Chapter 10
Biochemistry Profile of Patients Receiving Dialysis in the UK in 2008: national and centre-specific analyses

Anne Dawnay[a], Ken Farrington[b], Clare Castledine[c], Dirk van Schalkwyk[c] and Graham Warwick[d]

[a]University College London Hospitals, London, UK; [b]Lister Hospital, Stevenage, UK; [c]UK Renal Registry, Bristol, UK; [d]Leicester General Hospital, Leicester, UK

Key Words
Bicarbonate · Biochemical variables · Calcium · Cholesterol · Dialysis · Haemodialysis · Parathyroid hormone · Peritoneal dialysis · Phosphate · Quality improvement

Abstract
Introduction: The UK Renal Association Clinical Practice Guidelines include clinical performance measures for biochemical parameters in dialysis patients [1]. The UK Renal Registry (UKRR) annually audits dialysis centre performance against these measures as part of its role in promoting continuous quality improvement. ***Methods:*** Cross sectional performance analyses were undertaken to compare dialysis centre achievement of clinical performance measures for prevalent haemodialysis (HD) and peritoneal dialysis (PD) cohorts in 2008. The biochemical variables studied were phosphate, adjusted calcium, calcium phosphate product, parathyroid hormone, bicarbonate, total cholesterol and HbA1c. In addition, longitudinal analyses were performed (2000–2008) to show changes in achievement of clinical performance measures over time. ***Results:*** Serum phosphate was between 1.1 and 1.8 mmol/L in 55% of HD and 64% of PD patients, which was similar to 2007. There was a fall in overall mean phosphate concentration to 1.55 mmol/L. A revised adjusted serum calcium target of 2.2–2.5 mmol/L was achieved by 63% of HD and 65% of PD patients. For comparison, the previous target of 2.2–2.6 mmol/L was achieved by 74% and 78% respectively, a figure little changed since 2005. The downward trend in serum calcium results evident for the previous nine years appears to have halted. The calcium phosphate target of $<4.8\,\text{mmol}^2/\text{L}^2$ was achieved by 84% of HD and 87% of PD patients, continuing the steady improvement over the past nine years and reflecting the downward trend in phosphate results. As in previous years, a minority of patients achieved the PTH target range of 16–32 pmol/L and there was considerable heterogeneity between centres. Although analytical and biological variability may have contributed to this, centres achieving the standards relating to one mineral parameter tended to achieve the standards in others suggesting that treatment factors were also relevant. The audit measure for bicarbonate was achieved in 71% of HD and 82% of PD patients. Eighty-five percent of HD patients and 69% of PD patients achieved a value for total cholesterol <5 mmol/L. This was the first year that HbA1c has been audited. Overall, 43% of diabetic dialysis patients

exceeded the target of 7.5% HbA1c and there was considerable variation between centres. ***Conclusion:*** There is wide variation between centres in attainment of biochemical performance measures. There is some evidence in bone mineral metabolism that centres performing well in one variable are more likely to also meet the other standards. The inter-centre variation may be explained in part by laboratory practices and case mix but probably also represents variation in practice and in effectiveness of processes of care. Apart from glycaemic control there are a number of analytical and clinical factors that affect HbA1c that would be worthy of further investigation as a cause of variability.

Introduction

The UKRR collected routine biochemical data from clinical information systems in renal centres in England, Wales and Northern Ireland. Whilst similar data are collected by the Scottish Renal Registry, the UKRR is currently unable to receive these data, a situation the UKRR and Scottish Registry are working together to resolve. Annual cross sectional analyses were undertaken on some of these variables to determine centre level performance against national (Renal Association) clinical performance measures. This enabled UK renal centres to compare their own performance against each other and to the UK average performance. The UK Renal Association Clinical Practice Guidelines were revised and the final version of the 4th edition of these guidelines was published in November 2007 and was used as the source of audit measures [1]. 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 provide enhanced 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 2008. The cohort studied were patients prevalent on dialysis treatment on 31/12/08. HD and PD cohorts were analysed separately except for HbA1c where HD and PD cohorts have been analysed together.

The biochemical variables analysed were phosphate, adjusted calcium, adjusted calcium phosphate product, parathyroid hormone, bicarbonate, cholesterol and HbA1c. The method of data collection and validation by the UKRR has been described elsewhere [2]. For each quarter of 2008, 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. 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. The audit measure for adjusted calcium in the 4th edition of the Renal Association Clinical Practice Guidelines depends on a local reference range but suggests an upper limit of 2.5 mmol/L [1]. The UKRR has this year changed to using adjusted calcium between 2.2–2.5 mmol/L as an audit measure rather than 2.2–2.6 mmol/L used previously. There are a variety of methods and reference ranges in use to measure parathyroid hormone. To enable some form of comparative audit the UKRR has chosen 2–4 times the median laboratory upper normal limit value as the audit measure. This equates to 16–32 pmol/L and is comparable to KDOQI (15–31 pmol/L) [1, 3, 4]. The measure used for serum bicarbonate in the PD cohort was 22–30 mmol/L as the new audit measure specifies that serum bicarbonate should be maintained in the 'normal range'. The derived measure of calcium phosphate product has an audit measure of below 4.8 $mmol^2/L^2$. There is no audit measure but guidance for cholesterol has changed to the new target of total cholesterol below 4 mmol/L in patients with a 10 year risk of cardiovascular disease of $>20\%$ (previously <5 mmol/L). The reporting of achievement of <5 mmol/L continues this year but the plan is to move to the new target for next years report. HbA1c is a new audit measure for the UKRR and the target of less than 7.5% (DCCT harmonised) has been used [1].

A summary of the current Renal Association audit measures and conversion factors from SI units are given in table 10.1.

Quarterly values were extracted from the database for the last two quarters for calcium, bicarbonate, phosphate and HbA1c, the last three quarters for PTH and the entire year for cholesterol. Patients who did not have a data item were excluded from that analysis. The completeness of data were 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 performance. Data were also excluded from plots when there were less than 20 patients with data at centre level. These 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 Renal Association or other surrogate clinical performance measure was also calculated. 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 units' [5]. 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 cross-referencing the 'n' value with the proportion of patients achieving the audit measure in the relevant table. Longitudinal

Table 10.1. Summary of clinical audit measures from the 4th edition of the Renal Association Clinical Practice Guidelines and used in the current analysis of data

Biochemical variable	Clinical audit measure	Conversion factor from SI units
Phosphate	1.1–1.8 mmol/L	mg/dL = mmol/L × 3.1
Calcium (adjusted)	Normal range (ideally 2.2–2.5 mmol/L)	mg/dL = mmol/L × 4
Calcium*phosphate	<4.8 mmol^2/L^2	mg^2/L^2 = mmol^2/L^2 × 12.4
Parathyroid hormone	2–4 times upper limit of normal (16–32 pmol/L)	ng/L = pmol/L × 9.5
Bicarbonate	HD patients: 20–26 mmol/L PD patients: Normal range (22–30 mmol/L)	mg/dl = mmol/L × 6.1
Total cholesterol	<5 mmol/L	mg/dl = mmol/L × 38.6
HbA1c	$<7.5\%$	n/a

analyses were performed for some data to calculate overall changes in achievement of a performance measure annually from 2000 to 2008. All data were unadjusted for case-mix.

Results

Mineral and bone parameters

Phosphate

The 4th edition of the Renal Association Clinical Practice Guidelines states:

'Serum phosphate in dialysis patients (measured before a "short gap" dialysis session in HD patients) should be maintained between 1.1 and 1.8 mmol/L.' (Module 2: Complications) [1]

The data for serum phosphate were 95% complete overall for HD patients (table 10.2) with seven centres attaining below 90% completeness (lowest 58%). For PD patients the data were 97% complete overall (table 10.4) but five centres with sufficient eligible patients attained below 90% completeness (lowest 74% complete). The individual centres' means and standard deviations are shown in tables 10.2 and 10.4.

There was between centre variation in the proportion of patients with serum phosphate concentration below, within and above the audit range of 1.1–1.8 mmol/L for HD (figures 10.1–10.6) and PD (figures 10.7–10.12) patients. Overall 55% (CI 55.4–56.0) of HD patients (table 10.3) and 64% (CI 62.5–65.7) of PD patients (table 10.5) achieved the target, showing little change

Table 10.2. Summary statistics for phosphate in haemodialysis patients in 2008

Centre	% completeness	Number of patients	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	98	120	1.40	0.54	1.32	1.00	1.78
B Heart	96	371	1.66	0.55	1.55	1.28	1.92
B QEH	97	715	1.53	0.48	1.48	1.20	1.77
Bangor	97	69	1.61	0.52	1.55	1.29	1.98
Basldn	99	124	1.57	0.46	1.53	1.22	1.84
Belfast	96	230	1.54	0.56	1.54	1.10	1.86
Bradfd	96	172	1.61	0.58	1.56	1.20	1.93
Brightn	89	263	1.53	0.53	1.47	1.15	1.84
Bristol	100	418	1.76	0.53	1.71	1.43	2.03
Camb	58	170	1.54	0.57	1.47	1.15	1.86
Cardff	97	434	1.58	0.53	1.50	1.22	1.83
Carlis	99	74	1.63	0.52	1.52	1.30	1.80
Carsh	99	570	1.53	0.55	1.51	1.19	1.84
Chelms	100	95	1.53	0.41	1.49	1.27	1.76
Clwyd	93	63	1.60	0.63	1.52	1.16	1.92
Colchr	100	103	1.51	0.44	1.47	1.24	1.79
Covnt	98	278	1.52	0.48	1.50	1.16	1.86

Table 10.2. Continued

Centre	% completeness	Number of patients	Mean	SD	Median	Lower quartile	Upper quartile
Derby	99	228	1.54	0.53	1.49	1.18	1.77
Derry	100	52	1.56	0.52	1.46	1.19	1.77
Donc	100	72	1.51	0.55	1.50	1.10	1.70
Dorset	99	185	1.57	0.50	1.51	1.26	1.80
Dudley	87	104	1.57	0.52	1.56	1.23	1.88
Exeter	100	284	1.57	0.48	1.50	1.24	1.84
Glouc	99	141	1.55	0.46	1.50	1.21	1.77
Hull	99	287	1.47	0.55	1.44	1.10	1.80
Ipswi	100	96	1.50	0.45	1.51	1.16	1.79
Kent	99	292	1.49	0.53	1.48	1.10	1.77
L Barts	100	570	1.59	0.54	1.53	1.23	1.89
L Guys	98	472	1.45	0.54	1.40	1.10	1.70
L Kings	100	378	1.49	0.42	1.42	1.20	1.71
L Rfree	84	518	1.51	0.52	1.43	1.15	1.82
L St G	100	204	1.48	0.53	1.41	1.14	1.78
L West	79	909	1.29	0.47	1.24	0.96	1.56
Leeds	99	450	1.56	0.54	1.49	1.17	1.86
Leic	99	673	1.64	0.48	1.59	1.30	1.93
Liv Ain	93	108	1.55	0.60	1.43	1.17	1.85
Liv RI	94	353	1.52	0.51	1.43	1.21	1.79
M Hope	84	241	1.54	0.59	1.45	1.12	1.92
M RI	72	277	1.60	0.61	1.52	1.16	1.91
Middlbr	98	265	1.68	0.53	1.60	1.30	2.00
Newc	100	252	1.51	0.57	1.43	1.15	1.77
Newry	99	87	1.60	0.51	1.55	1.23	1.92
Norwch	99	283	1.50	0.53	1.45	1.16	1.84
Nottm	100	352	1.53	0.48	1.50	1.20	1.80
Oxford	99	324	1.59	0.50	1.58	1.20	1.90
Plymth	97	109	1.51	0.62	1.40	1.07	1.84
Ports	100	411	1.70	0.54	1.65	1.33	2.01
Prestn	100	412	1.64	0.53	1.58	1.28	1.94
Redng	100	232	1.34	0.42	1.29	1.05	1.54
Sheff	100	567	1.65	0.48	1.61	1.31	1.96
Shrew	99	168	1.53	0.50	1.53	1.20	1.79
Stevng	98	336	1.58	0.47	1.55	1.25	1.83
Sthend	99	121	1.56	0.48	1.53	1.19	1.83
Stoke	98	234	1.56	0.51	1.50	1.20	1.89
Sund	96	145	1.70	0.58	1.69	1.31	2.05
Swanse	98	312	1.53	0.53	1.47	1.18	1.81
Truro	100	134	1.70	0.48	1.63	1.36	1.95
Tyrone	100	84	1.43	0.42	1.40	1.18	1.70
Ulster	100	77	1.62	0.47	1.59	1.25	1.87
Wirral	98	159	1.55	0.57	1.50	1.16	1.85
Wolve	99	273	1.50	0.51	1.43	1.15	1.80
Wrexm	100	71	1.52	0.64	1.35	1.12	1.87
York	97	107	1.63	0.59	1.55	1.21	1.84
England	**95**	**15,079**	**1.55**	**0.52**	**1.50**	**1.20**	**1.84**
N Ireland	**98**	**650**	**1.52**	**0.53**	**1.47**	**1.16**	**1.83**
Wales	**97**	**949**	**1.56**	**0.55**	**1.48**	**1.20**	**1.83**
E, W & NI	**95**	**16,678**	**1.55**	**0.53**	**1.49**	**1.20**	**1.84**

Table 10.3. Percentage of haemodialysis patients within, below and above the range for phosphate (1.1–1.8 mmol/L) in 2008

Centre	N	% phos 1.1–1.8 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	Lower 95% CI	Upper 95% CI	% phos >1.8 mmol/L	Lower 95% CI	Upper 95% CI
Antrim	120	48.3	39.5	57.2	29.2	21.7	37.9	22.5	15.9	30.8
B Heart	371	56.9	51.8	61.8	9.4	6.9	12.9	33.7	29.1	38.7
B QEH	715	62.8	59.2	66.3	15.0	12.5	17.8	22.2	19.3	25.4
Bangor	69	52.2	40.5	63.6	14.5	8.0	24.9	33.3	23.3	45.2
Basldn	124	58.1	49.2	66.4	14.5	9.3	21.9	27.4	20.3	35.9
Belfast	230	47.8	41.4	54.3	24.4	19.2	30.3	27.8	22.4	34.0
Bradfd	172	49.4	42.0	56.9	20.4	15.0	27.0	30.2	23.8	37.5
Brightn	263	52.5	46.4	58.4	20.2	15.7	25.4	27.4	22.3	33.1
Bristol	418	48.3	43.6	53.1	7.7	5.5	10.6	44.0	39.3	48.8
Camb	170	51.2	43.7	58.6	20.0	14.7	26.7	28.8	22.5	36.1
Cardff	434	57.1	52.4	61.7	15.7	12.5	19.4	27.2	23.2	31.6
Carlis	74	64.9	53.4	74.9	10.8	5.5	20.2	24.3	15.9	35.3
Carsh	570	52.3	48.2	56.4	19.8	16.8	23.3	27.9	24.4	31.7
Chelms	95	64.2	54.1	73.2	12.6	7.3	20.9	23.2	15.8	32.7
Clwyd	63	52.4	40.2	64.3	17.5	9.9	28.9	30.2	20.1	42.5
Colchr	103	62.1	52.4	71.0	14.6	9.0	22.8	23.3	16.1	32.4
Covnt	278	50.4	44.5	56.2	21.9	17.5	27.2	27.7	22.8	33.3
Derby	228	59.2	52.7	65.4	17.1	12.8	22.6	23.7	18.6	29.6
Derry	52	55.8	42.2	68.6	21.2	12.1	34.3	23.1	13.6	36.4
Donc	72	66.7	55.1	76.6	18.1	10.8	28.7	15.3	8.7	25.5
Dorset	185	61.1	53.9	67.8	14.6	10.2	20.5	24.3	18.7	31.0
Dudley	104	52.9	43.3	62.3	16.4	10.4	24.7	30.8	22.7	40.3
Exeter	284	60.9	55.1	66.4	12.7	9.3	17.1	26.4	21.6	31.8
Glouc	141	63.1	54.9	70.7	12.8	8.2	19.4	24.1	17.8	31.9
Hull	287	50.9	45.1	56.6	24.4	19.8	29.7	24.7	20.1	30.1
Ipswi	96	58.3	48.3	67.8	19.8	13.0	29.0	21.9	14.7	31.2
Kent	292	54.1	48.4	59.8	24.7	20.1	29.9	21.2	16.9	26.3
L Barts	570	54.7	50.6	58.8	14.6	11.9	17.7	30.7	27.1	34.6
L Guys	472	58.9	54.4	63.3	21.2	17.7	25.1	19.9	16.6	23.8
L Kings	378	63.2	58.3	67.9	16.9	13.5	21.1	19.8	16.1	24.2
L Rfree	518	54.6	50.3	58.9	20.1	16.9	23.8	25.3	21.7	29.2
L St G	204	54.9	48.0	61.6	22.1	16.9	28.3	23.0	17.8	29.3
L West	909	51.3	48.0	54.5	36.1	33.0	39.3	12.7	10.6	15.0
Leeds	450	52.4	47.8	57.0	19.3	15.9	23.2	28.2	24.3	32.6
Leic	673	58.0	54.2	61.6	9.7	7.7	12.1	32.4	29.0	36.0
Liv Ain	108	54.6	45.2	63.8	17.6	11.5	25.9	27.8	20.2	37.0
Liv RI	353	60.6	55.4	65.6	15.9	12.4	20.1	23.5	19.4	28.2
M Hope	241	45.2	39.1	51.6	22.8	18.0	28.6	32.0	26.4	38.1
M RI	277	47.3	41.5	53.2	21.3	16.9	26.5	31.4	26.2	37.1
Middlbr	265	58.5	52.5	64.3	9.1	6.1	13.2	32.5	27.1	38.3
Newc	252	55.2	49.0	61.2	22.2	17.5	27.8	22.6	17.9	28.2
Newry	87	57.5	46.9	67.4	11.5	6.3	20.1	31.0	22.2	41.5
Norwch	283	49.8	44.0	55.6	21.9	17.5	27.1	28.3	23.3	33.8
Nottm	352	61.7	56.5	66.6	16.2	12.7	20.4	22.2	18.1	26.8
Oxford	324	55.6	50.1	60.9	14.2	10.8	18.4	30.3	25.5	35.5
Plymth	109	45.9	36.8	55.3	27.5	20.0	36.6	26.6	19.2	35.7
Ports	411	49.6	44.8	54.5	11.4	8.7	14.9	38.9	34.3	43.7
Prestn	412	51.2	46.4	56.0	14.1	11.0	17.8	34.7	30.3	39.4
Redng	232	58.6	52.2	64.8	28.0	22.6	34.1	13.4	9.6	18.4
Sheff	567	53.8	49.7	57.9	12.0	9.6	14.9	34.2	30.4	38.2
Shrew	168	57.7	50.2	65.0	19.1	13.8	25.7	23.2	17.5	30.2
Stevng	336	58.9	53.6	64.1	14.6	11.2	18.8	26.5	22.0	31.5
Sthend	121	57.9	48.9	66.3	14.9	9.6	22.4	27.3	20.1	35.9
Stoke	234	61.5	55.2	67.6	12.8	9.1	17.8	25.6	20.5	31.6

Table 10.3. Continued

Centre	N	% phos 1.1–1.8 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	Lower 95% CI	Upper 95% CI	% phos >1.8 mmol/L	Lower 95% CI	Upper 95% CI
Sund	145	48.3	40.3	56.4	13.8	9.1	20.4	37.9	30.4	46.1
Swanse	312	54.8	49.3	60.3	19.6	15.5	24.3	25.6	21.1	30.8
Truro	134	60.5	52.0	68.4	3.0	1.1	7.7	36.6	28.9	45.0
Tyrone	84	64.3	53.5	73.8	17.9	11.1	27.5	17.9	11.1	27.5
Ulster	77	58.4	47.2	68.9	10.4	5.3	19.4	31.2	21.9	42.3
Wirral	159	53.5	45.7	61.1	20.1	14.6	27.1	26.4	20.2	33.8
Wolve	273	54.6	48.6	60.4	21.3	16.8	26.5	24.2	19.5	29.6
Wrexm	71	42.3	31.4	54.0	23.9	15.4	35.2	33.8	23.8	45.5
York	107	56.1	46.6	65.2	15.9	10.1	24.1	28.0	20.4	37.3
England	**15,079**	**55.4**	**54.6**	**56.2**	**17.7**	**17.1**	**18.3**	**26.9**	**26.2**	**27.6**
N Ireland	**650**	**53.2**	**49.4**	**57.0**	**20.8**	**17.8**	**24.1**	**26.0**	**22.8**	**29.5**
Wales	**949**	**54.6**	**51.4**	**57.7**	**17.6**	**15.3**	**20.2**	**27.8**	**25.1**	**30.8**
E, W & NI	**16,678**	**55.2**	**54.5**	**56.0**	**17.8**	**17.3**	**18.4**	**26.9**	**26.3**	**27.6**

Table 10.4. Summary statistics for phosphate in peritoneal dialysis patients in 2008

Centre	% completeness	Number of patients	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	94	15					
B Heart	100	28	1.42	0.36	1.38	1.18	1.67
B QEH	85	106	1.52	0.47	1.43	1.25	1.76
Bangor	100	29	1.46	0.39	1.41	1.22	1.72
Basldn	100	30	1.43	0.29	1.45	1.22	1.58
Belfast	98	45	1.69	0.5	1.56	1.42	1.92
Bradfd	97	31	1.62	0.39	1.6	1.35	1.83
Brightn	100	80	1.42	0.4	1.43	1.14	1.67
Bristol	100	72	1.69	0.44	1.64	1.37	1.95
Camb	100	40	1.35	0.36	1.32	1.15	1.55
Cardff	99	113	1.53	0.41	1.46	1.25	1.74
Carlis	100	17					
Carsh	98	118	1.59	0.48	1.53	1.28	1.78
Chelms	100	39	1.36	0.36	1.28	1.12	1.64
Clwyd	80	8					
Colchr	n/a	0					
Covnt	86	61	1.5	0.37	1.48	1.26	1.71
Derby	100	75	1.44	0.32	1.39	1.23	1.67
Derry	100	5					
Donc	100	37	1.56	0.43	1.5	1.3	1.8
Dorset	98	49	1.42	0.25	1.41	1.26	1.57
Dudley	98	46	1.55	0.4	1.58	1.29	1.76
Exeter	100	71	1.55	0.46	1.47	1.29	1.73
Glouc	100	33	1.63	0.34	1.6	1.5	1.81
Hull	97	70	1.59	0.33	1.59	1.37	1.79
Ipswi	98	48	1.79	0.5	1.71	1.43	2.02
Kent	97	70	1.49	0.39	1.43	1.3	1.61
L Barts	100	208	1.51	0.47	1.46	1.14	1.81
L Guys	98	49	1.51	0.35	1.5	1.3	1.7
L Kings	100	72	1.54	0.38	1.48	1.25	1.78
L Rfree	89	75	1.49	0.36	1.49	1.22	1.74
L St G	98	50	1.44	0.46	1.32	1.12	1.63
L West	100	42	1.55	0.47	1.48	1.22	1.8
Leeds	99	86	1.57	0.44	1.6	1.28	1.83

Table 10.4. Continued

Centre	% completeness	Number of patients	Mean	SD	Median	Lower quartile	Upper quartile
Leic	99	156	1.56	0.45	1.54	1.24	1.84
Liv Ain	50	1					
Liv RI	90	85	1.49	0.4	1.45	1.19	1.75
M Hope	98	116	1.62	0.5	1.52	1.29	1.95
M RI	100	91	1.55	0.55	1.48	1.18	1.86
Middlbr	91	20	1.54	0.39	1.51	1.23	1.8
Newc	98	44	1.6	0.45	1.58	1.34	1.9
Newry	100	10					
Norwch	93	55	1.5	0.35	1.44	1.2	1.77
Nottm	99	110	1.53	0.38	1.5	1.3	1.8
Oxford	99	106	1.59	0.39	1.58	1.24	1.84
Plymth	100	45	1.48	0.37	1.43	1.18	1.74
Ports	92	70	1.78	0.49	1.73	1.45	2.06
Prestn	98	57	1.68	0.44	1.64	1.33	1.94
Redng	100	75	1.4	0.35	1.41	1.24	1.6
Sheff	100	71	1.6	0.38	1.55	1.38	1.88
Shrew	94	30	1.62	0.34	1.65	1.47	1.86
Stevng	97	36	1.56	0.43	1.49	1.29	1.7
Sthend	93	14					
Stoke	100	72	1.53	0.38	1.5	1.3	1.8
Sund	100	20	1.48	0.44	1.52	1.29	1.84
Swanse	98	59	1.4	0.33	1.33	1.15	1.64
Truro	100	26	1.68	0.46	1.57	1.29	2.11
Tyrone	100	7					
Ulster	100	5					
Wirral	74	25	1.54	0.4	1.54	1.26	1.72
Wolve	100	57	1.44	0.42	1.41	1.13	1.64
Wrexm	95	21	1.71	0.59	1.63	1.38	1.88
York	100	19					
England	**97**	**3,104**	**1.54**	**0.43**	**1.5**	**1.26**	**1.8**
N Ireland	**98**	**87**	**1.62**	**0.42**	**1.57**	**1.39**	**1.84**
Wales	**98**	**230**	**1.51**	**0.41**	**1.45**	**1.23**	**1.73**
E, W & NI	**97**	**3,421**	**1.54**	**0.42**	**1.5**	**1.25**	**1.79**

Blank cells denote centres excluded from analyses due to low patient numbers or poor data completeness
n/a not applicable

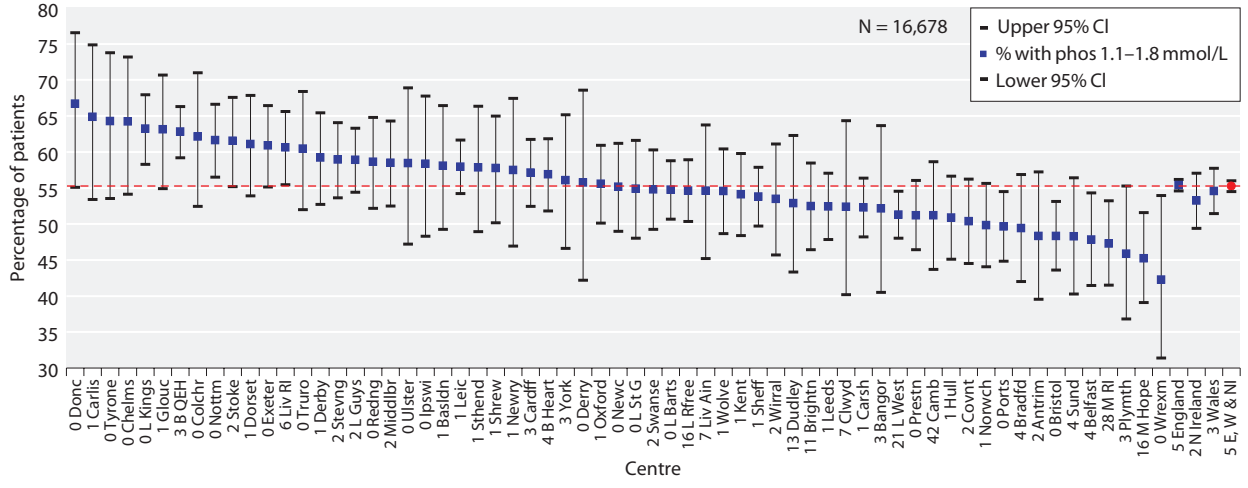

Fig. 10.1. Percentage of haemodialysis patients with phosphate 1.1–1.8 mmol/L by centre in 2008

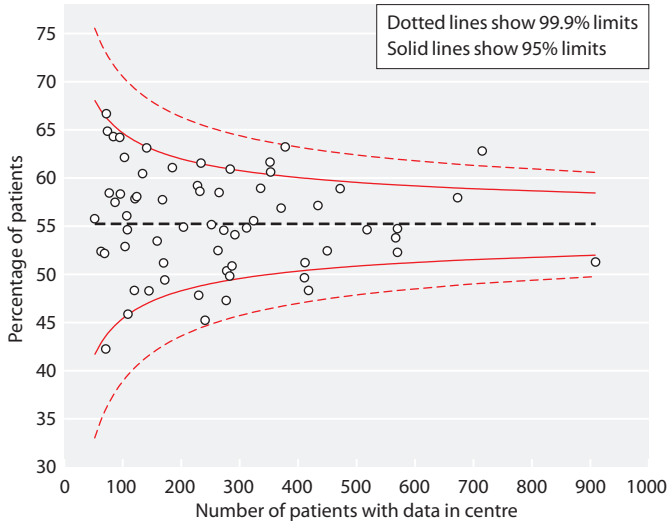

Fig. 10.2. Funnel plot of percentage of haemodialysis patients with phosphate 1.1–1.8 mmol/L by centre in 2008

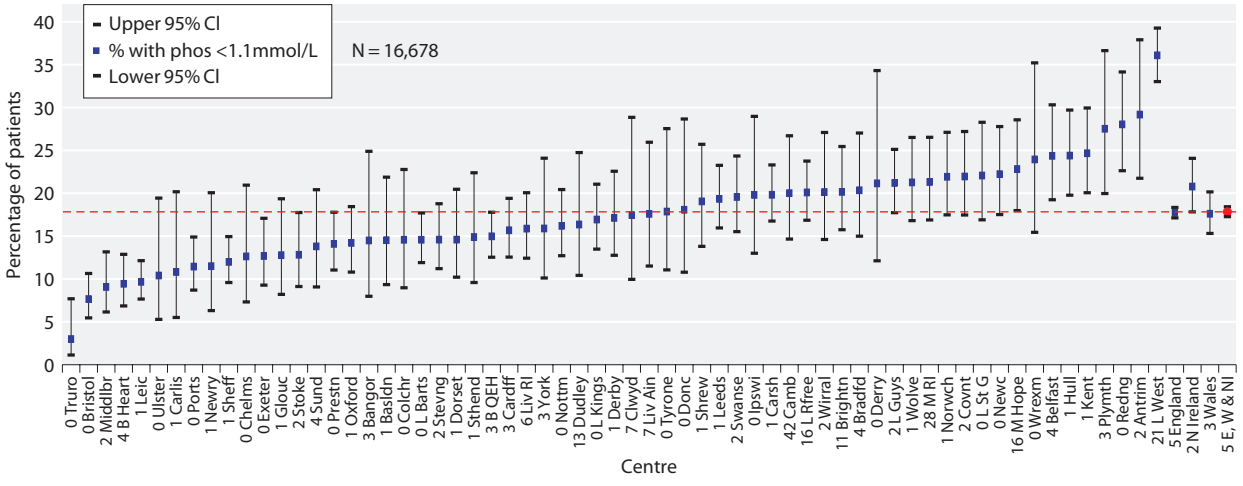

Fig. 10.3. Percentage of haemodialysis patients with phosphate <1.1 mmol/L by centre in 2008

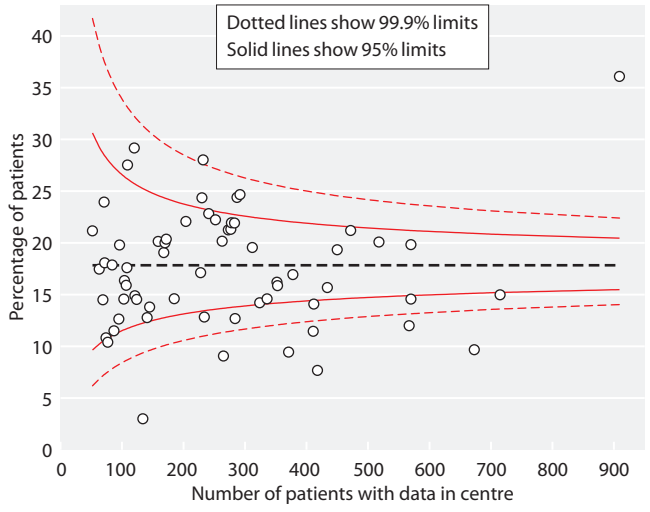

Fig. 10.4. Funnel plot of percentage of haemodialysis patients with phosphate <1.1 mmol/L by centre in 2008

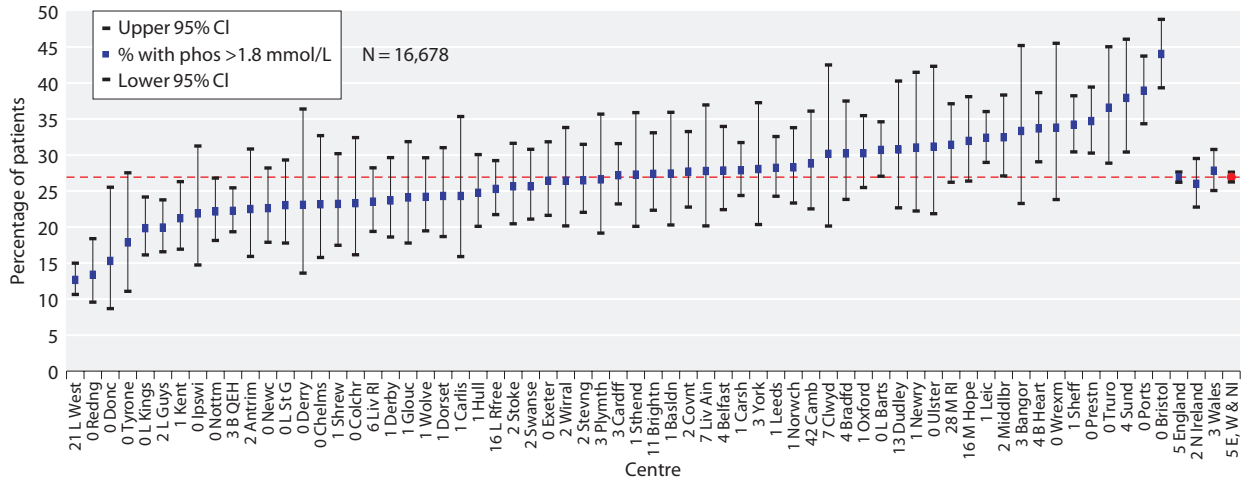

Fig. 10.5. Percentage of haemodialysis patients with phosphate >1.8 mmol/L by centre in 2008

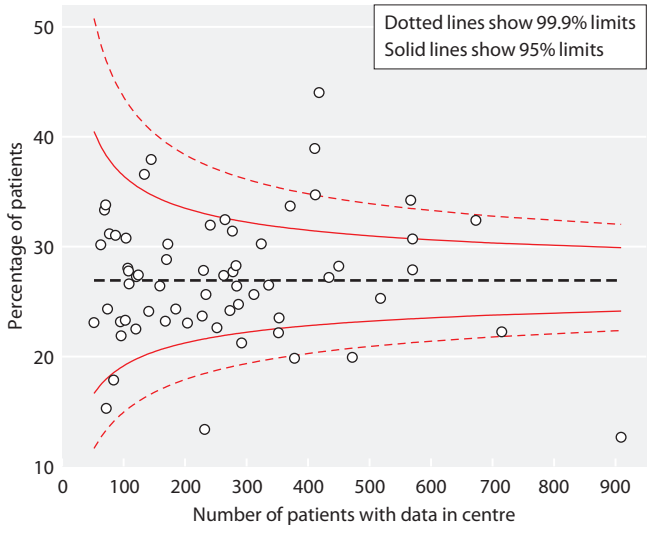

Fig. 10.6. Funnel plot of percentage of haemodialysis patients with phosphate >1.8 mmol/L by centre in 2008

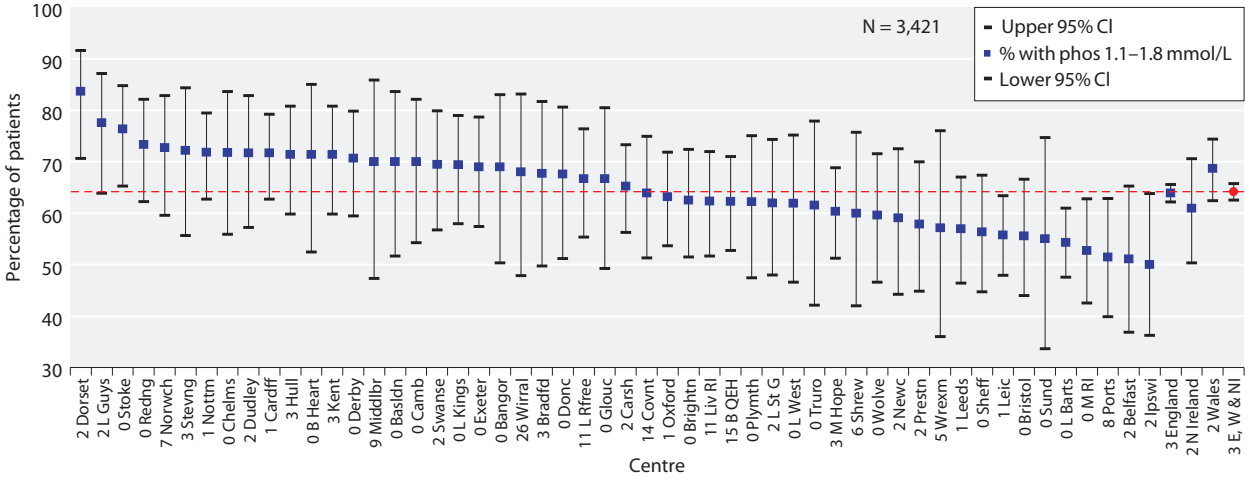

Fig. 10.7. Percentage of peritoneal dialysis patients with phosphate 1.1–1.8 mmol/L by centre in 2008

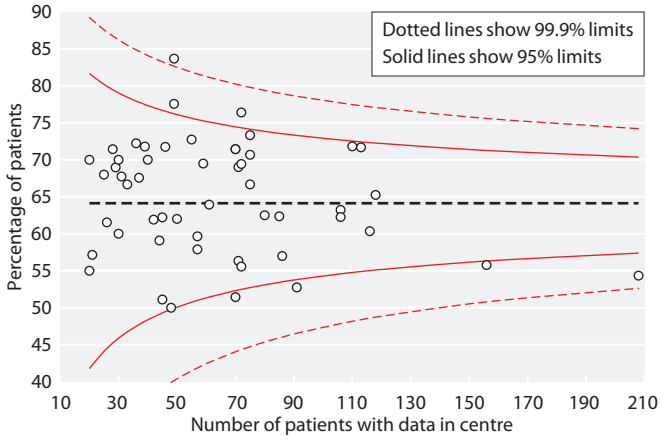

Fig. 10.8. Funnel plot of percentage of peritoneal dialysis patients with phosphate 1.1–1.8 mmol/L by centre in 2008

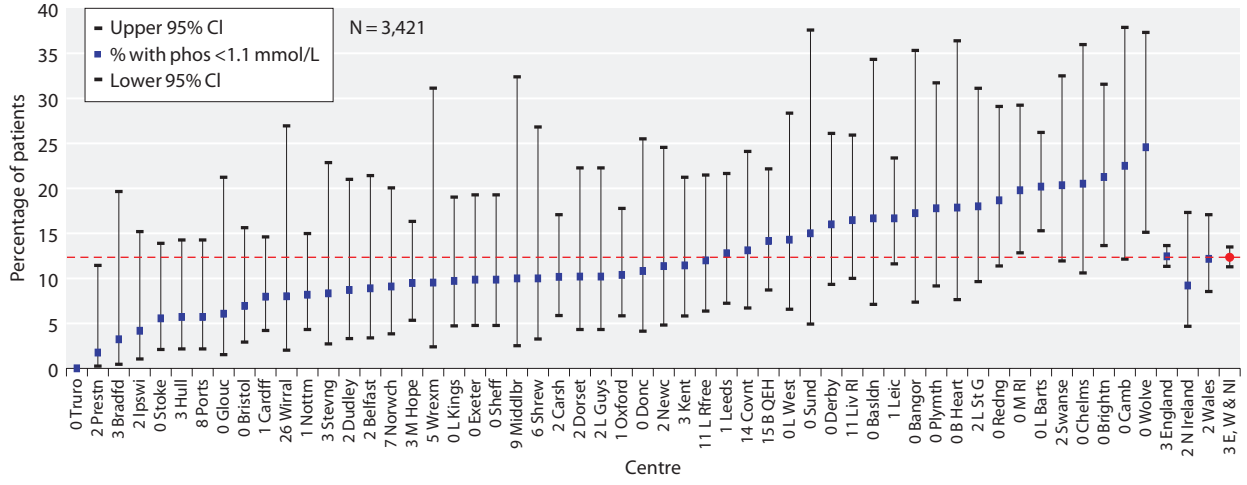

Fig. 10.9. Percentage of peritoneal dialysis patients with phosphate <1.1 mmol/L by centre in 2008

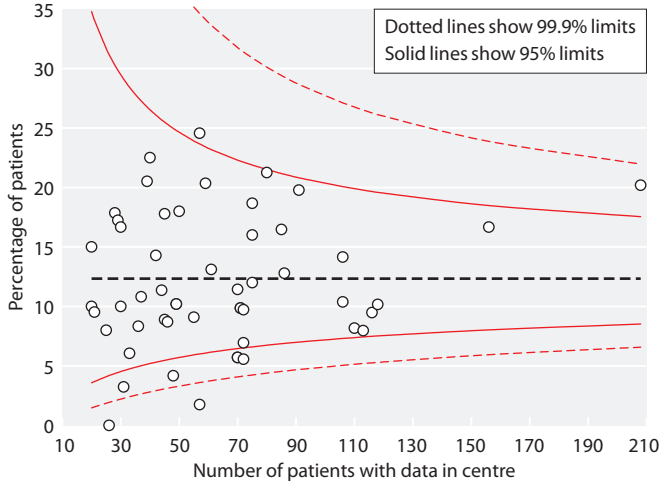

Fig. 10.10. Funnel plot of percentage of peritoneal dialysis patients with phosphate <1.1 mmol/L by centre in 2008

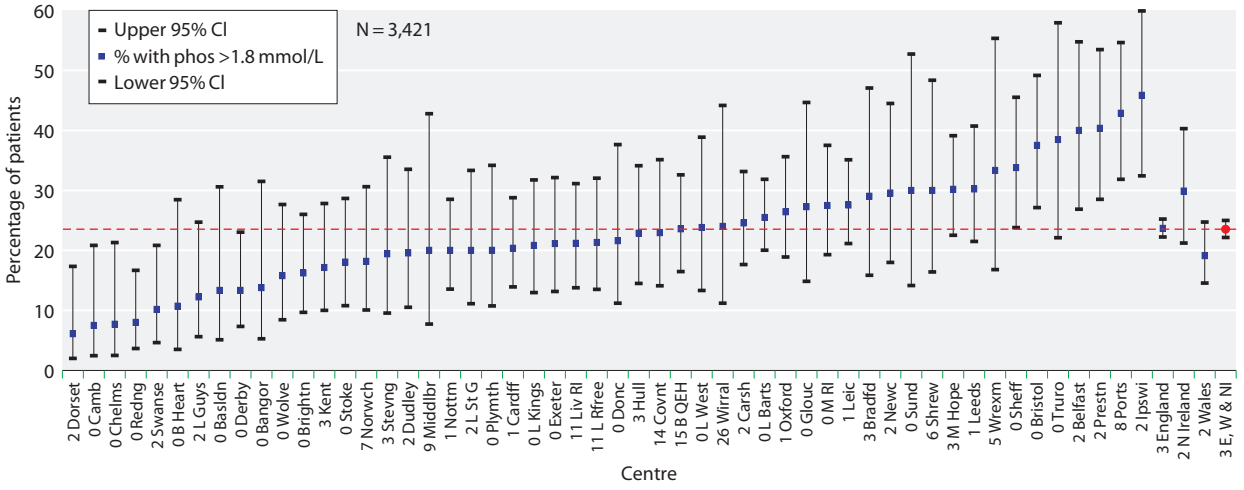

Fig. 10.11. Percentage of peritoneal dialysis patients with phosphate >1.8 mmol/L by centre in 2008

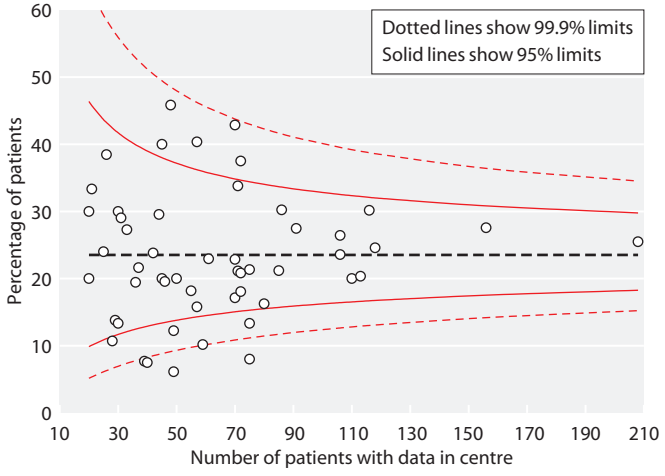

Fig. 10.12. Funnel plot of percentage of peritoneal dialysis patients with phosphate >1.8 mmol/L by centre in 2008

Table 10.5. Percentage of peritoneal dialysis patients within, below and above the range for phosphate (1.1–1.8 mmol/L) in 2008

Centre	N	% phos 1.1–1.8 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	Lower 95% CI	Upper 95% CI	% phos >1.8 mmol/L	Lower 95% CI	Upper 95% CI
B Heart	28	71.4	52.4	85.0	17.9	7.6	36.4	10.7	3.5	28.4
B QEH	106	62.3	52.7	71.0	14.2	8.7	22.2	23.6	16.5	32.6
Bangor	29	69.0	50.3	83.0	17.2	7.4	35.3	13.8	5.3	31.5
Basldn	30	70.0	51.7	83.6	16.7	7.1	34.3	13.3	5.1	30.6
Belfast	45	51.1	36.8	65.2	8.9	3.4	21.4	40.0	26.9	54.8
Bradfd	31	67.7	49.7	81.7	3.2	0.5	19.6	29.0	15.9	47.1
Brightn	80	62.5	51.5	72.4	21.3	13.6	31.6	16.3	9.7	26.0
Bristol	72	55.6	44.0	66.6	6.9	2.9	15.6	37.5	27.1	49.2
Camb	40	70.0	54.3	82.1	22.5	12.1	37.9	7.5	2.4	20.8

Table 10.5. Continued

Centre	N	% phos 1.1–1.8 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	Lower 95% CI	Upper 95% CI	% phos >1.8 mmol/L	Lower 95% CI	Upper 95% CI
Cardff	113	71.7	62.7	79.2	8.0	4.2	14.6	20.4	13.9	28.8
Carsh	118	65.3	56.3	73.3	10.2	5.9	17.1	24.6	17.7	33.1
Chelms	39	71.8	55.9	83.6	20.5	10.6	36.0	7.7	2.5	21.3
Covnt	61	63.9	51.3	74.9	13.1	6.7	24.1	23.0	14.1	35.1
Derby	75	70.7	59.4	79.8	16.0	9.3	26.1	13.3	7.3	23.0
Donc	37	67.6	51.1	80.6	10.8	4.1	25.5	21.6	11.2	37.6
Dorset	49	83.7	70.6	91.6	10.2	4.3	22.3	6.1	2.0	17.3
Dudley	46	71.7	57.2	82.8	8.7	3.3	21.0	19.6	10.5	33.5
Exeter	71	69.0	57.4	78.7	9.9	4.8	19.3	21.1	13.2	32.1
Glouc	33	66.7	49.2	80.5	6.1	1.5	21.2	27.3	14.8	44.7
Hull	70	71.4	59.8	80.8	5.7	2.2	14.3	22.9	14.5	34.1
Ipswi	48	50.0	36.2	63.8	4.2	1.0	15.2	45.8	32.4	59.9
Kent	70	71.4	59.8	80.8	11.4	5.8	21.2	17.1	10.0	27.8
L Barts	208	54.3	47.5	61.0	20.2	15.3	26.2	25.5	20.0	31.8
L Guys	49	77.6	63.8	87.1	10.2	4.3	22.3	12.2	5.6	24.7
L Kings	72	69.4	57.9	79.0	9.7	4.7	19.0	20.8	13.0	31.7
L Rfree	75	66.7	55.3	76.4	12.0	6.4	21.5	21.3	13.5	32.0
L St G	50	62.0	48.0	74.3	18.0	9.6	31.1	20.0	11.1	33.3
L West	42	61.9	46.6	75.2	14.3	6.6	28.3	23.8	13.3	38.9
Leeds	86	57.0	46.4	67.0	12.8	7.2	21.6	30.2	21.5	40.7
Leic	156	55.8	47.9	63.4	16.7	11.6	23.4	27.6	21.1	35.1
Liv RI	85	62.4	51.6	72.0	16.5	10.0	25.9	21.2	13.8	31.1
M Hope	116	60.3	51.2	68.8	9.5	5.3	16.3	30.2	22.5	39.1
M RI	91	52.8	42.5	62.8	19.8	12.8	29.2	27.5	19.3	37.5
Middlbr	20	70.0	47.3	85.9	10.0	2.5	32.4	20.0	7.7	42.8
Newc	44	59.1	44.2	72.5	11.4	4.8	24.5	29.6	18.0	44.5
Norwch	55	72.7	59.6	82.8	9.1	3.8	20.1	18.2	10.1	30.6
Nottm	110	71.8	62.7	79.4	8.2	4.3	15.0	20.0	13.6	28.5
Oxford	106	63.2	53.7	71.8	10.4	5.8	17.8	26.4	18.9	35.6
Plymth	45	62.2	47.4	75.1	17.8	9.2	31.7	20.0	10.8	34.2
Ports	70	51.4	39.9	62.9	5.7	2.2	14.3	42.9	31.8	54.6
Prestn	57	57.9	44.8	69.9	1.8	0.3	11.4	40.4	28.5	53.5
Redng	75	73.3	62.2	82.1	18.7	11.4	29.1	8.0	3.6	16.7
Sheff	71	56.3	44.7	67.4	9.9	4.8	19.3	33.8	23.8	45.5
Shrew	30	60.0	42.0	75.7	10.0	3.3	26.8	30.0	16.4	48.3
Stevng	36	72.2	55.6	84.4	8.3	2.7	22.9	19.4	9.6	35.5
Stoke	72	76.4	65.3	84.8	5.6	2.1	13.9	18.1	10.8	28.7
Sund	20	55.0	33.6	74.7	15.0	4.9	37.6	30.0	14.1	52.7
Swanse	59	69.5	56.7	79.9	20.3	11.9	32.5	10.2	4.6	20.8
Truro	26	61.5	42.1	77.9	0.0	0.0	0.0	38.5	22.1	57.9
Wirral	25	68.0	47.8	83.1	8.0	2.0	26.9	24.0	11.2	44.2
Wolve	57	59.7	46.6	71.5	24.6	15.1	37.3	15.8	8.4	27.7
Wrexm	21	57.1	36.0	76.0	9.5	2.4	31.1	33.3	16.8	55.3
England	**3,104**	**63.9**	**62.2**	**65.6**	**12.4**	**11.3**	**13.6**	**23.7**	**22.2**	**25.2**
N Ireland	**87**	**60.9**	**50.3**	**70.6**	**9.2**	**4.7**	**17.3**	**29.9**	**21.2**	**40.3**
Wales	**230**	**68.7**	**62.4**	**74.4**	**12.2**	**8.5**	**17.1**	**19.1**	**14.6**	**24.7**
E, W & NI	**3,421**	**64.1**	**62.5**	**65.7**	**12.3**	**11.3**	**13.5**	**23.5**	**22.1**	**25.0**

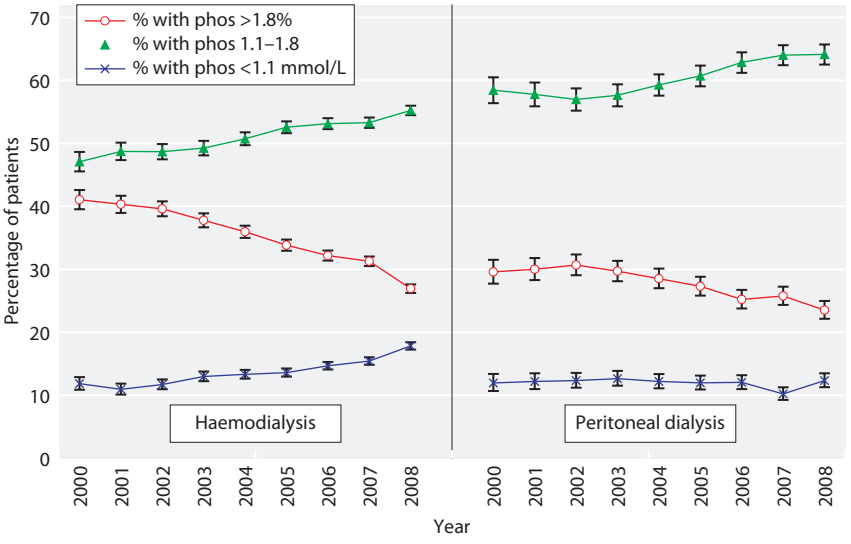

Fig. 10.13. Longitudinal change in percentage of patients with phosphate <1.1 mmol/L, 1.1–1.8 mmol/L and >1.8 mmol/L by dialysis modality 2000–2008

from the numbers in 2007 (53% and 64% respectively). Table 10.3 can be used to identify centres in each funnel plot of phosphate achievement in HD patients (figures 10.2, 10.4, 10.6). The funnel plots for patients within the audit target showed two centres performing significantly better than the national data, Birmingham (QEH) for HD (figure 10.2) and Dorset for PD (figure 10.8).

The mean proportion of HD patients with serum phosphate levels above the upper limit of the target range (1.8 mmol/L) was 27% (CI 26.3–27.6) and below the lower limit (1.1 mmol/L) was 18% (CI 17–18), continuing the gradual improvement in serum phosphate control over the last nine years (figure 10.13). The funnel plot showing the percentage of HD patients with serum phosphate above 1.8 mmol/L (figure 10.6) showed four centres with significantly higher percentages of patients above range (Portsmouth, Bristol, Sheffield, Preston) and four with significantly fewer (Reading, London Guys, London Kings, London West). For the analysis of patients with serum phosphate below 1.1 mmol/L, the funnel plot displayed considerable heterogeneity (figure 10.4) with two centres having significantly higher percentages of patients with low phosphate (Reading, London West). London West had a large percentage (36.1%) of patients with low phosphate although the completeness of data from this centre was relatively low at 78.6%. Seven centres had significantly fewer hypophosphataemic patients (Truro, Middlesbrough, Birmingham Heartlands, Portsmouth, Bristol, Sheffield and Leicester) than the national average. This probably represents a higher median value and range in these centres rather than specific measures to avoid hypophosphataemia. Table 10.4 can be used to identify centres in each funnel plot of phosphate achievement in PD patients (figures 10.8, 10.10, 10.12). The proportion of PD patients above 1.8 mmol/L was 24% (CI 22–25), a continuing improvement on previous years, while below 1.1 mmol/L was 12% (CI 11–14), a figure that appears stable (figure 10.13). The funnel plot for patients with serum phosphate above 1.8 mmol/L (figure 10.12) showed no centres with significantly more but four centres with significantly fewer patients with hyperphosphataemia (Cambridge, Chelmsford, Dorset, Reading). There were no centres with more hypophosphateamic patients but two centres with significantly fewer hypophosphataemic patients (Truro, Preston) (figure 10.10).

Centres should take the opportunity to review the way their blood samples are stored before reaching the laboratory, particularly if the delay is greater than eight hours or if the temperature at which the sample is stored before centrifugation is higher than 25°C [6, 7]. Delays in centrifugation lead to significant increases in serum phosphate due to release of intracellular stores and from organic phosphate esters. If blood samples cannot reach the laboratory within eight hours and at an ambient temperature less than 25°C, centres should centrifuge the samples to preserve them. Centres returning an excessively high percentage of patients with serum phosphate above target should consider whether a delay in sample processing may be a contributing factor. Centres returning a low percentage below target should also consider whether a delay in sample processing may be spuriously increasing the serum phosphate. This might be particularly relevant for the three centres (Portsmouth, Bristol, Sheffield) which, in the funnel

plots for HD, are both high outliers for the percentage of patients above 1.8 mmol/L and low outliers for the percentage of patients below 1.1 mmol/L. There remains large variation in centre level attainment of phosphate control which if laboratory processing errors have been excluded must represent differences in clinical practices.

Adjusted calcium

The 4th edition of the Renal Association Clinical Practice Guidelines states:

'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 HD patients) and ideally maintained between 2.2 and 2.5 mmol/L.' (Module 2: Complications) [1] (Note that previous UKRR reports have used an adjusted calcium of 2.2–2.6 mmol/L as the target range).

The data for adjusted serum calcium were 95% complete overall for HD patients (table 10.6) with eight centres attaining below 90% completeness (lowest 58%). For PD patients, the data were 97% complete overall (table 10.8) but three centres with sufficient eligible patients attained below 90% completeness (lowest 74% complete). The individual centres' means and standard deviations are shown in tables 10.6 and 10.8.

There was between centre variation in the proportion of patients below, within and above the audit range of 2.2–2.5 mmol/L for HD (figures 10.14–10.17) and PD (figures 10.18–10.22) patients. Overall 63% (CI 62–64) of HD patients (table 10.7) and 65% (CI 64–67) of PD patients (table 10.9) achieved the target, substantially less than the numbers in 2007 (73% and 78% respectively) using the previous target of 2.2–2.6 mmol/L. For comparative purposes, the previous target of 2.2–2.6 mmol/L was achieved by 74% of HD patients and 78% of PD patients, indicating that the previous standards had been maintained. Table 10.7 can be used to identify centres in the funnel plot of calcium achievement in HD patients (figure 10.15) and table 10.9 in PD patients (figures 10.19, 10.22). The funnel plot for patients within the audit target showed two centres achieved the target in significantly more HD patients (Ulster and London West) and two centres achieved the target in significantly fewer HD patients (Bristol and the Royal Free) (figure 10.15). In PD patients Brighton achieved the target in significantly more patients whilst Nottingham and Bristol achieved the target in significantly fewer patients (figure 10.19).

The proportion of HD patients above the 2.5 mmol/L target was 19% (CI 17.9–19.1) and below 2.2 mmol/L was 19% (CI 18.0–19.2) (figure 10.23). For comparison with previous years, 8% were above the previous 2.6 mmol/L target (figure 10.24). The proportion of PD patients above 2.5 mmol/L was 23% (CI 21–24) (figure 10.23) and 10% were above 2.6 mmol/L (figure 10.24), while the proportion below 2.2 mmol/L was 12% (CI 11–13), (figure 10.23). These data show that the proportions below the lower target limit has remained constant for HD and PD patients. The proportion of patients above the previous 2.6 mmol/L target has not increased and it is anticipated that as the new guidelines are implemented there will be improvements in the proportions attaining the new target.

Table 10.6. Summary statistics for adjusted calcium in haemodialysis patients in 2008

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	98	120	2.33	0.16	2.33	2.21	2.42
B Heart	96	371	2.27	0.19	2.28	2.15	2.4
B QEH	98	717	2.34	0.2	2.34	2.22	2.45
Bangor	97	69	2.36	0.16	2.37	2.26	2.48
Basldn	99	124	2.42	0.12	2.43	2.35	2.51
Belfast	96	230	2.34	0.17	2.33	2.23	2.45
Bradfd	96	173	2.39	0.19	2.36	2.28	2.49
Brightn	71	210	2.27	0.19	2.29	2.15	2.41
Bristol	100	418	2.5	0.16	2.5	2.39	2.5
Camb	58	170	2.34	0.18	2.32	2.23	2.45
Cardff	97	433	2.35	0.19	2.34	2.23	2.45
Carlis	99	74	2.23	0.22	2.22	2.12	2.33
Carsh	99	570	2.27	0.21	2.27	2.17	2.37

Table 10.6. Continued

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Chelms	100	95	2.37	0.2	2.38	2.28	2.51
Clwyd	93	63	2.37	0.16	2.37	2.27	2.48
Colchr	100	103	2.43	0.15	2.4	2.35	2.51
Covnt	98	280	2.33	0.18	2.3	2.21	2.43
Derby	99	228	2.39	0.17	2.4	2.29	2.49
Derry	100	52	2.4	0.13	2.41	2.33	2.48
Donc	100	72	2.42	0.13	2.44	2.35	2.49
Dorset	100	187	2.39	0.23	2.37	2.26	2.52
Dudley	87	104	2.3	0.22	2.32	2.19	2.42
Exeter	100	284	2.35	0.21	2.35	2.23	2.46
Glouc	100	142	2.37	0.18	2.35	2.24	2.45
Hull	99	287	2.41	0.18	2.39	2.3	2.52
Ipswi	100	96	2.35	0.15	2.33	2.27	2.45
Kent	99	292	2.46	0.17	2.5	2.4	2.5
L Barts	100	570	2.3	0.21	2.29	2.17	2.43
L Guys	98	472	2.33	0.19	2.32	2.22	2.43
L Kings	100	378	2.26	0.16	2.27	2.17	2.34
L Rfree	84	519	2.26	0.19	2.26	2.14	2.37
L St G	100	204	2.41	0.16	2.42	2.3	2.52
L West	78	908	2.34	0.16	2.35	2.25	2.44
Leeds	99	449	2.41	0.17	2.41	2.31	2.51
Leic	99	672	2.36	0.18	2.36	2.24	2.46
Liv Ain	93	108	2.42	0.15	2.42	2.34	2.51
Liv RI	94	353	2.38	0.22	2.38	2.27	2.5
M Hope	84	241	2.29	0.19	2.28	2.18	2.41
M RI	72	279	2.27	0.19	2.27	2.16	2.37
Middlbr	98	265	2.32	0.21	2.34	2.2	2.45
Newc	100	252	2.4	0.19	2.39	2.29	2.48
Newry	99	87	2.28	0.18	2.28	2.16	2.4
Norwch	99	283	2.44	0.16	2.42	2.34	2.53
Nottm	100	352	2.45	0.19	2.45	2.33	2.55
Oxford	99	324	2.39	0.19	2.4	2.27	2.52
Plymth	97	109	2.34	0.18	2.34	2.23	2.44
Ports	100	411	2.37	0.17	2.37	2.27	2.48
Prestn	100	412	2.31	0.21	2.31	2.19	2.45
Redng	100	232	2.3	0.14	2.29	2.22	2.38
Sheff	99	567	2.3	0.17	2.3	2.2	2.4
Shrew	99	169	2.3	0.18	2.3	2.2	2.4
Stevng	98	336	2.39	0.17	2.38	2.29	2.51
Sthend	99	121	2.38	0.19	2.39	2.27	2.49
Stoke	100	240	2.38	0.17	2.38	2.3	2.48
Sund	96	145	2.43	0.18	2.43	2.35	2.54
Swanse	98	312	2.27	0.17	2.27	2.17	2.38
Truro	100	134	2.37	0.17	2.35	2.26	2.44
Tyrone	100	84	2.45	0.18	2.46	2.34	2.55
Ulster	100	77	2.4	0.12	2.42	2.34	2.48
Wirral	98	159	2.4	0.16	2.39	2.3	2.48
Wolve	100	274	2.35	0.22	2.33	2.22	2.46
Wrexm	100	71	2.45	0.16	2.48	2.32	2.57
York	87	96	2.37	0.14	2.39	2.31	2.45
England	**94**	**15,031**	**2.35**	**0.19**	**2.35**	**2.23**	**2.47**
N Ireland	**98**	**650**	**2.36**	**0.17**	**2.36**	**2.24**	**2.47**
Wales	**97**	**948**	**2.33**	**0.18**	**2.33**	**2.22**	**2.44**
E, W & NI	**95**	**16,629**	**2.35**	**0.19**	**2.35**	**2.23**	**2.47**

Table 10.7. Percentage of haemodialysis patients within, below and above the range for adjusted calcium (2.2–2.5 mmol/L) in 2008

Centre	Total	% adjusted Ca 2.2–2.5 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca <2.2 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca >2.5 mmol/L	Lower 95% CI	Upper 95% CI
Antrim	120	66.7	57.8	74.5	21.7	15.2	29.9	11.7	7.0	18.7
B Heart	371	55.3	50.2	60.2	33.2	28.6	38.1	11.6	8.7	15.3
B QEH	717	61.4	57.8	64.9	20.2	17.4	23.3	18.4	15.7	21.4
Bangor	69	63.8	51.9	74.2	14.5	8.0	24.9	21.7	13.6	33.0
Basldn	124	71.0	62.4	78.3	4.0	1.7	9.3	25.0	18.2	33.4
Belfast	230	67.4	61.1	73.1	17.4	13.0	22.8	15.2	11.1	20.5
Bradfd	173	69.4	62.1	75.8	8.7	5.3	13.9	22.0	16.4	28.8
Brightn	210	57.6	50.8	64.1	32.9	26.8	39.5	9.5	6.2	14.3
Bristol	418	48.8	44.0	53.6	2.5	1.5	4.7	48.6	43.8	53.4
Camb	170	64.1	56.6	71.0	18.8	13.6	25.4	17.1	12.1	23.5
Cardff	433	64.0	59.3	68.4	18.9	15.5	22.9	17.1	13.8	20.9
Carlis	74	47.3	36.3	58.6	43.2	32.5	54.7	9.5	4.6	18.5
Carsh	570	56.7	52.6	60.7	33.5	29.8	37.5	9.8	7.6	12.6
Chelms	95	55.8	45.7	65.4	19.0	12.3	28.1	25.3	17.6	34.9
Clwyd	63	66.7	54.2	77.2	12.7	6.5	23.4	20.6	12.4	32.4
Colchr	103	68.0	58.4	76.2	5.8	2.5	12.4	26.2	18.6	35.5
Covnt	280	61.8	56.0	67.3	23.9	19.3	29.3	14.3	10.7	18.9
Derby	228	68.4	62.1	74.1	9.7	6.4	14.2	21.9	17.0	27.8
Derry	52	78.9	65.7	87.9	7.7	2.9	18.8	13.5	6.6	25.7
Donc	72	75.0	63.8	83.6	6.9	2.9	15.6	18.1	10.8	28.7
Dorset	187	55.6	48.4	62.6	17.1	12.4	23.2	27.3	21.4	34.1
Dudley	104	58.7	49.0	67.7	26.0	18.5	35.2	15.4	9.6	23.7
Exeter	284	60.6	54.8	66.1	20.4	16.1	25.5	19.0	14.9	24.0
Glouc	142	69.0	61.0	76.1	13.4	8.7	20.0	17.6	12.2	24.8
Hull	287	62.7	57.0	68.1	10.1	7.1	14.2	27.2	22.3	32.5
Ipswi	96	76.0	66.5	83.5	10.4	5.7	18.3	13.5	8.0	21.9
Kent	292	69.2	63.7	74.2	2.4	1.2	4.9	28.4	23.6	33.9
L Barts	570	56.1	52.0	60.2	28.4	24.9	32.3	15.4	12.7	18.6
L Guys	472	67.0	62.6	71.1	18.2	15.0	22.0	14.8	11.9	18.3
L Kings	378	63.0	58.0	67.7	30.2	25.7	35.0	6.9	4.7	9.9
L Rfree	519	55.3	51.0	59.5	34.9	30.9	39.1	9.8	7.6	12.7
L St G	204	63.2	56.4	69.6	10.3	6.8	15.3	26.5	20.9	33.0
L West	908	69.5	66.4	72.4	16.4	14.1	19.0	14.1	12.0	16.5
Leeds	449	63.9	59.4	68.2	8.9	6.6	11.9	27.2	23.3	31.5
Leic	672	64.0	60.3	67.5	17.7	15.0	20.8	18.3	15.6	21.4
Liv Ain	108	67.6	58.2	75.7	5.6	2.5	11.8	26.9	19.4	36.0
Liv RI	353	60.3	55.1	65.3	15.6	12.2	19.8	24.1	19.9	28.8
M Hope	241	56.4	50.1	62.6	29.9	24.4	36.0	13.7	9.9	18.6
M RI	279	57.4	51.5	63.0	32.5	27.4	38.3	10.0	7.0	14.2
Middlbr	265	65.7	59.7	71.1	20.8	16.3	26.1	13.6	10.0	18.3
Newc	252	69.1	63.1	74.5	9.9	6.8	14.3	21.0	16.4	26.5
Newry	87	58.6	48.0	68.5	31.0	22.2	41.5	10.3	5.5	18.7
Norwch	283	68.9	63.3	74.0	3.2	1.7	6.0	27.9	23.0	33.4
Nottm	352	57.1	51.9	62.2	7.4	5.1	10.6	35.5	30.7	40.7
Oxford	324	58.3	52.9	63.6	13.6	10.3	17.8	28.1	23.5	33.2
Plymth	109	66.1	56.7	74.3	19.3	12.9	27.8	14.7	9.2	22.5
Ports	411	69.8	65.2	74.1	11.0	8.3	14.4	19.2	15.7	23.3
Prestn	412	55.3	50.5	60.1	27.4	23.3	31.9	17.2	13.9	21.2
Redng	232	72.4	66.3	77.8	19.8	15.2	25.5	7.8	4.9	12.0
Sheff	567	67.0	63.0	70.8	24.3	21.0	28.0	8.6	6.6	11.3
Shrew	169	73.4	66.2	79.5	16.0	11.2	22.3	10.7	6.8	16.3
Stevng	336	62.2	56.9	67.2	12.8	9.6	16.8	25.0	20.7	29.9
Sthend	121	63.6	54.7	71.7	13.2	8.3	20.5	23.1	16.5	31.5
Stoke	240	68.3	62.2	73.9	13.8	9.9	18.7	17.9	13.6	23.3
Sund	145	60.0	51.8	67.7	8.3	4.8	14.0	31.7	24.7	39.7

Table 10.7. Continued

Centre	Total	% adjusted Ca 2.2–2.5 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca <2.2 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca >2.5 mmol/L	Lower 95% CI	Upper 95% CI
Swanse	312	60.3	54.7	65.5	32.6	27.7	38.1	7.1	4.7	10.5
Truro	1340	64.9	56.5	72.5	13.4	8.6	20.3	21.6	15.5	29.4
Tyrone	84	58.3	47.6	68.4	3.6	1.2	10.5	38.1	28.4	48.9
Ulster	77	83.1	73.1	89.9	2.5	0.7	9.8	14.3	8.1	24.0
Wirral	159	69.2	61.6	75.9	10.1	6.3	15.8	20.8	15.2	27.8
Wolve	274	63.1	57.3	68.7	20.4	16.1	25.6	16.4	12.5	21.3
Wrexm	710	49.3	37.9	60.8	5.6	2.1	14.1	45.1	34.0	56.7
York	96	76.0	66.5	83.5	11.5	6.5	19.5	12.5	7.2	20.7
England	**15,031**	**62.8**	**62.0**	**63.5**	**18.5**	**17.8**	**19.1**	**18.8**	**18.2**	**19.4**
N Ireland	**650**	**67.7**	**64.0**	**71.2**	**15.7**	**13.1**	**18.7**	**16.6**	**14.0**	**19.7**
Wales	**948**	**61.8**	**58.7**	**64.9**	**21.7**	**19.2**	**24.5**	**16.5**	**14.2**	**19.0**
E, W & NI	**16,629**	**62.9**	**62.2**	**63.6**	**18.5**	**17.9**	**19.1**	**18.6**	**18.0**	**19.2**

Table 10.8. Summary statistics for adjusted calcium in peritoneal dialysis patients in 2008

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	94	15					
B Heart	100	28	2.29	0.17	2.31	2.19	2.39
B QEH	86	107	2.33	0.17	2.31	2.21	2.43
Bangor	100	29	2.4	0.12	2.42	2.37	2.49
Basldn	100	30	2.44	0.14	2.41	2.37	2.53
Belfast	98	45	2.35	0.19	2.34	2.22	2.44
Bradfd	97	31	2.43	0.11	2.42	2.35	2.52
Brightn	100	80	2.37	0.13	2.35	2.3	2.45
Bristol	100	72	2.51	0.16	2.51	2.43	2.5
Camb	100	40	2.34	0.15	2.32	2.24	2.43
Cardff	99	113	2.35	0.15	2.35	2.28	2.45
Carlis	100	17					
Carsh	98	118	2.34	0.19	2.33	2.21	2.44
Chelms	100	39	2.42	0.18	2.39	2.27	2.57
Clwyd	80	8					
Colch	n/a	0					
Covnt	96	68	2.32	0.14	2.3	2.21	2.43
Derby	100	75	2.42	0.14	2.44	2.33	2.52
Derry	100	5					
Donc	100	37	2.48	0.13	2.48	2.39	2.57
Dorset	98	49	2.41	0.12	2.42	2.33	2.5
Dudley	98	46	2.36	0.18	2.35	2.26	2.47
Exeter	100	71	2.35	0.21	2.37	2.25	2.46
Glouc	100	33	2.44	0.13	2.44	2.35	2.54
Hull	97	70	2.46	0.11	2.46	2.42	2.53
Ipswi	98	48	2.37	0.16	2.38	2.32	2.46
Kent	99	71	2.54	0.16	2.5	2.4	2.52
L Barts	100	208	2.35	0.18	2.34	2.24	2.45
L Guys	98	49	2.36	0.16	2.37	2.3	2.46
L Kings	100	72	2.3	0.14	2.29	2.2	2.39
L Rfree	89	75	2.35	0.17	2.31	2.23	2.46
L St G	98	50	2.47	0.16	2.46	2.38	2.57
L West	100	42	2.44	0.19	2.41	2.33	2.51
Leeds	99	86	2.43	0.15	2.45	2.36	2.51
Leic	99	156	2.38	0.16	2.4	2.28	2.48

Table 10.8. Continued

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Liv Ain	50	1					
Liv RI	90	85	2.41	0.17	2.41	2.3	2.5
M Hope	98	116	2.29	0.2	2.28	2.17	2.39
M RI	100	91	2.34	0.16	2.33	2.24	2.43
Middlbr	91	20	2.28	0.17	2.29	2.2	2.39
Newc	98	44	2.39	0.13	2.37	2.3	2.46
Newry	100	10					
Norwch	93	55	2.48	0.13	2.49	2.37	2.55
Nottm	99	110	2.53	0.16	2.53	2.43	2.54
Oxford	99	106	2.47	0.16	2.47	2.38	2.57
Plymth	100	45	2.41	0.14	2.42	2.33	2.5
Ports	93	71	2.39	0.18	2.4	2.24	2.49
Prestn	98	57	2.36	0.15	2.33	2.26	2.47
Redng	100	75	2.34	0.15	2.34	2.24	2.42
Sheff	100	71	2.35	0.17	2.35	2.28	2.44
Shrew	94	30	2.3	0.17	2.3	2.2	2.4
Stevng	97	36	2.43	0.15	2.45	2.33	2.55
Sthend	93	14					
Stoke	100	72	2.44	0.15	2.44	2.37	2.51
Sund	100	20	2.4	0.13	2.41	2.37	2.5
Swanse	98	59	2.26	0.13	2.27	2.16	2.35
Truro	100	26	2.4	0.22	2.36	2.29	2.49
Tyrone	100	7					
Ulster	100	5					
Wirral	74	25	2.42	0.19	2.44	2.32	2.53
Wolve	100	57	2.32	0.2	2.33	2.2	2.42
Wrexm	95	21	2.54	0.13	2.53	2.48	2.51
York	95	18					
England	**97**	**3,113**	**2.39**	**0.18**	**2.39**	**2.28**	**2.5**
N Ireland	**98**	**87**	**2.36**	**0.17**	**2.35**	**2.23**	**2.48**
Wales	**98**	**230**	**2.35**	**0.16**	**2.35**	**2.26**	**2.46**
E, W & NI	**97**	**3,430**	**2.39**	**0.17**	**2.39**	**2.28**	**2.49**

Blank cells denote centres excluded from analyses due to low patient numbers or poor data completeness
n/a not applicable

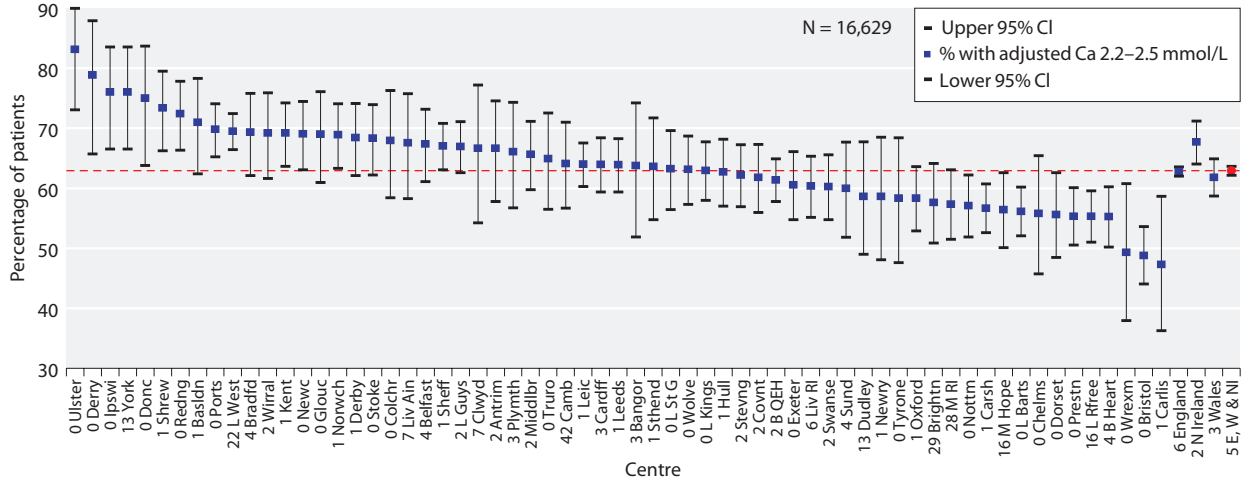

Fig. 10.14. Percentage of haemodialysis patients with adjusted calcium 2.2–2.5 mmol/L by centre in 2008

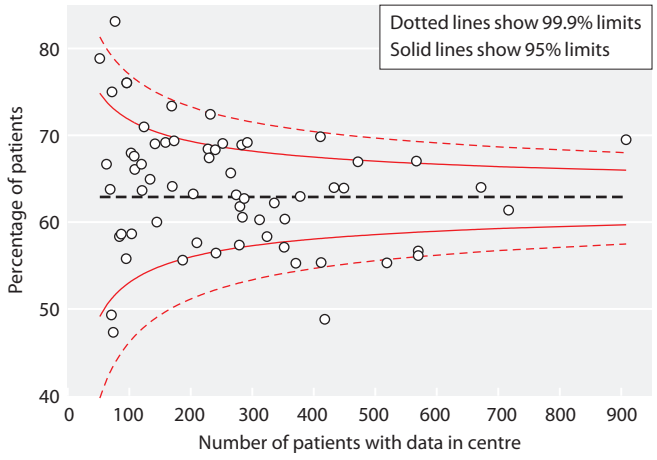

Fig. 10.15. Funnel plot of percentage of haemodialysis patients with adjusted calcium 2.2–2.5 mmol/L by centre in 2008

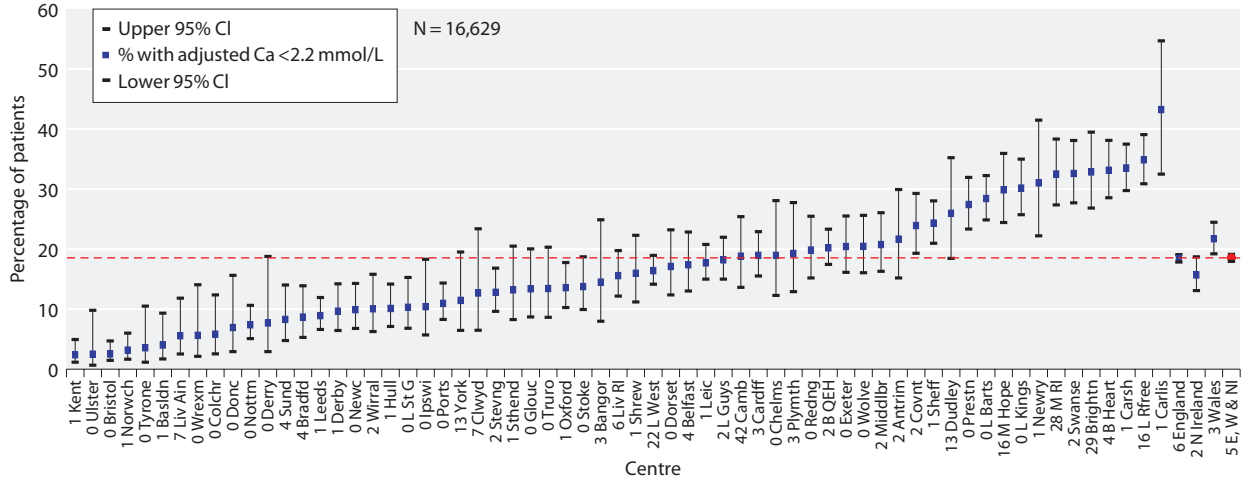

Fig. 10.16. Percentage of haemodialysis patients with adjusted calcium <2.2 mmol/L by centre in 2008

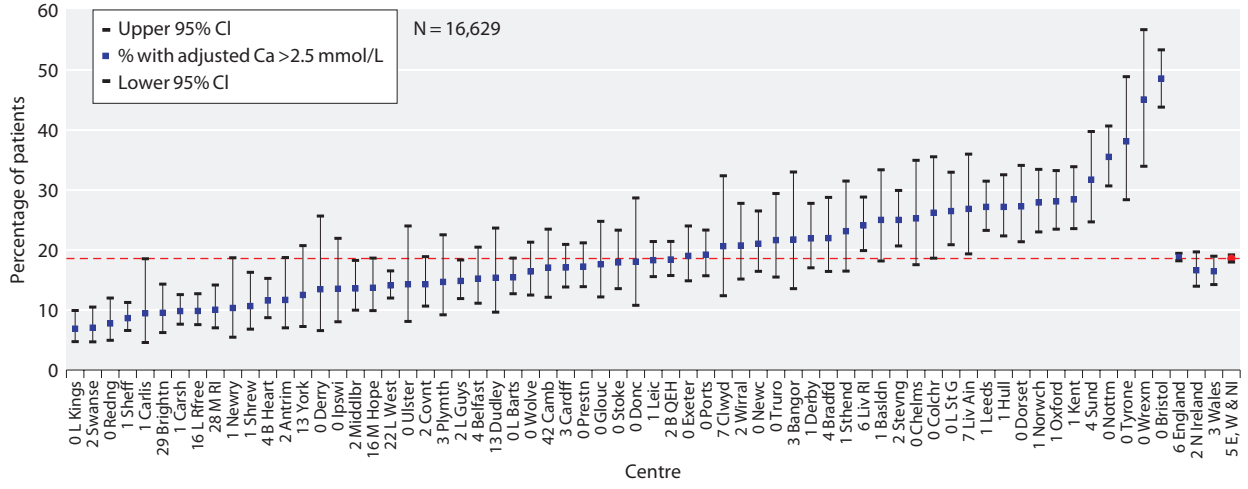

Fig. 10.17 Percentage of haemodialysis patients with adjusted calcium >2.5 mmol/L by centre in 2008

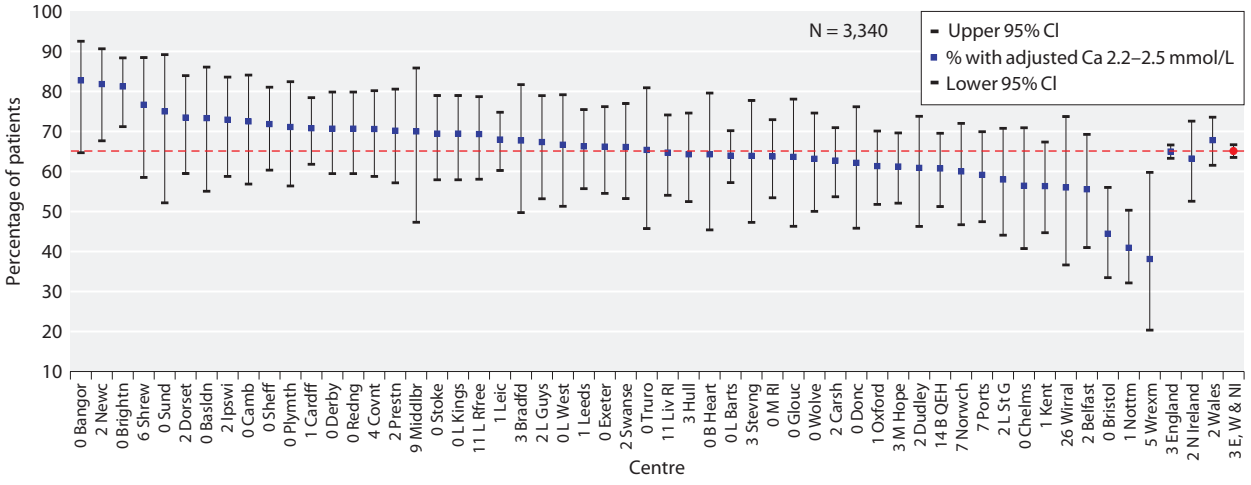

Fig. 10.18. Percentage of peritoneal dialysis patients with adjusted calcium 2.2–2.5 mmol/L by centre in 2008

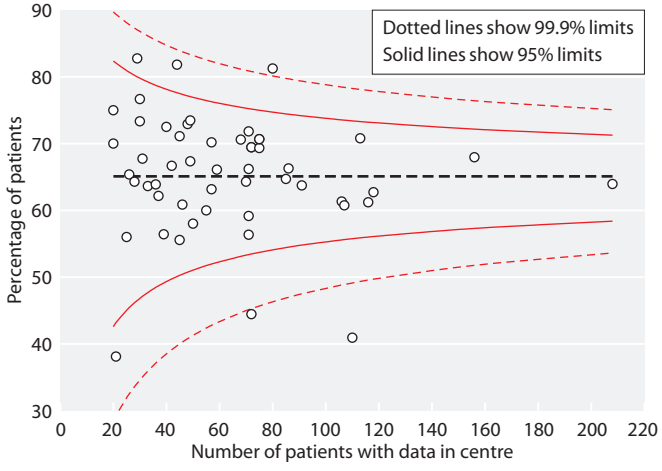

Fig. 10.19. Funnel plot of percentage of peritoneal dialysis patients with adjusted calcium 2.2–2.5 mmol/L by centre in 2008

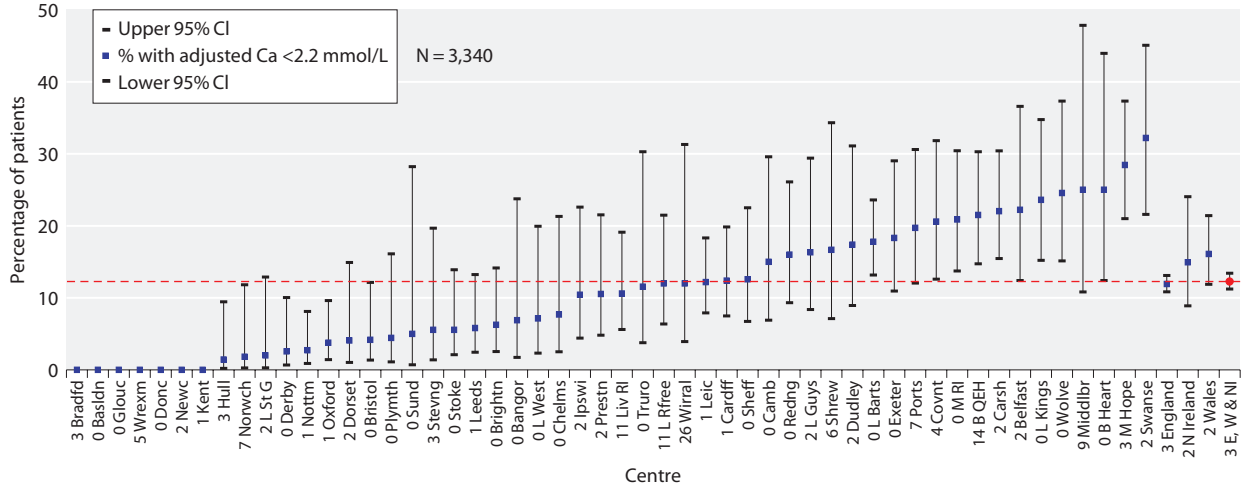

Fig. 10.20. Percentage of peritoneal dialysis patients with adjusted calcium <2.2 mmol/L by centre in 2008

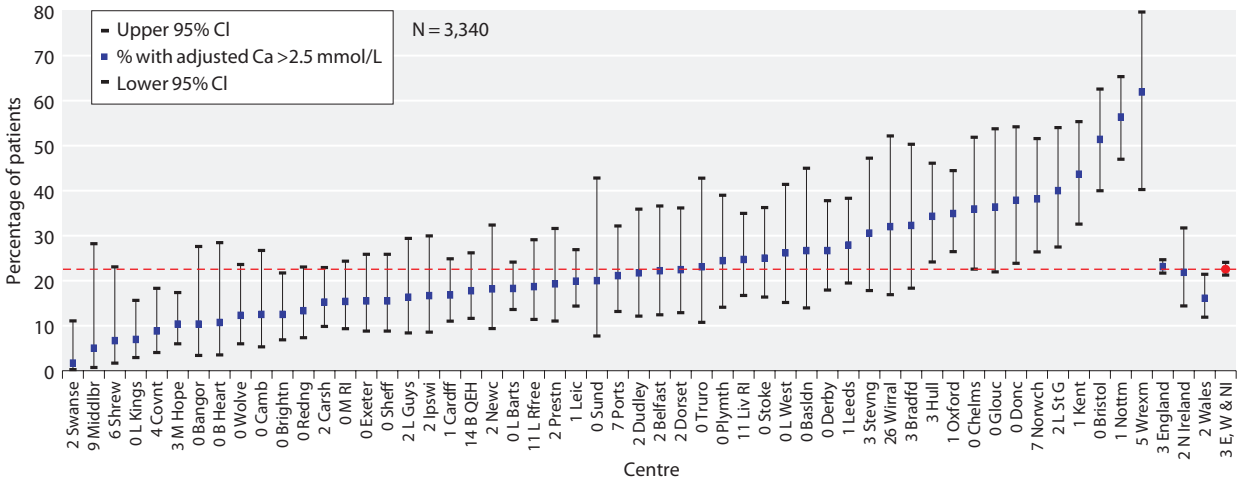

Fig. 10.21. Percentage of peritoneal dialysis patients with adjusted calcium >2.5 mmol/L by centre in 2008

The funnel plots for adjusted calcium concentration greater than 2.5 mmol/L and less than 2.2 mmol/L showed considerable heterogeneity in HD patients (plots not shown). There is over dispersion of the data which makes interpretation difficult. This may have arisen because there are multiple patient and centre level factors which contribute to hyper and hypocalcaemia which are not measured here. For PD patients, there were three centres returning significantly high proportions of patients with calcium levels above 2.5 mmol/L (Kent, Bristol, Nottingham) (figure 10.22).

Examining individual centres longitudinally, one centre (Nottingham) showed an approximately threefold increase in the proportion of both HD and PD patients exceeding the previous upper target limit of 2.6 mmol/L compared with previous years. Further investigations revealed laboratory changes during the year to the formula in use for adjusting calcium and the development of biases in the methods used for albumin and calcium, all factors that conspired to increase adjusted calcium values by some 0.15 mmol/L. Retrospective correction of the adjusted calcium values by 0.15 mmol/L revealed this to be the cause of the increase in proportion of patients exceeding the upper target value. The data shown for Nottingham are as reported without any correction. This problem serves to emphasise the importance of dialysis centres establishing good working relationships with their laboratories. Other centres with excessive proportions of patients outside limits should consider consulting their laboratories about possible biases.

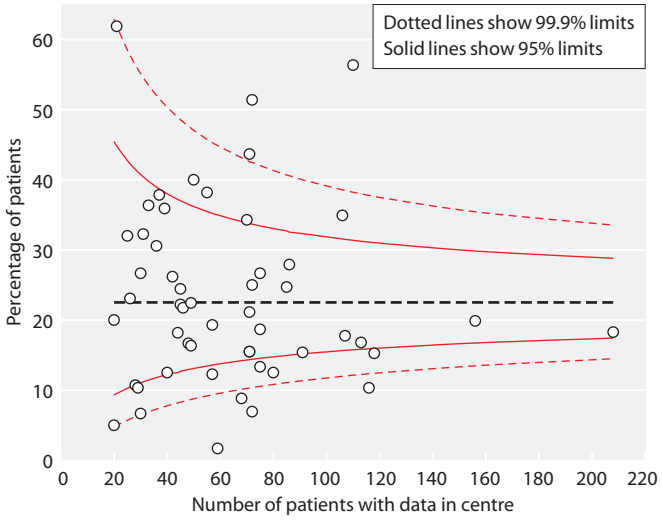

Fig. 10.22. Funnel plot of percentage of peritoneal dialysis patients with adjusted calcium >2.5 mmol/L by centre in 2008

Calcium phosphate product

The 4th edition of the Renal Association Clinical Practice Guidelines states:

'The serum albumin corrected calcium and phosphorus product should be maintained below 4.8 mmol^2/L^2 and ideally below 4.2 mmol^2/L^2 in all CKD patients.' (Module 2: Complications) [1]

The data for calcium phosphate product were 95% complete overall for HD patients with eight centres attaining less than 90% completeness. For PD patients, the data were 97% complete with five centres with sufficient eligible patients attaining below 90% completeness (data not shown).

Table 10.9. Percentage of peritoneal dialysis patients within, below and above the range for adjusted calcium (2.2–2.5 mmol/L) in 2008

Centre	N	% adjusted Ca 2.2–2.5 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca <2.2 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca >2.5 mmol/L	Lower 95% CI	Upper 95% CI
B Heart	28	64.3	45.4	79.6	25.0	12.4	44.0	10.7	3.5	28.4
B QEH	107	60.8	51.2	69.5	21.5	14.7	30.3	17.8	11.6	26.2
Bangor	29	82.8	64.7	92.5	6.9	1.7	23.8	10.3	3.4	27.6
Basldn	30	73.3	55.0	86.1	0.0	0.0	0.0	26.7	13.9	45.0
Belfast	45	55.6	41.0	69.2	22.2	12.4	36.6	22.2	12.4	36.6
Bradfd	31	67.7	49.7	81.7	0.0	0.0	100.0	32.3	18.3	50.3
Brightn	80	81.3	71.2	88.4	6.3	2.5	14.2	12.5	6.9	21.7
Bristol	72	44.4	33.5	56.0	4.2	1.4	12.1	51.4	40.0	62.6
Camb	40	72.5	56.8	84.1	15.0	6.9	29.6	12.5	5.3	26.7
Cardff	113	70.8	61.8	78.4	12.4	7.5	19.8	16.8	11.0	24.9
Carsh	118	62.7	53.7	71.0	22.0	15.5	30.4	15.3	9.8	22.9
Chelms	39	56.4	40.7	70.9	7.7	2.5	21.3	35.9	22.6	51.9
Covnt	68	70.6	58.8	80.2	20.6	12.6	31.8	8.8	4.0	18.3
Derby	75	70.7	59.4	79.8	2.6	0.7	10.0	26.7	17.9	37.8
Donc	37	62.2	45.8	76.2	0.0	0.0	0.0	37.8	23.9	54.2
Dorset	49	73.5	59.5	83.9	4.1	1.0	14.9	22.5	12.9	36.2
Dudley	46	60.9	46.3	73.8	17.4	8.9	31.1	21.7	12.1	35.9
Exeter	71	66.2	54.5	76.2	18.3	10.9	29.0	15.5	8.8	25.9
Glouc	33	63.6	46.3	78.1	0.0	0.0	0.0	36.4	21.9	53.7
Hull	70	64.3	52.5	74.6	1.4	0.2	9.5	34.3	24.2	46.1
Ipswi	48	72.9	58.8	83.6	10.4	4.4	22.6	16.7	8.6	29.9
Kent	71	56.3	44.7	67.4	0.0	0.0	0.0	43.7	32.6	55.3
L Barts	208	63.9	57.2	70.2	17.8	13.2	23.6	18.3	13.6	24.1
L Guys	49	67.4	53.2	78.9	16.3	8.4	29.4	16.3	8.4	29.4
L Kings	72	69.4	57.9	79.0	23.6	15.2	34.8	6.9	2.9	15.6
L Rfree	75	69.3	58.1	78.7	12.0	6.4	21.5	18.7	11.4	29.1
L St G	50	58.0	44.1	70.8	2.0	0.3	12.9	40.0	27.5	54.0
L West	42	66.7	51.3	79.2	7.1	2.3	19.9	26.2	15.1	41.4
Leeds	86	66.3	55.7	75.5	5.8	2.4	13.2	27.9	19.5	38.3
Leic	156	68.0	60.2	74.8	12.2	7.9	18.3	19.9	14.3	26.9
Liv RI	85	64.7	54.0	74.1	10.6	5.6	19.1	24.7	16.7	34.9
M Hope	116	61.2	52.1	69.6	28.5	21.0	37.3	10.3	6.0	17.3
M RI	91	63.7	53.4	72.9	20.9	13.7	30.4	15.4	9.3	24.3
Middlbr	20	70.0	47.3	85.9	25.0	10.8	47.8	5.0	0.7	28.2
Newc	44	81.8	67.7	90.6	0.0	0.0	0.0	18.2	9.4	32.3
Norwch	55	60.0	46.7	72.0	1.8	0.3	11.8	38.2	26.4	51.6
Nottm	110	40.9	32.1	50.3	2.7	0.9	8.1	56.4	47.0	65.3
Oxford	106	61.3	51.8	70.1	3.8	1.4	9.6	34.9	26.5	44.4
Plymth	45	71.1	56.4	82.4	4.4	1.1	16.1	24.4	14.1	39.0
Ports	71	59.2	47.4	69.9	19.7	12.0	30.6	21.1	13.2	32.1
Prestn	57	70.2	57.2	80.6	10.5	4.8	21.5	19.3	11.0	31.6
Redng	75	70.7	59.4	79.8	16.0	9.3	26.1	13.3	7.3	23.0
Sheff	71	71.8	60.3	81.1	12.6	6.7	22.5	15.5	8.8	25.9
Shrew	30	76.7	58.5	88.5	16.7	7.1	34.3	6.7	1.7	23.1
Stevng	36	63.9	47.3	77.7	5.6	1.4	19.7	30.6	17.8	47.2
Stoke	72	69.4	57.9	79.0	5.6	2.1	13.9	25.0	16.4	36.2
Sund	20	75.0	52.2	89.2	5.0	0.7	28.2	20.0	7.7	42.8
Swanse	59	66.1	53.2	77.0	32.2	21.6	45.1	1.7	0.2	11.1
Truro	26	65.4	45.7	80.9	11.5	3.8	30.3	23.1	10.8	42.8
Wirral	25	56.0	36.6	73.7	12.0	3.9	31.3	32.0	16.9	52.2
Wolve	57	63.2	50.0	74.6	24.6	15.1	37.3	12.3	6.0	23.6
Wrexm	21	38.1	20.3	59.8	0.0	0.0	0.0	61.9	40.3	79.7
England	**3,113**	**65.0**	**63.3**	**66.6**	**11.9**	**10.8**	**13.1**	**23.1**	**21.7**	**24.6**
N Ireland	**87**	**63.2**	**52.5**	**72.6**	**14.9**	**8.9**	**24.1**	**21.8**	**14.4**	**31.7**
Wales	**230**	**67.8**	**61.5**	**73.5**	**16.1**	**11.9**	**21.4**	**16.1**	**11.9**	**21.4**
E, W & NI	**3,430**	**65.1**	**63.5**	**66.7**	**12.3**	**11.2**	**13.4**	**22.5**	**21.3**	**24.1**

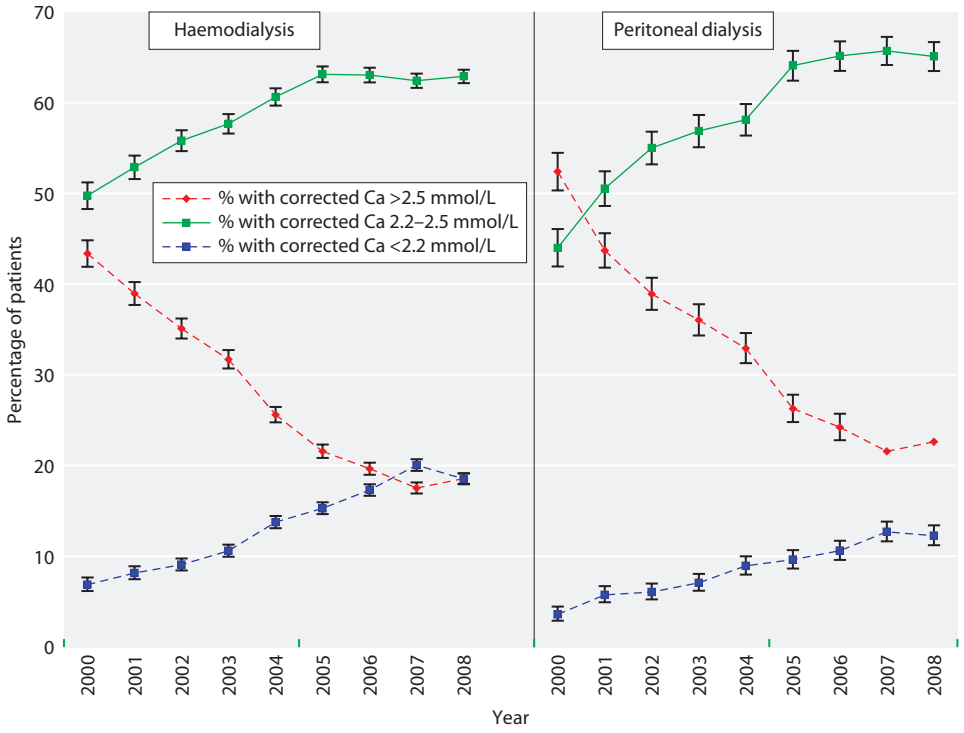

Fig. 10.23. Longitudinal change in percentage of patients with adjusted calcium <2.2 mmol/L, 2.2–2.5 mmol/L and >2.5 mmol/L by dialysis modality 2000–2008

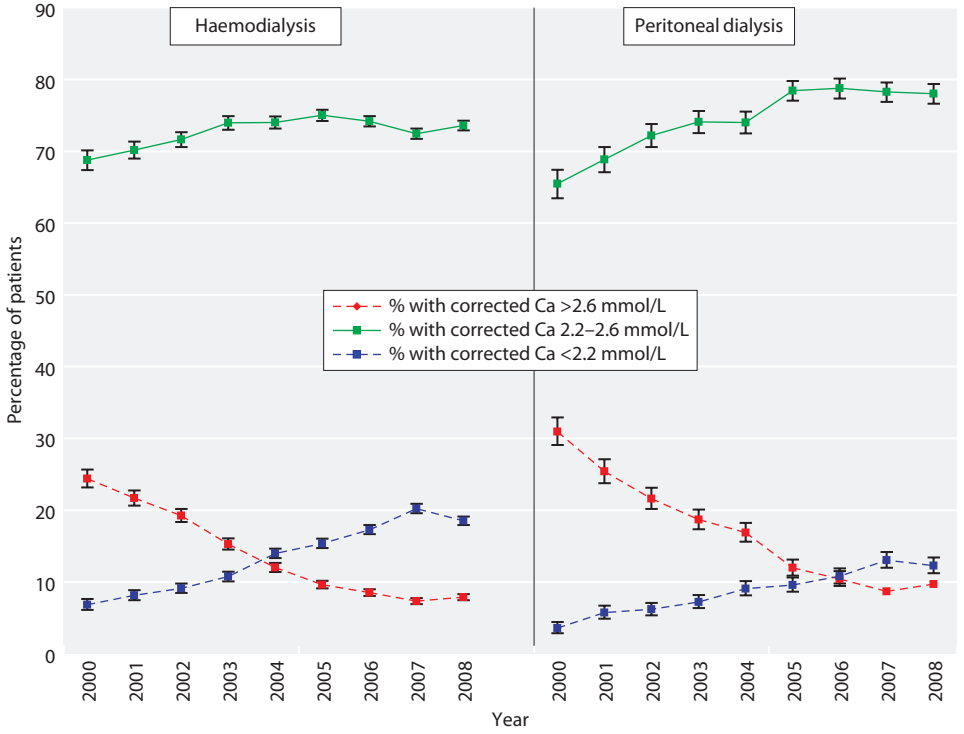

Fig. 10.24. Longitudinal change in percentage of patients with adjusted calcium <2.2 mmol/L, 2.2–2.6 mmol/L and >2.6 mmol/L by dialysis modality 2000–2008

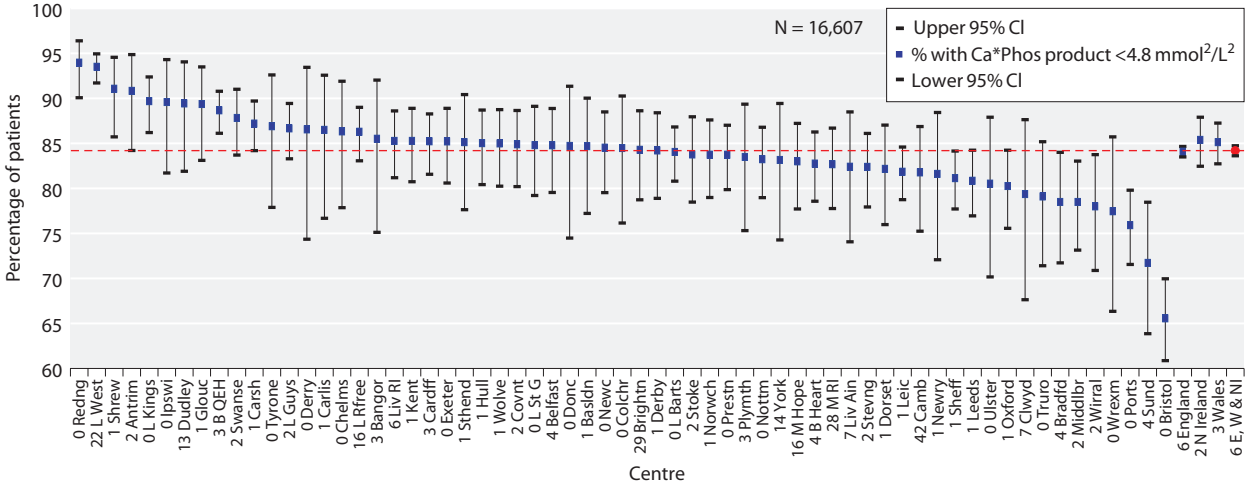

Fig. 10.25. Percentage of haemodialysis patients with calcium*phosphate product <4.8 mmol^2/L^2 by centre in 2008

Overall 84% (CI 84–85) of HD patients (figure 10.25) and 87% (CI 85–88) of PD patients (figure 10.26) achieved the target of below 4.8 mmol^2/L^2. The funnel plots for percentage of patients above 4.8 mmol^2/L^2 showed two centres with significantly more patients above this target than the national average (Portsmouth 24%, Bristol 34%) for HD patients (figure 10.27) but no outlying centres for PD patients (figure 10.28). Four centres achieved the audit standard in significantly more HD patients (Reading, London West, London Kings, Birmingham QE) (figure 10.29) than the national average. Likewise four centres achieved the audit standard in significantly more PD patients (Chelmsford, Cambridge, Dorset and Swansea) (figure 10.30). For both dialysis modes, there has been a continuing steady decline in the proportion of patients with a corrected calcium phosphate product above 4.8 mmol^2/L^2 (figure 10.31).

The two centres (London West, Reading) with the lowest proportion of patients (6–7%) with a calcium-phosphate product above 4.8 mmol^2/L^2 also had large numbers of patients with low serum phosphates but not calcium. This may be due to a number of reasons that cannot be dissected out here but assuming phosphate concentrations are correct might include poor diet and malnutrition, early start dialysis or over-use of phosphate binder therapy.

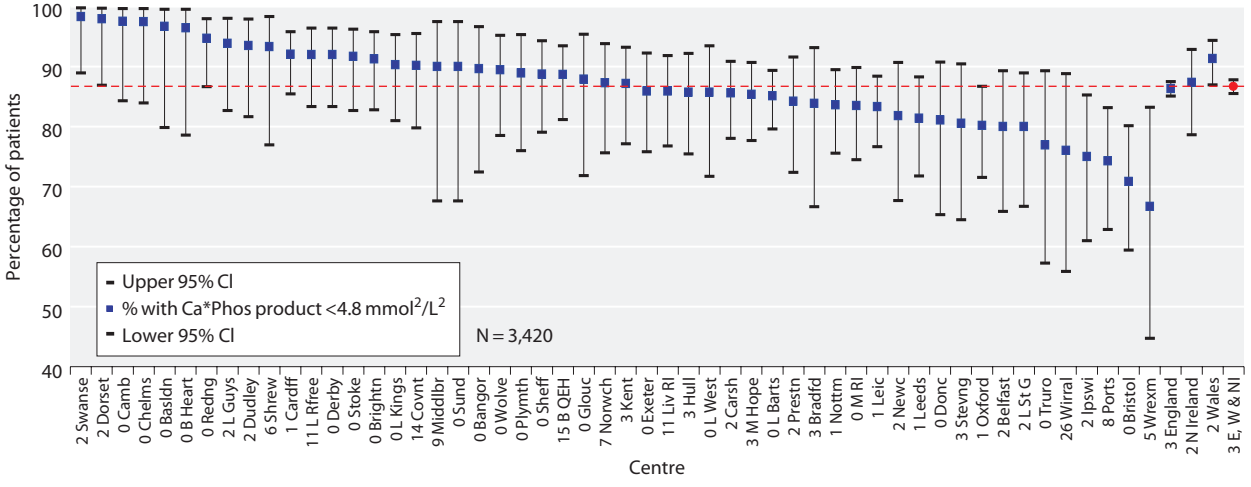

Fig. 10.26. Percentage of peritoneal dialysis patients with calcium*phosphate product <4.8 mmol^2/L^2 by centre in 2008

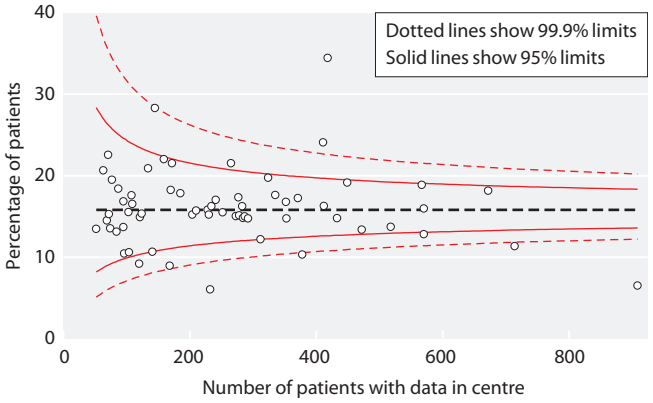

Fig. 10.27. Funnel plot of percentage of haemodialysis patients with calcium*phosphate product $\geqslant 4.8\,mmol^2/L^2$ by centre in 2008

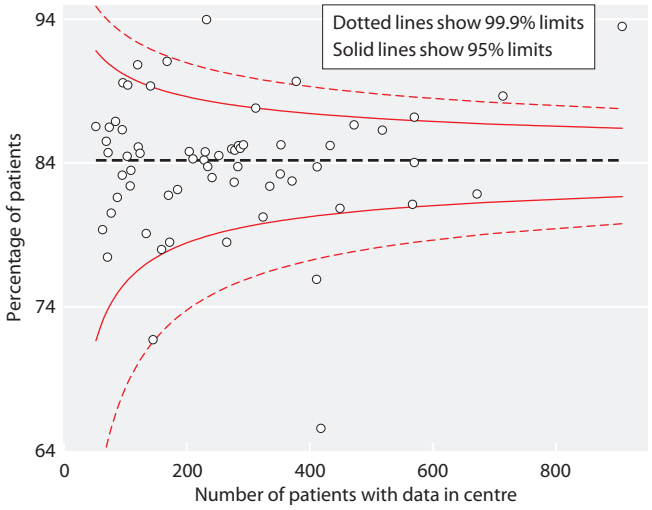

Fig. 10.29. Funnel plot of percentage of haemodialysis patients with calcium*phosphate product $<4.8\,mmol^2/L^2$ by centre in 2008

Parathyroid hormone

The 4th edition of the Renal Association Clinical Practice Guidelines states:

'The target range for parathyroid hormone measured using an intact PTH assay should be between 2 and 4 times the upper limit of normal for the intact PTH assay used. The same target range should apply when using the whole molecule PTH assay.' (Module 2: Complications) [1]

As in previous years an upper reference range limit of 8 pmol/L has been adopted as an average giving a target PTH range of 16–32 pmol/L against which to audit.

The data for PTH were 86% complete overall for HD patients (table 10.10) with six centres failing to attain 70% completeness; two centres (Carshalton and Kent) were omitted from the analysis due to less than 50% completeness. In PD patients, the data were 87% complete overall (table 10.12) with only one centre with sufficient eligible patients attaining below 70% completeness. Completeness of data showed a slight improvement over 2007. The individual centres' means and standard deviations are shown in tables 10.10 and 10.12.

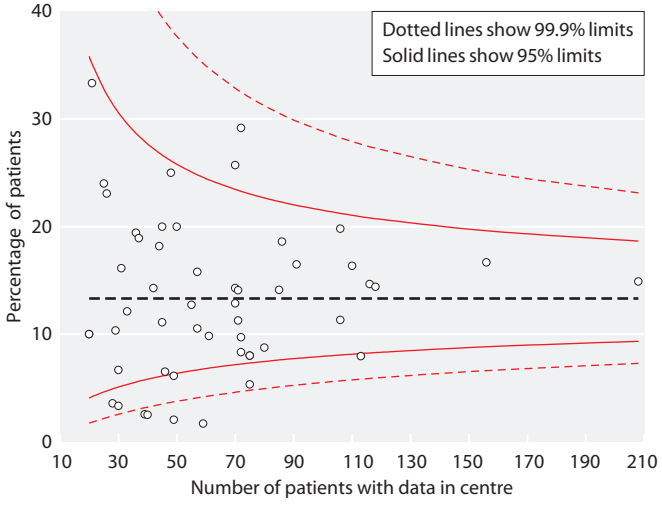

Fig. 10.28. Funnel plot of percentage of peritoneal dialysis patients with calcium*phosphate product $\geqslant 4.8\,mmol^2/L^2$ by centre in 2008

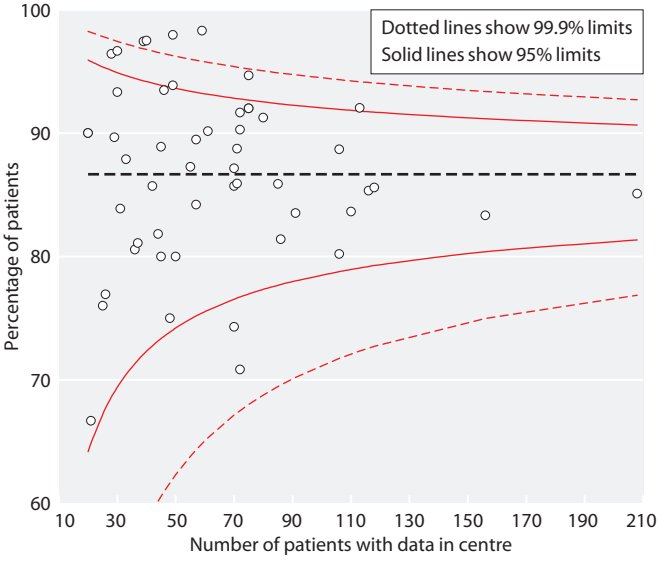

Fig. 10.30. Funnel plot of percentage of peritoneal dialysis patients with calcium*phosphate product $<4.8\,mmol^2/L^2$ by centre in 2008

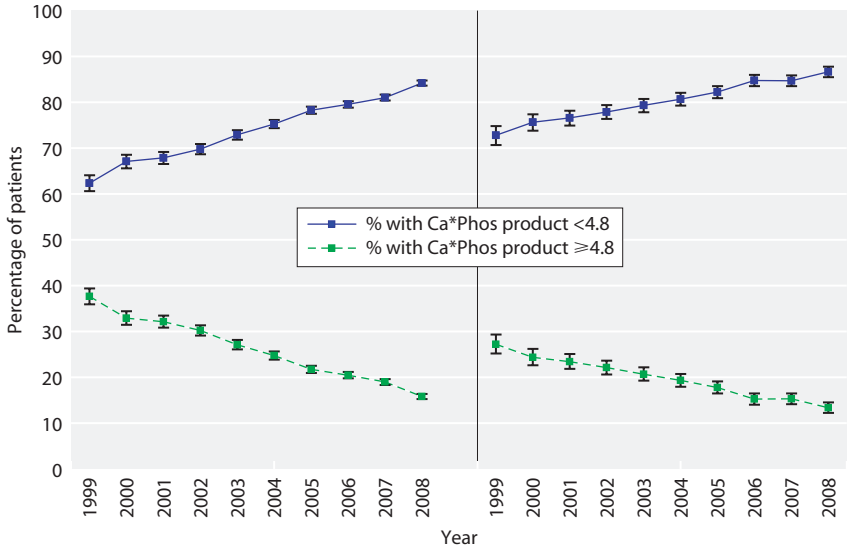

Fig. 10.31. Percentage of patients with calcium*phosphate product <4.8 mmol^2/L^2 and $\geqslant 4.8$ mmol^2/L^2 by dialysis modality 1999–2008

Twenty seven percent (CI 26–27) of HD patients (table 10.11) and 29% (CI 27–30) of PD patients (table 10.13) achieved a PTH within the target range of 16–32 pmol/L. The proportion of HD patients with a PTH exceeding 32 pmol/L was 41% (CI 40–42) and the proportion with a PTH lower than 16 pmol/L was 32% (CI 32–33) (table 10.11). The data were similar for PD patients, the proportion with a PTH exceeding 32 pmol/L being 41% (CI 39–43) and the proportion with a PTH lower than 16 pmol/L being 31% (CI 29–32) (table 10.13). These data show little change from 2007. There was again considerable variation between centres in the proportion of patients below, within and above the range specified by the clinical performance measure for both HD (figures 10.32–10.37) and PD (figures 10.38–10.43).

Table 10.11 for HD patients and table 10.13 for PD patients can be used to identify centres in each funnel plot showing PTH achievement (figures 10.33, 10.35, 10.37, 10.39, 10.41, 10.43). The funnel plot for HD patients within the PTH target range of 16–32 pmol/L showed two centres (Birmingham QE, Ulster) with a significantly high proportion of patients achieving the standard, and three centres (Portsmouth, Leicester, London West) with a significantly low proportion of patients (figure 10.33). For PD patients, there were no

Table 10.10. Summary statistics for PTH in haemodialysis patients in 2008

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	98	120	30.9	36.0	20.6	10.3	36.4
B Heart	89	344	41.2	38.5	32.5	14.7	53.3
B QEH	58	425	22.6	14.5	21.5	11.1	33.7
Bangor	97	69	34.4	50.4	18.8	9.6	36.9
Basldn	96	120	36.9	40.4	25.7	13.3	44.9
Belfast	94	224	43.2	44.5	28.8	13.4	57.7
Bradfd	91	163	38.0	45.6	21.0	10.3	43.3
Brightn	95	281	36.8	40.0	25.2	8.8	50.7
Bristol	95	397	29.9	32.6	20.1	10.6	37.3
Camb	55	160	33.2	35.2	24.8	13.0	40.1
Cardff	93	417	41.0	44.2	27.0	12.7	55.3
Carlis	99	74	36.1	32.1	27.1	12.8	45.9
Carsh	20	118					
Chelms	99	94	43.4	40.5	33.1	20.6	53.6

Table 10.10. Continued

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Clwyd	90	61	26.0	30.0	16.0	6.0	33.0
Colchr	98	101	39.0	32.4	27.9	15.6	56.0
Covnt	95	271	46.4	52.1	30.0	14.0	63.0
Derby	99	227	31.1	35.6	23.0	12.2	37.8
Derry	98	51	39.1	29.8	30.4	22.0	41.5
Donc	100	72	44.6	43.3	30.1	16.1	63.0
Dorset	90	169	31.1	33.0	21.9	9.2	43.0
Dudley	74	89	40.9	46.0	27.6	12.8	44.9
Exeter	99	283	20.8	27.8	12.4	3.9	27.1
Glouc	99	141	26.8	26.5	21.0	11.1	31.0
Hull	92	265	39.6	46.9	24.0	9.6	50.6
Ipswi	99	95	35.6	33.7	24.2	12.4	47.3
Kent	0	1					
L Barts	100	569	49.7	54.1	32.0	14.2	62.8
L Guys	95	460	44.6	43.6	29.6	13.6	60.6
L Kings	91	345	42.8	39.8	31.9	16.8	54.8
L Rfree	80	496	35.3	36.4	25.0	13.0	45.0
L St G	96	197	48.6	43.3	31.9	18.4	68.1
L West	75	866	58.8	63.6	37.9	17.5	76.0
Leeds	96	435	28.3	29.9	19.0	10.4	37.3
Leic	94	635	40.6	42.5	27.8	8.7	59.8
Liv Ain	73	85	35.6	40.9	23.0	11.0	44.0
Liv RI	92	346	41.5	40.6	29.5	14.0	54.0
M Hope	79	228	38.2	49.2	20.7	8.9	44.7
M RI	54	207	45.6	39.6	36.0	16.0	63.6
Middlbr	89	241	43.1	39.8	31.5	15.7	55.6
Newc	98	247	30.0	29.6	21.1	10.4	36.6
Newry	98	86	33.0	27.4	25.3	13.7	46.5
Norwch	96	273	35.8	42.9	24.0	13.3	42.0
Nottm	99	348	35.6	43.1	23.9	10.4	39.8
Oxford	95	310	48.3	49.5	31.6	13.7	65.5
Plymth	96	108	26.3	31.8	17.3	6.2	31.7
Ports	95	392	47.5	54.0	27.9	11.9	57.5
Prestn	98	404	36.2	37.2	24.8	10.8	49.7
Redng	100	232	23.8	25.9	17.7	8.3	29.4
Sheff	97	553	40.7	37.1	30.3	15.5	55.2
Shrew	97	164	37.3	39.3	25.4	10.6	47.3
Stevng	97	332	46.1	42.7	38.0	19.0	57.0
Sthend	90	110	52.1	45.6	39.7	19.8	67.8
Stoke	98	234	44.0	42.3	33.2	14.7	53.7
Sund	97	146	35.2	34.6	22.8	12.1	49.2
Swanse	97	308	39.7	37.2	26.4	13.7	55.2
Truro	99	133	30.0	26.7	21.8	9.9	41.9
Tyrone	100	84	36.1	30.0	28.7	16.7	45.4
Ulster	99	76	31.2	29.8	21.9	16.0	35.5
Wirral	62	101	41.2	39.1	25.8	16.7	52.9
Wolve	98	268	21.6	31.8	12.0	5.4	24.8
Wrexm	94	67	30.2	37.1	18.9	6.1	45.0
York	96	105	35.7	36.0	21.3	7.9	56.1
England	**85**	**13,460**	**39.0**	**42.7**	**25.9**	**12.1**	**49.3**
N Ireland	**97**	**641**	**36.9**	**36.7**	**25.2**	**14.1**	**45.2**
Wales	**95**	**922**	**38.3**	**41.3**	**24.7**	**11.9**	**51.5**
E, W & NI	**86**	**15,023**	**38.9**	**42.4**	**25.7**	**12.1**	**49.3**

Table 10.11. Percentage of haemodialysis patients within, below and above the range for PTH (16–32 pmol/L) in 2008

Centre	N	% PTH 16–32 pmol/L	Lower 95% CI	Upper 95% CI	% PTH <16 pmol/L	Lower 95% CI	Upper 95% CI	% PTH >32 pmol/L	Lower 95% CI	Upper 95% CI
Antrim	120	33.3	25.5	42.2	39.2	30.9	48.2	27.5	20.3	36.2
B Heart	344	21.8	17.8	26.5	27.6	23.2	32.6	50.6	45.3	55.8
B QEH	425	36.5	32.0	41.2	36.7	32.3	41.4	26.8	22.8	31.2
Bangor	69	24.6	15.9	36.1	43.5	32.3	55.3	31.9	22.0	43.7
Basldn	120	30.8	23.2	39.6	33.3	25.5	42.2	35.8	27.8	44.8
Belfast	224	23.7	18.6	29.7	30.4	24.7	36.7	46.0	39.6	52.5
Bradfd	163	27.0	20.7	34.3	36.8	29.8	44.5	36.2	29.2	43.9
Brightn	281	21.7	17.3	26.9	37.4	31.9	43.2	40.9	35.3	46.8
Bristol	397	31.0	26.6	35.7	40.3	35.6	45.2	28.7	24.5	33.4
Camb	160	31.9	25.1	39.5	31.9	25.1	39.5	36.3	29.2	44.0
Cardff	417	26.6	22.6	31.1	30.9	26.7	35.5	42.5	37.8	47.3
Carlis	74	32.4	22.8	43.9	29.7	20.5	41.1	37.8	27.6	49.3
Chelms	94	30.9	22.4	40.9	18.1	11.6	27.2	51.1	41.1	61.0
Clwyd	61	24.6	15.4	36.9	49.2	36.9	61.5	26.2	16.7	38.6
Colchr	101	24.8	17.3	34.1	27.7	19.9	37.2	47.5	38.0	57.2
Covnt	271	23.6	18.9	29.0	28.0	23.0	33.7	48.3	42.4	54.3
Derby	227	33.9	28.1	40.3	35.2	29.3	41.7	30.8	25.2	37.1
Derry	51	37.3	25.2	51.2	13.7	6.7	26.1	49.0	35.7	62.5
Donc	72	30.6	21.0	42.1	25.0	16.4	36.2	44.4	33.5	56.0
Dorset	169	23.7	17.9	30.7	40.8	33.7	48.4	35.5	28.7	43.0
Dudley	89	28.1	19.8	38.3	28.1	19.8	38.3	43.8	33.9	54.3
Exeter	283	22.3	17.8	27.5	57.6	51.8	63.2	20.1	15.9	25.2
Glouc	141	40.4	32.7	48.7	36.2	28.7	44.4	23.4	17.1	31.1
Hull	265	22.6	18.0	28.1	36.2	30.7	42.2	41.1	35.4	47.2
Ipswi	95	34.7	25.9	44.8	29.5	21.2	39.4	35.8	26.8	45.9
L Barts	569	22.5	19.3	26.1	27.6	24.1	31.4	49.9	45.8	54.0
L Guys	460	24.8	21.1	28.9	28.9	25.0	33.2	46.3	41.8	50.9
L Kings	345	27.3	22.8	32.2	22.9	18.8	27.6	49.9	44.6	55.1
L Rfree	496	30.4	26.6	34.6	30.7	26.7	34.8	38.9	34.7	43.3
L St G	197	30.5	24.4	37.2	19.8	14.8	26.0	49.8	42.8	56.7
L West	866	21.7	19.1	24.6	21.9	19.3	24.8	56.4	53.0	59.6
Leeds	435	27.4	23.4	31.7	40.9	36.4	45.6	31.7	27.5	36.3
Leic	635	20.6	17.7	24.0	35.0	31.4	38.8	44.4	40.6	48.3
Liv Ain	85	32.9	23.8	43.6	29.4	20.7	39.9	37.7	28.0	48.4
Liv RI	346	26.9	22.5	31.8	27.5	23.0	32.4	45.7	40.5	50.9
M Hope	228	23.7	18.6	29.6	39.5	33.3	46.0	36.8	30.8	43.3
M RI	207	20.3	15.4	26.3	24.6	19.2	31.0	55.1	48.2	61.7
Middlbr	241	24.5	19.5	30.3	25.7	20.6	31.6	49.8	43.5	56.1
Newc	247	29.2	23.8	35.1	40.9	34.9	47.1	30.0	24.6	36.0
Newry	86	36.1	26.6	46.7	26.7	18.5	37.1	37.2	27.7	47.9
Norwch	273	34.1	28.7	39.9	30.0	24.9	35.7	35.9	30.4	41.8
Nottm	348	29.9	25.3	34.9	35.6	30.8	40.8	34.5	29.7	39.6
Oxford	310	19.4	15.3	24.1	30.7	25.8	36.0	50.0	44.5	55.5
Plymth	108	25.9	18.5	35.0	49.1	39.8	58.4	25.0	17.7	34.0
Ports	392	18.4	14.8	22.5	36.5	31.9	41.4	45.2	40.3	50.1
Prestn	404	28.5	24.3	33.1	33.7	29.2	38.4	37.9	33.3	42.7
Redng	232	37.1	31.1	43.5	42.7	36.5	49.1	20.3	15.6	25.9
Sheff	553	26.6	23.1	30.4	25.9	22.4	29.7	47.6	43.4	51.7
Shrew	164	26.8	20.6	34.1	35.4	28.4	43.0	37.8	30.7	45.5
Stevng	332	32.5	27.7	37.8	14.2	10.8	18.3	53.3	47.9	58.6

Table 10.11. Continued

Centre	N	% PTH 16–32 pmol/L	Lower 95% CI	Upper 95% CI	% PTH <16 pmol/L	Lower 95% CI	Upper 95% CI	% PTH >32 pmol/L	Lower 95% CI	Upper 95% CI
Sthend	110	21.8	15.1	30.5	18.2	12.0	26.5	60.0	50.6	68.7
Stoke	234	23.1	18.1	28.9	26.5	21.2	32.5	50.4	44.1	56.8
Sund	146	24.7	18.3	32.3	37.0	29.6	45.1	38.4	30.8	46.5
Swanse	308	25.0	20.5	30.1	31.5	26.6	36.9	43.5	38.1	49.1
Truro	133	27.1	20.2	35.2	36.8	29.1	45.4	36.1	28.4	44.6
Tyrone	84	35.7	26.2	46.5	21.4	13.9	31.5	42.9	32.7	53.6
Ulster	76	46.1	35.2	57.3	25.0	16.6	35.9	29.0	19.9	40.1
Wirral	101	35.6	26.9	45.4	22.8	15.6	32.0	41.6	32.4	51.4
Wolve	268	20.5	16.1	25.8	62.7	56.7	68.3	16.8	12.8	21.8
Wrexm	67	23.9	15.2	35.5	43.3	32.0	55.3	32.8	22.7	44.9
York	105	24.8	17.4	33.9	40.0	31.1	49.6	35.2	26.7	44.8
England	**13,460**	**26.4**	**25.7**	**27.2**	**32.5**	**31.7**	**33.3**	**41.1**	**40.3**	**41.9**
N Ireland	**641**	**32.5**	**28.9**	**36.2**	**28.4**	**25.0**	**32.0**	**39.2**	**35.5**	**43.0**
Wales	**922**	**25.6**	**22.9**	**28.5**	**34.2**	**31.2**	**37.3**	**40.2**	**37.1**	**43.4**
E, W & NI	**15,023**	**26.6**	**25.9**	**27.3**	**32.4**	**31.7**	**33.2**	**41.0**	**40.2**	**41.8**

Table 10.12. Summary statistics for PTH in peritoneal dialysis patients in 2008

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	94	15					
B Heart	89	25	27.3	20.4	23.7	13.6	34.4
B QEH	71	89	18.1	13.9	14.8	5.2	29.8
Bangor	100	29	31.7	28.4	28.5	11.9	39.9
Basldn	100	30	34.7	22.5	28.3	18.5	46.9
Belfast	96	44	57.1	41.8	49.2	23.9	78.7
Bradfd	91	29	47.4	42.0	37.2	22.7	62.0
Brightn	94	75	33.0	28.2	23.3	16.3	38.8
Bristol	90	65	48.1	53.5	32.5	13.7	60.7
Camb	100	40	35.7	23.8	33.5	19.2	51.0
Cardff	98	112	46.7	36.5	40.7	22.3	64.5
Carlis	94	16					
Carsh	13	15					
Chelms	95	37	30.3	26.1	25.8	11.1	40.0
Clwyd	80	8					
Colchr	n/a	0					
Covnt	83	59	32.7	26.0	27.0	15.0	39.0
Derby	100	75	21.6	15.3	18.1	12.4	29.9
Derry	100	5					
Donc	87	32	27.0	24.7	20.9	10.1	32.8
Dorset	84	42	23.2	22.8	15.2	7.3	34.6
Dudley	89	42	33.1	41.4	14.3	7.4	37.4

Table 10.12. Continued

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Exeter	97	69	24.5	21.4	18.9	10.3	30.4
Glouc	100	33	26.9	28.6	16.9	8.0	37.0
Hull	81	58	29.6	27.8	23.3	7.4	41.9
Ipswi	98	48	38.2	33.0	25.3	16.7	55.9
Kent	0	0					
L Barts	100	208	34.3	32.1	24.0	12.8	46.1
L Guys	98	49	39.5	36.1	28.6	14.3	48.0
L Kings	100	72	35.7	27.2	27.7	16.7	46.1
L Rfree	85	71	26.3	18.8	22.0	13.0	36.0
L St G	94	48	36.0	34.0	25.7	9.4	48.7
L West	100	42	49.5	42.5	35.4	28.7	56.9
Leeds	100	87	29.1	24.9	24.5	13.3	36.9
Leic	89	140	49.9	55.6	36.1	16.2	65.2
Liv Ain	0	0					
Liv RI	84	80	32.3	31.5	23.0	13.0	39.5
M Hope	94	112	30.1	29.0	22.0	11.1	38.7
M RI	99	90	41.6	39.5	34.1	15.9	55.6
Middlbr	73	16					
Newc	93	42	24.6	22.6	18.6	11.7	31.2
Newry	100	10					
Norwch	73	43	31.6	35.1	21.0	9.6	39.4
Nottm	95	105	28.9	27.0	20.1	7.1	45.2
Oxford	93	99	47.6	45.8	30.5	14.7	68.1
Plymth	84	38	23.3	21.5	15.5	8.5	33.1
Ports	80	61	52.0	42.9	41.5	25.0	69.8
Prestn	97	56	38.3	26.6	29.5	20.0	53.9
Redng	99	74	24.6	18.0	23.7	12.4	32.9
Sheff	90	64	53.7	38.5	50.3	27.7	72.8
Shrew	97	31	39.1	37.0	28.0	14.1	47.3
Stevng	87	32	53.4	55.8	38.0	19.0	66.5
Sthend	80	12					
Stoke	82	59	49.1	41.5	33.5	22.5	63.9
Sund	100	20	32.9	27.7	21.5	14.3	45.1
Swanse	93	56	44.3	32.5	39.0	23.7	59.8
Truro	85	22	36.3	30.4	33.1	12.1	45.5
Tyrone	100	7					
Ulster	100	5					
Wirral	68	23	35.7	40.2	18.4	7.5	51.7
Wolve	95	54	25.4	22.7	20.3	11.8	28.9
Wrexm	91	20	20.3	16.2	13.7	7.7	30.6
York	100	19					
England	**86**	**2,748**	**34.8**	**34.4**	**25.3**	**12.8**	**44.8**
N Ireland	**97**	**86**	**43.8**	**35.9**	**31.1**	**18.6**	**58.0**
Wales	**96**	**225**	**41.5**	**33.6**	**34.2**	**18.2**	**55.3**
E, W & NI	**87**	**3,059**	**35.5**	**34.4**	**26.2**	**13.0**	**46.0**

Blank cells denote centres excluded from analyses due to low patient numbers or poor data completeness
n/a not applicable

Table 10.13. Percentage of peritoneal dialysis patients within, below and above the range for PTH (16–32 pmol/L) in 2008

Centre	N	% PTH 16–32 pmol/L	Lower 95% CI	Upper 95% CI	% PTH <16 pmol/L	Lower 95% CI	Upper 95% CI	% PTH >32 pmol/L	Lower 95% CI	Upper 95% CI
B Heart	25	40.0	23.1	59.7	28.0	14.0	48.2	32.0	16.9	52.2
B QEH	89	28.1	19.8	38.3	50.6	40.3	60.8	21.4	14.1	31.1
Bangor	29	27.6	14.4	46.2	34.5	19.7	53.1	37.9	22.4	56.4
Basldn	30	40.0	24.3	58.1	20.0	9.3	38.0	40.0	24.3	58.1
Belfast	44	25.0	14.4	39.7	13.6	6.3	27.2	61.4	46.4	74.5
Bradfd	29	20.7	9.6	39.1	20.7	9.6	39.1	58.6	40.4	74.8
Brightn	75	38.7	28.4	50.1	21.3	13.5	32.0	40.0	29.6	51.4
Bristol	65	18.5	10.8	29.8	30.8	20.8	42.9	50.8	38.8	62.7
Camb	40	30.0	17.9	45.7	20.0	10.3	35.2	50.0	35.0	65.0
Cardff	112	17.9	11.8	26.1	19.6	13.3	28.0	62.5	53.2	71.0
Chelms	37	29.7	17.3	46.1	35.1	21.6	51.6	35.1	21.6	51.6
Covnt	59	35.6	24.5	48.5	27.1	17.3	39.8	37.3	26.0	50.2
Derby	75	40.0	29.6	51.4	40.0	29.6	51.4	20.0	12.4	30.6
Donc	32	40.6	25.3	58.1	34.4	20.2	52.1	25.0	13.0	42.6
Dorset	42	21.4	11.5	36.3	52.4	37.5	66.8	26.2	15.1	41.4
Dudley	42	16.7	8.2	31.1	54.8	39.7	69.0	28.6	17.0	43.9
Exeter	69	36.2	25.8	48.1	40.6	29.7	52.5	23.2	14.7	34.6
Glouc	33	27.3	14.8	44.7	45.5	29.6	62.3	27.3	14.8	44.7
Hull	58	22.4	13.5	34.9	37.9	26.5	51.0	39.7	28.0	52.7
Ipswi	48	35.4	23.3	49.8	22.9	13.2	36.8	41.7	28.7	55.9
L Barts	208	30.3	24.4	36.9	33.2	27.1	39.9	36.5	30.3	43.3
L Guys	49	24.5	14.5	38.4	28.6	17.7	42.6	46.9	33.5	60.8
L Kings	72	36.1	25.9	47.8	19.4	11.9	30.2	44.4	33.5	56.0
L Rfree	71	42.3	31.4	54.0	29.6	20.2	41.2	28.2	19.0	39.7
L St G	48	16.7	8.6	29.9	37.5	25.1	51.8	45.8	32.4	59.9
L West	42	35.7	22.8	51.1	4.8	1.2	17.1	59.5	44.3	73.1
Leeds	87	40.2	30.5	50.8	29.9	21.2	40.3	29.9	21.2	40.3
Leic	140	20.0	14.2	27.4	24.3	17.9	32.1	55.7	47.4	63.7
Liv RI	80	27.5	18.8	38.3	35.0	25.4	46.0	37.5	27.6	48.6
M Hope	112	27.7	20.2	36.7	39.3	30.7	48.6	33.0	25.0	42.2
M RI	90	22.2	14.8	32.0	25.6	17.6	35.5	52.2	42.0	62.3
Newc	42	31.0	18.9	46.3	45.2	31.0	60.3	23.8	13.3	38.9
Norwch	43	25.6	14.8	40.5	44.2	30.3	59.1	30.2	18.4	45.4
Nottm	105	20.0	13.4	28.7	41.9	32.9	51.5	38.1	29.3	47.7
Oxford	99	23.2	16.0	32.6	27.3	19.4	36.9	49.5	39.8	59.2
Plymth	38	23.7	12.8	39.6	50.0	34.6	65.4	26.3	14.8	42.4
Ports	61	16.4	9.1	27.9	18.0	10.3	29.7	65.6	52.9	76.4
Prestn	56	42.9	30.6	56.0	14.3	7.3	26.1	42.9	30.6	56.0
Redng	74	40.5	30.0	52.0	32.4	22.8	43.9	27.0	18.2	38.2
Sheff	64	14.1	7.5	24.9	15.6	8.6	26.7	70.3	58.1	80.2
Shrew	31	29.0	15.9	47.1	25.8	13.5	43.7	45.2	28.9	62.6
Stevng	32	28.1	15.3	45.8	15.6	6.7	32.5	56.3	39.0	72.1
Stoke	59	30.5	20.1	43.3	15.3	8.1	26.8	54.2	41.5	66.4
Sund	20	35.0	17.7	57.4	30.0	14.1	52.7	35.0	17.7	57.4
Swanse	56	33.9	22.8	47.2	10.7	4.9	21.9	55.4	42.3	67.7
Truro	22	13.6	4.5	34.8	31.8	16.0	53.4	54.6	34.1	73.5
Wirral	23	21.7	9.4	42.8	43.5	25.2	63.7	34.8	18.4	55.7
Wolve	54	48.2	35.3	61.3	31.5	20.6	44.9	20.4	11.7	33.2
Wrexm	20	15.0	4.9	37.6	60.0	38.0	78.6	25.0	10.8	47.8
England	**2,748**	**28.9**	**27.3**	**30.7**	**31.6**	**29.8**	**33.3**	**39.5**	**37.7**	**41.4**
N Ireland	**86**	**33.7**	**24.6**	**44.3**	**18.6**	**11.7**	**28.2**	**47.7**	**37.4**	**58.2**
Wales	**225**	**23.1**	**18.1**	**29.1**	**22.7**	**17.7**	**28.6**	**54.2**	**47.7**	**60.6**
E, W & NI	**3,059**	**28.6**	**27.1**	**30.3**	**30.5**	**28.9**	**32.2**	**40.8**	**39.1**	**42.6**

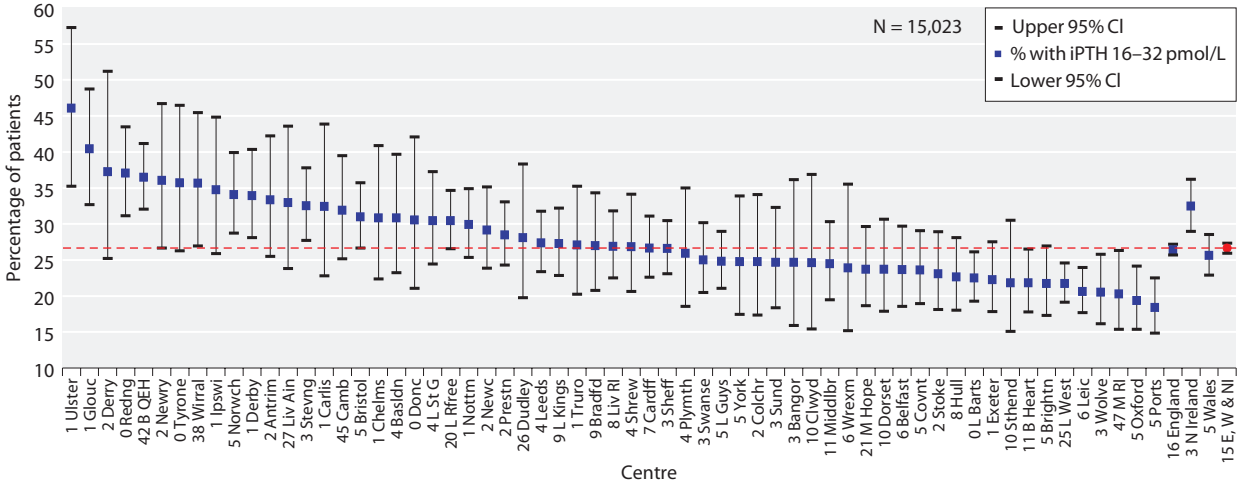

Fig. 10.32. Percentage of haemodialysis patients with PTH 16–32 pmol/L by centre in 2008

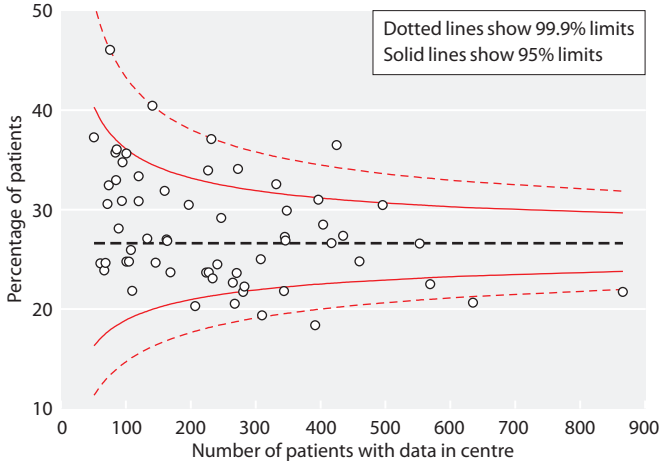

Fig. 10.33. Funnel plot of percentage of haemodialysis patients with PTH 16–32 pmol/L by centre in 2008

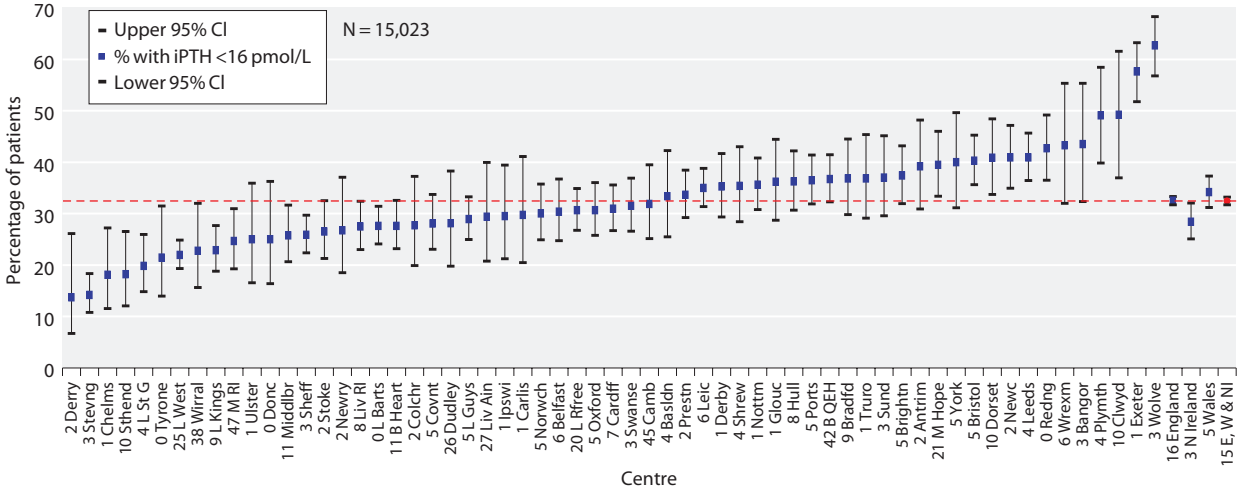

Fig. 10.34. Percentage of haemodialysis patients with PTH <16 pmol/L by centre in 2008

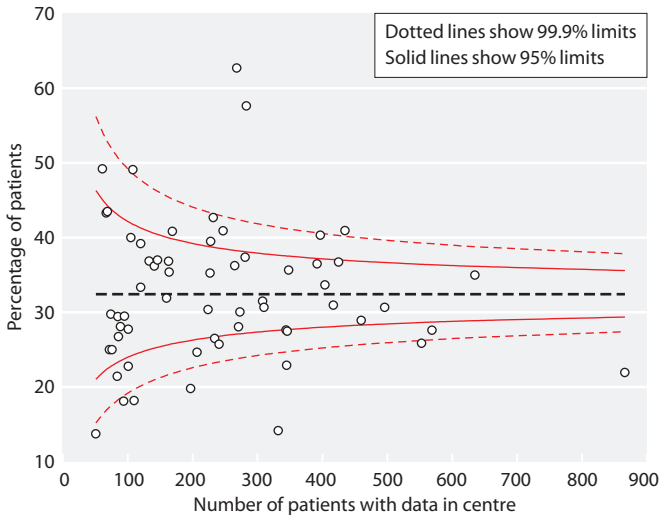

Fig. 10.35. Funnel plot of percentage of haemodialysis patients with PTH <16 pmol/L by centre in 2008

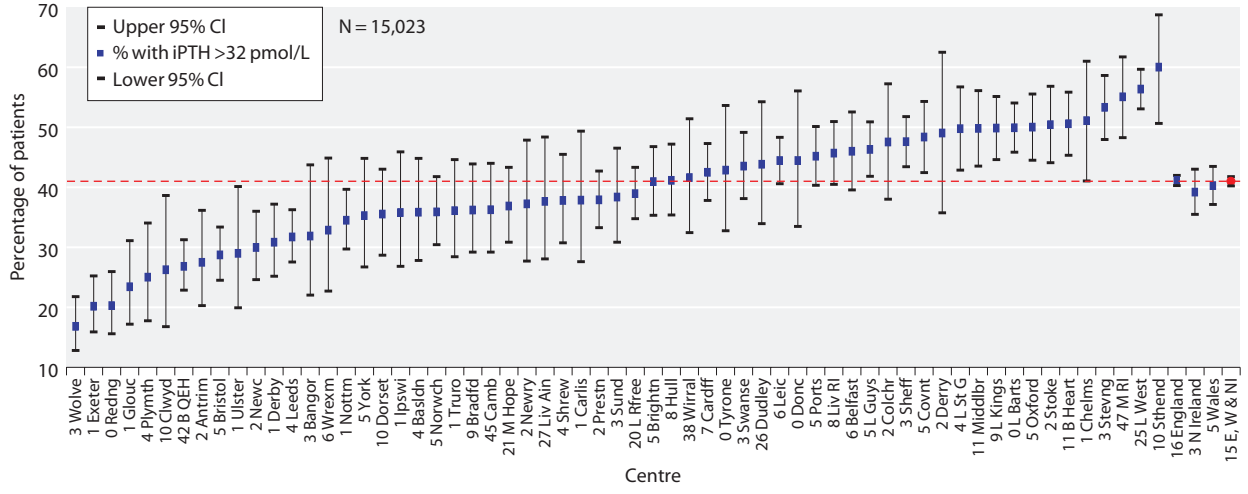

Fig. 10.36. Percentage of haemodialysis patients with PTH >32 pmol/L by centre in 2008

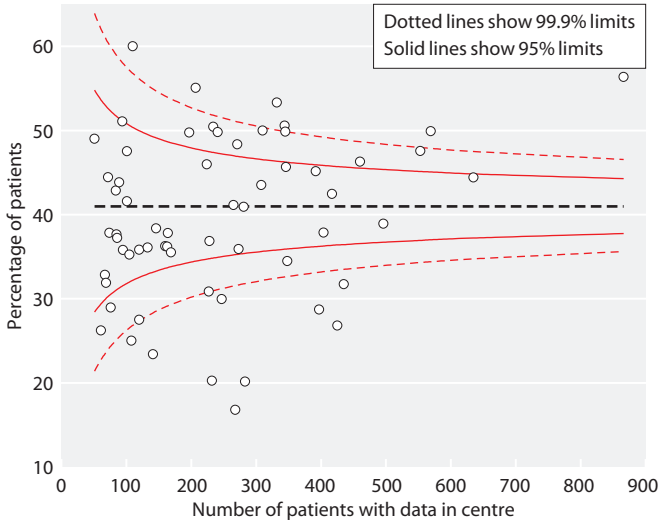

Fig. 10.37. Funnel plot of percentage of haemodialysis patients with PTH >32 pmol/L by centre in 2008

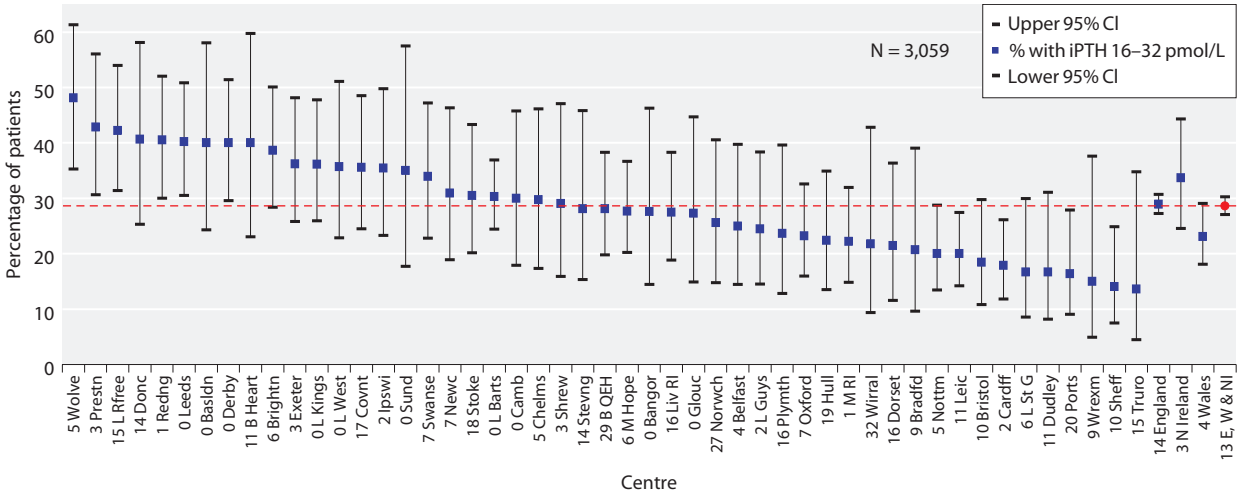

Fig. 10.38. Percentage of peritoneal dialysis patients with PTH 16–32 pmol/L by centre in 2008

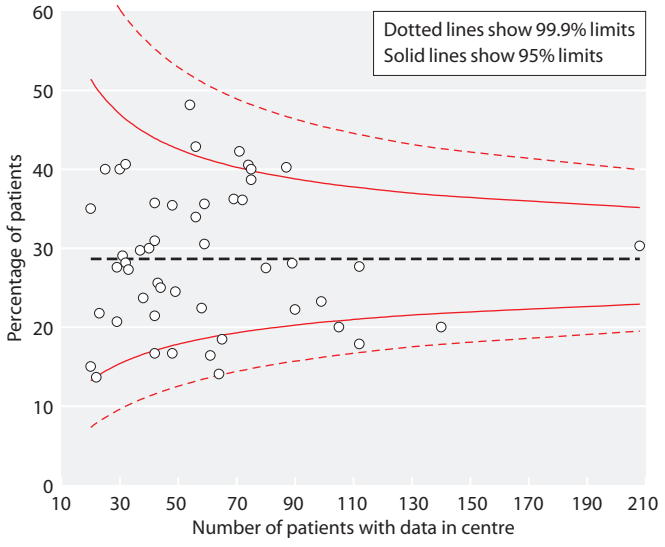

Fig. 10.39. Funnel plot of percentage of peritoneal dialysis patients with PTH 16–32 pmol/L by centre in 2008

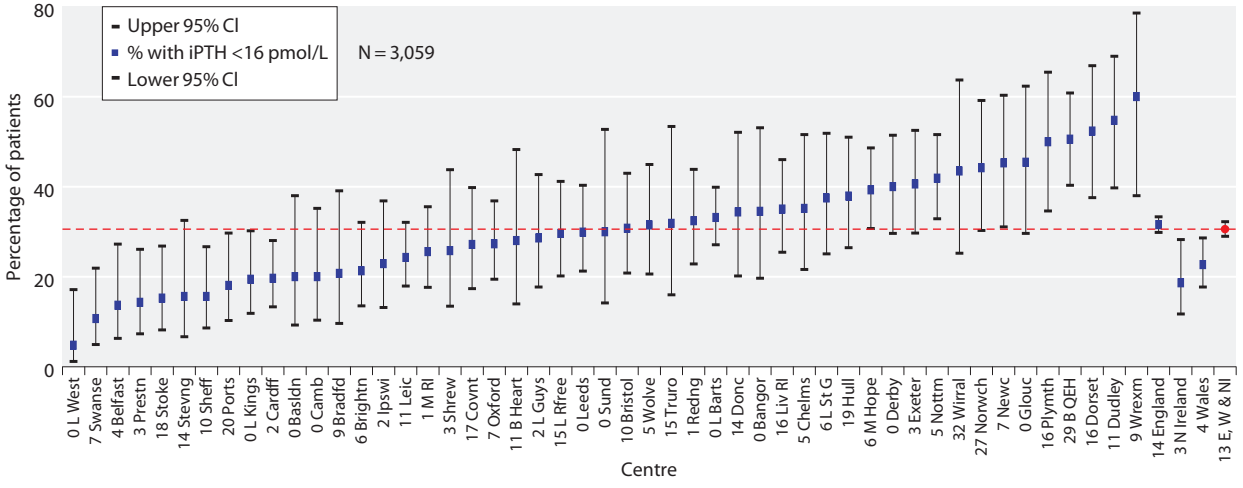

Fig. 10.40. Percentage of peritoneal dialysis patients with PTH <16 pmol/L by centre in 2008

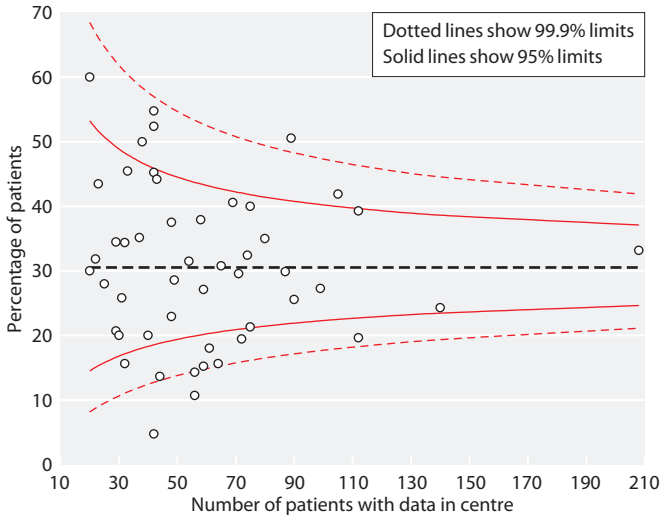

Fig. 10.41. Funnel plot of percentage of peritoneal dialysis patients with PTH <16 pmol/L by centre in 2008

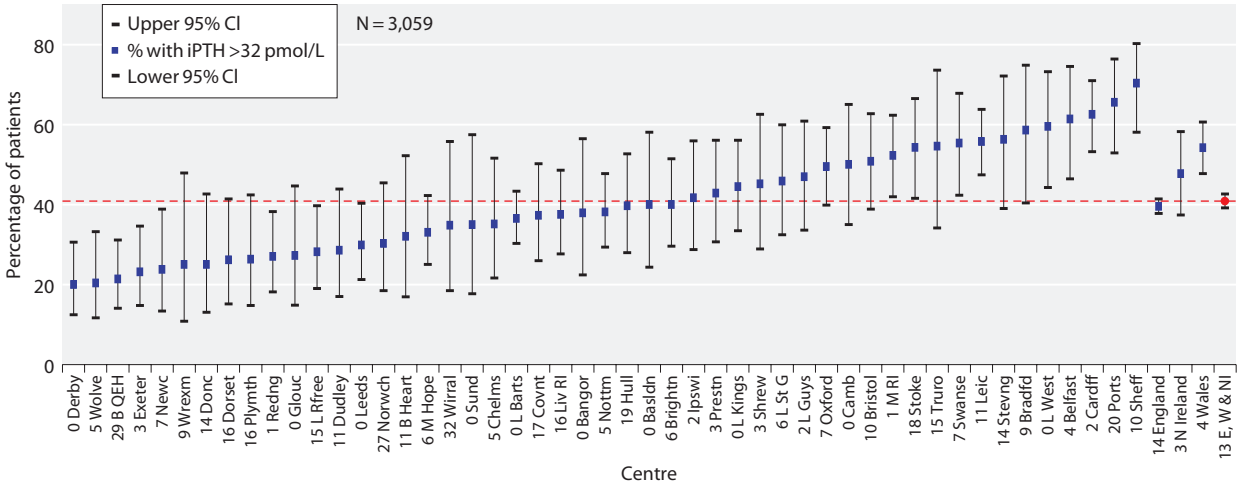

Fig. 10.42. Percentage of peritoneal dialysis patients with PTH >32 pmol/L by centre in 2008

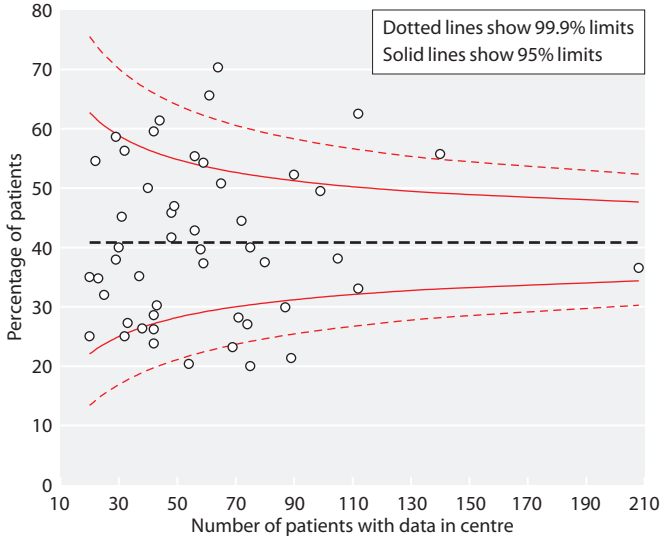

Fig. 10.43. Funnel plot of percentage of peritoneal dialysis patients with PTH >32 pmol/L by centre in 2008

outliers with respect to this target (figure 10.39). The proportion of HD patients with serum PTH concentrations above 32 pmol/L was significantly high in six centres (Southend, London West, Manchester Royal Infirmary, Stevenage, Birmingham Heartlands, London Barts) (figure 10.37). For PD patients, four centres (Portsmouth, Sheffield, Cardiff, Leicester) had a significantly high proportion of their patients with PTH levels above 32 pmol/L (figure 10.43). There was a disproportionately high number of HD patients with PTH levels below 16 pmol/L at four centres (Wolverhampton, Exeter, Plymouth, Leeds) (figure 10.35). One centre (Birmingham QE) had an excess of PD patients with low PTH concentrations (figure 10.41).

Centres which achieved the standards relating to one mineral parameter tended to achieve the standards in others. Figure 10.44 shows the significant relationship between the proportion of HD patients in a centre with calcium levels between 2.2 and 2.5 mmol/L and the proportion with PTH levels between 16 and 32 pmol/L ($r = 0.324$: $p = 0.011$). Figure 10.45 shows the relationship between the proportion of HD patients with serum phosphate levels between 1.1 and 1.8 mmol/L and the proportion with PTH levels between 16 and 32 pmol/L ($r = 0.319$: $p = 0.012$). There is a similar relationship for PD patients between the proportion of patients in a centre with calcium levels between 2.2 and 2.5 mmol/L and the proportion with PTH levels between 16 and 32 pmol/L ($r = 0.402$: $p = 0.004$). The relationship between the proportion of PD patients in a centre with serum phosphate levels between 1.1 and 1.8 mmol/L and the proportion with PTH levels between 16 and 32 pmol/L was not significant.

There are many issues to consider in interpreting PTH levels. There is considerable biological variation in PTH measurements in the normal population [8]. A similar degree of variation in the renal failure population, would require considerable circumspection in determining the significance of even quite considerable concentration changes within the individual and will contribute to variability in target achievement although such effects will not account for the marked bias in some centres. The recent introduction of cinacalcet has added a further layer of complexity, relating to the timing of the sampling. Most clinical studies of the use of this drug in the treatment of secondary hyperparathyroidism describe sampling 24 hours after the previous dose [9] whilst the maximum suppression of PTH occurs at 2–4 hours depending on the dose [10]. Depending on local centre practice, this would contribute to PTH variation within the individual and the population and may be an additional factor in the observed centre variation seen this year, although large variation in centre achievement of PTH targets also existed before the introduction of cinacalcet. Differences in the specificity of PTH assays may also contribute to variation.

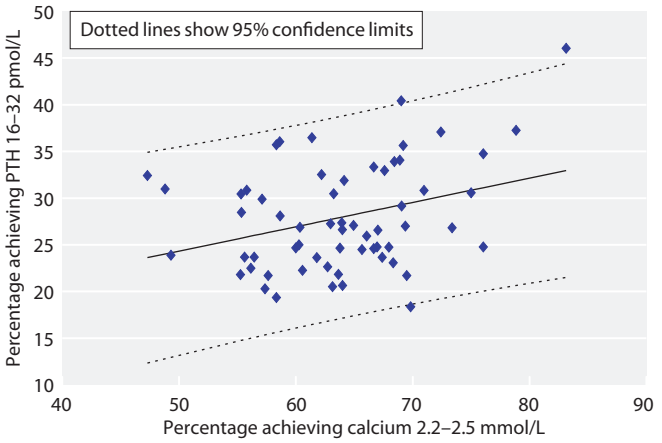

Fig. 10.44. Relationship between the proportion of HD patients achieving calcium and PTH standards within centre in 2008

Discussion – Mineral and bone parameters

There is evidence from epidemiological studies that hyperphosphataemia is a risk factor for secondary hyperparathyroidism and that it predicts mortality [11–19]. However, there is no evidence that lowering serum phosphate to a specific target range improves outcome. There is also evidence that low phosphate levels are associated with increased mortality [15]. High adjusted serum calcium levels are also associated with mortality,

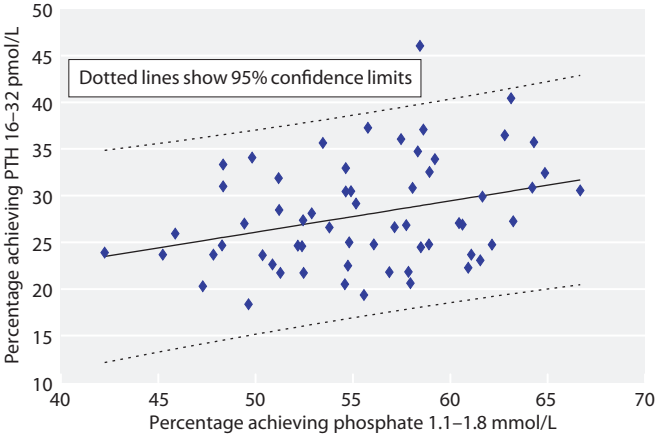

Fig. 10.45. Relationship between the proportion of HD patients achieving phosphate and PTH standards within centre in 2008

though the serum level above which the increased risk occurs varies in different studies across the range 2.38 and 2.85 mmol/L [11, 15–18]. Low serum calcium levels (less than 2.10 mmol/L) may also be associated with increased risk, although this is even more contentious [11, 15].

There are observational data demonstrating increased mortality risk in patients with PTH levels at the extremes [11, 16–19], but again no evidence that controlling PTH within particular limits improves clinical outcomes. Setting a target range is also complicated by methodological problems in that PTH assays differ in their capacity to recognise accumulating PTH fragments, differ in their pre-analytical sample handling requirements and their predictive power for underlying bone histology is poor. Such factors have lead to a significant change of direction in the recent KDIGO guidelines which suggest ***'lowering elevated phosphate levels toward the normal range, maintaining serum calcium in the normal range, and maintaining iPTH levels in the range of approximately two to nine times the upper normal limit for the assay' [20].*** This approach at least has the advantage of recognising the complex relationship between mortality risk and the different possible combinations of serum calcium, phosphate and PTH levels [15–21].

This lack of a firm evidence base, the complexity of the clinical processes required to manage mineral and bone disorders, differences in case-mix, and the potential for measurement bias related to variability in assay methods across the UK for calcium (and albumin), phosphate and parathyroid hormone, may all be factors in the centre level differences consistently demonstrated by the UKRR.

Bicarbonate

The 4th edition of the Renal Association Clinical Practice Guidelines state:

'For HD patients pre-dialysis serum bicarbonate concentrations measured with minimum delay after venepuncture and before a 'short gap' dialysis session should be between 20 and 26 mmol/L (Module 3a: Haemodialysis)

For PD patients, Plasma bicarbonate should be maintained within the normal range' (Module 3b: Peritoneal dialysis) [1]

The data for serum bicarbonate were 84% complete overall for HD patients (table 10.14) with four centres (Coventry, London West, Manchester Hope, Stoke) returning less than 50% and hence excluded from analysis. For PD patients the data were 85% complete (table 10.16) with one centre (Nottingham) with sufficient eligible patients returning below 50% and excluded from subsequent analysis.

Overall 71% (CI 71–72) of HD patients (table 10.15) were within the target range of 20–26 mmol/L, a figure unchanged from 2007. There was considerable variation

Table 10.14. Summary statistics for bicarbonate in haemodialysis patients in 2008

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	98	118	23	2.5	23	21	24
B Heart	93	349	25	2.9	25	23	27
B QEH	89	636	25	2.9	25	23	26
Bangor	97	64	24	3.1	23	21	25
Basldn	99	124	23	2.9	23	21	25
Belfast	96	222	23	2.7	23	21	25
Bradfd	96	172	22	3.4	22	20	24
Brightn	87	238	23	2.7	23	21	25
Bristol	100	391	24	2.7	24	22	26
Camb	54	153	23	3.0	23	21	25
Cardff	83	372	22	3.0	22	20	24
Carlis	99	74	23	2.8	23	22	25
Carsh	98	566	25	3.5	25	22	27
Chelms	100	94	25	2.3	25	24	27
Clwyd	93	62	24	2.8	23	22	25
Colchr	100	103	26	2.6	26	24	28
Covnt	45	124					
Derby	99	215	22	2.7	22	21	24

Table 10.14. Continued

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Derry	100	52	21	1.9	21	19	22
Donc	97	70	24	2.5	24	23	26
Dorset	99	183	23	3.2	23	21	25
Dudley	81	96	25	2.9	25	23	27
Exeter	100	283	22	2.8	23	21	24
Glouc	100	142	25	2.6	25	23	27
Hull	99	272	22	2.4	22	20	23
Ipswi	100	93	22	3.1	22	20	24
Kent	100	290	22	2.9	22	20	24
L Barts	100	561	23	3.1	22	21	25
L Guys	85	389	23	2.7	23	22	25
L Kings	100	378	24	2.5	24	22	26
L Rfree	83	499	24	3.2	24	23	26
L St G	100	199	26	3.0	27	24	29
L West	4	43					
Leeds	99	433	22	2.8	22	20	23
Leic	98	650	24	3.7	24	21	26
Liv Ain	95	106	23	2.9	22	21	25
Liv RI	91	337	24	3.4	24	22	26
M Hope	0	0					
M RI	66	217	24	3.6	23	21	26
Middlbr	97	260	26	3.1	26	24	28
Newc	100	241	24	3.4	24	22	26
Newry	99	85	25	2.8	25	23	26
Norwch	97	270	21	2.8	21	19	23
Nottm	76	263	25	3.2	25	23	27
Oxford	98	303	24	3.9	24	21	26
Plymth	98	109	21	3.3	22	20	23
Ports	100	411	23	2.8	23	21	25
Prestn	77	303	23	3.0	23	21	25
Redng	100	231	24	3.0	24	22	26
Sheff	99	528	25	2.7	25	23	27
Shrew	100	169	23	3.4	22	21	25
Stevng	99	339	23	3.2	23	21	25
Sthend	99	121	23	3.1	23	21	26
Stoke	0	0					
Sund	99	149	24	3.2	24	22	25
Swanse	98	297	23	3.5	23	21	26
Truro	99	130	20	2.3	20	19	22
Tyrone	100	83	26	3.5	26	24	28
Ulster	100	76	19	2.0	19	18	20
Wirral	98	156	24	3.3	25	22	27
Wolve	99	273	21	3.1	21	19	23
Wrexm	100	67	23	2.7	23	21	25
York	98	107	23	3.3	23	21	25
England	**83**	**12,843**	**24**	**3.3**	**24**	**21**	**26**
N Ireland	**98**	**636**	**23**	**3.3**	**23**	**21**	**25**
Wales	**91**	**862**	**23**	**3.2**	**23**	**21**	**25**
E, W & NI	**84**	**14,341**	**23**	**3.3**	**23**	**21**	**26**

Blank cells denote centres excluded from analyses due to low patient numbers or poor data completeness

Table 10.15. Percentage of haemodialysis patients within, below and above the range for bicarbonate (20–26 mmol/L) in 2008

Centre	N	% bicarb 20–26 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb <20 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb >26 mmol/L	Lower 95% CI	Upper 95% CI
Antrim	118	83.9	76.1	89.5	9.3	5.2	16.1	6.8	3.4	13.0
B Heart	349	59.6	54.4	64.6	3.7	2.2	6.3	36.7	31.8	41.9
B QEH	636	68.2	64.5	71.7	4.6	3.2	6.5	27.2	23.9	30.8
Bangor	64	67.2	54.9	77.5	10.9	5.3	21.2	21.9	13.4	33.6
Basldn	124	79.0	71.0	85.3	12.9	8.1	20.0	8.1	4.4	14.3
Belfast	222	80.2	74.4	84.9	9.5	6.3	14.1	10.4	7.0	15.1
Bradfd	172	69.8	62.5	76.2	18.0	13.0	24.5	12.2	8.1	18.0
Brightn	238	76.1	70.2	81.1	13.9	10.0	18.9	10.1	6.9	14.6
Bristol	391	81.8	77.7	85.4	5.1	3.3	7.8	13.0	10.1	16.8
Camb	153	76.5	69.1	82.5	12.4	8.1	18.7	11.1	7.0	17.2
Cardff	372	70.7	65.9	75.1	21.2	17.4	25.7	8.1	5.7	11.3
Carlis	74	77.0	66.1	85.2	9.5	4.6	18.5	13.5	7.4	23.3
Carsh	566	64.7	60.6	68.5	6.2	4.5	8.5	29.2	25.6	33.0
Chelms	94	68.1	58.0	76.7	0.0	0.0	0.0	31.9	23.3	42.0
Clwyd	62	83.9	72.6	91.1	3.2	0.8	12.0	12.9	6.6	23.7
Colchr	103	56.3	46.6	65.6	1.0	0.1	6.6	42.7	33.5	52.4
Derby	215	82.8	77.2	87.3	12.1	8.4	17.2	5.1	2.9	9.0
Derry	52	73.1	59.5	83.4	26.9	16.6	40.5	0.0	0.0	0.0
Donc	70	78.6	67.4	86.7	2.9	0.7	10.7	18.6	11.1	29.4
Dorset	183	76.5	69.8	82.1	13.1	9.0	18.8	10.4	6.7	15.7
Dudley	96	61.5	51.4	70.6	4.2	1.6	10.6	34.4	25.6	44.4
Exeter	283	79.2	74.0	83.5	14.1	10.5	18.7	6.7	4.3	10.3
Glouc	142	72.5	64.6	79.2	2.1	0.7	6.3	25.4	18.9	33.1
Hull	272	78.3	73.0	82.8	19.5	15.2	24.6	2.2	1.0	4.8
Ipswi	93	75.3	65.5	83.0	18.3	11.7	27.5	6.5	2.9	13.6
Kent	290	74.1	68.8	78.9	18.6	14.6	23.5	7.2	4.8	10.9
L Barts	561	77.4	73.7	80.6	14.4	11.8	17.6	8.2	6.2	10.8
L Guys	389	84.1	80.1	87.4	5.9	4.0	8.7	10.0	7.4	13.4
L Kings	378	80.4	76.1	84.1	2.4	1.2	4.5	17.2	13.7	21.3
L Rfree	499	73.6	69.5	77.2	5.6	3.9	8.0	20.8	17.5	24.6
L St G	199	44.2	37.5	51.2	1.0	0.3	3.9	54.8	47.8	61.6
Leeds	433	75.3	71.0	79.1	20.3	16.8	24.4	4.4	2.8	6.8
Leic	650	64.6	60.9	68.2	12.2	9.9	14.9	23.2	20.1	26.6
Liv Ain	106	79.3	70.5	85.9	9.4	5.2	16.7	11.3	6.5	18.9
Liv RI	337	70.9	65.9	75.5	9.8	7.1	13.5	19.3	15.4	23.9
M RI	217	68.2	61.7	74.1	8.8	5.7	13.3	23.0	17.9	29.1
Middlbr	260	54.6	48.5	60.6	3.1	1.6	6.0	42.3	36.4	48.4
Newc	241	72.2	66.2	77.5	9.1	6.1	13.5	18.7	14.2	24.1
Newry	85	68.2	57.6	77.2	5.9	2.5	13.4	25.9	17.7	36.2
Norwch	270	71.5	65.8	76.6	25.6	20.7	31.1	3.0	1.5	5.8
Nottm	263	65.8	59.8	71.3	3.4	1.8	6.4	30.8	25.5	36.6
Oxford	303	68.3	62.9	73.3	9.2	6.5	13.1	22.4	18.1	27.5
Plymth	109	70.6	61.4	78.4	23.9	16.8	32.7	5.5	2.5	11.7
Ports	411	74.0	69.5	78.0	12.7	9.8	16.2	13.4	10.4	17.0
Prestn	303	74.9	69.7	79.5	11.2	8.1	15.3	13.9	10.4	18.2
Redng	231	71.4	65.3	76.9	5.2	3.0	8.9	23.4	18.4	29.3
Sheff	528	72.4	68.4	76.0	2.7	1.6	4.4	25.0	21.5	28.9
Shrew	169	71.0	63.7	77.4	17.8	12.7	24.3	11.2	7.3	17.0
Stevng	339	76.1	71.3	80.4	8.9	6.3	12.4	15.0	11.6	19.3
Sthend	121	71.9	63.3	79.2	12.4	7.6	19.6	15.7	10.3	23.3
Sund	149	74.5	66.9	80.9	8.1	4.6	13.7	17.5	12.2	24.4
Swanse	297	68.0	62.5	73.1	15.5	11.8	20.1	16.5	12.7	21.2
Truro	130	57.7	49.1	65.9	40.0	31.9	48.6	2.3	0.8	6.9
Tyrone	83	60.2	49.4	70.2	2.4	0.6	9.1	37.4	27.7	48.2
Ulster	76	38.2	28.0	49.5	61.8	50.5	72.0	0.0	0.0	0.0
Wirral	156	63.5	55.6	70.6	6.4	3.5	11.5	30.1	23.5	37.8
Wolve	273	65.9	60.1	71.3	31.5	26.3	37.3	2.6	1.2	5.3
Wrexm	67	76.1	64.5	84.8	13.4	7.1	23.9	10.5	5.1	20.3
York	107	71.0	61.8	78.8	14.0	8.6	22.0	15.0	9.4	23.0
England	**12,843**	**71.3**	**70.5**	**72.1**	**10.5**	**10.0**	**11.1**	**18.2**	**17.5**	**18.8**
N Ireland	**636**	**71.1**	**67.4**	**74.5**	**15.7**	**13.1**	**18.8**	**13.2**	**10.8**	**16.1**
Wales	**862**	**70.9**	**67.8**	**73.8**	**16.6**	**14.3**	**19.2**	**12.5**	**10.5**	**14.9**
E, W & NI	**14,341**	**71.3**	**70.5**	**72.0**	**11.1**	**10.6**	**11.7**	**17.6**	**17.0**	**18.2**

Table 10.16. Summary statistics for serum bicarbonate in peritoneal dialysis patients in 2008

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	56	9					
B Heart	100	28	25.9	2.5	25.8	24.2	27.3
B QEH	74	92	25.6	3.2	25.9	23.4	27.9
Bangor	97	28	26.0	3.4	25.8	23.5	28.6
Basldn	100	30	26.4	3.3	27.0	23.0	28.0
Belfast	98	45	25.1	2.9	25.0	23.0	27.0
Bradfd	97	31	25.3	4.3	25.0	22.0	28.0
Brightn	98	78	23.9	3.7	23.9	21.6	26.2
Bristol	99	71	25.1	2.6	26.0	24.0	27.0
Camb	100	40	25.9	2.9	26.0	23.5	27.5
Cardff	99	113	22.9	2.8	23.0	21.0	24.7
Carlis	100	17					
Carsh	95	114	27.6	3.0	28.0	26.0	30.0
Chelms	100	39	27.9	2.9	28.0	26.0	30.0
Clwyd	80	8					
Colchr	n/a	0					
Covnt	68	48	26.3	3.0	27.0	24.0	29.0
Derby	100	75	26.4	3.4	26.0	24.0	29.0
Derry	100	5					
Donc	22	8					
Dorset	98	49	25.7	2.3	26.0	24.0	27.0
Dudley	96	45	25.2	2.8	25.3	24.2	27.4
Exeter	100	71	24.5	3.8	25.0	22.0	26.0
Glouc	100	33	27.1	3.2	27.0	25.0	30.0
Hull	96	69	26.6	3.1	26.0	25.0	29.0
Ipswi	98	48	24.7	3.3	25.0	23.5	27.0
Kent	97	70	23.3	3.3	22.0	21.0	26.0
L Barts	100	208	25.5	3.4	26.0	23.0	28.0
L Guys	98	49	24.0	2.7	25.0	22.0	26.0
L Kings	100	72	25.7	2.8	26.0	24.0	27.5
L Rfree	89	75	26.4	3.5	26.0	24.0	29.0
L St G	98	50	26.5	3.2	27.0	24.0	29.0
L West	7	3					
Leeds	99	86	26.2	3.0	26.0	25.0	28.0
Leic	94	149	26.5	3.2	27.0	24.0	28.7
Liv Ain	50	1					
Liv RI	92	87	24.6	2.7	25.0	23.0	27.0
M Hope	0	0					
M RI	100	91	25.8	2.9	26.0	24.0	28.0
Middlbr	86	19					
Newc	98	44	26.0	3.3	26.0	24.0	28.0
Newry	60	6					
Norwch	93	55	21.3	2.5	21.0	20.0	23.0
Nottm	47	52					
Oxford	67	72	26.1	3.7	26.5	24.0	28.0
Plymth	100	45	24.4	3.1	24.0	23.0	26.0
Ports	76	58	24.7	2.6	24.3	22.7	26.7
Prestn	81	47	24.0	2.5	24.0	23.0	26.0
Redng	100	75	25.1	2.3	25.0	24.0	26.0
Sheff	100	71	26.6	2.9	26.0	24.0	28.0
Shrew	100	32	25.9	2.6	26.0	24.0	27.0
Stevng	92	34	25.9	3.0	26.5	25.0	28.0
Sthend	93	14					
Stoke	12	9					

Table 10.16. Continued

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Sund	100	20	24.1	2.8	24.5	23.0	26.0
Swanse	98	59	26.3	3.0	26.0	25.0	28.0
Truro	100	26	23.9	2.4	24.0	22.0	25.0
Tyrone	100	7					
Ulster	80	4					
Wirral	74	25	26.2	2.9	27.0	23.0	28.0
Wolve	98	56	25.6	2.9	25.0	23.5	28.0
Wrexm	96	21	25.3	2.2	25.0	24.0	27.0
York	100	19					
England	**84**	**2,700**	**25.6**	**3.3**	**26.0**	**23.1**	**28.0**
N Ireland	**85**	**76**	**24.9**	**3.0**	**25.0**	**23.0**	**27.0**
Wales	**98**	**229**	**24.5**	**3.3**	**24.0**	**22.0**	**26.8**
E, W & NI	**85**	**3,005**	**25.5**	**3.3**	**26.0**	**23.0**	**28.0**

Blank cells denote centres excluded from analyses due to low patient numbers or poor data completeness

between centres in achieving the target, with seven centres achieving it in a significantly higher proportion of patients (Antrim, Derby, Belfast, London Kings, London Guys, Bristol, London Barts) and five in a significantly lower proportion of patients (Ulster, London St George's, Middlesbrough, Birmingham Heartlands, Leicester) (figure 10.46). Table 10.15 for HD patients and 10.17 for PD patients can be used to identify centres in each funnel plot showing bicarbonate achievement (figures 10.46–10.50). Six centres (Ulster, Truro, Wolverhampton, Norwich, Cardiff, Leeds) had a significantly high proportion of their patients with serum bicarbonate below 20 mmol/L (figure 10.47). Twelve centres (Tyrone, Colchester, London St George's, Middlesborough, Nottingham, Birmingham Heartlands, Sheffield, Carshalton, Birmingham QEH, Leicester, Dudley, Wirral) had a significantly high proportion with serum bicarbonate above 26 mmol/L (figure 10.48). These show over-dispersion of data and are therefore difficult to interpret.

For PD patients the target is to maintain values in the normal range which, in contrast to previous years, has been taken as 22–30 mmol/L. Overall 82% (CI 81–83) were within the target range (table 10.17). One centre (Norwich) achieved the target in a significantly lower proportion of their patients whilst in two centres (Dorset and Wrexham), the target was achieved in a significantly higher proportion (figure 10.49). The funnel plot shows two outlying centres (Norwich, Cardiff) with a high proportion of patients below 22 mmol/L (51% and 31% respectively) (figure 10.50). There were

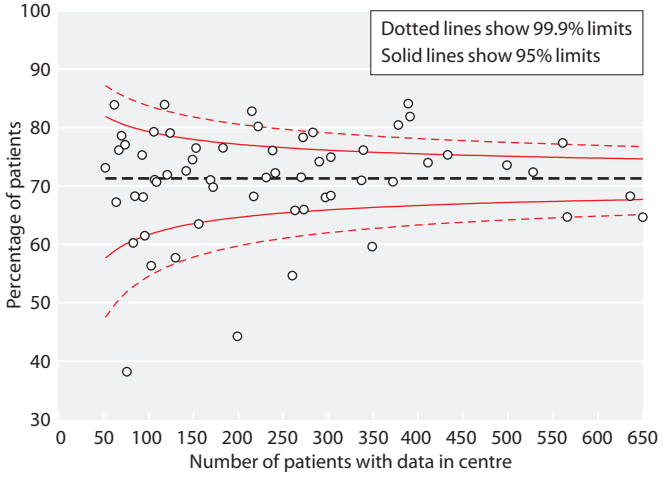

Fig. 10.46. Funnel plot of percentage of haemodialysis patients with bicarbonate 20–26 mmol/L by centre in 2008

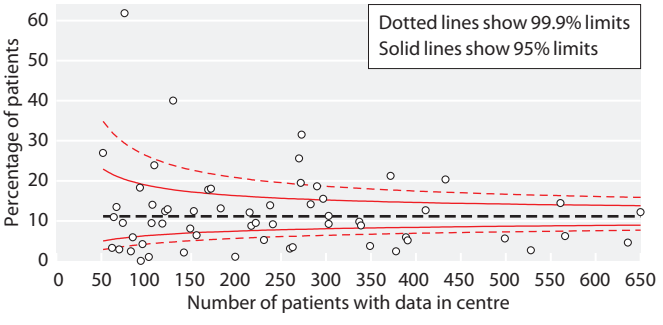

Fig. 10.47. Funnel plot of percentage of haemodialysis patients with bicarbonate <20 mmol/L by centre in 2008

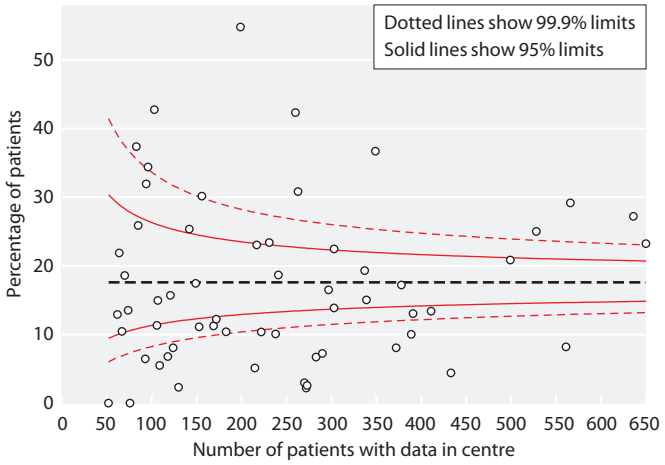

Fig. 10.48. Funnel plot of percentage of haemodialysis patients with bicarbonate >26 mmol/L by centre in 2008

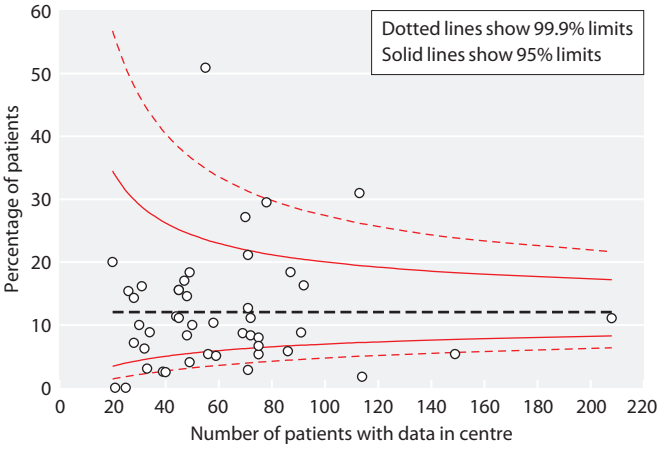

Fig. 10.50. Funnel plot of peritoneal dialysis patients with bicarbonate <22 mmol/L by centre in 2008

no centres with a higher than expected proportion of patients with serum bicarbonate greater than 30 mmol/L (funnel plot not shown).

The determinants of serum bicarbonate concentration in dialysis patients are multiple. They include pre-analytic factors such as the method of sampling, storage of the sample after collection and transport arrangements. Delays in transport to the laboratories can lead to significant reductions in serum bicarbonate. The analytic method employed may also be important. There are also numerous patient related factors including dietary protein intake, the degree of catabolism, dialysis frequency, dialysis adequacy, compliance with dialysis schedules, the dialysate bicarbonate concentration, the use of oral sodium bicarbonate and the use of calcium carbonate and sevelamer hydrochloride for phosphate binding. The UKRR previously conducted a limited survey into the possible underlying causes of the observed variation in serum bicarbonate concentrations and was unable to detect significant differences in sample processing or in dialysis treatment between centres except the association of low serum bicarbonate levels and the use of twice weekly haemodialysis [22].

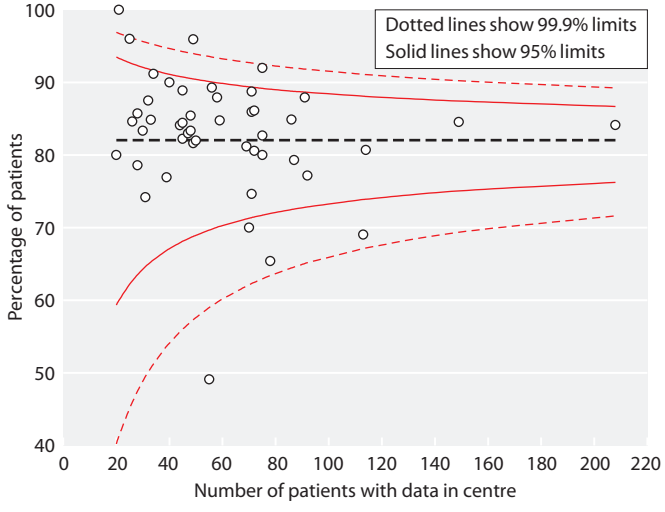

Fig. 10.49. Funnel plot of percentage of peritoneal dialysis patients with bicarbonate 22–30 mmol/L by centre in 2008

Other factors such as case mix or unmeasured processes including dialysis and oral bicarbonate prescription might account for the variation observed. Metabolic acidosis in haemodialysis patients has been positively associated with increased protein nitrogen appearance and negatively with increased Kt/V and increased use of calcium carbonate [23].

The haemodialysis module of the 4th edition of the Renal Association guidelines has recently been revised (1st December 2009) [24] and states (guideline 6.3) that:

'pre-dialysis serum bicarbonate concentrations measured with minimum delay after venepuncture should be between 18 and 24 mmol/L'.

The justification for a 2 mmol/L downward revision of the target range is as follows:

'Complete correction of pre-dialysis metabolic acidosis in HD patients may lead to post-dialysis metabolic alkalosis and consequently hypoventilation, phosphate transfer into cells and a higher risk of soft tissue and vascular calcification.'

It should also be noted that oral administration of sodium bicarbonate may contribute to sodium (and fluid) retention and hypertension.

Table 10.17. Percentage of peritoneal dialysis patients within, below and above the range for bicarbonate (22–30 mmol/L) in 2008

Centre	N	% bicarb 22–30 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb <22 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb >30 mmol/L	Lower 95% CI	Upper 95% CI
B Heart	28	85.7	67.6	94.5	7.1	1.8	24.5	7.1	1.8	24.5
B QEH	92	77.2	67.5	84.6	16.3	10.1	25.3	6.5	3.0	13.8
Bangor	28	78.6	59.8	90.0	14.3	5.5	32.5	7.1	1.8	24.5
Basldn	30	83.3	65.7	92.9	10.0	3.3	26.8	6.7	1.7	23.1
Belfast	45	82.2	68.3	90.9	15.6	7.6	29.2	2.2	0.3	14.2
Bradfd	31	74.2	56.3	86.5	16.1	6.9	33.4	9.7	3.2	26.1
Brightn	78	65.4	54.2	75.1	29.5	20.5	40.5	5.1	1.9	12.9
Bristol	71	85.9	75.8	92.3	12.7	6.7	22.6	1.4	0.2	9.3
Camb	40	90.0	76.2	96.2	2.5	0.4	15.7	7.5	2.4	20.8
Cardff	113	69.0	59.9	76.9	31.0	23.2	40.1	0.0	0.0	0.0
Carsh	114	80.7	72.4	86.9	1.8	0.4	6.7	17.5	11.6	25.6
Chelms	39	76.9	61.3	87.5	2.6	0.4	16.1	20.5	10.6	36.0
Covnt	48	83.3	70.1	91.4	8.3	3.2	20.2	8.3	3.2	20.2
Derby	75	80.0	69.4	87.6	5.3	2.0	13.4	14.7	8.3	24.6
Dorset	49	95.9	85.1	99.0	4.1	1.0	14.9	0.0	0.0	0.0
Dudley	45	88.9	76.0	95.3	11.1	4.7	24.1	0.0	0.0	0.0
Exeter	71	74.7	63.3	83.4	21.1	13.2	32.1	4.2	1.4	12.3
Glouc	33	84.9	68.4	93.6	3.0	0.4	18.6	12.1	4.6	28.2
Hull	69	81.2	70.2	88.7	8.7	4.0	18.0	10.1	4.9	19.8
Ipswi	48	85.4	72.4	92.9	14.6	7.1	27.6	0.0	0.0	100.0
Kent	70	70.0	58.3	79.6	27.1	18.0	38.7	2.9	0.7	10.7
L Barts	208	84.1	78.5	88.5	11.1	7.5	16.1	4.8	2.6	8.7
L Guys	49	81.6	68.3	90.2	18.4	9.8	31.7	0.0	0.0	0.0
L Kings	72	86.1	76.1	92.4	8.3	3.8	17.3	5.6	2.1	13.9
L Rfree	75	82.7	72.4	89.7	8.0	3.6	16.7	9.3	4.5	18.3
L St G	50	82.0	68.9	90.4	10.0	4.2	21.9	8.0	3.0	19.5
Leeds	86	84.9	75.7	91.0	5.8	2.4	13.2	9.3	4.7	17.5
Leic	149	84.6	77.8	89.5	5.4	2.7	10.4	10.1	6.2	16.0
Liv RI	87	79.3	69.5	86.6	18.4	11.6	27.9	2.3	0.6	8.7
M RI	91	87.9	79.5	93.2	8.8	4.5	16.6	3.3	1.1	9.7
Newc	44	84.1	70.2	92.2	11.4	4.8	24.5	4.6	1.1	16.4
Norwch	55	49.1	36.2	62.1	50.9	37.9	63.8	0.0	0.0	0.0
Oxford	72	80.6	69.8	88.1	11.1	5.7	20.7	8.3	3.8	17.3
Plymth	45	84.4	70.8	92.4	15.6	7.6	29.2	0.0	0.0	0.0
Ports	58	87.9	76.8	94.1	10.3	4.7	21.2	1.7	0.2	11.2
Prestn	47	83.0	69.5	91.3	17.0	8.8	30.5	0.0	0.0	0.0
Redng	75	92.0	83.3	96.4	6.7	2.8	15.0	1.3	0.2	8.9
Sheff	71	88.7	79.1	94.3	2.8	0.7	10.6	8.5	3.9	17.6
Shrew	32	87.5	71.1	95.2	6.3	1.6	21.8	6.3	1.6	21.8
Stevng	34	91.2	76.0	97.1	8.8	2.9	24.0	0.0	0.0	0.0
Sund	20	80.0	57.2	92.3	20.0	7.7	42.8	0.0	0.0	0.0
Swanse	59	84.8	73.2	91.9	5.1	1.7	14.6	10.2	4.6	20.8
Truro	26	84.6	65.5	94.1	15.4	5.9	34.5	0.0	0.0	0.0
Wirral	25	96.0	76.5	99.4	0.0	0.0	100.0	4.0	0.6	23.6
Wolve	56	89.3	78.1	95.1	5.4	1.7	15.3	5.4	1.7	15.3
Wrexm	21	100.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
England	**2,700**	**82.4**	**81.0**	**83.8**	**11.4**	**10.3**	**12.7**	**6.2**	**5.3**	**7.1**
N Ireland	**76**	**81.6**	**71.3**	**88.8**	**15.8**	**9.2**	**25.8**	**2.6**	**0.7**	**9.9**
Wales	**229**	**77.7**	**71.9**	**82.7**	**18.3**	**13.9**	**23.9**	**3.9**	**2.1**	**7.4**
E, W & NI	**3,005**	**82.1**	**80.7**	**83.4**	**12.1**	**10.9**	**13.3**	**5.9**	**5.1**	**6.8**

'In a large observational study the risk of death was lowest in HD patients with pre-dialysis serum bicarbonate concentrations within the 18.0–24.0 mmol/L range (Lowrie EG, Teng M, Lew NL et al. Toward a continuous quality improvement paradigm for hemodialysis providers with preliminary suggestions for clinical practice monitoring and measurement. Hemodial Int 2003;7:28–51). Review of the target pre-dialysis serum bicarbonate levels set by international clinical practice guidelines indicates that a mild degree of pre--dialysis acidosis is recommended to minimize the risk of adverse events.'

Total cholesterol

There is no audit standard for total cholesterol in the 4th edition of the Renal Association Clinical Practice Guidelines. Current guidance on lipid management states:

'Three hydroxy-3 methylglutaryl-Co-enzyme A reductase inhibitors (statins) should be considered for primary prevention in all CKD including dialysis patients with a 10-year risk of cardiovascular disease, calculated as >20% according to the Joint British Societies' Guidelines (JBS 2), despite the fact that these calculations have not been validated in patients with renal disease. The target total cholesterol should be <4 mmol/L or a 25% reduction from baseline, and 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 (Evidence in CKD 1–3, Good Practice in CKD 4–5 and dialysis 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. (Good Practice).' (Module 2: Complications) [1]

Total cholesterol data were 83% complete for both HD (table 10.18) and PD (table 10.19) patients. Six centres (Brighton, Colchester, Coventry, Doncaster, Liverpool Royal Infirmary, Stevenage) with <50% completeness for HD and two centres (Brighton, Carshalton) with more than 20 patients but <50% completeness for PD were excluded from further analysis. The median cholesterol achieved for HD patients was 3.8 mmol/L (figure 10.51) and for PD patients was 4.4 mmol/L (figure 10.52).

Serial data for 2000–2008 (figure 10.53) show that the percentage of HD patients achieving a cholesterol less than 5 mmol/L has been stable at 85% for three years whereas there has been a slight decline (72 to 69%) in PD patients over the same time period.

A number of case mix factors (comorbidity, inflammation and malnutrition) may contribute to inter centre variation in cholesterol levels in addition to differences in clinical practice with relation to the prescription of lipid lowering medication and other therapies, such as sevelamer, which are known to influence lipid levels. The UKRR plans to collect an enhanced dataset to include more detailed lipid profiles, which, in conjunction with the awaited results from the SHARP study, may help inform lipid management practice in dialysis patients.

Table 10.18. Summary statistics for total cholesterol in haemodialysis patients in 2008

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	98	119	3.9	1.1	3.9	3.1	4.7
B Heart	87	339	4.4	1.1	4.3	3.7	5.0
B QEH	86	631	4.0	1.1	3.8	3.2	4.5
Bangor	87	62	4.1	1.1	4.1	3.3	4.8
Basldn	99	124	4.0	1.0	3.9	3.4	4.5
Belfast	84	201	4.0	1.0	3.8	3.3	4.5
Bradfd	81	145	4.4	1.4	4.2	3.6	5.0
Brightn	32	95					
Bristol	93	389	4.1	1.1	3.9	3.3	4.7
Camb	80	232	3.8	1.0	3.7	3.1	4.3
Cardff	92	413	4.0	1.1	3.8	3.2	4.6
Carlis	97	73	4.2	1.0	4.2	3.4	4.7
Carsh	84	484	4.1	1.1	3.9	3.4	4.8
Chelms	99	94	4.0	1.2	3.6	3.2	4.7

Table 10.18. Continued

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Clwyd	87	59	4.0	0.8	3.9	3.4	4.6
Colchr	20	21					
Covnt	0	0					
Derby	97	222	3.7	0.9	3.7	3.2	4.2
Derry	100	52	4.0	0.9	3.7	3.5	4.4
Donc	36	26					
Dorset	96	179	4.0	1.0	4.0	3.4	4.6
Dudley	75	90	3.4	0.8	3.4	2.7	4.0
Exeter	78	221	4.0	1.1	3.9	3.1	4.7
Glouc	94	134	4.1	1.2	4.0	3.3	4.8
Hull	92	267	4.1	1.1	4.1	3.4	4.9
Ipswi	88	84	3.8	1.0	3.6	3.1	4.3
Kent	99	291	4.1	1.0	4.0	3.4	4.8
L Barts	100	570	3.8	1.0	3.7	3.1	4.4
L Guys	96	462	4.0	1.1	3.9	3.3	4.6
L Kings	93	354	4.0	1.0	3.9	3.3	4.6
L Rfree	83	514	4.1	1.1	4.0	3.4	4.7
L St G	99	203	4.1	1.0	4.0	3.2	4.8
L West	74	861	3.8	1.0	3.6	3.1	4.3
Leeds	96	438	3.9	1.0	3.8	3.2	4.5
Leic	95	642	3.8	1.0	3.7	3.1	4.4
Liv Ain	53	61	4.0	1.1	3.9	3.0	4.7
Liv RI	10	38					
M Hope	80	229	3.6	0.9	3.5	3.0	4.0
M RI	69	265	3.8	1.0	3.8	3.0	4.5
Middlbr	97	264	4.3	1.1	4.3	3.4	5.0
Newc	91	229	3.8	1.0	3.7	3.1	4.4
Newry	99	87	3.6	1.0	3.4	2.8	4.1
Norwch	99	284	4.0	1.1	3.8	3.3	4.6
Nottm	98	344	3.7	1.0	3.6	3.1	4.3
Oxford	89	291	3.8	1.0	3.7	3.0	4.5
Plymth	88	99	3.9	1.0	3.9	3.3	4.6
Ports	64	264	4.0	1.2	3.8	3.1	4.6
Prestn	99	410	4.0	1.0	3.9	3.3	4.6
Redng	92	214	3.7	0.9	3.7	3.1	4.3
Sheff	93	529	3.8	1.0	3.7	3.0	4.3
Shrew	99	169	4.0	1.0	3.9	3.3	4.5
Stevng	40	138					
Sthend	87	106	4.0	1.0	3.8	3.3	4.5
Stoke	95	228	3.6	1.0	3.6	3.0	4.2
Sund	99	149	3.8	1.0	3.6	2.9	4.4
Swanse	96	303	4.1	1.1	4.0	3.3	4.7
Truro	100	134	3.9	1.1	3.9	3.1	4.4
Tyrone	100	84	4.2	1.0	4.1	3.6	4.7
Ulster	100	77	3.9	0.9	3.8	3.2	4.4
Wirral	91	149	3.8	1.1	3.7	3.0	4.4
Wolve	95	262	4.1	1.0	4.0	3.4	4.7
Wrexm	78	55	3.9	1.1	3.8	3.3	4.3
York	90	99	4.5	1.1	4.3	3.7	5.3
England	**83**	**13,140**	**3.9**	**1.1**	**3.8**	**3.2**	**4.5**
N Ireland	**94**	**620**	**3.9**	**1.0**	**3.8**	**3.2**	**4.5**
Wales	**92**	**892**	**4.0**	**1.1**	**3.9**	**3.3**	**4.7**
E, W & NI	**83**	**14,652**	**3.9**	**1.1**	**3.8**	**3.2**	**4.5**

Blank cells denote centres excluded from analyses due to low patient numbers or poor data completeness

Table 10.19. Summary statistics for total cholesterol in peritoneal dialysis patients in 2008

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	88	14					
B Heart	100	28	4.9	1.2	4.9	4.0	5.7
B QEH	82	103	4.4	1.2	4.2	3.7	5.2
Bangor	97	28	4.8	1.1	4.7	4.0	5.2
Basldn	100	30	4.4	1.0	4.5	4.0	5.0
Belfast	91	42	4.6	1.3	4.2	3.7	5.4
Bradfd	97	31	4.9	1.5	4.8	3.7	5.9
Brightn	45	36					
Bristol	79	57	4.6	1.2	4.3	3.7	5.3
Camb	100	40	4.2	1.1	4.2	3.4	5.2
Cardff	99	113	4.6	1.2	4.5	3.6	5.4
Carlis	88	15					
Carsh	39	47					
Chelms	90	35	4.4	1.3	4.3	3.6	4.9
Clwyd	70	7					
Colchr	n/a	0					
Covnt	1	1					
Derby	89	67	4.2	1.0	4.1	3.4	4.8
Derry	100	5					
Donc	60	22	4.4	1.8	3.7	3.3	5.4
Dorset	88	44	4.4	1.0	4.4	3.7	5.0
Dudley	87	41	3.9	0.9	3.9	3.3	4.2
Exeter	82	58	4.8	1.3	4.6	4.0	5.8
Glouc	100	33	4.6	1.2	4.7	3.8	5.3
Hull	86	62	4.6	1.1	4.5	4.0	5.1
Ipswi	96	47	4.2	1.0	4.3	3.4	4.9
Kent	92	66	4.7	1.1	4.6	3.9	5.2
L Barts	100	208	4.4	1.2	4.2	3.6	5.1
L Guys	96	48	5.1	1.4	4.9	4.2	5.7
L Kings	86	62	4.6	1.2	4.5	3.9	5.2
L Rfree	94	79	4.4	1.1	4.3	3.7	5.0
L St G	94	48	5.1	1.4	5.0	4.2	6.0
L West	100	42	4.5	0.9	4.6	4.0	5.0
Leeds	95	83	4.3	1.0	4.1	3.5	4.9
Leic	96	151	4.3	1.4	4.1	3.5	4.7
Liv Ain	0	0					
Liv RI	0	0					
M Hope	88	105	4.3	1.2	4.0	3.4	5.0
M RI	99	90	4.4	1.1	4.3	3.5	4.8
Middlbr	55	12					
Newc	98	44	4.3	1.5	3.9	3.3	4.7
Newry	100	10					
Norwch	97	57	5.0	1.3	4.9	4.1	5.9
Nottm	96	107	4.2	0.9	4.2	3.6	4.8
Oxford	89	95	4.8	1.3	4.6	3.9	5.7
Plymth	82	37	4.9	1.0	4.9	4.2	5.4
Ports	53	40	4.8	1.5	4.6	3.6	5.6
Prestn	97	56	4.5	0.9	4.5	3.9	5.1
Redng	100	75	4.3	1.0	4.2	3.5	4.8
Sheff	55	39	4.4	1.2	4.1	3.4	5.1
Shrew	100	32	5.0	1.4	4.7	4.1	5.8
Stevng	43	16					
Sthend	80	12					
Stoke	100	72	3.4	1.4	3.5	2.1	4.5

Table 10.19. Continued

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Sund	50	10					
Swanse	98	59	4.7	1.4	4.4	3.7	5.4
Truro	96	25	4.7	1.1	4.4	3.9	5.4
Tyrone	86	6					
Ulster	100	5					
Wirral	71	24	4.2	1.1	3.9	3.4	4.6
Wolve	90	51	5.1	1.8	4.6	4.0	5.9
Wrexm	96	21	4.4	1.7	4.1	3.6	4.7
York	84	16					
England	**81**	**2,599**	**4.5**	**1.2**	**4.3**	**3.7**	**5.1**
N Ireland	**92**	**82**	**4.6**	**1.2**	**4.3**	**3.7**	**5.2**
Wales	**97**	**228**	**4.6**	**1.3**	**4.4**	**3.7**	**5.3**
E, W & NI	**83**	**2,909**	**4.5**	**1.3**	**4.4**	**3.7**	**5.2**

Blank cells denote centres excluded from analyses due to low patient numbers or poor data completeness

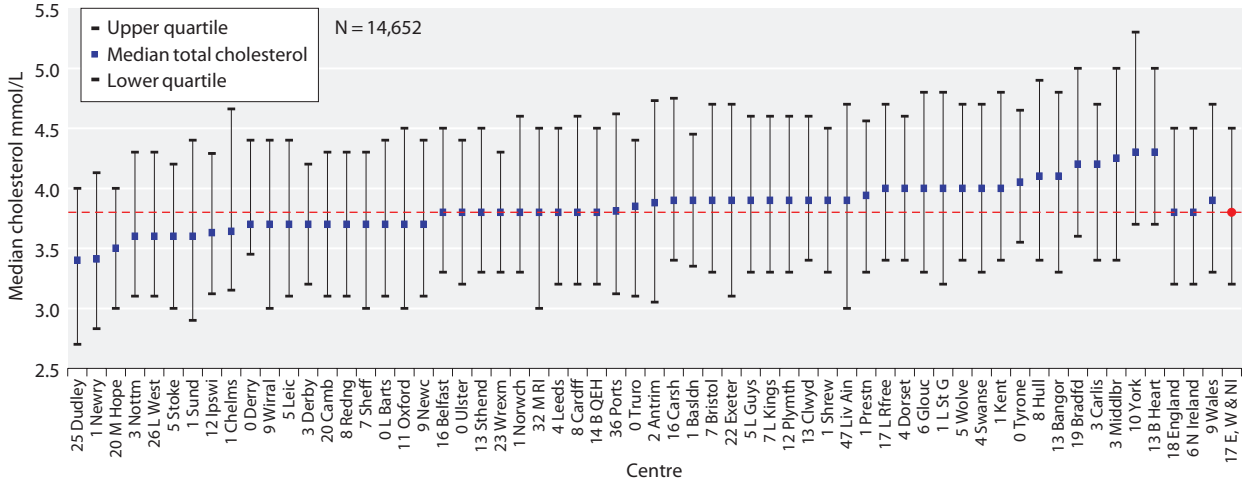

Fig. 10.51. Median total cholesterol in haemodialysis patients by centre in 2008

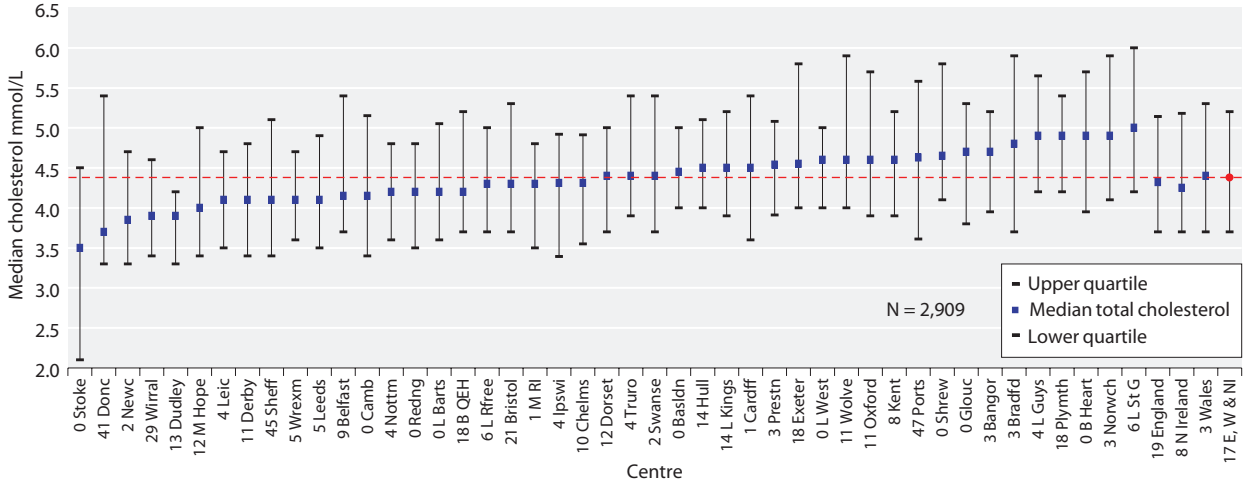

Fig. 10.52. Median total cholesterol in peritoneal dialysis patients by centre in 2008

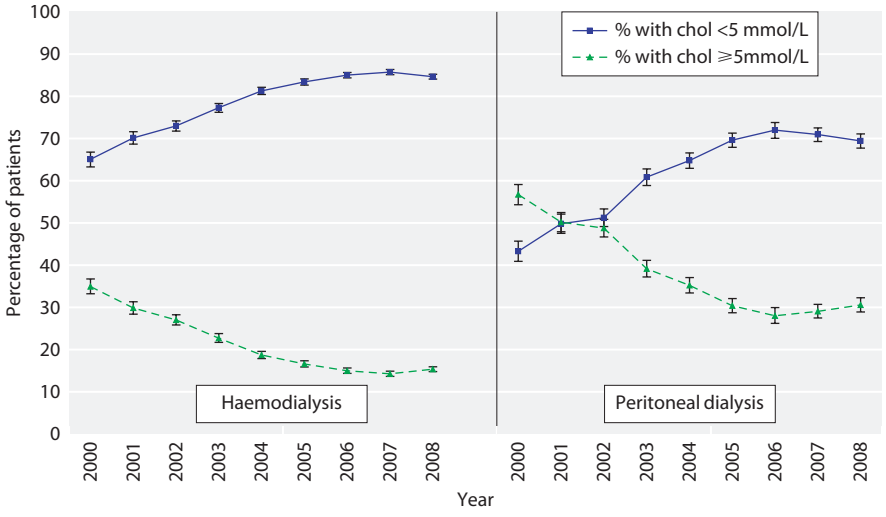

Fig. 10.53. Percentage of dialysis patients with serum total cholesterol <5 mmol/L and ⩾5 mmol/L, 2000–2008

HbA1c

The 4th edition of the Renal Association Clinical Practice Guidelines state:

'In all CKD and dialysis patients with diabetes, the glycated haemoglobin (HbA1c) should be kept below 7.5%. HbA1c should be measured using an assay method which has been harmonised to the Diabetes Control and Complications Trial (DCCT) standard'. (Module 2: Complications) [1]

The data for HbA1c for dialysis patients with a diagnosis of diabetes mellitus were 71% complete overall (table 10.20). Peritoneal and haemodialysis patients were not analysed separately due to low numbers in many centres. Four centres returned no data (Bangor, Cardiff, Derby and Wolverhampton) and four others (Birmingham QEH, Manchester RI, Portsmouth, Stoke) were excluded from further analysis due to less than 50% completeness. Sixteen others were excluded because they had less than 20 eligible patients. Median HbA1c was 7.2% (figure 10.54). Overall, 43% of dialysis patients exceeded the target of 7.5% HbA1c with a two-fold variation between centres (30% of patients at London West, 60% of patients at Ipswich and Swansea) (figure 10.55).

All methods for HbA1c in the UK are DCCT aligned and further harmonisation will be achieved with the ongoing worldwide adoption by manufacturers of

Table 10.20. Summary statistics for HbA1c in dialysis patients with diabetes mellitus in 2008

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	88	38	7.4	1.2	7.5	6.6	8.0
B Heart	86	91	7.8	1.6	7.6	6.7	8.8
B QEH	50	103					
Bangor	0	0					
Basldn	97	28	7.7	1.2	7.5	7.1	8.6
Belfast	94	50	7.2	1.3	7.2	6.2	8.1
Bradfd	94	51	7.4	1.6	7.3	6.0	8.6
Brightn	65	35	7.4	1.6	7.4	6.2	8.7
Bristol	99	92	7.3	1.5	7.0	6.3	8.0
Camb	44	10					
Cardff	0	0					
Carlis	100	13					
Carsh	72	90	7.4	1.6	7.1	6.3	8.4
Chelms	79	22	7.9	2.4	7.3	6.4	9.5

Table 10.20. Continued

Centre	% completeness	Number of patients with data	Mean	SD	Median	Lower quartile	Upper quartile
Clwyd	95	19					
Colchr	71	5					
Covnt	94	59	7.6	1.7	7.3	6.6	8.1
Derby	0	0					
Derry	100	11					
Donc	78	14					
Dorset	46	13					
Dudley	89	32	7.4	1.6	7.1	6.0	8.6
Exeter	66	25	8.1	1.9	7.7	6.7	9.4
Glouc	95	20	7.5	1.6	7.2	6.2	8.5
Hull	73	43	7.5	1.4	7.4	6.3	8.6
Ipswi	83	20	8.0	1.5	7.9	6.9	9.3
Kent	95	59	7.5	1.5	7.4	6.3	8.4
L Barts	99	231	7.8	1.9	7.6	6.4	8.7
L Guys	94	129	6.9	1.4	6.7	5.8	7.8
L Kings	89	104	7.2	1.5	6.9	6.1	8.1
L Rfree	70	64	7.8	1.6	7.8	6.5	8.7
L St G	90	73	7.7	1.5	7.5	6.7	8.8
L West	62	206	6.8	1.6	6.7	5.8	7.7
Leeds	91	71	7.4	1.7	7.1	6.1	8.4
Leic	69	90	7.1	1.3	7.0	6.0	7.9
Liv Ain	20	1					
Liv RI	72	42	7.0	1.6	7.0	5.6	7.7
M Hope	54	7					
M RI	46	26					
Middlbr	39	18					
Newc	100	37	7.7	1.4	7.5	6.5	8.6
Newry	93	14					
Norwch	84	41	7.6	1.9	7.5	6.2	8.4
Nottm	81	81	7.6	1.7	7.4	6.3	8.6
Oxford	64	47	7.7	1.7	7.4	6.3	8.5
Plymth	91	20	7.4	1.2	7.2	6.5	8.1
Ports	47	36					
Prestn	90	71	7.6	1.5	7.4	6.3	8.5
Redng	99	75	7.5	1.7	7.1	6.1	8.5
Sheff	82	88	7.8	1.5	7.9	6.6	8.8
Shrew	97	34	7.1	1.2	6.7	6.1	8.0
Stevng	92	72	7.3	1.4	7.2	6.3	8.3
Sthend	41	12					
Stoke	46	28					
Sund	69	24	7.2	1.7	6.9	6.1	8.5
Swanse	78	50	7.8	1.6	7.9	6.6	8.7
Truro	96	25	7.1	1.1	6.8	6.4	7.7
Tyrone	91	10					
Ulster	100	18					
Wirral	38	9					
Wolve	0	0					
Wrexm	39	5					
York	79	11					
England	**73**	**2,598**	**7.4**	**1.6**	**7.2**	**6.2**	**8.4**
N Ireland	**93**	**141**	**7.4**	**1.5**	**7.4**	**6.4**	**8.1**
Wales	**31**	**74**					
E, W & NI	**71**	**2,813**	**7.4**	**1.6**	**7.2**	**6.2**	**8.4**

Blank cells denote centres excluded from analyses due to low patient numbers or poor data completeness

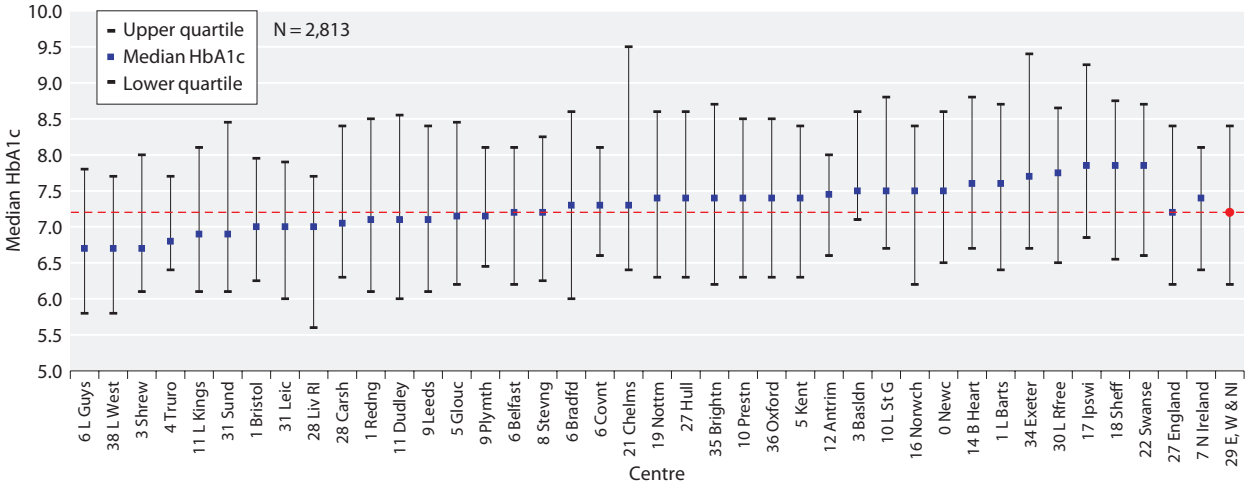

Fig. 10.54. Median HbA1c in dialysis patients with diabetes mellitus by centre in 2008

calibration via the International Federation of Clinical Chemistry reference system with results to be reported as mmol/mol haemoglobin in many countries, including the UK. A master equation will then be applied to derive the percentage HbA1c for a two year transition period of dual reporting. However, these changes will not alter some of the fundamental analytical and clinical problems confounding the interpretation of HbA1c that are unrelated to its use as an indicator of glycaemic control.

Haemoglobinopathies (especially HbS, C and E) may cause analytical interference that may be positive or negative depending on the method. Some methods suffer positive interference from carbamylated haemoglobin. Any cause of shortened red cell survival will diminish the amount of HbA1c simply because there is less time for glycation to occur, whereas it is increased with longer red cell lifespan (e.g. iron deficiency, splenectomy). Recent transfusions invalidate its use due to the presence of donor red cells and erythropoietin use may also have an impact.

Some of the observed variation between centres may be due to variations in the proportion of patients with haemoglobinopathies. Indeed one centre (London West) returned a small number of results (1.5%) below the 4% lower limit of the DCCT aligned reference range, suggesting that patients with haemoglobinopathies may have been included. Some laboratories use methods for HbA1c that will detect the presence of abnormal haemoglobins enabling the reporting of the patient as unsuitable for HbA1c analysis but many

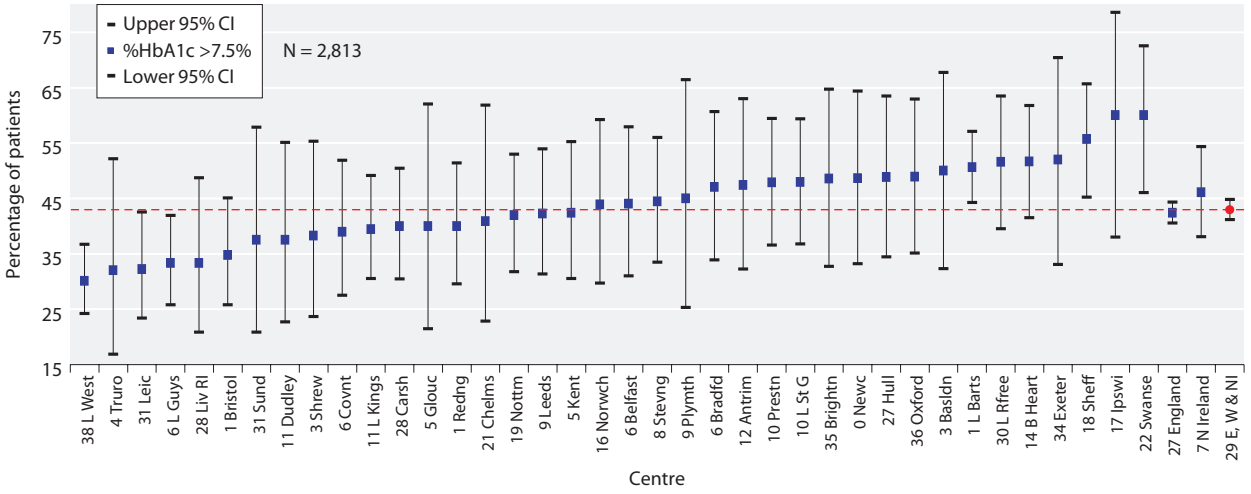

Fig. 10.55. Percentage of dialysis patients with diabetes mellitus and serum HbA1c >7.5% by centre in 2008

laboratories do not. Centres are advised to check with their laboratories about local practice and to consider the likelihood of interference in people of African, Mediterranean or South Asian origin, especially when glucose and HbA1c results are discrepant, or when HbA1c is less than 4% or greater than 15%.

Conflict of interest: none

References

1 Renal Association. Cinical practice guidelines. 4th edition Module 2: complications wwwrenalorg/guidelines 2007.
2 Ansell D, Fogarty D, Tomson C, Williams AJ, Warwick G. UK Renal Registry 11th Annual report (December 2008) Chapter15: The UK Renal Registry, UKRR database, validation and methodology. Nephron Clin Prac 2008;111(Suppl 1):277–85.
3 Lamb EJ, Vickery S, Ellis AR. Parathyroid hormone, kidney disease, evidence and guidelines. Ann Clin Biochem 2007;44(1):1–4.
4 Campbell KH, Dale W, Stankus N, Sachs GA. Older adults and chronic kidney disease decision making by primary care physicians: a scholarly review and research agenda. Journal of General Internal Medicine 2008;23(3):329–36.
5 Spiegelhalter DJ. Funnel plots for comparing institutional performance. Statistics in Medicine 2005;24(8):1185–202.
6 Zhang DJ, Elswick RK, Miller WG, Bailey JL. Effect of serum-clot contact time on clinical chemistry laboratory results. Clin Chem 1998; 44(6):1325–33.
7 Tanner M, Kent N, Smith B, Fletcher S, Lewer M. Stability of common biochemical analytes in serum gel tubes subjected to various storage temperatures and times pre-centrifugation. Ann Clin Biochem 2008;45(4):375–9.
8. Viljoen A, Singh DK, Twomey PJ, Farrington K. Analytical quality goals for parathyroid hormone based on biological variation. Clinical Chemistry and Laboratory Medicine 2008;46(10):1438–42.
9 Block GA, Martin KJ, de Francisco ALM, Turner SA, Avram MM, Suranyi MG *et al.* Cinacalcet for Secondary Hyperparathyroidism in Patients Receiving Hemodialysis. N Engl J Med 2004;350(15):1516–25.
10 Goodman WG, Hladik GA, Turner SA, Blaisdell PW, Goodkin DA, Liu W *et al.* The Calcimimetic Agent AMG 073 Lowers Plasma Parathyroid Hormone Levels in Hemodialysis Patients with Secondary Hyperparathyroidism. J Am Soc Nephrol 2002;13(4):1017–24.
11 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(8):2208–18.
12 Ganesh SK, Stack AG, Levin NW, Hulbert-Shearon T, Port FK. Association of Elevated Serum PO_4, Ca PO_4 Product, and Parathyroid Hormone with Cardiac Mortality Risk in Chronic Hemodialysis Patients. J Am Soc Nephrol 2001;12(10):2131–8.
13 Kestenbaum B, Sampson JN, Rudser KD, Patterson DJ, Seliger SL, Young B *et al.* Serum Phosphate Levels and Mortality Risk among People with Chronic Kidney Disease. J Am Soc Nephrol 2005;16(2):520–8.
14 Alberto R-B, Alejandro M-M, Alvarez-Lara MA, Mariano R, Pedro A. Mild Hyperphosphatemia and Mortality in Hemodialysis Patients. American journal of kidney diseases: the official journal of the National Kidney Foundation 2005;46(1):68–77.
15 Tentori F, Blayney MJ, Albert JM, Gillespie BW, Kerr PG, Bommer J *et al.* Mortality Risk for Dialysis Patients With Different Levels of Serum Calcium, Phosphorus, and PTH: The Dialysis Outcomes and Practice Patterns Study (DOPPS). American journal of kidney diseases: the official journal of the National Kidney Foundation 2008;52(3):519–30.
16 Kalantar-Zadeh K, Kuwae N, Regidor DL, Kovesdy CP, Kilpatrick RD, Shinaberger CS *et al.* Survival predictability of time-varying indicators of bone disease in maintenance hemodialysis patients. Kidney Int 2006;70(4):771–80.
17 Young EW, Albert JM, Satayathum S, Goodkin DA, Pisoni RL, Akiba T *et al.* Predictors and consequences of altered mineral metabolism: The Dialysis Outcomes and Practice Patterns Study. Kidney Int 2005; 67(3):1179–87.
18 Kimata N, Albert JM, Akiba T, Yamazaki S, Kawaguchi Y, Fukuhara S *et al.* Association of mineral metabolism factors with all-cause and cardiovascular mortality in hemodialysis patients: The Japan dialysis outcomes and practice patterns study. Hemodialysis International 2007;11(3):340–8.
19 Block GA, Hulbert-Shearon TE, Levin NW, Port FK. Association of serum phosphorus and calcium × phosphate product with mortality risk in chronic hemodialysis patients: A national study. American journal of kidney diseases: the official journal of the National Kidney Foundation 1998;31(4):607–17.
20 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). Chapter 1: Introduction and definition of CKD-MBD and the development of the guideline statements. Kidney Int;76(S113):S1–S130.
21 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(3):770–9.
22 Ansell D, Feest TG. Chapter 6: Adequacy of haemodialysis and serum bicarbonate, UK Renal Registry Annual Report 2004, UK Renal Registry, Bristol, UK. 2004.
23 Soudan K, Ricanati ES, Leon JB, Sehgal AR. Determinants of metabolic acidosis among hemodialysis patients. Hemodialysis International 2006;10(2):209–14.
24 Renal Association. Clinical practice guidelines http://wwwrenalorg/pages/pages/guidelines/current/haemodialysisphp2009