Chapter 7: Haemodialysis Dose and Serum Bicarbonate

Charlie Tomson, David Thomas, Raman Rao, Dirk van Schalkwyk and David Ansell

Summary

- Data from 21 renal units was insufficient to allow analyses of the dose of dialysis in those units. Amongst the remainder, there is evidence of a progressive increase in the proportion of patients meeting the Renal Association audit standard for Urea Reduction Ratio (URR).
- In the UK as a whole, 81% of prevalent haemodialysis patients met the standard for URR in 2005. Greater achievement of the standard in a given unit is associated with a higher median URR in that unit, although there is some evidence that some units have been able to narrow the distribution of achieved URR values.
- Achievement of the standard remains, as in previous years' Reports, less common amongst patients recently established on haemodialysis compared to those established on haemodialysis for longer.
- Correction of acidosis, as measured by serum bicarbonate concentration remains highly variable, although there is continued uncertainty about the interpretation of routine measurements of venous serum bicarbonate concentration in haemodialysis patients.
- Overall, around 64% of UK haemodialysis patients, and 50% of peritoneal dialysis patients met the Renal Association standard for serum bicarbonate in 2005.

Introduction

Dialysis dose is an important predictor of outcome amongst patients receiving conventional thrice weekly dialysis and is highly susceptible to clinical intervention. Serum bicarbonate in contrast, bears an uncertain relationship to outcome, is highly influenced by non patient-related factors such as delay in analysis after venepuncture and it is less clear how clinicians can improve achievement of the desired bicarbonate concentration.

Completeness of data

No data on URR were received from Barts, Brighton, Hammersmith/Charing Cross, Royal Free, Newcastle or Wirral. Both Brighton and Newcastle are running CCL Clinicalvision which currently does not support calculation of URRs. Most remaining centres returned data on >90% of patients, the exceptions being Belfast (89%), Cambridge (56%), Carshalton (64%), Chelmsford (80%), Clwyd (88%), Dudley (71%), Dundee (2%), Guys (81%), Kings (79%), Manchester West (52%), Oxford (66%), Preston (76%), Swansea (69%), Wolverhampton (79%) and Wrexham (69%) (Table 7.1).

The Scottish Renal Registry does not currently report serum bicarbonate data from Scottish Renal Units to the UK Renal Registry.

The completeness is recorded as within the last six months for England, Wales and Northern Ireland centres and within the last year for Scotland.

Centres reporting data on less than 20 patients or less than 50% of prevalent patients were not included in the centre level analyses. The number preceding the centre name in each figure indicates the percentage of missing data for that centre.

Dialysis dose

Introduction

The Renal Association guidelines offer both Kt/V and URR as markers of haemodialysis dose. The relevant audit standards agreed by the Renal Association[1] are as follows:

Table 7.1: Percentage completeness of data returns

	URR	Bicarb HD	Bicarb PD		URR	Bicarb HD	Bicarb PD
Abrdn	98			L H&CX	0	99	98
Airdrie	92			L Kings	79	92	82
Antrim	97	99	89	L Rfree	0	0	1
B Heart	95	95	100	Leeds	98	100	98
B QEH	95	95	88	Leic	95	87	94
Bangor	94	95	91	Livrpl	94	98	98
Basldn	99	99	100	ManWst	52	0	0
Belfast	89	95	94	Middlbr	96	98	100
Bradfd	96	100	100	Newc	0	100	100
Brightn	0	56	49	Newry	99	99	86
Bristol	99	100	100	Norwch	98	100	100
Camb	56	68	100	Nottm	100	79	17
Cardff	93	82	96	Oxford	66	94	98
Carlis	91	93	100	Plymth	97	99	97
Carsh	64	83	90	Ports	98	99	81
Chelms	80	99	97	Prestn	76	86	82
Clwyd	88	94	92	Redng	97	99	100
Covnt	94	16	62	Sheff	94	99	99
D&Gall	100			Shrew	96	100	100
Derby	96	99	94	Stevng	99	98	98
Dorset	96	100	98	Sthend	96	97	95
Dudley	71	77	91	Sund	97	97	100
Dundee	2			Swanse	69	97	99
Dunfn	98			Truro	97	99	97
Edinb	98			Tyrone	93	98	100
Exeter	98	99	99	Ulster	97	100	100
GlasRI	95			Wirral	0	9	4
GlasWI	96			Wolve	79	99	98
Glouc	94	100	97	Wrexm	69	81	85
Hull	94	98	96	York	99	100	100
Inverns	95			**Eng**	**72**	**81**	**77**
Ipswi	95	100	98	**NI**	**93**	**97**	**92**
Klmarnk	99			**Sct**	**88**		
L Barts	0	0	0	**Wls**	**83**	**88**	**94**
L Guys	81	88	99	**UK**	**75**	**83**	**78**

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. (Good practice)

Every patient receiving thrice weekly HD should show:

- ***either urea reduction ratio (URR) consistently >65%***
- ***or equilibrated Kt/V of >1.2 (calculated from pre- and post-dialysis urea values, duration of dialysis and weight loss during dialysis). (B)***

Patients receiving twice weekly dialysis for reasons of geography should receive a higher sessional dose of dialysis, with a total Kt/V urea (combined residual renal and HD) of >1.8. If this cannot be achieved, then it should be recognised that there is a compromise between the practicalities of dialysis and the patient's long-term health. (Good practice)

Measurement of the 'dose' or 'adequacy' of HD should be performed monthly in all patients. All dialysis units should collect and report to the Registry, data on pre- and post-dialysis urea values, duration of dialysis, and weight loss during dialysis. (Good practice)

Post-dialysis blood samples should be collected either by the slow-flow method, the simplified stop-flow method, or the stop-dialysate-flow method (Appendix 2). The method used should remain consistent within renal units and should be reported to the Registry. (B)

For pragmatic reasons (because most centres do not report duration of dialysis or weight loss during dialysis) the Registry has chosen URR for comparative audit. Data on post-dialysis sampling methods were last collected by telephone survey in 2002[2]. No reliable data is held on whether the important variations in post-dialysis sampling methodology identified at that time still persist.

As in all other analyses, data are taken from the last quarter of the year (unless otherwise stated); if that data point is missing, data from the 3rd quarter are taken. Data on frequency of dialysis are not routinely reported by all centres and were last collected systematically as part of the 2002 National Renal Survey[3]. For the purposes of the analyses reported below, data from patients known to be receiving twice weekly dialysis are omitted. However, not all centres report frequency of dialysis, so it is possible that some data from a very small number of patients receiving twice weekly dialysis are included in the analyses, but this would not have a large influence on the overall centre mean.

HD session length has been shown to predict outcome independently of URR[4]. The Registry is able to collect data on recorded session time but a few centres report prescribed session time. No data are currently collected on dialyser characteristics (eg surface area, clearance, flux, membrane type).

Several centres in the UK now use on-line measurement of ionic dialysance to measure small molecular clearance during haemodialysis, relying on small studies that have demonstrated a close linear relationship between this measure and conventional measures of urea clearance[4]. However, the Registry strongly encourages these centres to continue to perform and report conventional pre- and post-dialysis measurements of blood urea concentration at least on a 3-monthly basis, to allow continued comparative audit.

No consensus has yet been reached on a 'common currency' by which to define the dose of peritoneal dialysis and so no attempt has been made to report comparative audits of peritoneal dialysis dose. Consensus is required on whether the Registry should collect 'raw' data from 24 hour urine and dialysate collections or calculated weekly Kt/V_{urea} and creatinine clearance; if the latter, a uniform methodology for derivation of these values will be required.

Achieved URR

Median URR achieved in each renal unit is shown in Figure 7.1. The percentage of reported patients meeting the Renal Association audit

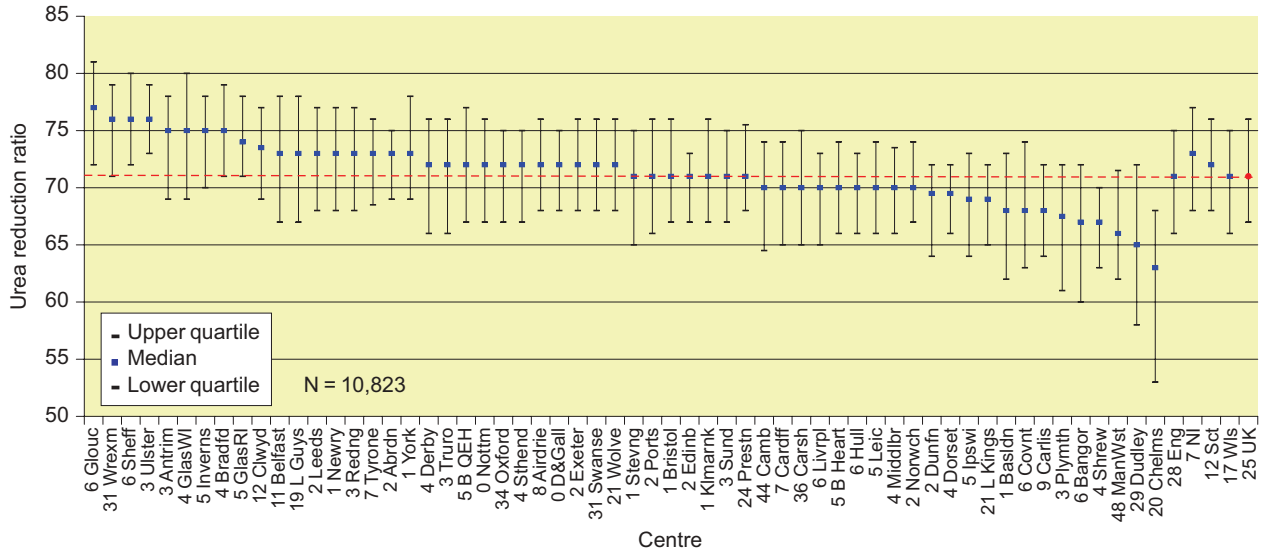

Figure 7.1: Median URR achieved in each centre, 2005

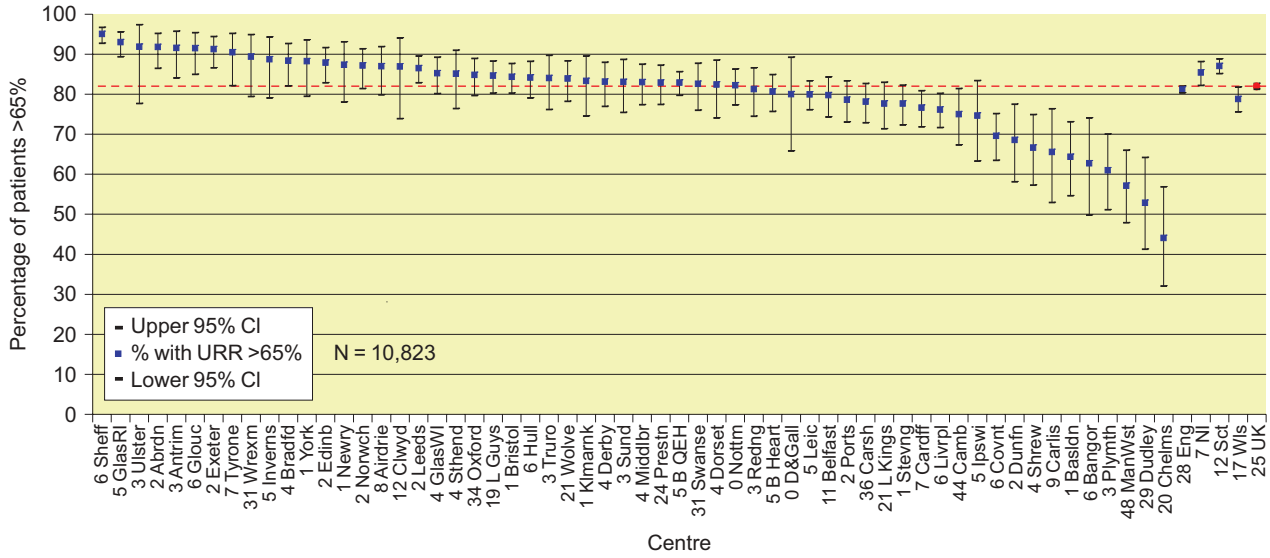

Figure 7.2: Percentage of patients with URR ⩾65% in each centre, 2005

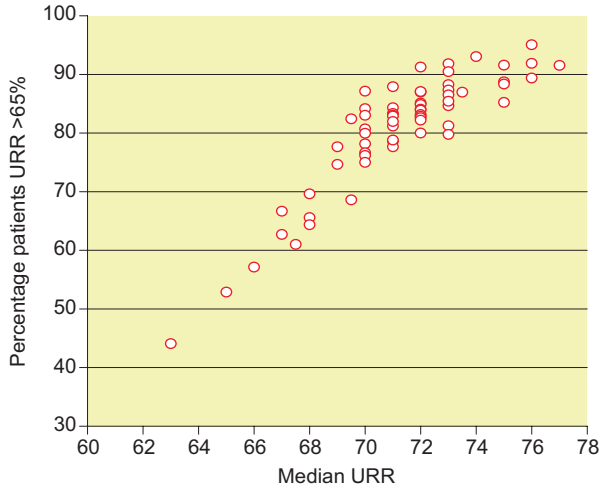

Figure 7.3: Relationship between achievement of the standard for URR and the median URR in each centre, 2005

standard of a URR of ⩾65% is shown in Figure 7.2. Figure 7.3 demonstrates that the two are closely related; however, the dispersion of values on this plot above a URR of 68% suggests that some higher performing units are achieving the standard in a high proportion of patients by narrowing the distribution rather than simply shifting the distribution upwards[5].

Changes in URR over time

Figure 7.4 shows the change in median URR between 1998 and 2005 in each renal unit. Figure 7.5 shows the change in percentage of reported dialysis patients with a URR ⩾65% in each unit over 1998–2005. Figure 7.6 shows summary data for England and Wales over the same time period. Although the median URR has remained at 71% over the last 3 years, the percentage of patients achieving a URR >65% has risen from 77% to 81%.

Variation of achieved URR with time on dialysis

As in previous analyses, the percentage of patients with URR ⩾65% is higher amongst patients who have been on RRT for longer than in those who recently started (Figure 7.7). However, the latter group has improved from 48% in 1999 to 68% in 2005. Figure 7.8 shows the percentage of patients with URR ⩾65% during the first quarter of treatment.

Commentary

There has been a progressive increase over time in the proportion of UK haemodialysis patients meeting the Renal Association audit standards for URR. However, although an increased dialysis dose is being achieved in patients just starting RRT, there is evidence that these standards are less frequently met in patients starting dialysis than in 'well-established' patients. This is possibly due to difficulties relating to vascular access in the first few months of dialysis. Previous reports[3] analysed whether this was partly due to selective drop-out (to death or other modalities) of those not initially achieving the audit standard and it was shown that this was not the case, with lower

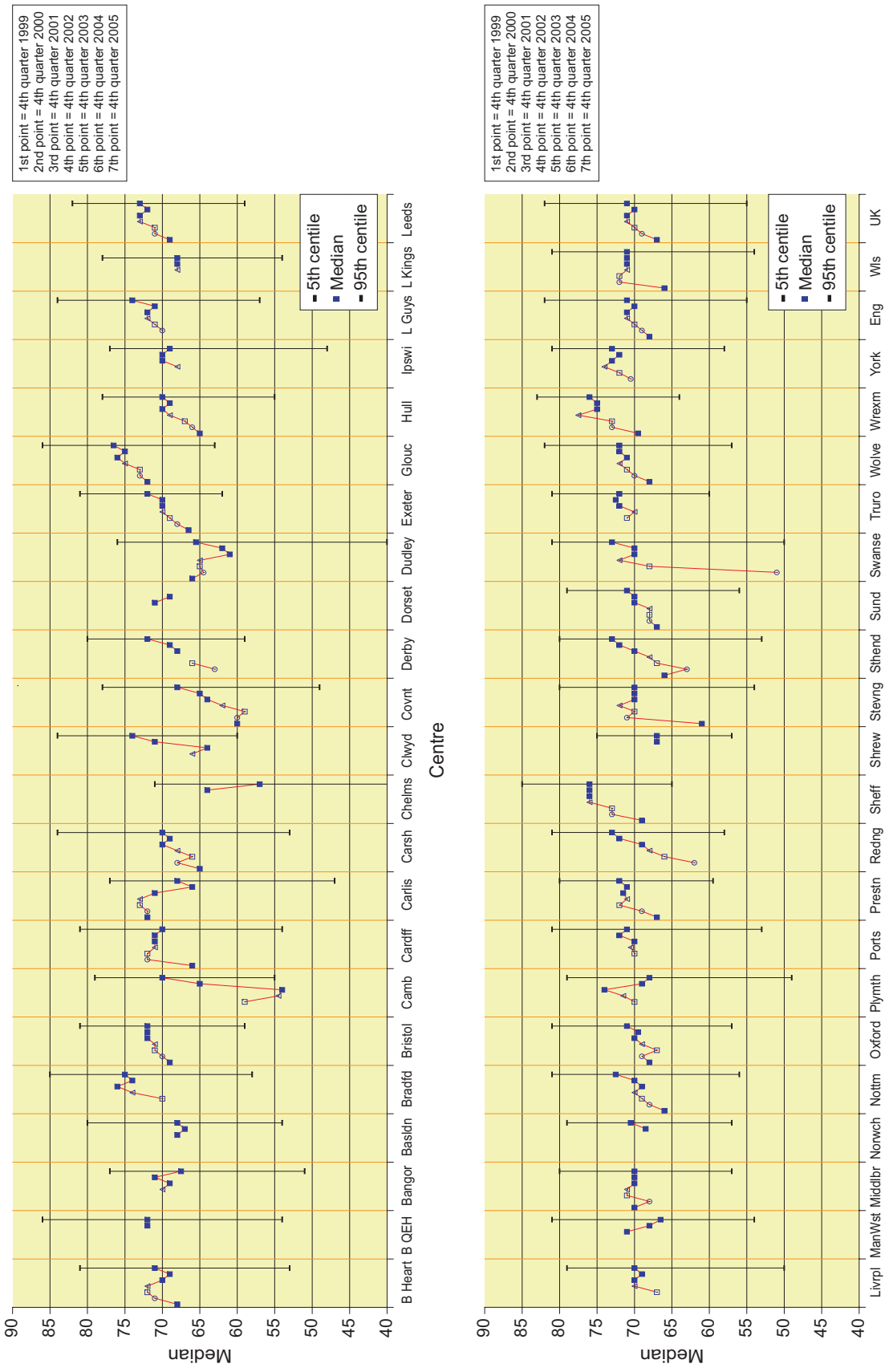

Figure 7.4: Change in median URR in each centre between 1998 and 2005

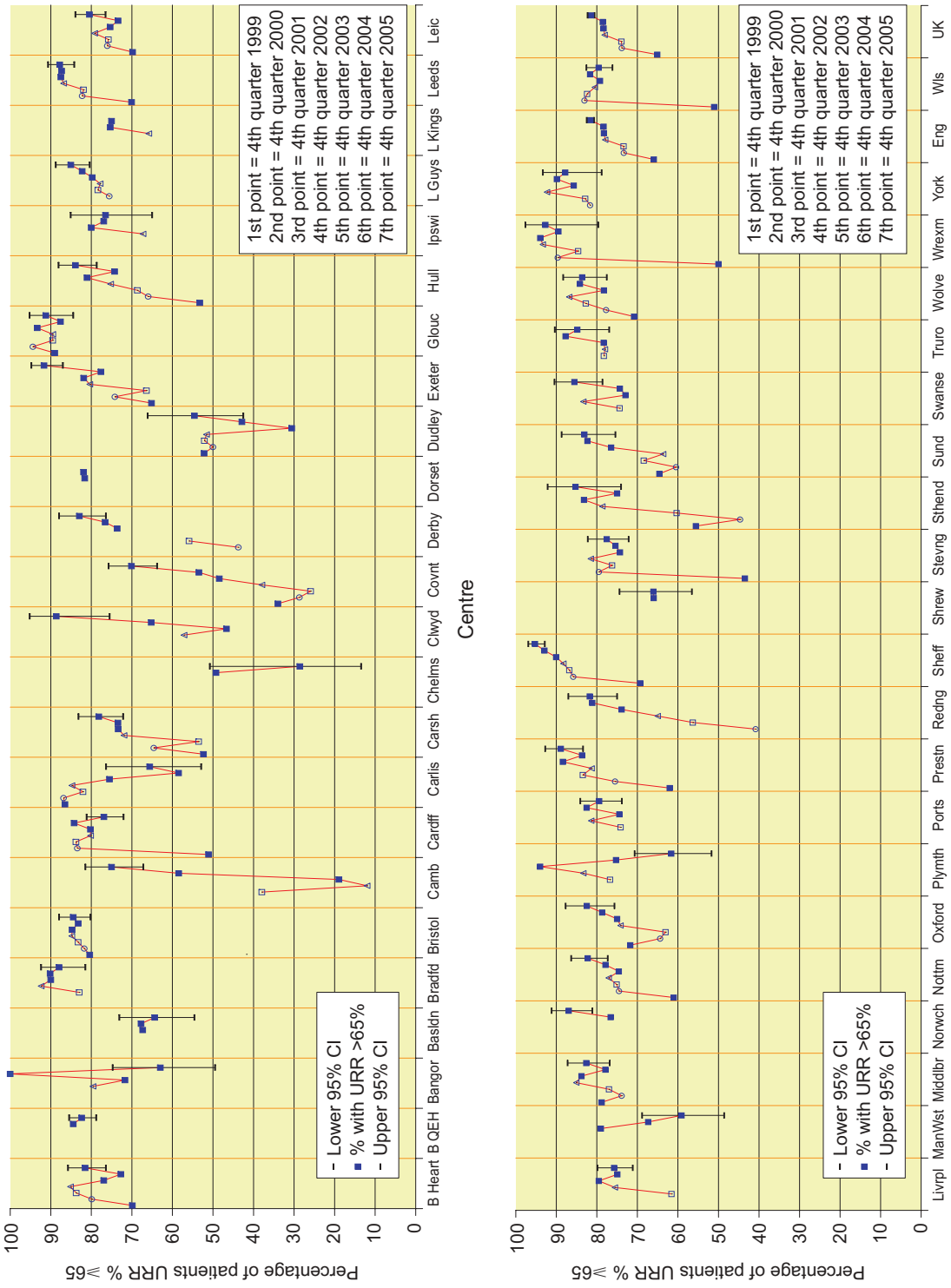

Figure 7.5: Change in achievement of the standard for URR in each centre between 1998 and 2005

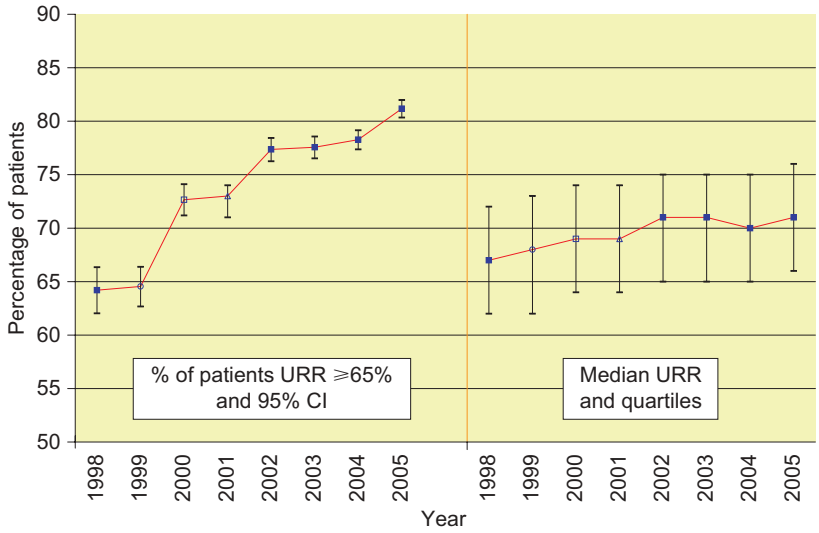

Figure 7.6: Change in the percentage of patients with URR ⩾65% and the median URR between 1998 and 2005 in England and Wales

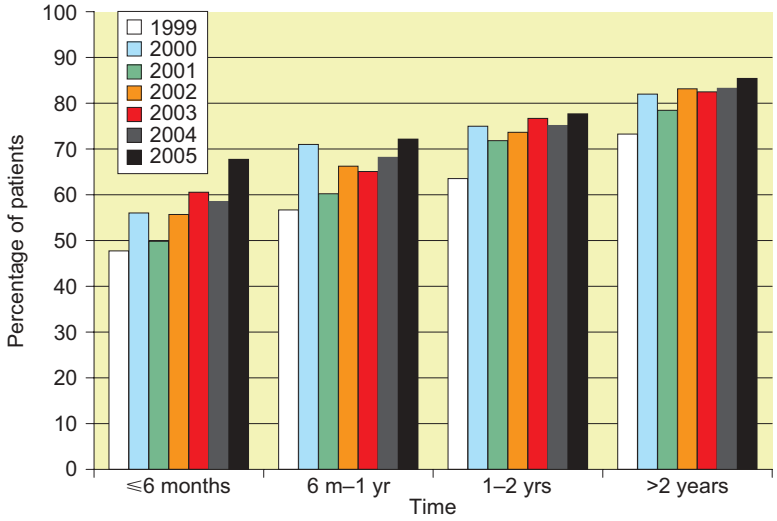

Figure 7.7: Percentage of prevalent haemodialysis patients achieving URR ⩾65% against duration on haemodialysis

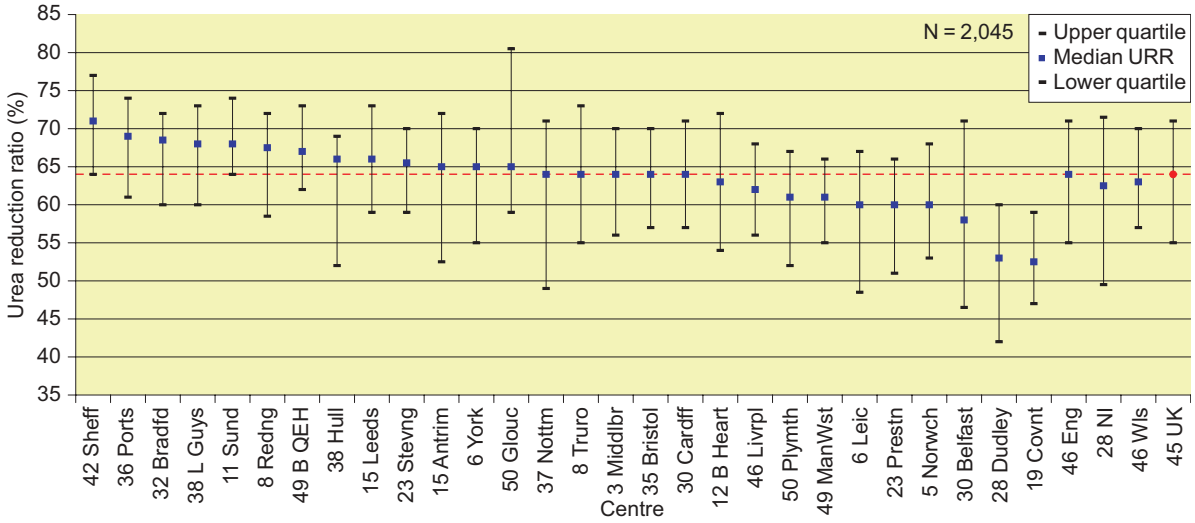

Figure 7.8: Median URR in the first quarter after starting RRT in patients who started haemodialysis in 2005

URRs achieved throughout the first year even in those patients that survived at least two years.

Serum bicarbonate

Introduction

The relevant audit standard agreed by the Renal Association[1] is as follows:

Serum bicarbonate, before a haemodialysis (HD) session, measured with minimal delay after venepuncture should be between 20 and 26 mmol/l. (C)

For continuous ambulatory peritoneal dialysis (CAPD) patients serum bicarbonate, measured with minimal delay after venepuncture, should be between 25 and 29 mmol/l. (B)

Haemodialysis

Median pre-dialysis serum bicarbonate amongst prevalent haemodialysis patients in each renal unit is given in Figure 7.9; the percentage of patients in each unit meeting the Renal Association standards is given in Figure 7.10. Figure 7.11 presents the same data as in Figure 7.10 as a funnel plot and Table 7.2 can be used to look up the data for individual centres.

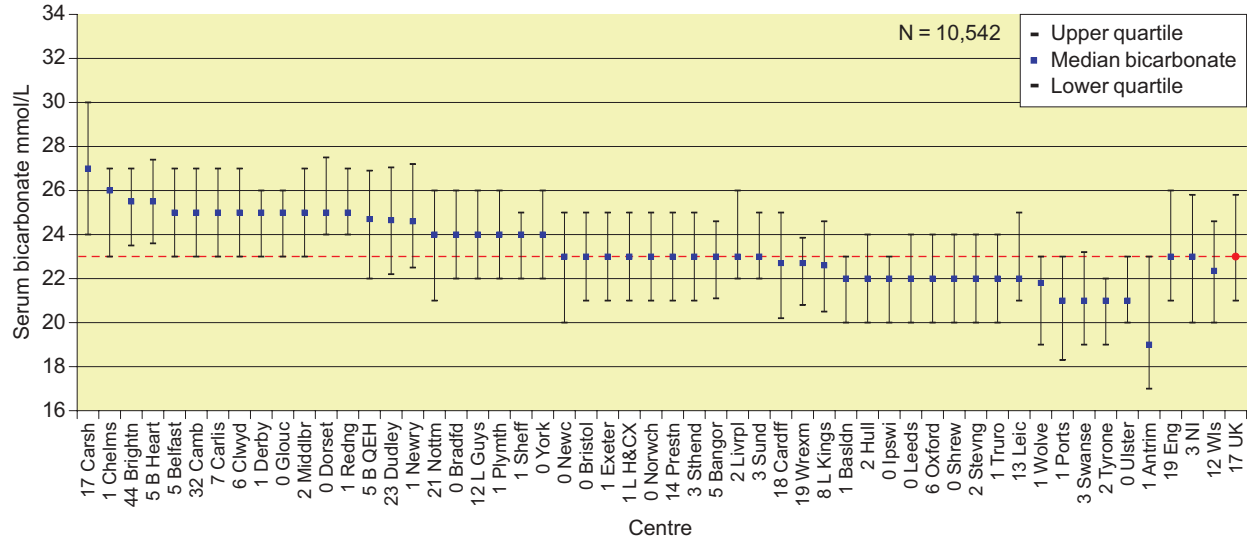

Figure 7.9: Median serum bicarbonate concentration amongst prevalent patients on haemodialysis, 2005

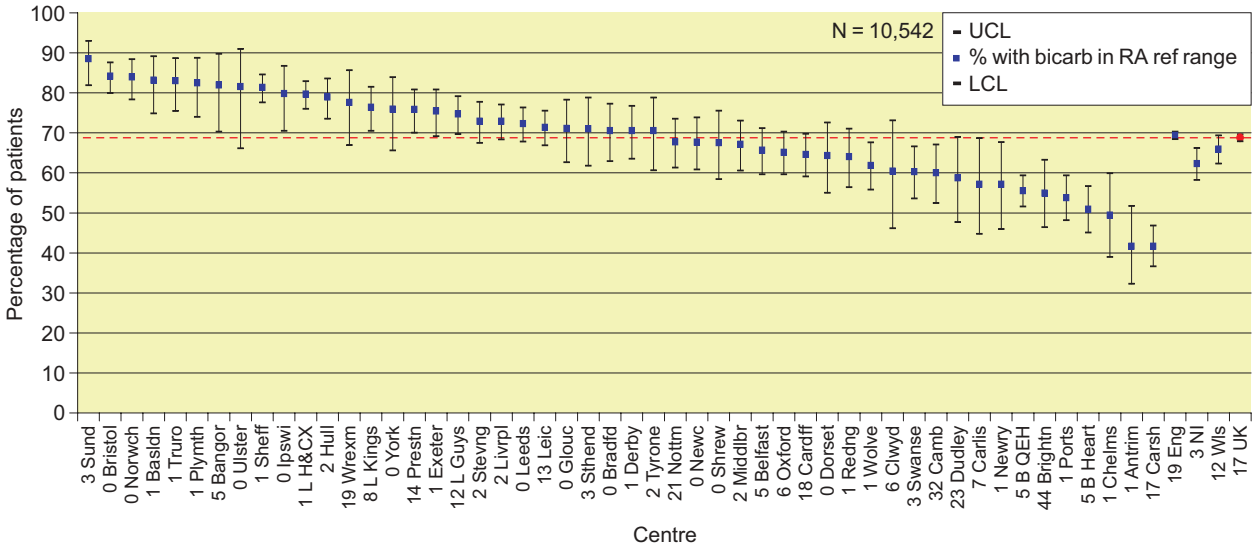

Figure 7.10: Percentage of prevalent haemodialysis patients with serum bicarbonate in the range 20–26 mmol/L, 2005

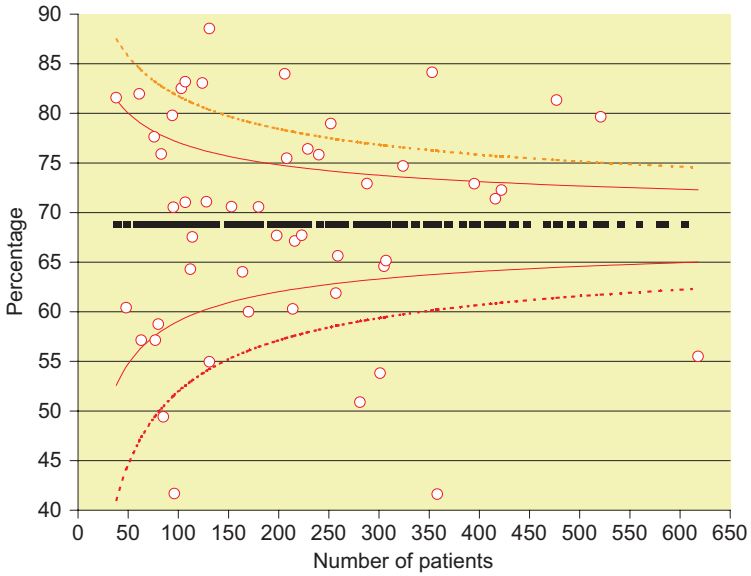

Figure 7.11: Funnel plot of the data in Figure 7.10

Table 7.2: Percentage of prevalent haemodialysis patients with serum bicarbonate in the range 20–26 mmol/L by centre

Centre	Total HD patients	% in RA ref range	Centre	Total HD patients	% in RA ref range
Ulster	38	82	Newc	198	68
Clwyd	48	60	Norwch	206	84
Bangor	61	82	Exeter	208	75
Carlis	63	57	Swanse	214	60
Wrexm	76	78	Middlbr	216	67
Newry	77	57	Nottm	223	68
Dudley	80	59	L Kings	229	76
York	83	76	Prestn	240	76
Chelms	85	49	Hull	252	79
Ipswi	94	80	Wolve	257	62
Tyrone	95	71	Belfast	259	66
Antrim	96	42	B Heart	281	51
Plymth	103	83	Stevng	288	73
Basldn	107	83	Ports	301	54
Sthend	107	71	Cardff	305	65
Dorset	112	64	Oxford	307	65
Shrew	114	68	L Guys	324	75
Truro	124	83	Bristol	353	84
Glouc	128	71	Carsh	358	42
Brightn	131	55	Livrpl	395	73
Sund	131	89	Leic	416	71
Bradfd	153	71	Leeds	422	72
Redng	164	64	Sheff	477	81
Camb	170	60	L H&CX	521	80
Derby	180	71	B QEH	618	56

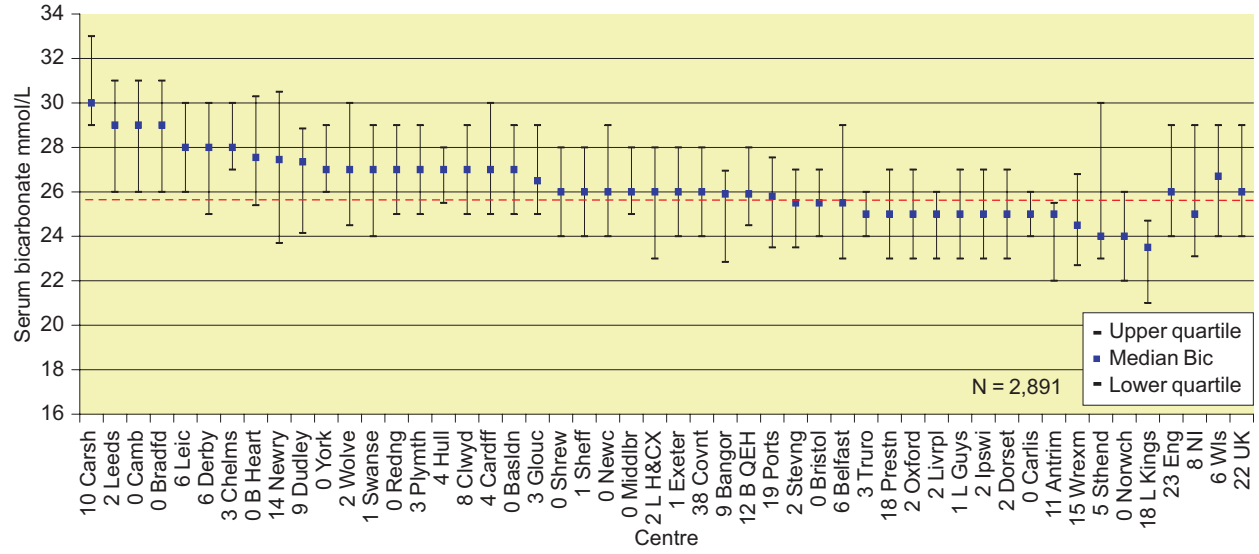

Figure 7.12: Median serum bicarbonate concentration amongst prevalent peritoneal dialysis patients, 2005

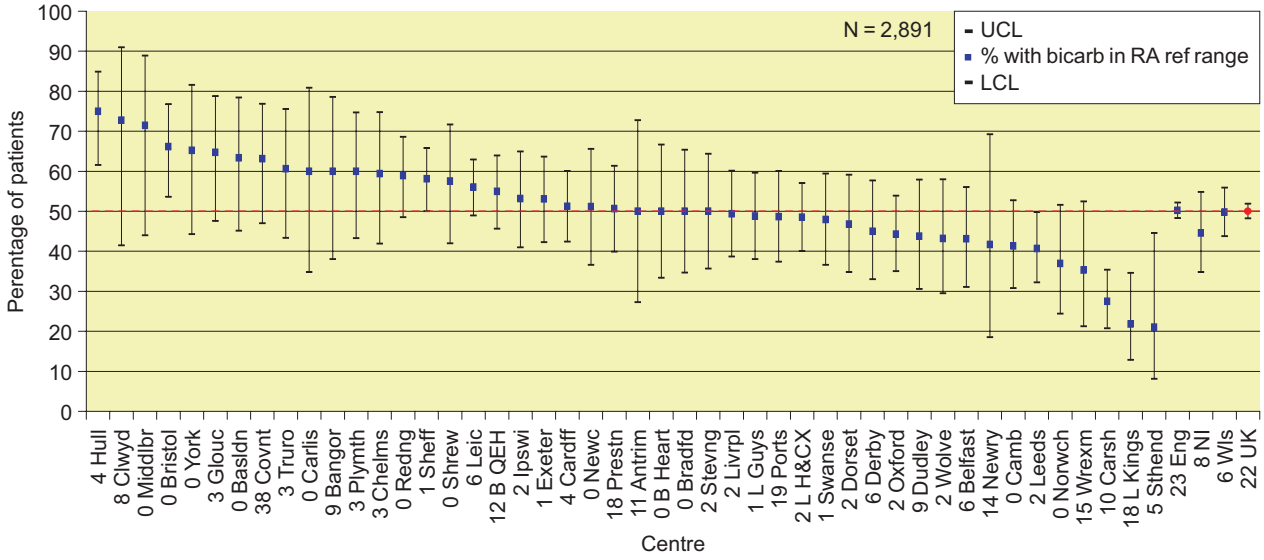

Figure 7.13: Percentage of prevalent peritoneal dialysis patients with serum bicarbonate in the range 25–29 mmol/L, 2005

Peritoneal dialysis

Median serum bicarbonate amongst prevalent peritoneal dialysis patients in each renal unit is given in Figure 7.12; the percentage of patients in each unit meeting the Renal Association standards is shown in Figure 7.13. Figure 7.14 presents the same data as in Figure 7.13 as a funnel plot and Table 7.3 can be used to look up the data for individual centres.

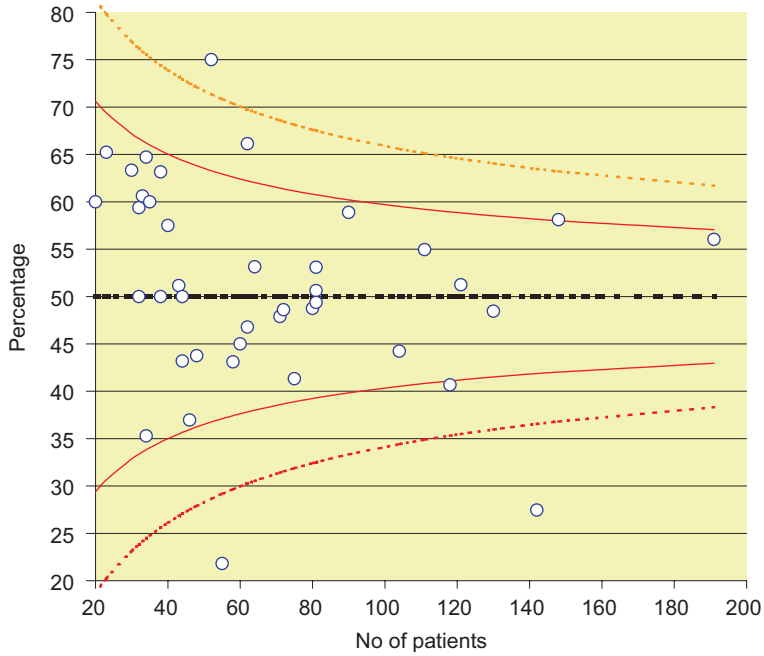

Figure 7.14: Funnel plot of the data in Figure 7.13

Table 7.3: Percentage of prevalent PD patients with serum bicarbonate in the range 20–26 mmol/L by centre

Centre	Total PD patients	% in RA ref range	Centre	Total PD patients	% in RA ref range
Bangor	20	60	Derby	60	45
York	23	65	Dorset	62	47
Basldn	30	63	Bristol	62	66
B Heart	32	50	Ipswi	64	53
Chelms	32	59	Swanse	71	48
Truro	33	61	Ports	72	49
Glouc	34	65	Camb	75	41
Wrexm	34	35	L Guys	80	49
Plymth	35	60	Exeter	81	53
Bradfd	38	50	Prestn	81	51
Covnt	38	63	Livrpl	81	49
Shrew	40	58	Redng	90	59
Newc	43	51	Oxford	104	44
Stevng	44	50	B QEH	111	55
Wolve	44	43	Leeds	118	41
Norwch	46	37	Cardff	121	51
Dudley	48	44	L H&CX	130	48
Hull	52	75	Carsh	142	27
L Kings	55	22	Sheff	148	58
Belfast	58	43	Leic	191	56

Transplant

Median serum bicarbonate amongst prevalent transplant patients in each renal unit is given in Figure 7.15. Mean serum creatinine and eGFR for the same populations are given in Table 7.4.

Commentary

An in-depth survey of the causes of variations between renal units in performance against the audit standard for serum bicarbonate concentration was reported in the 2004 Report[6]. Few of these causes of variation have been

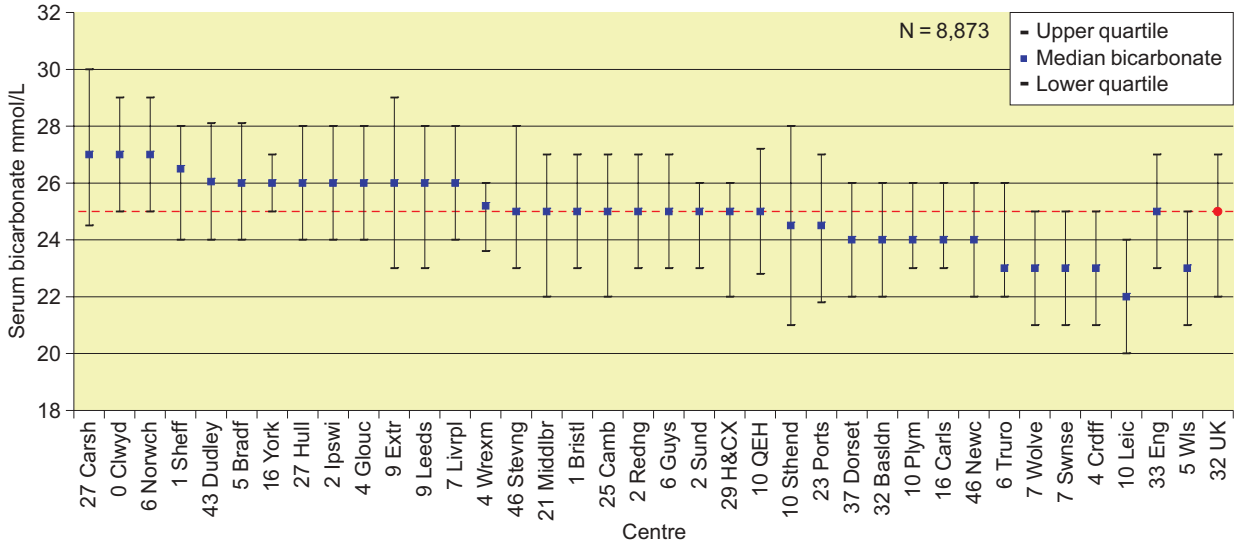

Figure 7.15: Median serum bicarbonate concentration amongst prevalent transplant patients, 2005

Table 7.4: Analysis of bicarbonate by CKD stage for prevalent transplant patients compared with dialysis patients

	Stage 1–2T (⩾60)	Stage 3T (30–59)	Stage 4T (15–29)	Stage 5T (<15)	Stage 5D
Number of patients	3,028	7,537	1,971	321	13,715
% of patients	23.6	58.6	15.3	2.5	
eGFR ml/min/1.73 m^2					
mean ± SD	73.0 ± 12.5	44.9 ± 8.3	24.0 ± 4.0	11.4 ± 2.6	
Median	69.6	44.8	24.6	12.1	
Bicarbonate mmol/L					
mean ± SD	26.4 ± 3.0	25.6 ± 3.4	23.4 ± 3.6	21.5 ± 4.0	24.0 ± 3.8

eliminated and the analyses reported here should therefore be interpreted with caution. However, more renal units than expected fall outside three standard deviations from the mean, suggesting that real differences in unit performance are present; it is recommended that those units whose data fall below the 3SD line review their practices relating to measurement of serum bicarbonate and to the correction of acidosis.

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