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

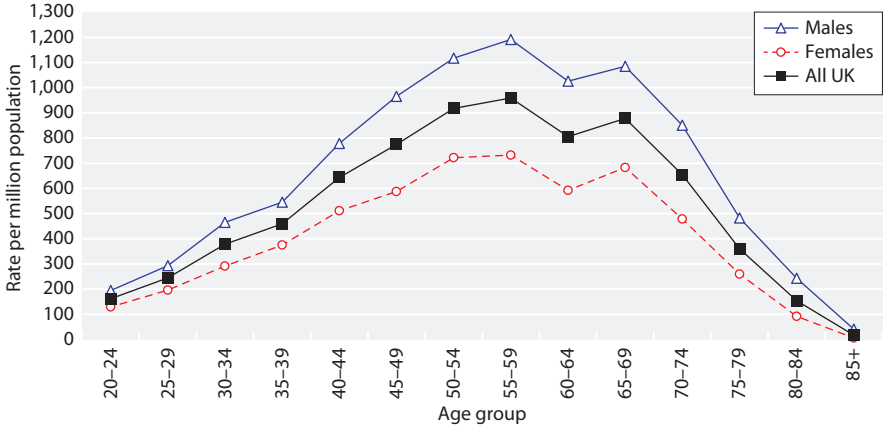

Fig. 3.1. Transplant prevalence rate per million population by age and gender on 31/12/2012

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**

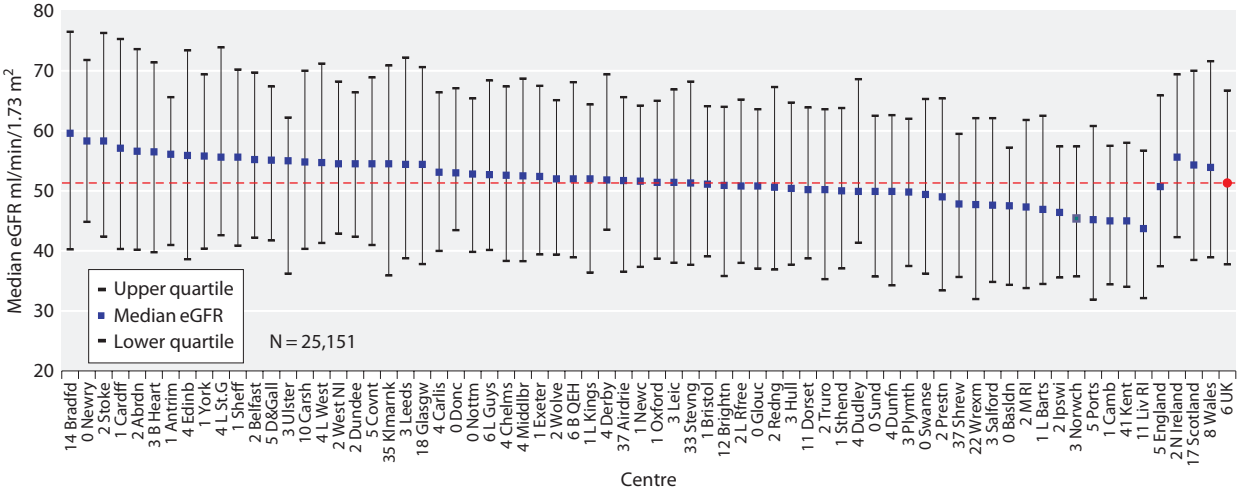

Fig. 3.2. Median eGFR in prevalent transplant patients by centre on 31/12/2012

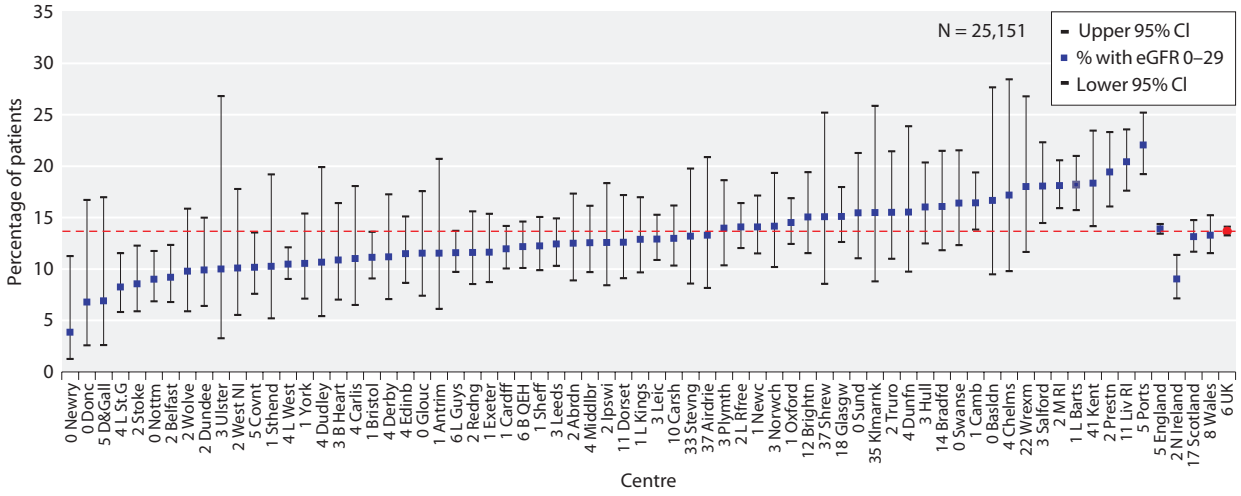

Fig. 3.3. Percentage of prevalent transplant patients by centre on 31/12/2012 with eGFR <30 ml/min/1.73 m^2

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			

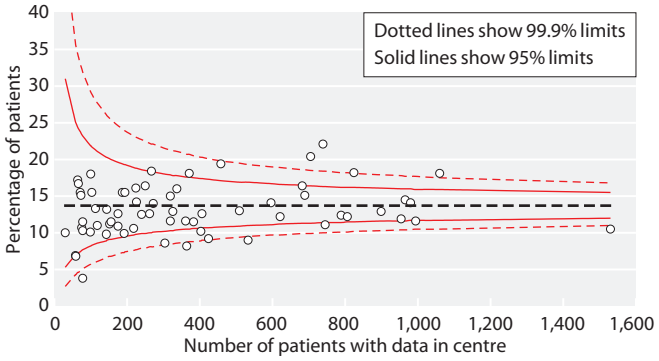

Fig. 3.4. Funnel plot of percentage of prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 by centre size on 31/12/2012

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).

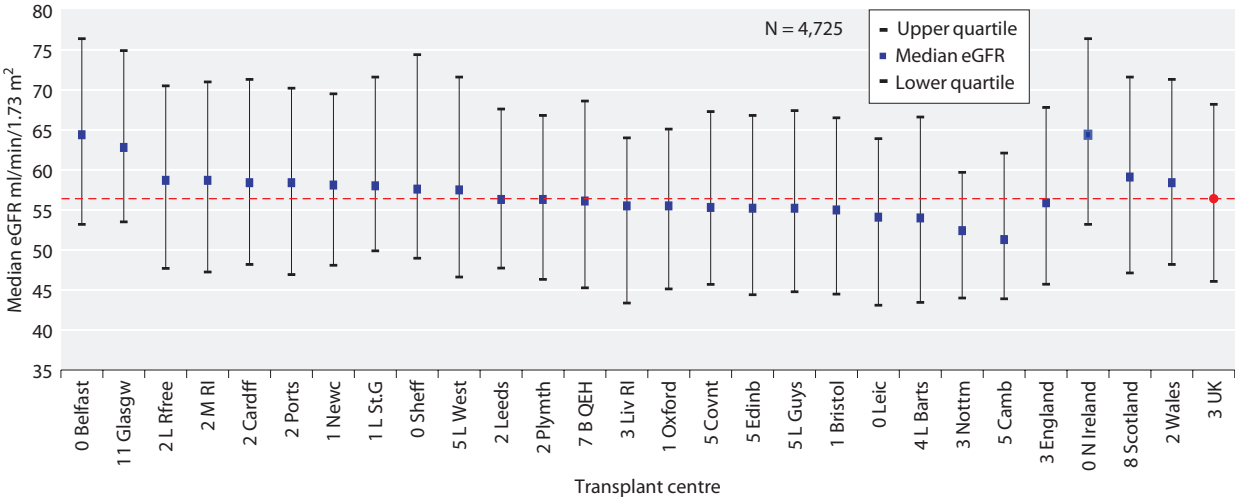

Fig. 3.5a. Median eGFR one year post-live donor transplant by transplant centre 2005–2011

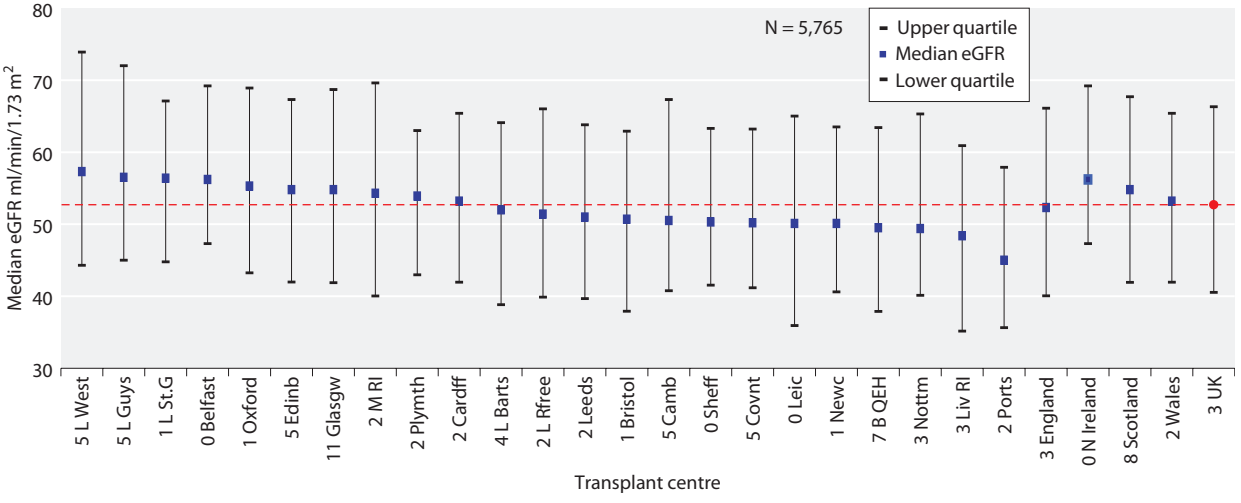

Fig. 3.5b. Median eGFR one year post-brainstem death donor transplant by transplant centre 2005–2011

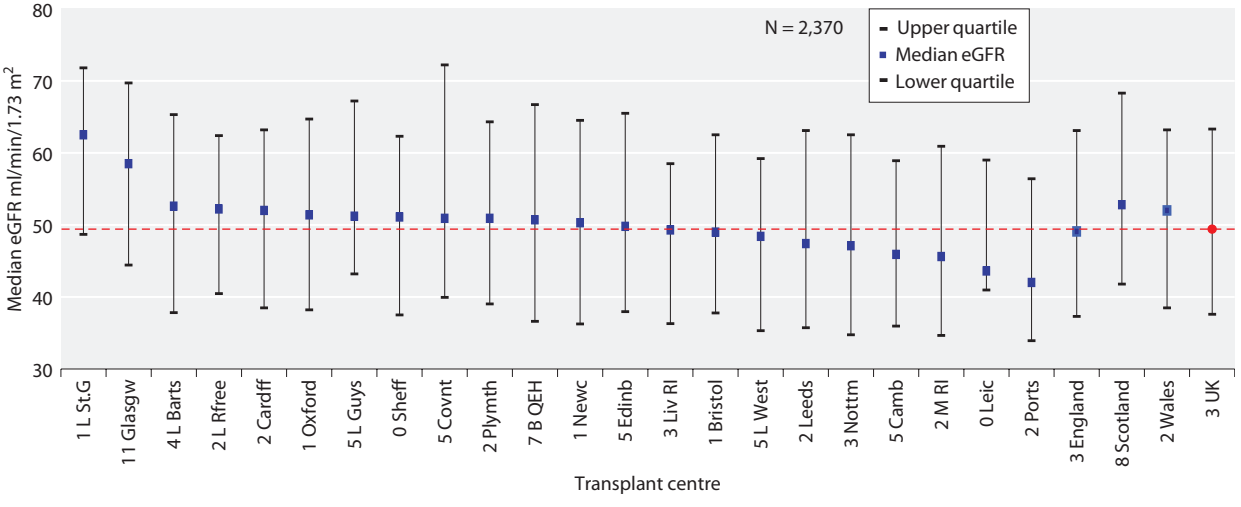

Fig. 3.5c. Median eGFR one year post-circulatory death donor transplant by transplant centre 2005–2011

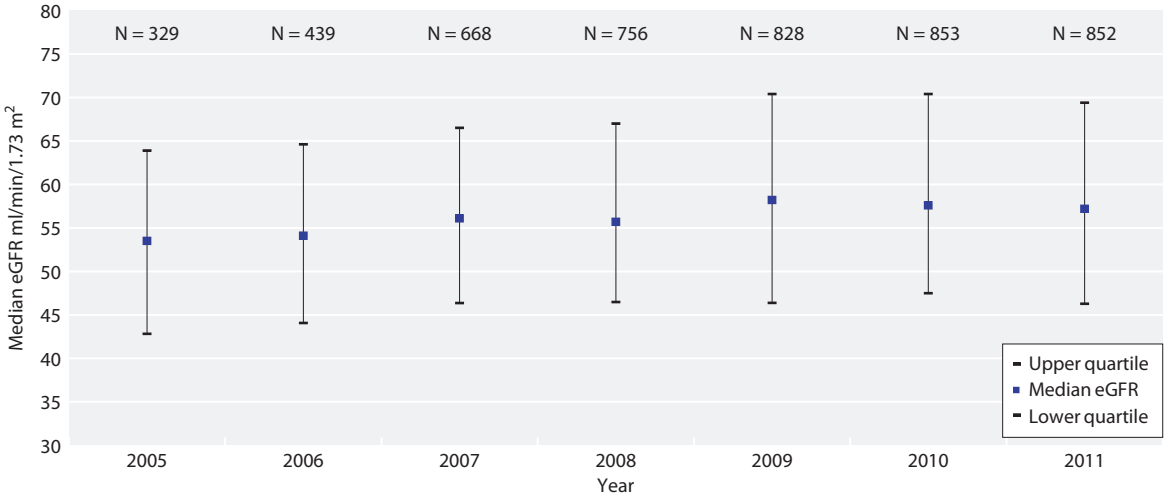

Fig. 3.6a. Median eGFR one year post-live donor transplant by year of transplantation 2005–2011

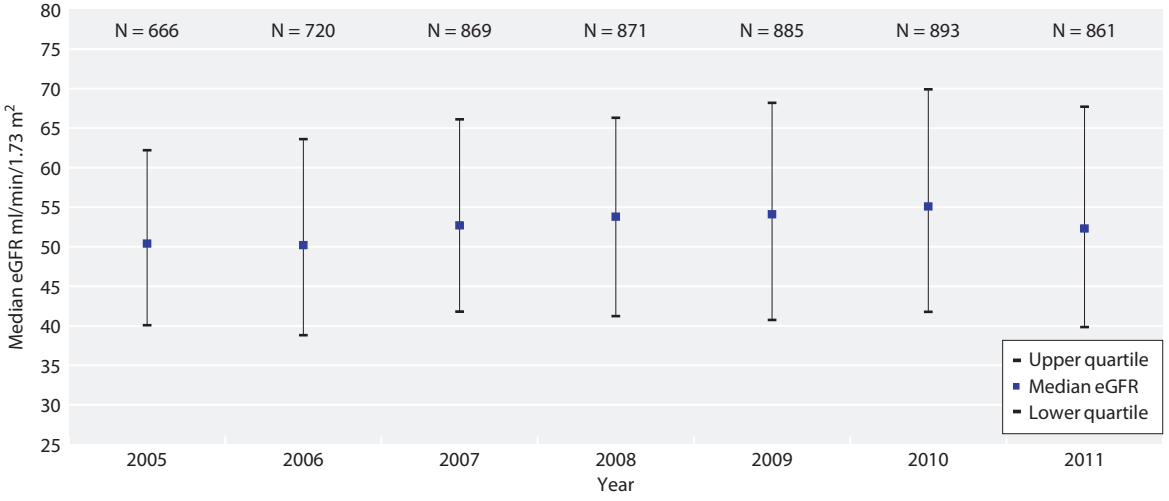

Fig. 3.6b. Median eGFR one year post-brainstem death donor transplant by year of transplantation 2005–2011

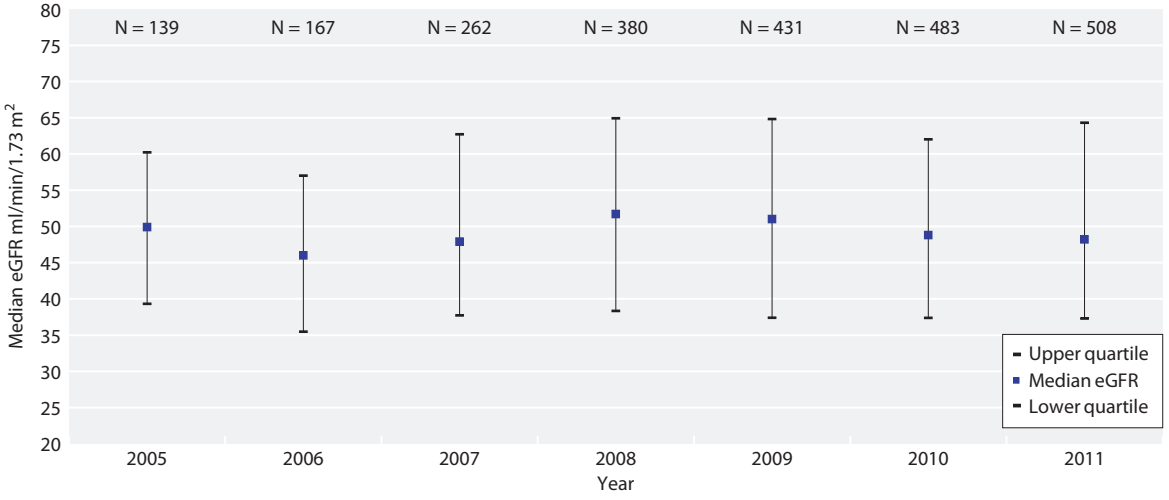

Fig. 3.6c. Median eGFR one year post-circulatory death donor transplant by year of transplantation 2005–2011

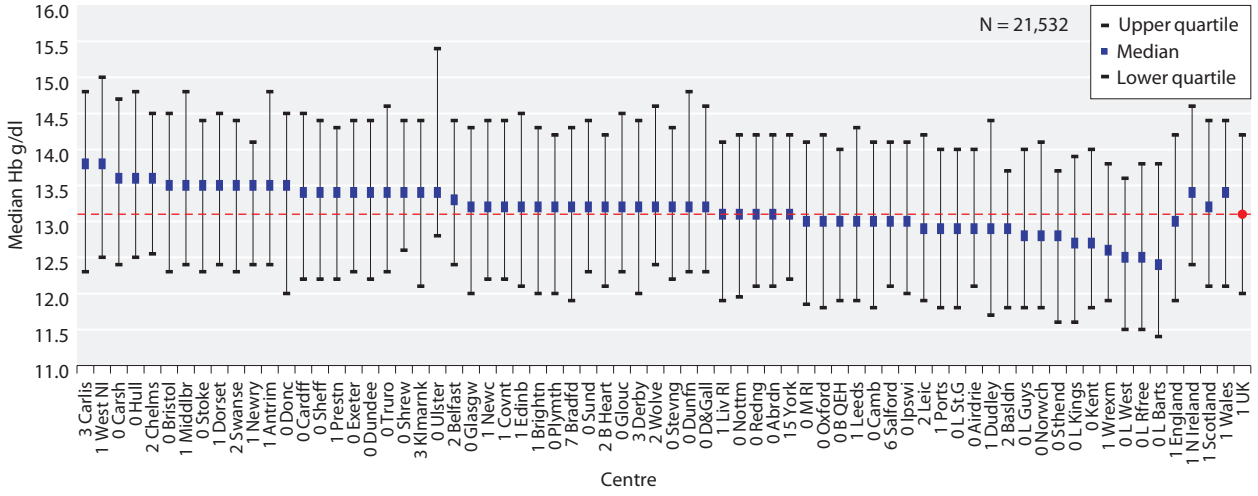

Fig. 3.7a. Median haemoglobin for prevalent transplant patients with eGFR ⩾30 ml/min/1.73 m^2 by centre on 31/12/2012

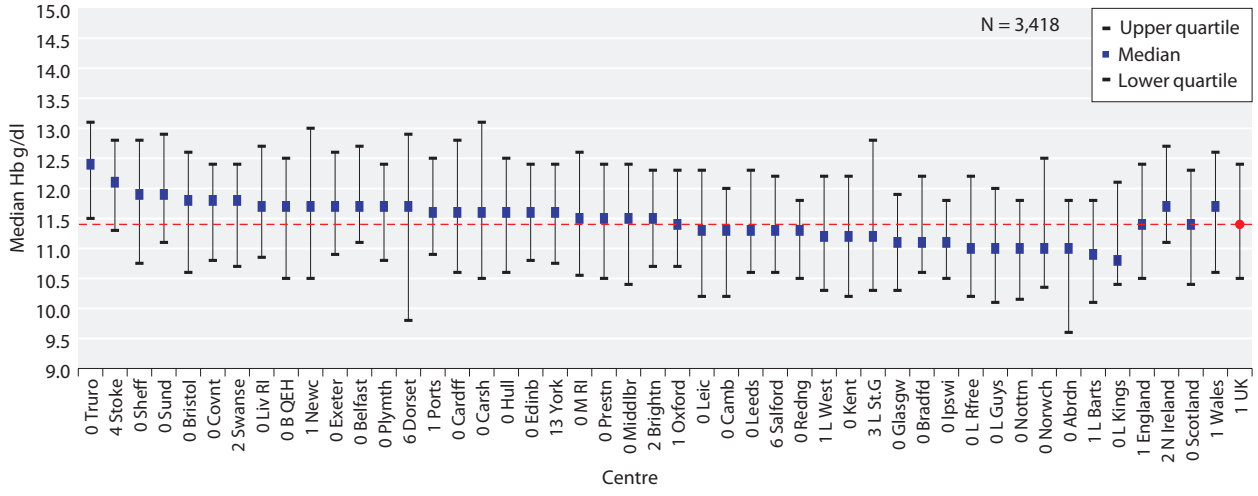

Fig. 3.7b. Median haemoglobin for prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 by centre on 31/12/2012

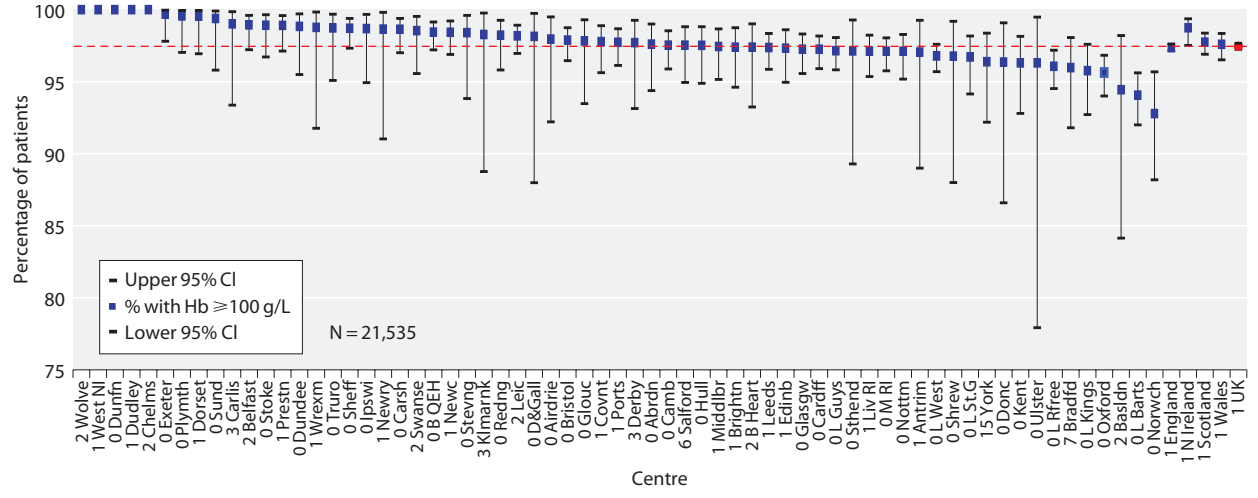

Fig. 3.8a. Percentage of prevalent transplant patients with eGFR ⩾30 ml/min/1.73 m^2 achieving haemoglobin ⩾100 g/L by centre on 31/12/2012

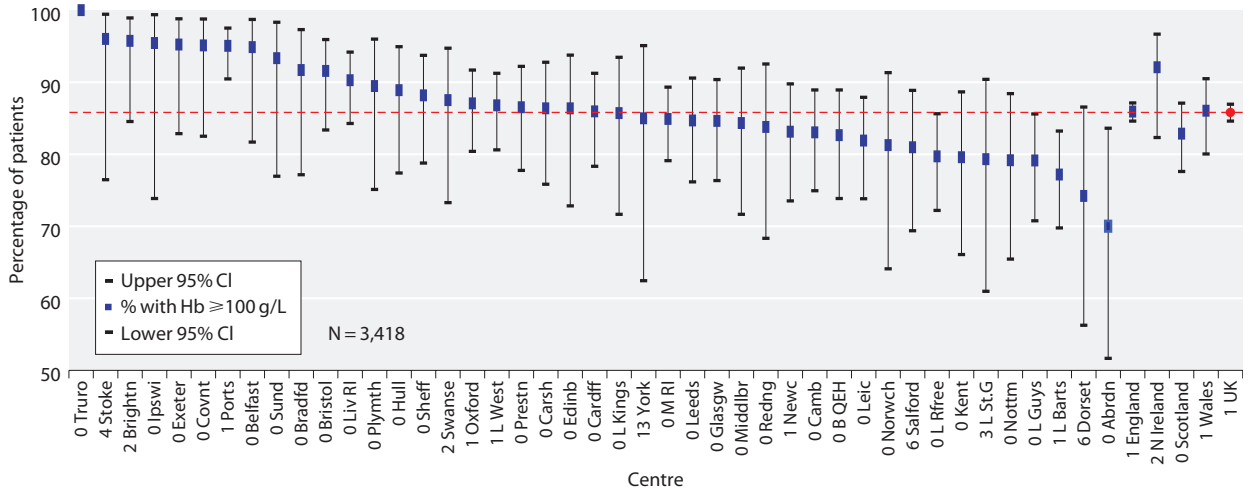

Fig. 3.8b. Percentage of prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 achieving haemoglobin ⩾100 g/L by centre on 31/12/2012

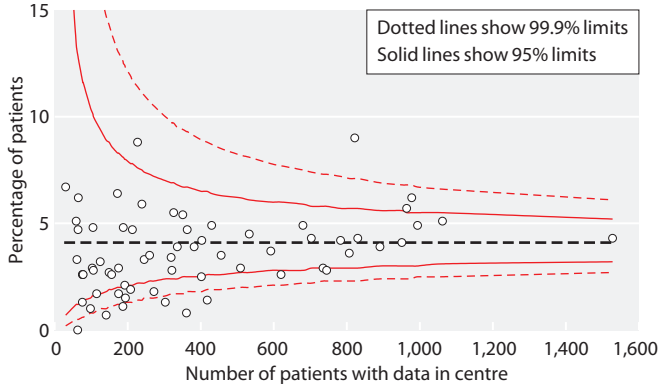

Fig. 3.9. Funnel plot of percentage of prevalent transplant patients with haemoglobin <100 g/L by centre size on 31/12/2012

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

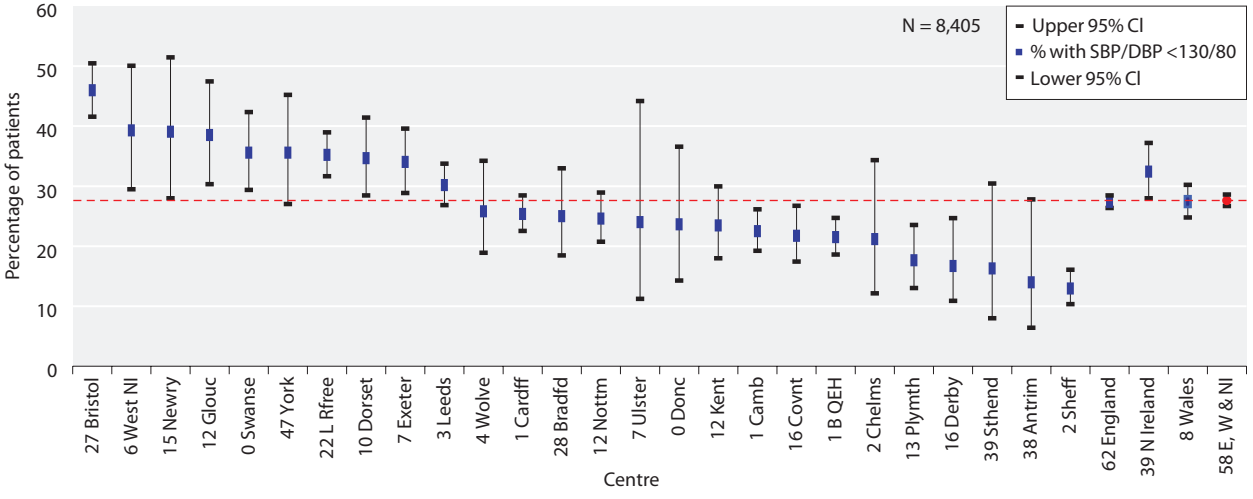

Fig. 3.10a. Percentage of prevalent transplant patients with eGFR ⩾30 ml/min/1.73 m^2 achieving blood pressure of <130/80 mmHg by centre on 31/12/2012

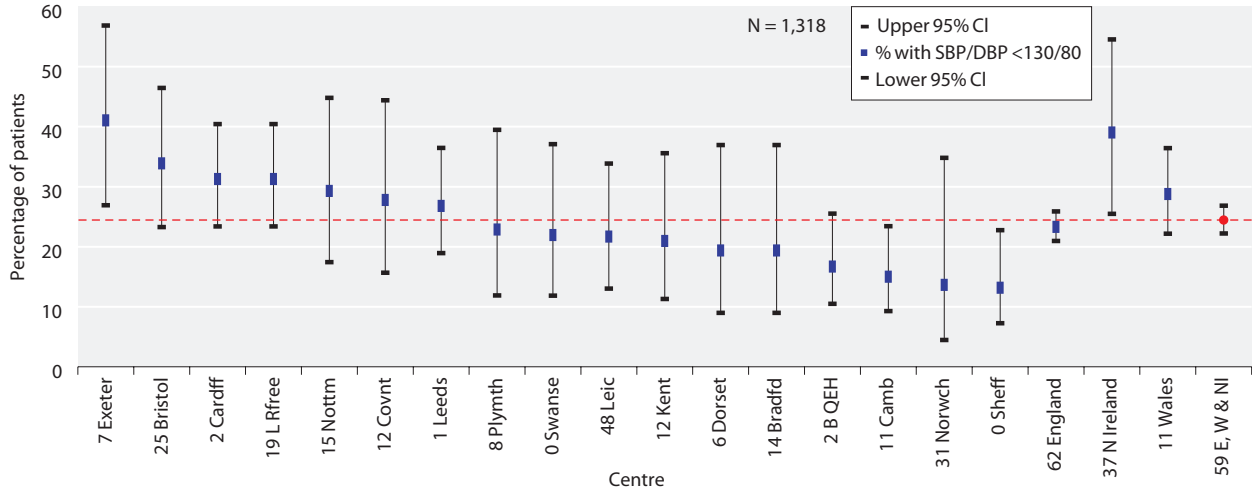

Fig. 3.10b. Percentage of prevalent transplant patients with eGFR <30 ml/min/1.73 m^2 achieving blood pressure of <130/80 mmHg by centre on 31/12/2012

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

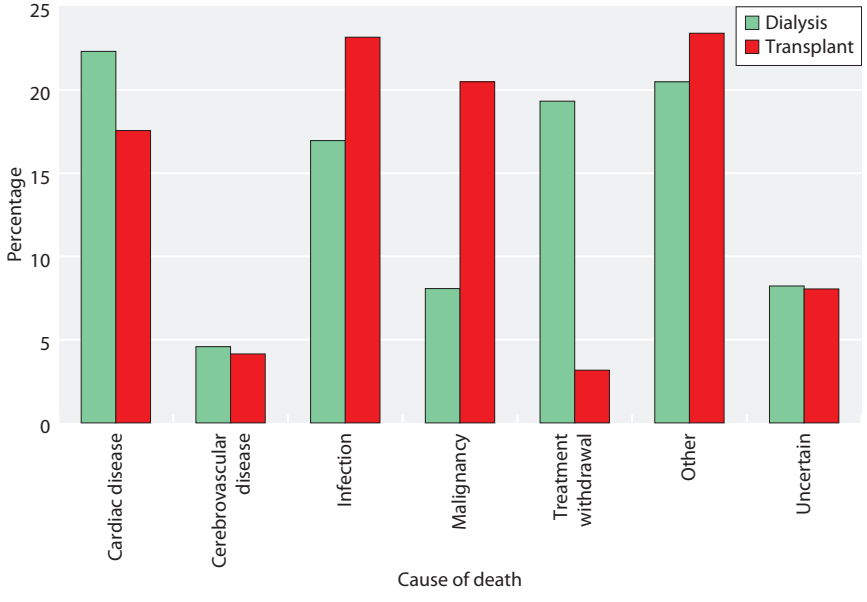

Fig. 3.11. Cause of death by modality for prevalent patients on 1/1/2012

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