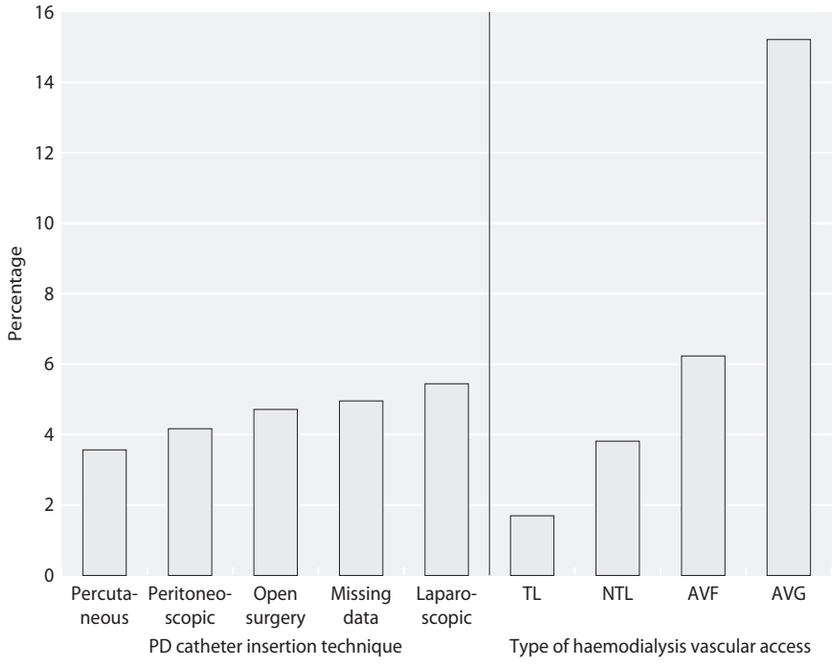

Fig. 14.18. Percentage of patients experiencing failure of first access within three months, by type of first access
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line; PD = peritoneal dialysis

Discussion and recommendations

- This multisite dialysis access audit from England, Wales and Northern Ireland has provided important information regarding the variation in access provision and outcomes. Although this audit represents an important advance for the UK, data collection is still not optimal as significant amounts of missing data across a range of fields exist. Equally, there remain ambiguities in the data fields which need to be refined to simplify collection and improve accuracy. It may be preferable to collect dialysis access at the fourth rather than the first dialysis session since non-tunnelled lines are often used for one or two dialysis sessions before more permanent access is achieved (PD catheter or tunnelled line).

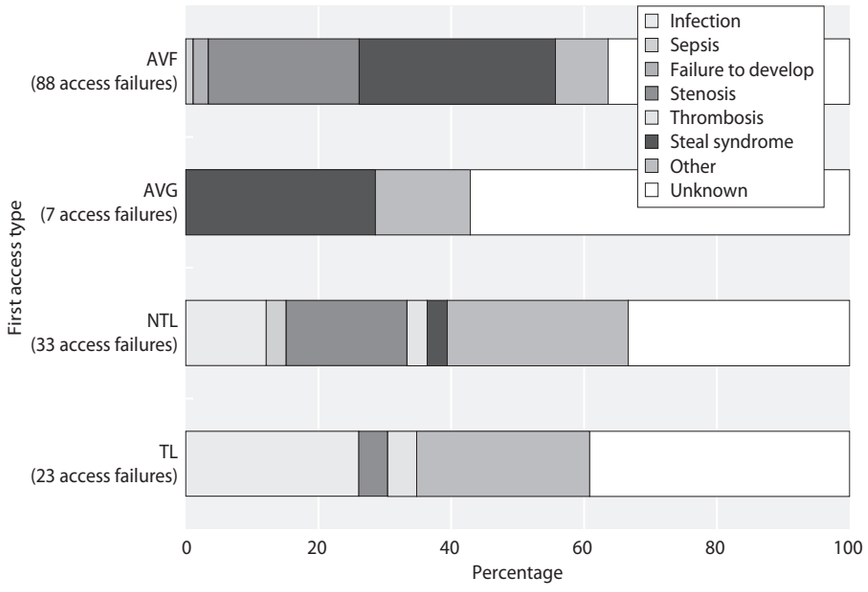

Fig. 14.19. Reported causes of access failure within three months (haemodialysis) stratified by first access type
AVF = arteriovenous fistula; AVG = arteriovenous graft; TL = tunnelled line; NTL = non-tunnelled line

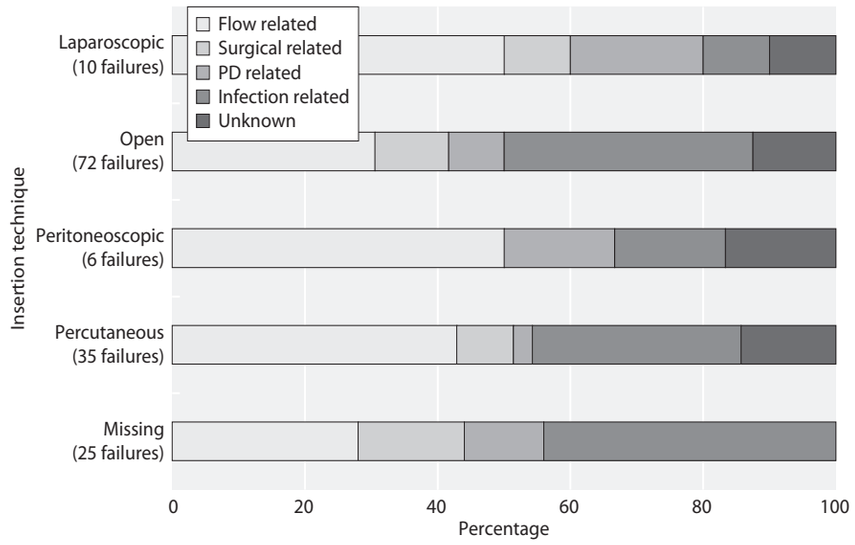

Fig. 14.20. Causes of dialysis access failure within one year of PD catheter insertion

- It is clear from the data that many centres still utilise high numbers of tunnelled and non-tunnelled dialysis catheters especially in patients presenting late. Of concern is that tunnelled lines continue to be used in approximately a third of patients three months post dialysis start and this figure is higher for patients presenting late (60%).
- Surgical assessment is of high importance in the development of permanent vascular access (AVF/AVG). Whereas, in those assessed by a surgeon at least three months prior to starting dialysis, 70.4% received an AVF, only 9.7% of those not assessed did. This strong relationship was not seen between surgical assessment and PD catheter placement, apart from the use of the laparoscopic insertion technique.

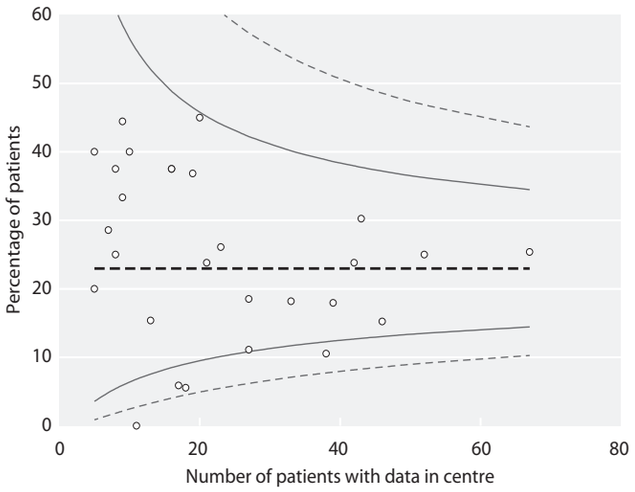

Fig. 14.21. Funnel plot of the percentage of PD catheter failures within one year of insertion

- The practice of PD catheter insertion in patients presenting late was used by relatively few centres. Only 13 out of 50 centres with sufficient data on patients presenting late placed a peritoneal dialysis catheter in more than 15% of patients as first dialysis access. If the National Service Specification for dialysis recommendation that PD catheters should be placed within 72 hours of being required is to be complied with, a significant practice change is needed [22]. This timeframe may be shortened in the future. It is relevant here that 50% of centres only reported using a single technique for PD catheter insertion.
- Variation demonstrated in PD catheter functionality suggests that further exploration of centre specific practice around PD access would also be of value.
- The guideline recommending that PD catheters should be inserted at least two weeks prior to use [16] should be reconsidered since it may be a disincentive to using PD for patients presenting late.

Acknowledgement

Thanks are expressed to the Healthcare Quality Improvement Partnership (HQIP) who contributed to the funding of the PD access audit and also the renal centres for their assistance in providing the data.

Conflicts of interest: none

References

1 Briggs V, et al. UK Renal Registry 15th annual report: Chapter 8 UK multisite peritoneal dialysis access catheter audit for first PD catheters 2011. Nephron Clin Pract 2013;123(suppl 1):165–181
2 NHS Information Centre. National Kidney Care Audit Vascular Access Report. 2011 [cited 2013 1st October]; Available from: http://www.hqip.org.uk/assets/NCAPOP-Library/VAReport2011Interactive03082011–FINAL.pdf
3 Fluck R, Pitcher D, Steenkamp R. Vascular Access Audit Report 2012: UK Renal Registry and NHS Kidney Care 2012
4 National Service Framework for Renal Services. Dialysis and Transplantation 2004, Department of Health
5 Ravani P, et al. Associations between hemodialysis access type and clinical outcomes: a systematic review. J Am Soc Nephrol 2013;24:3:465–473
6 National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI). Clinical Practice Guidelines and Clinical Practice Recommendations 2006 Updates – Vascular Access 2006
7 Perl J. et al. Hemodialysis vascular access modifies the association between dialysis modality and survival. J Am Soc Nephrol 2011;22:6:1113–1121
8 Koch M. et al. Comparable outcome of acute unplanned peritoneal dialysis and haemodialysis. Nephrol Dial Transplant 2012;27:1:375–380
9 Coentrao L. et al. Effects of starting hemodialysis with an arteriovenous fistula or central venous catheter compared with peritoneal dialysis: a retrospective cohort study. BMC Nephrol 2012;13:88
10 National Institute for Health and Clinical Excellence, NICE clinical guideline 125 – Peritoneal dialysis in the treatment of stage 5 chronic kidney disease 2011
11 Shaw C. et al. UK Renal Registry 15th annual report: Chapter 2 UK RRT prevalence in 2011: national and centre-specific analyses. Nephron Clin Pract 2013;123(suppl 1):29–54
12 Lobbedez T. et al. Peritoneal dialysis in polycystic kidney disease patients. Report from the French peritoneal dialysis registry (RDPLF). Nephrol Dial Transplant 2011;26:7:2332–2339
13 O'Hare AM. et al. Mortality risk stratification in chronic kidney disease: one size for all ages? J Am Soc Nephrol 2006;17:3:846–853
14 Roderick PJ. Chronic kidney disease in older people: a cause for concern? Nephrol Dial Transplant 2011;26:10:3083–3086
15 Eriksen BO, Ingebretsen OC. The progression of chronic kidney disease: a 10-year population-based study of the effects of gender and age. Kidney Int 2006;69:2:375–382
16 Wilkie M, Jenkins S, Shrestha B. Renal Association Peritoneal dialysis access clinical guidelines. 2009. 31st August 2013. http://www.renal.org/Clinical/GuidelinesSection/PeritonealAccess.aspx
17 Povlsen JV, Ivarsen P. How to start the late referred ESRD patient urgently on chronic APD. Nephrol Dial Transplant 2006;21(suppl 2):ii:56–59
18 Spiegelhalter DJ. Funnel plots for comparing institutional performance. Stat Med 2005; 24:8:1185–1202
19 Spiegelhalter D. Funnel plots for institutional comparison. Qual Saf Health Care 2002;11:4:390–391
20 Figueiredo A. et al. Clinical practice guidelines for peritoneal access. Perit Dial Int 2010;30:4:424–429
21 Singh, N. et al. Risk factors associated with peritoneal dialysis catheter survival: a 9-year single-center study in 315 patients. J Vasc Access 2010;11:4:316–322
22 NHS England 2013/14 NHS Standard contract for renal dialysis: Peritoneal (adult) 2013

UK Renal Registry 16th Annual Report: Chapter 15 Epidemiology of Reported Infections amongst Patients Receiving Dialysis for Established Renal Failure in England from May 2011 to April 2012: a Joint Report from Public Health England and the UK Renal Registry

Lisa Crowley[a], David Pitcher[b], Jennie Wilson[c], Rebecca Guy[d], Richard Fluck[a]

[a]Royal Derby Hospital, Derby, UK; [b]UK Renal Registry, Bristol, UK; [c]Institute for Practice, Interdisciplinary Research and Enterprise, University of West London, London, UK; [d]Centre for Infectious Disease surveillance and Control, PHE, London, UK

Key Words
Clostridium difficile · *Eschericia coli* · Dialysis · Established renal failure · Infection · Staphylococcus

Summary

- From May 1st 2011 to April 30th 2012 there were 49 episodes of methicillin resistant *Staphylococcus aureus* (MRSA) bacteraemia in end stage renal failure patients on dialysis. This represents a further slight decline in MRSA bacteraemia rates which have been falling since data collection began in 2007.
- In the same period there were 138 *Clostridium difficile* infection episodes with a rate of 0.61 per 100 prevalent dialysis patients per year.
- Methicillin sensitive *Staphylococcus aureus* (MSSA) bacteraemia rates were 1.15 per 100 prevalent dialysis patients per year with 322 episodes of blood stream infection reported.
- *Eschericia coli* data were available from June 2011 and showed a reported rate of 0.92 per 100 prevalent dialysis patients per year.
- In each infection type the presence of a central venous catheter appeared to correlate with increased risk.

Introduction

Infection remains the second leading cause of death in patients with established renal failure (ERF) who receive renal replacement therapy (RRT). The high rates of systemic infection reported in haemodialysis patients are related to their impaired immune system, the high number of invasive procedures they are exposed to and the type of vascular access used [1].

Previous UK Renal Registry (UKRR) reports have detailed the epidemiology of staphylococcal bacteraemias in patients with ERF receiving dialysis [2]. These were joint reports from the UKRR and the Health Protection Agency (HPA). As of 1st April 2013 the HPA has now become part of Public Health England (PHE) within the Department of Health. In addition to staphylococcal bacteraemias, surveillance has been expanded to incorporate *Escherichia coli* (*E. coli*) bloodstream infections (BSIs). As well as the mandatory reporting of methicillin resistant *Staphylococcus aureus* (MRSA) BSIs, methicillin sensitive *Staphylococcus aureus* (MSSA) BSIs have been mandatory to report since January 2011 and *E. coli* BSIs since June 2011; *Clostridium difficile* infection (CDI) reporting has been mandatory for all patients aged two and above since 2007. CDIs are reported according to a national testing protocol although during the timeframe of this report there may have been some inter-hospital variation in testing methods [2].

MRSA BSI surveillance is the only data collection of the four which displays a prompt for additional renal failure information although the unprompted feature is available for the other collections; however, completion of renal failure information is not a requirement for any of these data collections. The data is supplied by clinical staff and captured using a secure web-based system, the Healthcare Associated Infection Data Capture System (HCAI-DCS). As in previous reports, a final round of data validation was also undertaken which involved emailing the clinical or infection control leads at each centre in order for them to check the details and accept the record. The dataset included dialysis modality, type of dialysis access and use of non-tunnelled venous catheters within the preceding 28 days. The previous report confirmed that while dialysis patients remain at increased risk from MRSA there has been a continued year on year decline in the number of bacteraemias [3]. The report also provided the first experience of MSSA BSI reporting for the first six months of mandatory surveillance.

This report covers one year of reporting for MRSA, MSSA and *CDI,* and eleven months of reporting for *E. coli BSI*, in patients with ERF who were receiving dialysis in England. This is the first UKRR report which will contain data on *Clostridium difficile (C. difficile)* and *E. coli* infections reported by laboratories as being associated with ERF patients receiving dialysis.

Methods

The report covers the period of 1st May 2011 to 30th April 2012. In choosing this time frame it is important to note that the data on MSSA reported here overlaps with the period included in the previous UKRR report where MSSA cases from January 2011 to June 2011 were reported.

It should also be noted that even though reporting is mandatory for these data collections (MRSA, MSSA and *E. coli* BSI and CDI) completion of renal failure and dialysis information is currently conducted on a voluntary basis depending on the data entry policy within the reporting NHS acute Trust. Therefore a reported infection rate of zero for an individual centre may represent a difference in reporting policy.

The methods used have been described in previous UKRR reports [4]. Briefly, four stages of data collection and validation were undertaken:

1 Identification of bacteraemias (and CDI) potentially associated with dialysis patients. This data was captured by the microbiology laboratory using the clinical details provided and the setting in which the sample was obtained.
2 This record was 'shared' with the parent renal centre. The microbiology laboratory attributed the record to the renal centre responsible for the dialysis of the patient which in turn triggered an email alert to the identified contact within the parent renal centre.
3 The renal centre then completed the additional renal data on the case via the HCAI-DCS website.
4 An additional validation and data capture step has been introduced as not all records were shared or completed. This involved emailing clinical or infection control leads at the parent centre to finish incomplete records and confirm that records associated with their centre were related to patients in ERF requiring dialysis.

This data reporting mechanism applies only to centres in England and is not utilised in Wales, Scotland or Northern Ireland.

For each infection, the number of individual episodes is shown alongside centre-specific rates which were calculated using the number of prevalent dialysis patients according to 2011 data [5]. The collection period for *E. coli* BSIs was eleven months compared to twelve months of collection for the other infections. The rates presented for *E. coli* have been adjusted accordingly to show the rate per 100 prevalent dialysis patients per year. Data on the type of access in use at the time of infection was also provided. In order to adjust for variation in precision of estimated rate, the rate of bacteraemia/CDI per 100 prevalent dialysis patients per year has been plotted against the centre size in a funnel plot. This process has been repeated for each infection. In the case of

MRSA a comparative box plot to demonstrate the overall trend is also included.

Results

Methicillin resistant Staphylococcus aureus

In total, 53 MRSA bacteraemias were reported to PHE as being associated with a dialysis patient during the time frame of this report. Of these, four episodes were rejected by the parent centre because they occurred in patients with acute kidney injury (AKI) rather than the patient being in ERF. This left a total of 49 episodes of MRSA bacteraemia within the time period. These episodes were split between 42 patients registering one episode, two patients registering two episodes and one patient registering three infection episodes.

The overall infection rate for England was 0.22 per 100 prevalent dialysis patients per year. This rate represents a further year on year fall in the MRSA bacteraemia rates in England as illustrated by the box plot in figure 15.1. Centre level data can be seen in table 15.1 and includes the absolute number of episodes and rates based on using the number of 2011 dialysis patients as the denominator. The majority of centres did not report any MRSA bacteraemia episodes. Only two centres had an infection rate in excess of one per 100 prevalent dialysis patients per year (figure 15.2). In order to adjust for variation in precision of estimated rate, the rate has been plotted against centre size in a funnel plot (figure 15.3).

Amongst patients for whom the type of access at the time of infection was known, the highest proportion of infections occurred in patients with a tunnelled central venous catheter (46.7%). In total, 51.1% of cases occurred in patients with either a tunnelled or non-tunnelled catheter in situ, 8.9% of cases occurred in patients with an arteriovenous graft while 37.8% occurred in patients with an arteriovenous fistula (table 15.2).

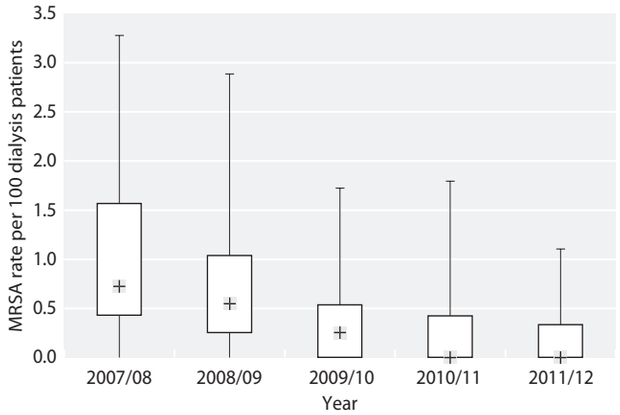

Fig. 15.1. Box and whisker plot of MRSA rates by renal centre per 100 prevalent dialysis patients per year by reporting year

Clostridium difficile

In total, 172 episodes of CDI were reported to PHE in the period covered by this report. Of these, only one episode was shared and completed in full. A further 26 episodes were shared of which two were rejected. Of the remaining unshared episodes, a further 32 were either rejected by the main centre or a main centre could not be identified. This left a total of 138 infections in dialysis patients giving a rate for England of 0.61 infections per 100 prevalent dialysis patients per year. Fourteen centres did not report any CDI episodes and the highest reported rate was 4.44 per 100 prevalent dialysis patients (table 15.3, figure 15.4). A funnel plot was created to display the rate compared to centre size (figure 15.5).

Amongst patients for whom the type of access was known, 49.5% of patients had a line at the time of the infection (47.4% tunnelled catheter, 2.1% non-tunnelled catheter), 42.3% of patients had an arteriovenous fistula and 2.1% of patients an arteriovenous graft (table 15.4). Six (6.2%) episodes occurred in peritoneal dialysis patients where access was via a Tenchkoff catheter.

Methicillin sensitive Staphylococcus aureus

In total, 322 episodes of MSSA bacteraemia were reported to PHE. However, 61 of these episodes were excluded leaving a final total of 261 bacteraemia episodes within the time frame. The main reasons for exclusion were a) the patient was unknown to the allocated centre and b) an inability to identify the centre responsible for the dialysis care. The majority of episodes were reported in haemodialysis patients, with just six reported episodes amongst peritoneal dialysis patients.

The overall MSSA bacteraemia rate for England was 1.15 per 100 prevalent dialysis patients per year. There was considerable variation in both the bacteraemia rate at each centre and also in the number of individual infection episodes at an individual centre which ranged from 0 to 25 (table 15.5). The highest rate reported was 3.83 per 100 prevalent dialysis patients per year (figure 15.6). Figure 15.7 is a funnel plot displaying the centre rates plotted against the size of the centre. A number of centres reported a zero infection rate. Centres reporting no MSSA infections are Birmingham Heartlands, Chelmsford, Nottingham, Plymouth, Ipswich,

Table 15.1. Centre-specific data for MRSA bacteraemia episodes by access type, 1/05/2011 to 30/04/2012

	Prevalent patients on 31/12/2011			MRSA bacteraemia episodes (1/5/2011–30/4/2012)							Rate per 100 dialysis patients
Centre	HD	PD	Dialysis	Total	AVF	AVG	NTC	TC	PD	UK	
B Heart	446	46	492	0	0	0	0	0	0	0	0.00
B QEH*	894	167	1,061	0	0	0	0	0	0	0	0.00
Basldn	155	26	181	2	2	0	0	0	0	0	1.10
Bradfd	196	32	228	1	1	0	0	0	0	0	0.44
Brightn	340	80	420	1	0	1	0	0	0	0	0.24
Bristol*	474	66	540	1	0	0	0	0	0	1	0.19
Camb*	371	41	412	0	0	0	0	0	0	0	0.00
Carlis	66	24	90	0	0	0	0	0	0	0	0.00
Carsh	753	103	856	3	0	0	0	3	0	0	0.35
Chelms	119	26	145	0	0	0	0	0	0	0	0.00
Colchr	120	0	120	0	0	0	0	0	0	0	0.00
Covnt*	362	90	452	0	0	0	0	0	0	0	0.00
Derby	207	112	319	0	0	0	0	0	0	0	0.00
Donc	162	26	188	0	0	0	0	0	0	0	0.00
Dorset	239	53	292	0	0	0	0	0	0	0	0.00
Dudley	146	53	199	0	0	0	0	0	0	0	0.00
Exeter	376	78	454	0	0	0	0	0	0	0	0.00
Glouc	194	39	233	0	0	0	0	0	0	0	0.00
Hull	323	89	412	0	0	0	0	0	0	0	0.00
Ipswi	125	31	156	1	0	0	0	0	0	1	0.64
Kent	376	68	444	2	1	0	0	1	0	0	0.45
L Barts*	899	171	1,070	0	0	0	0	0	0	0	0.00
L Guys*	607	33	640	1	0	0	0	0	0	1	0.16
L Kings	468	89	557	1	1	0	0	0	0	0	0.18
L Rfree*	711	94	805	1	0	1	0	0	0	0	0.12
L St.G*	294	55	349	1	0	0	0	1	0	0	0.29
L West*	1,412	35	1,447	4	1	0	0	3	0	0	0.28
Leeds*	513	92	605	2	0	1	0	1	0	0	0.33
Leic*	854	159	1,013	8	3	0	1	4	0	0	0.79
Liv Ain	179	15	194	0	0	0	0	0	0	0	0.00
Liv RI*	381	74	455	2	0	0	0	2	0	0	0.44
M RI*	481	91	572	4	2	0	0	2	0	0	0.70
Middlbr	315	18	333	0	0	0	0	0	0	0	0.00
Newc*	265	48	313	0	0	0	0	0	0	0	0.00
Norwch	309	59	368	0	0	0	0	0	0	0	0.00
Nottm*	402	92	494	0	0	0	0	0	0	0	0.00
Oxford*	419	92	511	1	0	0	1	0	0	0	0.20
Plymth*	132	47	179	0	0	0	0	0	0	0	0.00
Ports*	524	95	619	1	0	0	0	1	0	0	0.16
Prestn	520	65	585	4	2	0	0	1	0	1	0.68
Redng	272	88	360	0	0	0	0	0	0	0	0.00
Salford	363	113	476	0	0	0	0	0	0	0	0.00
Sheff*	591	62	653	3	2	1	0	0	0	0	0.46
Shrew	187	35	222	0	0	0	0	0	0	0	0.00
Stevng	412	30	442	0	0	0	0	0	0	0	0.00
Sthend	122	18	140	1	0	0	0	1	0	0	0.71
Stoke	318	82	400	2	2	0	0	0	0	0	0.50
Sund	178	17	195	2	0	0	0	1	1	0	1.03
Truro	152	26	178	0	0	0	0	0	0	0	0.00
Wirral	196	42	238	0	0	0	0	0	0	0	0.00
Wolve	307	71	378	0	0	0	0	0	0	0	0.00
York	144	25	169	0	0	0	0	0	0	0	0.00
England	**19,371**	**3,283**	**22,654**	**49**	**17**	**4**	**2**	**21**	**1**	**4**	**0.22**

*Transplant centres

AVF = arteriovenous fistula; AVG = arteriovenous graft; NTC = non-tunnelled catheter; TC = tunnelled catheter; PD = peritoneal dialysis; UK = unknown access type

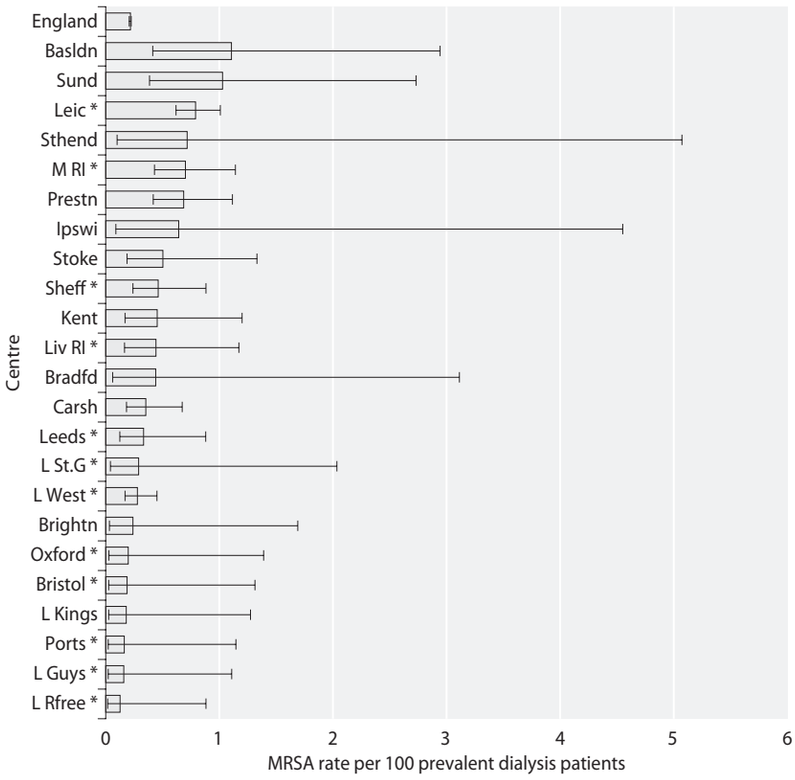

Fig. 15.2. MRSA bacteraemia rate per 100 prevalent dialysis patients per year by renal centre
Centres with no reported infection episodes are not displayed

Portsmouth and Reading. At present it is not clear whether this represents lack of reporting rather than no reportable episodes.

Amongst patients with an MSSA episode and for whom the type of access was known, a tunnelled catheter was in situ at the time of infection for 54.1% whilst 35.4% had a native arteriovenous fistula (table 15.6).

Escherichia coli

A total of 284 episodes of *E. coli* bacteraemia were reported in dialysis patients. A total of 93 episodes were excluded from the final total (the highest number of

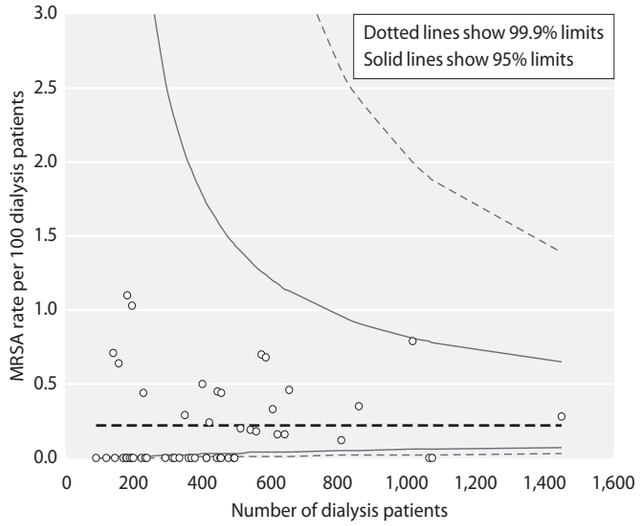

Fig. 15.3. Funnel plot of the MRSA bacteraemia rate per 100 prevalent dialysis patients per year by renal centre

Table 15.2. Type of renal access in patients with established renal failure where record shared and completed for the MRSA bacteraemia episodes

	MRSA bacteraemia (1/5/2011–30/4/2012)		
Renal access type	*N*	%	Access class
Unknown	4		
Haemodialysis			
Other	0		
Arteriovenous fistula	17	37.8	46.7
Arteriovenous graft	4	8.9	
Non-tunnelled catheter	2	4.4	51.1
Tunnelled catheter	21	46.7	
Peritoneal dialysis	1	2.2	2.2
Total	**49**		
Total known access	**45**		

Table 15.3. Centre-specific data for *Clostridium difficile* episodes by access type, 1/05/2011 to 30/04/2012

	Prevalent patients on 31/12/2011			*Clostridium difficile* episodes (1/5/2011–30/4/2012)							Rate per 100 dialysis patients
Centre	HD	PD	Dialysis	Total	AVF	AVG	NTC	TC	PD	UK	
B Heart	446	46	492	0	0	0	0	0	0	0	0.00
B QEH*	894	167	1,061	0	0	0	0	0	0	0	0.00
Basldn	155	26	181	0	0	0	0	0	0	0	0.00
Bradfd	196	32	228	8	3	0	0	5	0	0	3.51
Brightn	340	80	420	2	1	0	0	0	0	1	0.48
Bristol*	474	66	540	1	1	0	0	0	0	0	0.19
Camb*	371	41	412	3	0	0	0	0	0	3	0.73
Carlis	66	24	90	4	0	0	0	0	2	2	4.44
Carsh	753	103	856	9	3	0	0	5	1	0	1.05
Chelms	119	26	145	0	0	0	0	0	0	0	0.00
Colchr	120	0	120	1	0	0	0	1	0	0	0.83
Covnt*	362	90	452	2	0	0	1	1	0	0	0.44
Derby	207	112	319	0	0	0	0	0	0	0	0.00
Donc	162	26	188	2	0	1	0	1	0	0	1.06
Dorset	239	53	292	8	0	0	0	7	0	1	2.74
Dudley	146	53	199	3	0	0	0	0	0	3	1.51
Exeter	376	78	454	0	0	0	0	0	0	0	0.00
Glouc	194	39	233	2	0	0	0	0	0	2	0.86
Hull	323	89	412	3	1	0	0	0	2	0	0.73
Ipswi	125	31	156	0	0	0	0	0	0	0	0.00
Kent	376	68	444	7	1	0	0	6	0	0	1.58
L Barts*	899	171	1,070	0	0	0	0	0	0	0	0.00
L Guys*	607	33	640	5	3	0	0	2	0	0	0.78
L Kings	468	89	557	1	1	0	0	0	0	0	0.18
L Rfree*	711	94	805	5	3	0	0	2	0	0	0.62
L St.G*	294	55	349	1	0	0	0	1	0	0	0.29
L West*	1,412	35	1,447	9	0	0	0	0	0	9	0.62
Leeds*	513	92	605	0	0	0	0	0	0	0	0.00
Leic*	854	159	1,013	3	0	0	0	0	0	3	0.30
Liv Ain	179	15	194	0	0	0	0	0	0	0	0.00
Liv RI*	381	74	455	7	0	0	0	0	0	7	1.54
M RI*	481	91	572	7	1	0	0	6	0	0	1.22
Middlbr	315	18	333	5	0	0	0	0	0	5	1.50
Newc*	265	48	313	0	0	0	0	0	0	0	0.00
Norwch	309	59	368	0	0	0	0	0	0	0	0.00
Nottm*	402	92	494	0	0	0	0	0	0	0	0.00
Oxford*	419	92	511	2	1	0	1	0	0	0	0.39
Plymth*	132	47	179	1	0	0	0	0	0	1	0.56
Ports*	524	95	619	1	0	0	0	0	0	1	0.16
Prestn	520	65	585	1	1	0	0	0	0	0	0.17
Redng	272	88	360	0	0	0	0	0	0	0	0.00
Salford	363	113	476	1	1	0	0	0	0	0	0.21
Sheff*	591	62	653	9	4	0	0	4	0	1	1.38
Shrew	187	35	222	8	5	1	0	0	0	2	3.60
Stevng	412	30	442	3	0	0	0	3	0	0	0.68
Sthend	122	18	140	0	0	0	0	0	0	0	0.00
Stoke	318	82	400	5	3	0	0	1	1	0	1.25
Sund	178	17	195	0	0	0	0	0	0	0	0.00
Truro	152	26	178	4	4	0	0	0	0	0	2.25
Wirral	196	42	238	0	0	0	0	0	0	0	0.00
Wolve	307	71	378	2	2	0	0	0	0	0	0.53
York	144	25	169	3	2	0	0	1	0	0	1.78
England	**19,371**	**3,283**	**22,654**	**138**	**41**	**2**	**2**	**46**	**6**	**41**	**0.61**

*Transplant centres

AVF = arteriovenous fistula; AVG = arteriovenous graft; NTC = non-tunnelled catheter; TC = tunnelled catheter; PD = peritoneal dialysis; UK = unknown access type

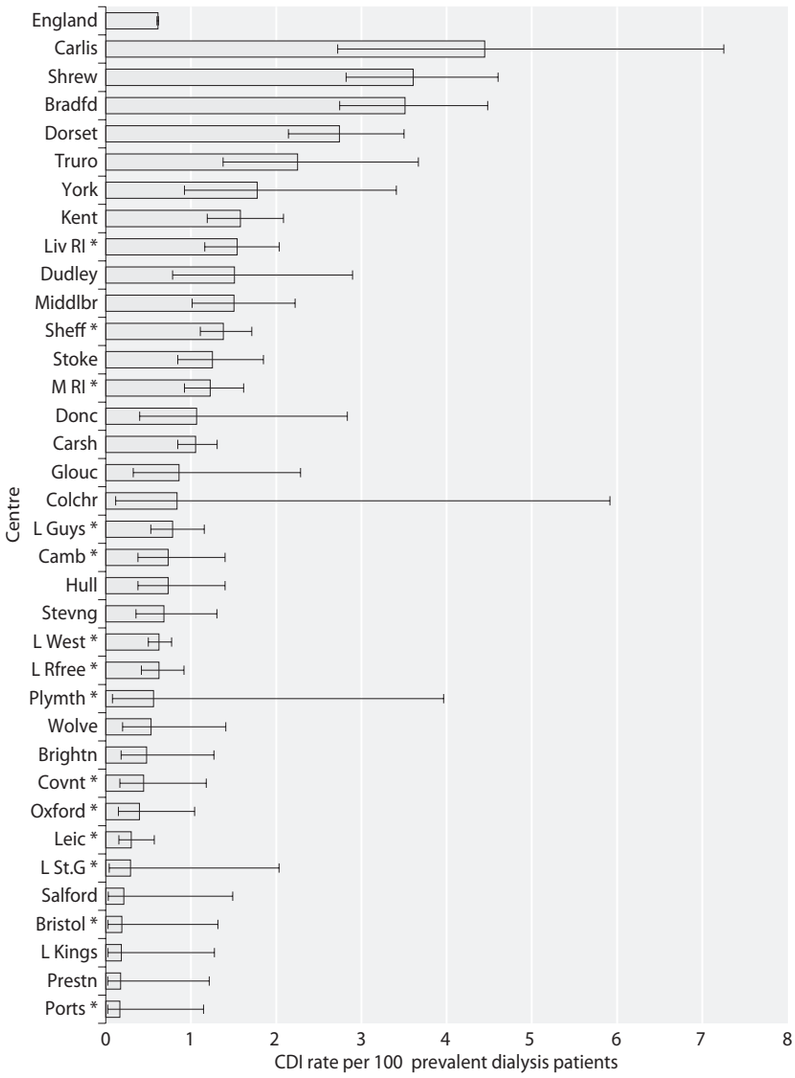

Fig. 15.4. CDI rate per 100 prevalent dialysis patients per year by renal centre
Centres with no reported infection episodes are not displayed

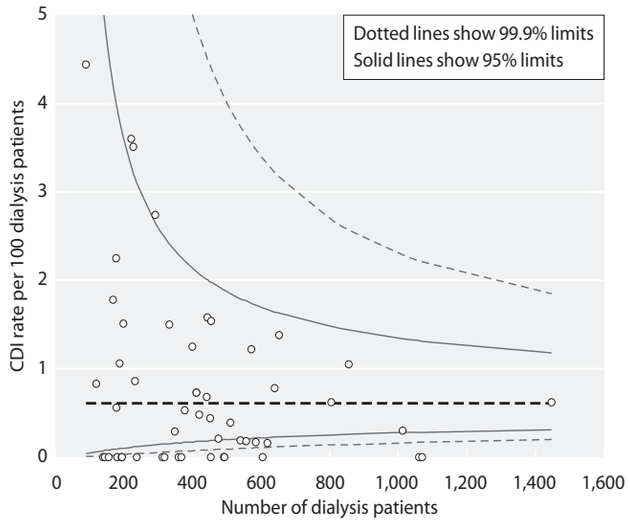

Fig. 15.5. Funnel plot of the CDI rate per 100 prevalent dialysis patients per year by renal centre

Table 15.4. Type of renal access in patients with established renal failure where record shared and completed for *Clostridium difficile* episodes

	Clostridium difficile episodes (1/5/2011–30/4/2012)		
Renal access type	*N*	%	Access class
Unknown	41		
Haemodialysis			
Other	0		
Arteriovenous fistula	41	42.3	44.3
Arteriovenous graft	2	2.1	
Non-tunnelled catheter	2	2.1	49.5
Tunnelled catheter	46	47.4	
Peritoneal dialysis	6	6.2	6.2
Total	**138**		
Total known access	**97**		

Table 15.5. Centre-specific data for MSSA bacteraemia episodes by access type, 1/05/2011 to 30/04/2012

	Prevalent patients on 31/12/2011			MSSA bacteraemia episodes (1/5/2011–30/4/2012)							Rate per 100 dialysis patients
Centre	HD	PD	Dialysis	Total	AVF	AVG	NTC	TC	PD	UK	
B Heart	446	46	492	0	0	0	0	0	0	0	0.00
B QEH*	894	167	1,061	10	4	0	0	6	0	0	0.94
Basldn	155	26	181	1	0	0	0	1	0	0	0.55
Bradfd	196	32	228	3	0	0	0	3	0	0	1.32
Brightn	340	80	420	7	4	2	0	1	0	0	1.67
Bristol*	474	66	540	6	3	0	0	3	0	0	1.11
Camb*	371	41	412	7	0	0	0	0	0	7	1.70
Carlis	66	24	90	3	0	0	0	3	0	0	3.33
Carsh	753	103	856	9	4	2	0	2	1	0	1.05
Chelms	119	26	145	0	0	0	0	0	0	0	0.00
Colchr	120	0	120	4	0	0	0	4	0	0	3.33
Covnt*	362	90	452	2	1	0	1	0	0	0	0.44
Derby	207	112	319	6	4	0	0	2	0	0	1.88
Donc	162	26	188	1	0	1	0	0	0	0	0.53
Dorset	239	53	292	3	1	0	0	2	0	0	1.03
Dudley	146	53	199	1	0	0	0	0	0	1	0.50
Exeter	376	78	454	6	3	1	0	1	0	1	1.32
Glouc	194	39	233	1	0	0	0	0	0	1	0.43
Hull	323	89	412	3	1	1	0	1	0	0	0.73
Ipswi	125	31	156	0	0	0	0	0	0	0	0.00
Kent	376	68	444	3	0	0	0	3	0	0	0.68
L Barts*	899	171	1,070	1	0	0	0	0	0	1	0.09
L Guys*	607	33	640	10	2	0	1	7	0	0	1.56
L Kings	468	89	557	3	2	0	0	1	0	0	0.54
L Rfree*	711	94	805	18	6	1	0	10	0	1	2.24
L St.G*	294	55	349	4	3	0	0	1	0	0	1.15
L West*	1,412	35	1,447	20	0	0	1	19	0	0	1.38
Leeds*	513	92	605	2	2	0	0	0	0	0	0.33
Leic*	854	159	1,013	11	0	0	0	0	0	11	1.09
Liv Ain	179	15	194	2	0	0	0	0	0	2	1.03
Liv RI*	381	74	455	13	4	0	0	9	0	0	2.86
M RI*	481	91	572	4	1	0	0	3	0	0	0.70
Middlbr	315	18	333	4	2	0	0	2	0	0	1.20
Newc*	265	48	313	0	0	0	0	0	0	0	0.00
Norwch	309	59	368	7	0	0	0	0	0	7	1.90
Nottm*	402	92	494	0	0	0	0	0	0	0	0.00
Oxford*	419	92	511	6	0	0	0	0	0	6	1.17
Plymth*	132	47	179	0	0	0	0	0	0	0	0.00
Ports*	524	95	619	0	0	0	0	0	0	0	0.00
Prestn	520	65	585	2	1	0	0	1	0	0	0.34
Redng	272	88	360	0	0	0	0	0	0	0	0.00
Salford	363	113	476	6	0	0	0	0	0	6	1.26
Sheff*	591	62	653	25	11	0	0	11	0	3	3.83
Shrew	187	35	222	5	2	2	0	0	0	1	2.25
Stevng	412	30	442	7	1	1	1	3	1	0	1.58
Sthend	122	18	140	4	1	0	0	3	0	0	2.86
Stoke	318	82	400	6	2	0	0	1	3	0	1.50
Sund	178	17	195	5	3	0	0	1	0	1	2.56
Truro	152	26	178	4	2	0	0	2	0	0	2.25
Wirral	196	42	238	3	0	0	0	0	0	3	1.26
Wolve	307	71	378	8	4	0	0	3	1	0	2.12
York	144	25	169	5	0	0	1	4	0	0	2.96
England	**19,371**	**3,283**	**22,654**	**261**	**74**	**11**	**5**	**113**	**6**	**52**	**1.15**

*Transplant centres

AVF = arteriovenous fistula; AVG = arteriovenous graft; NTC = non-tunnelled catheter; TC = tunnelled catheter; PD = peritoneal dialysis; UK = unknown access type

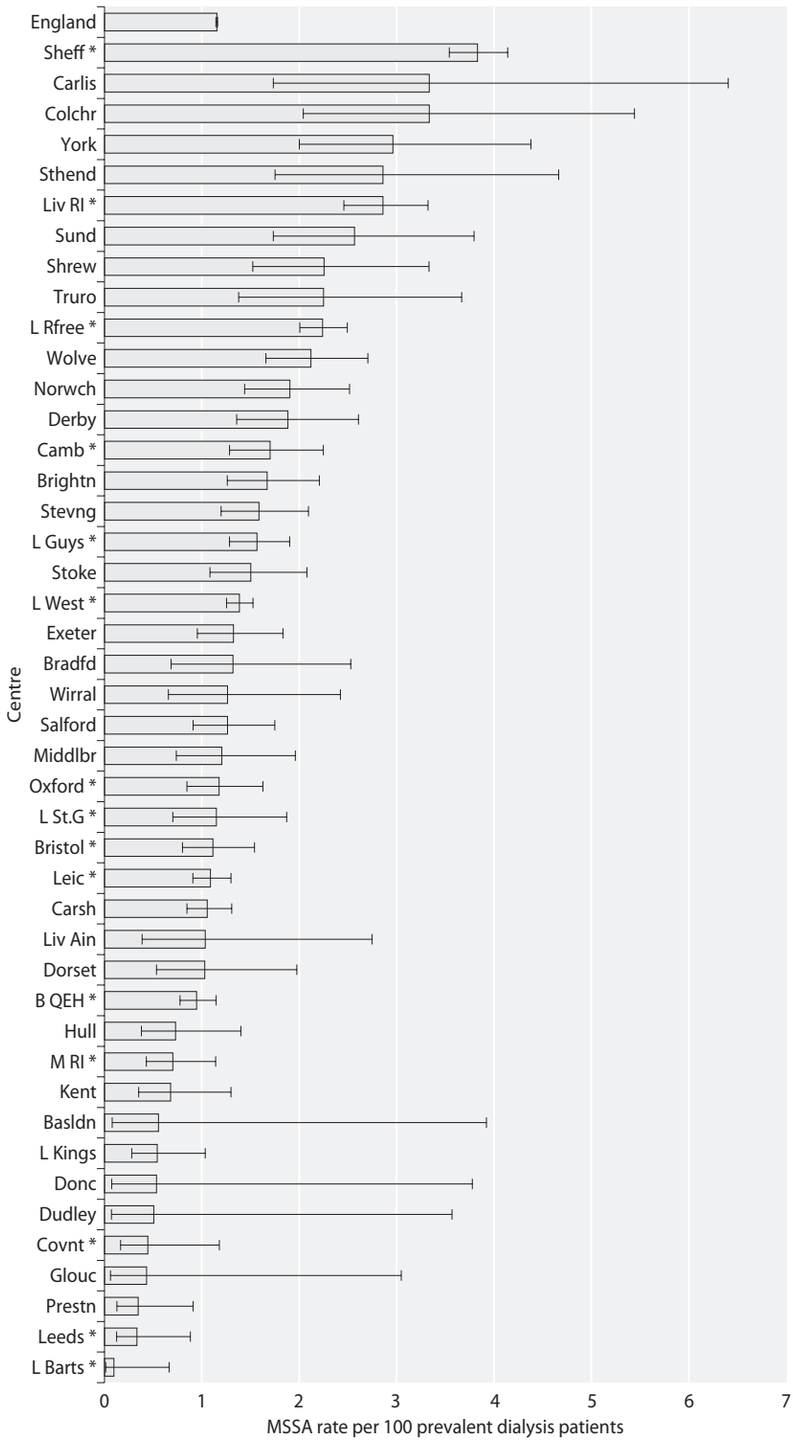

Fig. 15.6. MSSA bacteraemia rate per 100 prevalent dialysis patients per year by renal centre

Centres with no reported infection episodes are not displayed

exclusions amongst the infections surveyed) with the commonest reason for exclusion being the patient was unknown to the parent centre. The number of bacteraemia episodes included totalled 191. Only eight of the records were both shared and completed by the parent centre whilst a further 96 were shared but not completed (12 of these episodes were rejected).

The overall infection rate for England was 0.92 per 100 prevalent dialysis patients per year (range 0 to 4.85) (table 15.7). As with MSSA there was considerable

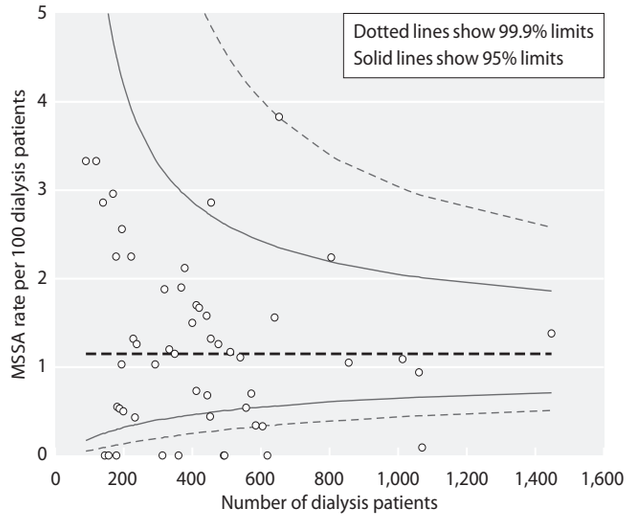

Fig. 15.7. Funnel plot of the MSSA bacteraemia rate per 100 prevalent dialysis patients per year by renal centre

Table 15.6. Type of renal access in patients with established renal failure where record shared and completed for MSSA bacteraemia episodes

	MSSA bacteraemia (1/5/2011–30/4/2012)		
Renal access type	*N*	%	Access class
Unknown	52		
Haemodialysis			
Other	0		
Arteriovenous fistula	74	35.4	40.7
Arteriovenous graft	11	5.3	
Non-tunnelled catheter	5	2.4	56.5
Tunnelled catheter	113	54.1	
Perioneal dialysis	6	2.9	2.9
Total	**261**		
Total known access	**209**		

variation in the bacteraemia rates between centres (figure 15.8). However, when centre size was taken into account, all the centres fell within the expected range (figure 15.9).

Amongst patients where the type of access was known, a slim majority (52.6%) had an arteriovenous fistula as their mode of access whilst a tunnelled central venous catheter was the next most common access type (35.3%) (table 15.8).

Discussion

The data presented are from one year of infections in ERF patients receiving dialysis that have been reported to PHE. This represents the fifth full year of reporting of MRSA BSIs in dialysis patients. These data demonstrate a further slight fall in the infection rate for MRSA in England in comparison to the report in 2011 (0.25 per 100 dialysis patients/year in 2009 vs. 0.22 per 100 dialysis patients/year in 2011). Just over half of these infections occurred in patients with a tunnelled or non-tunnelled venous catheter in comparison to patients with an arteriovenous fistula. Assuming a catheter rate of 25%, this would suggest that there remains an increased risk of infection in patients with central venous access as opposed to an arteriovenous fistula. The reasons for the decline in infection rate are likely to be multifactorial. Enhanced screening programmes, attention to the care of access and reduction in the number of central venous catheters are likely to be amongst the contributing factors [6].

This report also presents the first full year of reporting of MSSA bacteraemias. There is higher incidence of MSSA bacteraemia episodes in England (compared to MRSA) with an overall infection rate of 1.15 per 100 prevalent dialysis patients per year. Again the presence of a central venous catheter confers an increased risk of MSSA bacteraemia on the patient. There was a very considerable between centre variation in terms of bacteraemia rates. These variations may be due to reporting bias because of the voluntary nature of MSSA dialysis information reporting and the fact that this is the first full year. The difference in rates between MRSA and MSSA are notable. The higher rate suggests that MSSA bacteraemia continues to be a significant issue in the dialysis population. Analyzing the discrepancy between the two rates is beyond the scope of this report but it does raise the possibility that while screening and decolonization programmes for MRSA have been successful, the reduction of MRSA strains has left patients still vulnerable to MSSA.

The first 12 months of *Clostridium difficile* reporting show an overall infection rate of 0.61 per 100 prevalent dialysis patients per year and once again demonstrates a degree of variation between centres. It is again worth noting that the presence of a central venous catheter appears to correlate with an increased risk of infection with nearly half of dialysis patients who recorded an episode of CDI being dialysed via a tunnelled or

Table 15.7. Centre-specific data for *Escherichia coli* bacteraemia episodes by access type, 1/06/2011 to 30/04/2012

	Prevalent patients on 31/12/2011			*E. coli* bacteraemia episodes (1/6/2011–30/4/2012)							Rate per 100 dialysis patients[a]
Centre	HD	PD	Dialysis	Total	AVF	AVG	NTC	TC	PD	UK	
B Heart	446	46	492	2	2	0	0	0	0	0	0.44
B QEH[b]	894	167	1,061	9	3	0	0	5	0	1	0.93
Basldn	155	26	181	1	0	0	0	1	0	0	0.60
Bradfd	196	32	228	0	0	0	0	0	0	0	0.00
Brightn	340	80	420	6	3	1	0	0	0	2	1.56
Bristol[b]	474	66	540	3	2	1	0	0	0	0	0.61
Camb[b]	371	41	412	8	0	0	0	0	0	8	2.12
Carlis	66	24	90	4	1	0	0	0	1	2	4.85
Carsh	753	103	856	14	4	0	1	7	2	0	1.78
Chelms	119	26	145	0	0	0	0	0	0	0	0.00
Colchr	120	0	120	4	1	0	0	3	0	0	3.64
Covnt[b]	362	90	452	2	1	0	0	1	0	0	0.48
Derby	207	112	319	2	2	0	0	0	0	0	0.68
Donc	162	26	188	0	0	0	0	0	0	0	0.00
Dorset	239	53	292	0	0	0	0	0	0	0	0.00
Dudley	146	53	199	2	0	0	0	0	0	2	1.10
Exeter	376	78	454	3	2	0	0	1	0	0	0.72
Glouc	194	39	233	5	0	0	0	0	0	5	2.34
Hull	323	89	412	4	4	0	0	0	0	0	1.06
Ipswi	125	31	156	0	0	0	0	0	0	0	0.00
Kent	376	68	444	5	3	0	0	2	0	0	1.23
L Barts[b]	899	171	1,070	1	0	0	0	0	0	1	0.10
L Guys[b]	607	33	640	6	4	0	0	2	0	0	1.02
L Kings	468	89	557	3	2	0	0	1	0	0	0.59
L Rfree[b]	711	94	805	6	3	0	0	3	0	0	0.81
L St.G[b]	294	55	349	0	0	0	0	0	0	0	0.00
L West[b]	1,412	35	1,447	5	0	0	0	0	0	5	0.38
Leeds[b]	513	92	605	11	7	1	0	3	0	0	1.98
Leic[b]	854	159	1,013	13	0	0	0	0	0	13	1.40
Liv Ain	179	15	194	4	0	0	0	0	0	4	2.25
Liv RI[b]	381	74	455	5	3	0	2	0	0	0	1.20
M RI[b]	481	91	572	4	1	0	0	3	0	0	0.76
Middlbr	315	18	333	5	0	0	0	0	0	5	1.64
Newc[b]	265	48	313	6	0	0	0	0	0	6	2.09
Norwch	309	59	368	1	0	0	0	0	0	1	0.30
Nottm[b]	402	92	494	0	0	0	0	0	0	0	0.00
Oxford[b]	419	92	511	5	2	3	0	0	0	0	1.07
Plymth[b]	132	47	179	0	0	0	0	0	0	0	0.00
Ports[b]	524	95	619	1	0	0	0	1	0	0	0.18
Prestn	520	65	585	9	5	0	0	2	1	1	1.68
Redng	272	88	360	0	0	0	0	0	0	0	0.00
Salford	363	113	476	1	0	0	0	1	0	0	0.23
Sheff[b]	591	62	653	8	3	0	1	3	1	0	1.34
Shrew	187	35	222	3	2	0	0	0	0	1	1.47
Stevng	412	30	442	6	2	0	0	4	0	0	1.48
Sthend	122	18	140	4	3	0	0	1	0	0	3.12
Stoke	318	82	400	0	0	0	0	0	0	0	0.00
Sund	178	17	195	2	2	0	0	0	0	0	1.12
Truro	152	26	178	1	0	0	0	1	0	0	0.61
Wirral	196	42	238	1	0	0	0	0	0	1	0.46
Wolve	307	71	378	4	3	0	0	0	1	0	1.15
York	144	25	169	2	0	0	0	2	0	0	1.29
England	**19,371**	**3,283**	**22,654**	**191**	**70**	**6**	**4**	**47**	**6**	**58**	**0.92**

[a]Rate per year calculated from the eleven month collection period; [b]Transplant centres
AVF = arteriovenous fistula; AVG = arteriovenous graft; NTC = non-tunnelled catheter; TC = tunnelled catheter; PD = peritoneal dialysis; UK = unknown access type

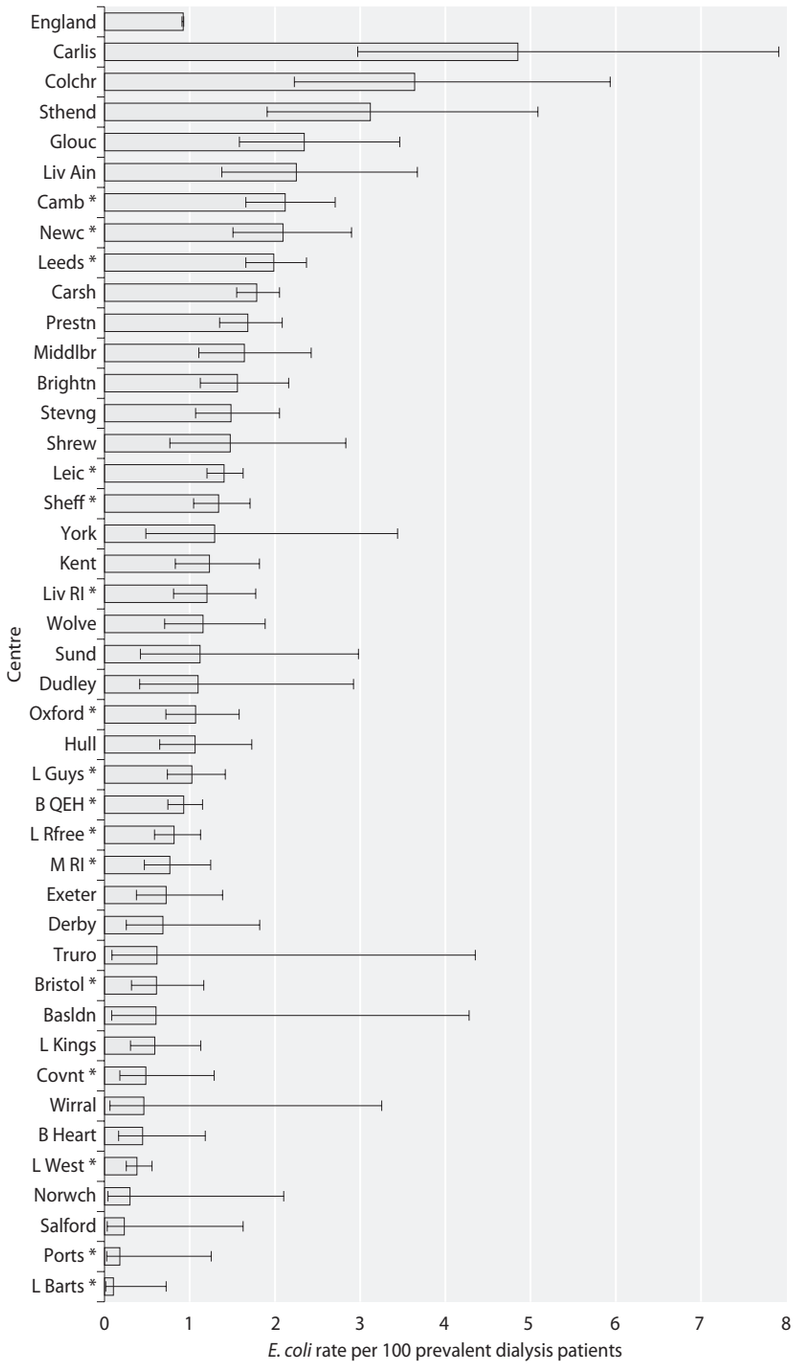

Fig. 15.8. *Escherichia coli* bacteraemia rate per 100 prevalent dialysis patients per year by renal centre
Centres with no reported infection episodes are not displayed

non-tunnelled catheter at the time. This may underline the vulnerability to infection in this group of patients and the increased likelihood that they are exposed to courses of antibiotics.

Lastly the report also considers the first eleven months of *Escherichia coli* reporting (beginning in June 2011). A national system for capturing data on *E. coli* bacteraemia has been established in England in response to concern about recent marked increases in the number of cases [7]. However, reporting of *E. coli* bacteraemia in patients in ERF is relatively new and as a result there was inconsistency in reporting by microbiology laboratories and a high proportion of records were excluded due to the patient not being in or known to the allocated main centre. There were again noticable variations in infection rate between centres, although this variation should be

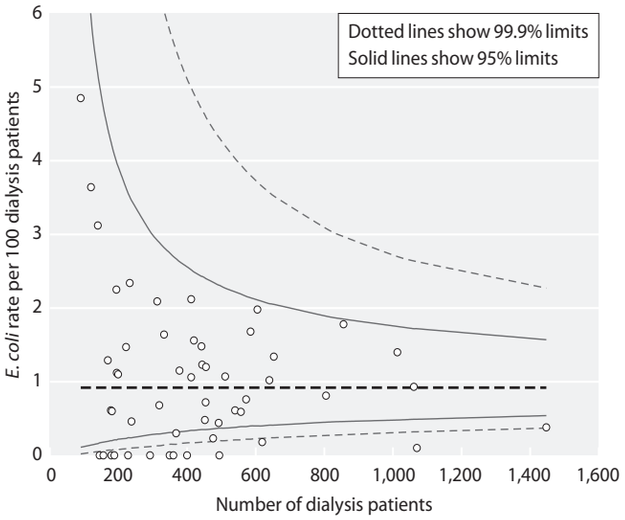

Fig. 15.9. Funnel plot of the *Escherichia coli* bacteraemia rate per 100 prevalent dialysis patients per year by renal centre

treated with caution because of the inconsistency in reporting. It is also worth noting that nationally, the reported rates of *E. coli* bacteraemia are more than three times that of MSSA so it is possible that there were a similar number of infections reported inaccurately.

It is again noticeable that a high proportion of *E. coli* infections occur in patients with a tunnelled catheter. *E. coli* is traditionally associated with urinary tract and other infections more than catheter related sepsis. Again this may highlight the increased vulnerability of patients reliant on lines for their dialysis access. Further work is needed over the next cycle to identify trends in these infections. Increased awareness of infection reporting amongst both renal centres and microbiology units would also help to improve the robustness of this data set.

Table 15.8. Type of renal access in patients with established renal failure where record shared and completed for *Escherichia coli* BSI episodes

	Escherichia coli BSI (1/6/2011–30/4/2012)		
Renal access type	*N*	%	Access class
Unknown	50		
Haemodialysis			
Other	8		
Arteriovenous fistula	70	52.6	57.1
Arteriovenous graft	6	4.5	
Non-tunnelled catheter	4	3.0	38.3
Tunnelled catheter	47	35.3	
Peritoneal dialysis	6	4.5	4.5
Total	**191**		
Total known access	**133**		

Summary

The data presented on bacteraemias occurring in ERF are as reported to Public Health England. These data demonstrate a further fall in the number and rate of MRSA bloodstream infections in England continuing the downward trend observed over the previous five years. They also show a substantial incidence of MSSA BSI in the first 12 months of reporting. Data are also included for CDI and *E. coli* BSI. In each infection the presence of a central venous catheter appears to confer a greater risk. Considerable regional variation is noted that may be at least partially explained by differences in reporting policies. Further work is needed to establish the overall trend in MSSA, CDI and *E. coli*. Finally, there is a need for consistency of reporting which would enable trends to be more clearly defined.

Conflicts of interest: none

Acknowledgements

The authors wish to acknowledge the help of our colleagues at renal centres across the country for their assistance in compiling this report.

References

1 Bray BD, Boyd J, Daly C, Donaldson K, Doyle A, Fox JG, et al. Vascular access type and risk of mortality in a national prospective cohort of haemodialysis patients. Qjm-an International Journal of Medicine. 2012;105(11):1097–1103
2 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/215135/dh_133016.pdf
3 Fluck R, Wilson J, Tomson CRV. UK Renal Registry 12th Annual Report (December 2009): Chapter 12 Epidemiology of methicillin resistant *Staphylococcus aureus* Bacteraemia Amongst Patients Receiving Dialysis for Established Renal Failure in England in 2008: a joint report from the UK Renal Registry and the Health Protection Agency. Nephron Clinical Practice. 2010;115:c261–c270
4 Crowley L, Wilson J, Guy R, Pitcher D, Fluck R. UK Renal Registry 14th Annual Report: Chapter 12 Epidemiology of *Staphylococcus aureus* Bacteraemia Amongst Patients Receiving Dialysis for Established Renal Failure in England in 2009 to 2011: A Joint Report from the Health

Protection Agency and the UK Renal Registry. Nephron Clinical Practice. 2012;120:c233–c245
5 Shaw C, Pruthi R, Pitcher D, Fogarty D. UK Renal Registry 15th Annual Report: Chapter 2 UK RRT Prevalence in 2011: National and Centre-Specific Analyses. Nephron Clinical Practice. 2013;123:29–54
6 Wilson J, Guy R, Elgohari S, Sheridan E, Davies J, Lamagni T, Pearson A. Trends in sources of methicillin-resistant Staphylococcus aureus (MRSA) bacteraemia: data from the national mandatory surveillance of MRSA bacteraemia in England, 2006–2009 J Hosp Infect. 2011 Nov;79(3): 211–217
7 Wilson J, Elgohari S, Livermore DM, Cookson B, Johnson A, Lamagni T, Chronias A, Sheridan E. Trends among pathogens reported as causing bacteraemia in England, 2004–2008 Clin Microbiol Infect. 2011 Mar;17(3):451–458

Appendix A: The UK Renal Registry Statement of Purpose

This appendix is available on the web only and can be found at http://www.karger.com/Journal/Home/228539 or www.renalreg.com

Appendix B: Definitions and Analysis Criteria

This appendix is available on the web only and can be found at http://www.karger.com/Journal/Home/228539 or www.renalreg.com

Appendix C: Renal Services Described for Non-physicians

This appendix is available on the web only and can be found at http://www.karger.com/Journal/Home/228539 or www.renalreg.com

Appendix D: Methodology used for Analyses of PCT/HB Incidence and Prevalence Rates and of Standardised Ratios

This appendix is available on the web only and can be found at http://www.karger.com/Journal/Home/228539 or www.renalreg.com

Appendix E: Methodology for Estimating Catchment Populations of Renal Centres in England for Dialysis Patients

This appendix is available on the web only and can be found at http://www.karger.com/Journal/Home/228539 or www.renalreg.com

Appendix F: Additional data tables for 2011 incident and prevalent patients

This appendix is available on the web only and can be found at http://www.karger.com/Journal/Home/228539 or www.renalreg.com

Appendix G: UK Renal Registry Dataset Specification

This appendix is available on the web only and can be found at www.renalreg.com

Appendix H: Coding: Ethnicity, EDTA Primary Renal Diagnoses, EDTA Causes of Death

This appendix is available on the web only and can be found at http://www.karger.com/Journal/Home/228539 or www.renalreg.com

UK Renal Registry 16th Annual Report: Appendix I Acronyms and Abbreviations used in the Report

ACE (inhibitor)	Angiotensin converting enzyme (inhibitor)
AKI	Acute kidney injury
ANZDATA	Australia and New Zealand Dialysis and Transplant Registry
APD	Automated peritoneal dialysis
ADPKD	Autosomal dominant polycystic kidney disease
APKD	Adult polycystic kidney disease
ATTOM	Access to transplant and transplant outcome measures
AV	Arteriovenous
AVF	Arteriovenous fistula
AVG	Arteriovenous graft
BAPN	British Association of Paediatric Nephrology
BCG	Bromocresol green
BCP	Bromocresol purple
BMD	Bone mineral disease
BMI	Body mass index
BP	Blood pressure
BSI	Blood stream infection
BTS	British Transplant Society
Ca	Calcium
CAB	Clinical Affairs Board (Renal Association)
CABG	Coronary artery bypass grafting
CAPD	Continuous ambulatory peritoneal dialysis
CCL	Clinical Computing Limited
CCPD	Cycling peritoneal dialysis
CDI	Clostridium difficile infection
Chol	Cholesterol
CHr	Target reticulocyte Hb content
CI	Confidence interval
CK	Creatine kinase
CKD	Chronic kidney disease
CKD-EPI	Chronic kidney disease epidemiology collaboration
CK-MB	Creatine kinase isoenzyme MB
COPD	Chronic obstructive pulmonary disease
CRF	Chronic renal failure
cRF	Calculated HLA antibody reaction frequency
CRP	C-reactive protein
CVVH	Continuous veno-venous haemofiltration
CXR	Chest x-ray
DBP	Diastolic blood pressure
DCCT	Diabetes Control and Complications Trial
DH	Department of Health

DM	Diabetes mellitus
DOB	Date of birth
DOPPS	Dialysis Outcomes and Practice Patterns Study
E&W	England and Wales
E, W & NI	England, Wales and Northern Ireland
EBPG	European Best Practice Guidelines
ECG	Electrocardiogram
EDTA	European Dialysis and Transplant Association
EF	Error factor
eGFR	Estimated glomerular filtration rate
E_i	Expected cases in area i
ECD	Extended Criteria Donor
EDTA	European Dialysis and Transplant Association
eKt/V	Equilibrated Kt/V
EPO	Erythropoietin
ERA	European Renal Association
ERA–EDTA	European Renal Association–European Dialysis and Transplant Association
ERF	Established renal failure
ESA	Erythropoiesis stimulating agent
ESRD	End stage renal disease
ESRF	End stage renal failure
EWNI	England, Wales and Northern Ireland
Ferr	Ferritin
FEV1	Forced expiratory volume in 1 second
FVC	Forced vital capacity
GFR	Glomerular filtration rate
GH	Growth hormone
GN	Glomerulonephritis
HA	Health Authority
HB	Health board
Hb	Haemoglobin
HbA1c	Glycated Haemoglobin
HBeAg	Hepatitis B e antigen
HCAI-DCS	Healthcare-associated infection data collection system
HD	Haemodialysis
HDF	Haemodialysis filtration
HDL	High-density lipoprotein
HLA	Human leucocyte antigen
HPA	Health Protection Agency
HQIP	Health Quality Improvement Partnership
HR	Hazard ratio
HRC	Hypochromic red blood cells
Ht	Height
ICU	Intensive care unit
IDMS	Isotope dilution mass spectrometry
IDOPPS	International Dialysis Outcomes and Practice Patterns Study
IFCC	International Federation of Clinical Chemistry & Laboratory Medicine
IHD	Ischaemic heart disease
IMD	Index of Multiple Deprivation
IOTF	International Obesity Taskforce
IPD	Intermittent peritoneal dialysis
IQR	Inter-quartile range
ISPD	International Society for Peritoneal Dialysis
IT	Information technology
IU	International units
IV	Intra venous
KDIGO	Kidney Disease: Improving Global Outcomes
KDOQI	Kidney Disease Outcomes Quality Initiative
KM	Kaplan Meier
Kt/V	Ratio between the product of urea clearance (K, in ml/min) and dialysis session duration (t, in minutes) divided by the volume of distribution of urea in the body (V, in ml)

LA	Local Authority
LCL	Lower confidence limit
LDL	Low-density lipoprotein
LTFU	Lost to follow-up
M:F	Male:Female
MAP	Mean arterial blood pressure
MDRD	Modification of diet in renal disease
MI	Myocardial infarction
MMF	Mycophenolate mofetil
MRSA	Methicillin resistant Staphylococcal aureus
MSSA	Methicillin sensitive Staphylococcal aureus
N	Number
N Ireland	Northern Ireland
NE	North East
NEQAS	UK National External Quality Assessment Scheme
NHBPEP	National high blood pressure education programme
NHS	National Health Service
NHS BT	National Health Service Blood and Transplant
NI	Northern Ireland
NICE	National Institute for Health and Clinical Excellence
NISRA	Northern Ireland Statistic and Research Agency
NMO	Non-mixed origin
NRS	National Records of Scotland
NSF	National service framework
NTC	Non-tunnelled dialysis catheter
NTL	Non-tunnelled line
NW	North West
O/E	Observed/expected
ODT	Organ Donation and Transplantation (a Directorate of NHS Blood and transplant)
O_i	Observed cases in area i
ONS	Office for National Statistics
OR	Odds ratio
PAS	Patient Administration System
PCT	Primary Care Trust
PD	Peritoneal dialysis
PHE	Public Health England
Phos	Phosphate
PIAG	Patient Information Advisory Group
PKD	Polycystic kidney disease
PMARP	Per million age related population
PMCP	Per million child population
PMP	Per million population
PP	Pulse pressure
PRD	Primary renal disease
PTH	Parathyroid hormone
PUV	Posterior urethral valves
PVD	Peripheral vascular disease
QOF	Quality and Outcomes Framework
QUEST	Quality European Studies
RA	Renal Association
rhGH	Recombinant human growth hormone
RI	Royal Infirmary
RNSF	Renal National Service Framework (or NSF)
RR	Relative risk
RRDSS	Renal Registry data set specification
RRT	Renal replacement therapy
RVD	Renovascular disease
SAR	Standardised acceptance ratio (=O/E)
SAS	Statistical Analysis System
SBP	Systolic blood pressure
SD	Standard deviation

SES	Socio-economic status
SHA	Strategic health authority
SHARP	Study of Heart and Renal Protection
SI	System International (units)
SMR	Standardised mortality ratios
spKt/V	Single pool Kt/V
SPR	Standardised prevalence ratio (=O/E)
SR	Standardised ratio (used to cover either SAR or SPR)
SUS	Secondary uses service
SW	South West
TC	Tunnelled dialysis catheter
TL	Tunnelled line
TSAT	Transferrin saturation
TWL	Transplant waiting list
Tx	Transplant
UCL	Upper confidence limit
UK	United Kingdom
UKRR	UK Renal Registry
UKT	UK Transplant (now ODT)
URR	Urea reduction ratio
US	United States
USA	United States of America
USRDS	United States Renal Data System
WHO	World health organization
Wt	Weight

UK Renal Registry 16th Annual Report: Appendix J Laboratory Conversion Factors

	Conversion factors from SI units
Albumin	g/dl = g/L × 0.1
Aluminium	μg/L = μmol/L × 27.3
Bicarbonate	mg/dl = mmol/L × 6.1
Calcium	mg/dl = mmol/L × 4
Calcium × phosphate	$mg^2/dl^2 = mmol^2/L^2 \times 12.4$
Cholesterol	mg/dl = mmol/L × 38.6
Creatinine	mg/dl = μmol/L × 0.011
Glucose	mg/d = mmol/L × 18
Phosphate	mg/dl = mmol/L × 3.1
PTH	ng/L = pmol/L × 9.5
Urea	mg/dl = mmol/L × 6.0
Urea nitrogen	mg/dl = mmol/L × 2.8

UK Renal Registry 16th Annual Report: Appendix K Renal Centre Names and Abbreviations used in the Figures and Data Tables

Adult Centres

City	Hospital	Abbreviation
England		
Basildon	Basildon Hospital	Basldn
Birmingham	Heartlands Hospital	B Heart
Birmingham	Queen Elizabeth Hospital	B QEH
Bradford	St Luke's Hospital	Bradfd
Brighton	Royal Sussex County Hospital	Brightn
Bristol	Southmead Hospital	Bristol
Cambridge	Addenbrooke's Hospital	Camb
Carlisle	Cumberland Infirmary	Carlis
Carshalton	St Helier Hospital	Carsh
Chelmsford	Broomfield Hospital	Chelms
Colchester	Colchester General Hospital	Colchr
Coventry	University Hospital Coventry	Covnt
Derby	Royal Derby Hospital	Derby
Doncaster	Doncaster Royal Infirmary	Donc
Dorset	Dorset County Hospital	Dorset
Dudley	Russells Hall Hospital	Dudley
Exeter	Royal Devon and Exeter Hospital	Exeter
Gloucester	Gloucestershire Royal Hospital	Glouc
Hull	Hull Royal Infirmary	Hull
Ipswich	Ipswich Hospital	Ipswi
Kent	Kent and Canterbury Hospital	Kent
Leeds	St James's University Hospital and Leeds General Infirmary	Leeds
Leicester	Leicester General Hospital	Leic
Liverpool	Aintree University Hospital	Liv Ain
Liverpool	Royal Liverpool University Hospital	Liv RI
London	St. Bartholomew's Hospital and The Royal London Hospital	L Barts
London	St George's Hospital and Queen Mary's Hospital	L St. G
London	Guy's Hospital and St Thomas' Hospital	L Guys
London	Hammersmith, Charing Cross, St Mary's	L West
London	King's College Hospital	L Kings
London	Royal Free, Middlesex and UCL Hospitals	L Rfree
Manchester	Manchester Royal Infirmary	M RI
Middlesbrough	The James Cook University Hospital	Middlbr
Newcastle	Freeman Hospital and Royal Victoria Infirmary	Newc
Norwich	Norfolk and Norwich University Hospital	Norwch

City	Hospital	Abbreviation
Nottingham	Nottingham City Hospital	Nottm
Oxford	John Radcliffe Hospital and Churchill Hospital	Oxford
Plymouth	Derriford Hospital	Plymth
Portsmouth	Queen Alexandra Hospital	Ports
Preston	Royal Preston Hospital	Prestn
Reading	Royal Berkshire Hospital	Redng
Salford	Salford Royal Hospital	Salford
Sheffield	Northern General Hospital	Sheff
Shrewsbury	Royal Shrewsbury Hospital	Shrew
Southend	Southend Hospital	Sthend
Stevenage	Lister Hospital	Stevng
Stoke	University Hospital of North Staffordshire	Stoke
Sunderland	Sunderland Royal Hospital	Sund
Truro	Royal Cornwall Hospital	Truro
Wirral	Arrowe Park Hospital	Wirral
Wolverhampton	New Cross Hospital	Wolve
York	The York Hospital	York
Wales		
Bangor	Ysbyty Gwynedd	Bangor
Cardiff	University Hospital of Wales	Cardff
Clwyd	Glan Clwyd Hospital	Clwyd
Swansea	Morriston Hospital	Swanse
Wrexham	Wrexham Maelor Hospital	Wrexm
Scotland		
Aberdeen	Aberdeen Royal Infirmary	Abrdn
Airdrie	Monklands Hospital	Airdrie
Dumfries	Dumfries & Galloway Royal Infirmary	D & Gall
Dundee	Ninewells Hospital	Dundee
Dunfermline	Queen Margaret Hospital	Dunfn
Edinburgh	Royal Infirmary of Edinburgh	Edinb
Glasgow	Western Infirmary, Glasgow Royal Infirmary and Stobhill Hospitals	Glasgw
Inverness	Raigmore Hospital	Inverns
Kilmarnock	University Hospital Crosshouse	Klmarnk
Northern Ireland		
Antrim	Antrim Area Hospital	Antrim
Belfast	Belfast City Hospital	Belfast
Londonderry & Omagh	Altnagelvin Area and Tyrone County Hospitals	West NI
Newry	Daisy Hill Hospital	Newry
Ulster	Ulster Hospital	Ulster

Paediatric Centres

City	Hospital	Abbreviation	Country
Belfast	Royal Belfast Hospital for Sick Children	Blfst_P	N Ireland
Birmingham	Birmingham Children's Hospital	Bham_P	England
Bristol	Bristol Royal Hospital for Children	Brstl_P	England
Cardiff	KRUF Children's Kidney Centre	Cardf_P	Wales
Glasgow	Royal Hospital for Sick Children	Glasg_P	Scotland
Leeds	Leeds Children's Hospital	Leeds_P	England
Liverpool	Alder Hey Children's Hospital	Livpl_P	England
London	Guy's Hospital (Evelina) – Paediatric	L Eve_P	England
London	Great Ormond Street Hospital for Children	LGOSH_P	England
Manchester	Royal Manchester Children's Hospital	Manch_P	England
Newcastle	Great North Children's Hospital	Newc_P	England
Nottingham	Nottingham Children's Hospital	Nottm_P	England
Southampton	Southampton General Hospital – Paediatric	Soton_P	England