UK Renal Registry 13th Annual Report (December 2010): Chapter 10 Calcium, Phosphate, Parathyroid Hormone, Bicarbonate and Total Cholesterol Concentrations amongst Patients Receiving Haemodialysis or Peritoneal Dialysis in England, Wales and Northern Ireland in 2009: National and Centre-Specific Analyses

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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 variables 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 audit measures for prevalent haemodialysis (HD) and peritoneal dialysis (PD) cohorts in 2009. The biochemical variables studied were phosphate,

adjusted calcium, parathyroid hormone, bicarbonate and total cholesterol. In addition longitudinal analyses were performed (2000–2009) to show changes in achievement of clinical performance measures over time. **Results:** Sixty-one percent of HD and 70% of PD patients had phosphate between 1.1–1.8 mmol/L. Seventy-four percent of HD and 75% of PD patients had adjusted calcium between 2.2–2.5 mmol/L. Twenty-eight percent of HD and 32% of PD patients had parathyroid hormone between 16–32 pmol/L. Seventy-two percent of HD and 83% of PD patients achieved the audit measure for bicarbonate. There was significant inter-centre variation for all variables studied. **Conclusions:** The UKRR consistently demonstrates significant inter-centre variation in achievement of biochemical clinical audit measures. Understanding the causes of this variation is an important part of improving the care of dialysis patients in the UK.

Introduction

The UK Renal Registry (UKRR) collects routine biochemical data from clinical information systems in renal centres in England, Wales and Northern Ireland. Annual cross sectional analyses are undertaken on some of these variables to determine centre level performance against national (Renal Association) clinical performance measures [1]. This enables UK renal centres to compare their own performance against each other and to the UK average performance [2]. 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 [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. The format of data presentation has been revised compared to previous UKRR reports. To supplement these performance analyses, summary statistical data have been provided to enhance understanding of the population characteristics of each centre and longitudinal analyses demonstrate changes over time.

Methods

These analyses relate to biochemical variables in the prevalent dialysis cohort in England, Wales and Northern Ireland in 2009. The cohort studied were patients prevalent on dialysis treatment on 31/12/2009, excluding patients receiving dialysis for less than 90 days and those who had changed modality or renal centre in the last 90 days. HD and PD cohorts were analysed separately.

A full definition of this cohort including inclusion and exclusion criteria is included in appendix B [www.renalreg.com/Report-Area/Report 2010/Appendix-B.pdf](http://www.renalreg.com/Report-Area/Report%202010/Appendix-B.pdf).

The biochemical variables analysed were phosphate, calcium, parathyroid hormone, bicarbonate and cholesterol. The method of data collection and validation by the UKRR has been described elsewhere [3]. For each quarter of 2009 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 [4]. The audit measure for adjusted calcium in the 4th edition of the Renal Association Clinical Practice Guidelines depends on a local reference range [1]. The UKRR has used adjusted calcium between 2.2–2.5 mmol/L as an audit measure. There are also 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 upper laboratory value as the audit measure. This equates to 16–32 pmol/L and is comparable to KDOQI (15–31 pmol/L) [5]. The audit measure used for serum bicarbonate in the HD cohort was 20–26 mmol/L and in the PD cohort was 22–30 mmol/L. A summary of the current Renal Association audit measures and conversion factors to SI units are given in table 10.1.

Quarterly values were extracted from the database for the last two quarters for calcium and phosphate, the last three quarters for PTH and the entire year for cholesterol. Patients who do not have these data were excluded from the analyses. 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 both at centre or country 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.

Centres report several biochemical variables with different levels of accuracy, leading to problems in comparative evaluation. For example, in the case of serum bicarbonate, data can be submitted as integer values but some centres submit data to one

Table 10.1. Summary of clinical audit measures and conversion factor from SI units

Biochemical variable	Clinical audit measure	Conversion factor from SI units
Phosphate	1.1–1.8 mmol/L	mg/dl = mmol/L × 3.1
Calcium	Normal range (ideally <2.5 mmol/L)	mg/dl = mmol/L × 4
Parathyroid hormone	2–4 times upper limit of normal	ng/L = pmol/L × 9.5
Bicarbonate	HD patients: 20–26 mmol/L PD patients: 22–30 mmol/L	mg/dl = mmol/L × 6.1
Cholesterol	No audit measure	mg/dl = mmol/L × 38.6

decimal place. All data has this year been rounded up in an attempt to make all centres more comparable. This has resulted in significant changes in target attainment for some centres and an overall increase in the percentage of patients achieving the treatment target.

The number preceding the centre name in each figure indicates the percentage of missing data for that centre [6]. Funnel plot analysis was used to identify 'outlying centres'. The percentage achieving each standard was plotted against centre size along with the upper and lower 95% and 99.9% limits. Centres can be identified on these plots by looking up the number of patients treated in each centre provided in the relevant table and finding this value on the x-axis. Longitudinal analyses were performed for some data to calculate overall changes in achievement of a performance measure annually from 2000 to 2009 and were recalculated for each previous year using the rounding procedure. All data were unadjusted for case-mix.

Results and Discussions

Mineral and bone variables

Phosphate

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 96% complete for HD patients and 98% complete for PD patients overall although there was considerable variation between centres (tables 10.2 and 10.4). The individual centre means and standard deviations are shown in tables 10.2 and 10.4. Sixty-one percent (CI 61–62%) of HD patients and 70% (CI 68–71%) of PD patients achieved a phosphate between 1.1–1.8 mmol/L (tables 10.3 and 10.5). The proportion of HD patients with hyperphosphataemia was 24% compared to 28% in 2008 and the proportion with hypophosphataemia was 15% compared to 2008 when it was 18% (table 10.3, figures 10.1 and 10.2). The proportion of PD patients with hyperphosphataemia was 23% compared to 24% in 2008 and the proportion with hypophosphataemia was 8% compared to 13% in 2008 (table 10.3, figures 10.3 and 10.4). The changes in the percentages above, below and within range for the period 2000 to 2009 for England, Northern Ireland and Wales combined, are shown in figure 10.5.

There was significant between centre variation in the proportion of patients below, within and above the range specified by the clinical performance measure (figures 10.1–10.4). The latest version of the Renal Association Clinical Practice Guidelines [7], finalised in 2010, suggests maintenance of serum phosphate between 1.1–1.7 mmol/L and this audit standard will be used in next year's report.

Table 10.2. Summary statistics for phosphate in haemodialysis patients in 2009

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	99.2	120	1.5	0.5	1.4	1.1	1.8
B Heart	95.3	387	1.7	0.5	1.6	1.3	1.9
B QEH	96.9	782	1.6	0.5	1.5	1.2	1.8
Bangor	100.0	74	1.6	0.5	1.5	1.2	1.8
Basldn	98.5	131	1.5	0.5	1.4	1.2	1.8
Belfast	98.7	226	1.5	0.5	1.4	1.1	1.8
Bradfd	94.3	166	1.4	0.5	1.4	1.1	1.8
Brightn	99.7	291	1.6	0.5	1.5	1.2	1.9
Bristol	100.0	403	1.7	0.5	1.7	1.4	2.0
Camb	70.1	230	1.5	0.5	1.5	1.2	1.8
Cardff	97.8	436	1.6	0.5	1.5	1.3	1.9
Carlis	100.0	57	1.5	0.5	1.4	1.2	1.8
Carsh	97.9	599	1.6	0.5	1.6	1.3	1.9
Chelms	100.0	109	1.4	0.4	1.3	1.1	1.6
Clwyd	100.0	74	1.7	0.5	1.6	1.3	2.1
Colchr	99.0	101	1.6	0.4	1.5	1.3	1.8

Table 10.2. Continued

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Covnt	98.1	308	1.5	0.5	1.5	1.2	1.9
Derby	100.0	236	1.5	0.5	1.5	1.2	1.8
Derry	100.0	60	1.6	0.4	1.5	1.3	1.9
Donc	100.0	109	1.5	0.5	1.5	1.2	1.8
Dorset	99.5	214	1.5	0.5	1.4	1.2	1.7
Dudley	84.6	121	1.6	0.6	1.6	1.2	2.0
Exeter	99.7	301	1.5	0.5	1.5	1.2	1.8
Glouc	100.0	173	1.6	0.5	1.6	1.3	1.9
Hull	99.7	300	1.6	0.6	1.5	1.2	1.8
Ipswi	99.0	96	1.5	0.5	1.5	1.2	1.7
Kent	98.4	309	1.7	0.5	1.6	1.3	2.0
L Barts	99.7	646	1.7	0.6	1.6	1.3	1.9
L Guys	96.7	519	1.4	0.5	1.4	1.1	1.7
L Kings	99.7	370	1.5	0.5	1.5	1.2	1.8
L Rfree	82.4	509	1.5	0.5	1.4	1.1	1.8
L St.G	98.4	243	1.5	0.5	1.4	1.1	1.7
L West	96.7	1,155	1.3	0.5	1.2	1.0	1.6
Leeds	98.9	463	1.6	0.5	1.5	1.2	1.8
Leic	99.6	703	1.6	0.5	1.5	1.3	1.8
Liv Ain	69.9	95	1.5	0.4	1.4	1.2	1.8
Liv RI	99.2	367	1.6	0.5	1.5	1.2	1.8
M Hope	87.8	288	1.6	0.6	1.5	1.2	2.0
M RI	60.2	245	1.6	0.6	1.5	1.2	2.0
Middlbr	98.5	264	1.6	0.5	1.5	1.2	1.9
Newc	100.0	252	1.6	0.6	1.5	1.2	1.9
Newry	98.9	93	1.5	0.5	1.5	1.1	1.9
Norwch	99.7	294	1.6	0.5	1.5	1.3	1.8
Nottm	100.0	379	1.5	0.5	1.4	1.2	1.8
Oxford	99.7	334	1.6	0.6	1.6	1.2	1.9
Plymth	99.1	112	1.5	0.5	1.4	1.2	1.8
Ports	99.8	440	1.6	0.5	1.6	1.3	2.0
Prestn	99.3	445	1.6	0.5	1.5	1.2	1.9
Redng	99.6	248	1.5	0.4	1.5	1.2	1.7
Sheff	99.8	570	1.6	0.5	1.6	1.3	1.9
Shrew	99.5	181	1.6	0.5	1.5	1.2	1.8
Stevng	99.2	349	1.6	0.5	1.6	1.3	2.0
Sthend	98.4	119	1.5	0.4	1.6	1.2	1.8
Stoke	99.6	276	1.5	0.5	1.5	1.2	1.8
Sund	96.4	159	1.7	0.6	1.6	1.3	2.0
Swanse	100.0	322	1.5	0.4	1.5	1.2	1.8
Truro	98.6	137	1.8	0.5	1.7	1.4	2.1
Tyrone	98.8	85	1.5	0.5	1.4	1.1	1.7
Ulster	100.0	86	1.4	0.4	1.4	1.1	1.7
Wirral	97.1	165	1.6	0.5	1.5	1.2	1.8
Wolve	99.7	286	1.6	0.5	1.5	1.2	1.9
Wrexm	100.0	71	1.4	0.5	1.4	1.1	1.7
York	98.8	167	1.4	0.5	1.3	1.1	1.6
England	96.0	16,203	1.6	0.5	1.5	1.2	1.8
N Ireland	99.1	670	1.5	0.5	1.4	1.1	1.8
Wales	99.0	977	1.6	0.5	1.5	1.2	1.8
E, W & NI	96.3	17,850	1.6	0.5	1.5	1.2	1.8

Table 10.3. Percentage of haemodialysis patients within, below and above the range specified in the RA audit measure for phosphate (1.1–1.8 mmol/L) in 2009

Centre	N	% phos 1.1–1.8 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	% phos >1.8 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Antrim	120	53.3	44.4	62.1	22.5	24.2	−1.3	−17.9	15.3
B Heart	387	62.0	57.1	66.7	7.5	30.5	0.7	−8.4	9.8
B QEH	782	66.5	63.1	69.7	11.4	22.1	−1.0	−7.2	5.3
Bangor	74	73.0	61.8	81.9	8.1	18.9	13.6	−6.7	33.8
Basldn	131	63.4	54.8	71.2	16.0	20.6	−0.4	−15.9	15.2
Belfast	226	61.1	54.6	67.2	16.4	22.6	7.1	−4.9	19.0
Bradfd	166	60.2	52.6	67.4	21.7	18.1	4.5	−9.5	18.5
Brightn	291	57.7	52.0	63.3	13.4	28.9	−2.7	−13.5	8.1
Bristol	403	56.3	51.4	61.1	6.5	37.2	1.5	−7.5	10.5
Camb	230	63.5	57.1	69.5	16.1	20.4	5.8	−6.9	18.4
Cardff	436	60.3	55.7	64.8	12.2	27.5	−4.9	−13.4	3.6
Carlisle	57	68.4	55.4	79.1	8.8	22.8	−3.4	−24.4	17.6
Carsh	599	64.9	61.0	68.7	9.4	25.7	7.0	−0.4	14.4
Chelms	109	60.6	51.1	69.3	23.9	15.6	−5.8	−23.2	11.6
Clwyd	74	56.8	45.3	67.5	13.5	29.7	0.5	−21.3	22.3
Colchr	101	74.3	64.9	81.8	5.9	19.8	6.9	−9.8	23.6
Covnt	308	56.8	51.2	62.2	18.2	25.0	0.4	−10.2	10.9
Derby	236	67.0	60.7	72.7	13.6	19.5	3.4	−8.1	14.8
Derry	60	71.7	59.1	81.6	3.3	25.0	8.2	−14.6	31.1
Donc	109	63.3	53.9	71.8	15.6	21.1	−3.4	−22.0	15.3
Dorset	214	70.6	64.1	76.3	11.7	17.8	4.6	−7.4	16.7
Dudley	121	57.0	48.1	65.5	14.1	28.9	−3.6	−20.8	13.6
Exeter	301	62.8	57.2	68.1	13.0	24.3	−3.3	−13.6	7.1
Glouc	173	63.6	56.2	70.4	9.3	27.2	−3.6	−17.5	10.4
Hull	300	59.0	53.3	64.4	16.7	24.3	4.3	−6.2	14.8
Ipswi	96	62.5	52.4	71.6	20.8	16.7	0.0	−18.0	18.0
Kent	309	62.1	56.6	67.4	7.1	30.7	3.7	−6.7	14.0
L Barts	646	57.3	53.4	61.0	11.8	31.0	−2.0	−9.3	5.3
L Guys	519	58.0	53.7	62.2	22.7	19.3	−1.0	−9.1	7.1
L Kings	370	64.9	59.9	69.6	14.9	20.3	1.9	−7.2	10.9
L Rfree	509	56.8	52.4	61.0	20.2	23.0	−2.3	−10.2	5.7
L St.G	243	60.5	54.2	66.5	19.3	20.2	−0.9	−12.9	11.1
L West	1,155	56.3	53.4	59.1	31.7	12.0	−0.4	−6.1	5.3
Leeds	463	61.1	56.6	65.5	14.9	24.0	3.6	−4.9	12.0
Leic	703	66.6	63.0	70.0	9.7	23.8	4.3	−2.3	11.0
Liv Ain	95	66.3	56.3	75.1	14.7	19.0	7.1	−10.4	24.5
Liv RI	367	64.3	59.3	69.0	14.2	21.5	−0.3	−9.6	8.9
M Hope	288	57.6	51.9	63.2	13.5	28.8	6.8	−4.5	18.1
M RI	245	54.7	48.4	60.8	16.7	28.6	0.5	−10.7	11.8
Middlbr	264	59.1	53.1	64.9	12.9	28.0	−1.5	−12.6	9.7
Newc	252	58.3	52.2	64.3	13.1	28.6	−1.9	−13.2	9.4
Newry	93	49.5	39.5	59.5	23.7	26.9	−12.2	−31.2	6.9
Norwch	294	64.6	59.0	69.9	12.2	23.1	9.3	−1.2	19.8
Nottm	379	62.3	57.3	67.0	16.6	21.1	0.6	−8.7	9.9
Oxford	334	59.0	53.6	64.1	12.9	28.1	−0.9	−10.8	9.0
Plymth	112	57.1	47.8	66.0	17.9	25.0	5.8	−11.5	23.0
Ports	440	58.9	54.2	63.4	9.8	31.4	4.2	−4.5	13.0
Prestn	445	60.5	55.8	64.9	11.7	27.9	3.1	−5.6	11.8
Redng	248	66.9	60.8	72.5	16.5	16.5	2.8	−8.3	14.0
Sheff	570	61.6	57.5	65.5	9.0	29.5	1.9	−5.6	9.4
Shrew	181	64.1	56.9	70.7	13.3	22.7	1.0	−12.3	14.3
Stevng	349	57.3	52.1	62.4	11.5	31.2	−7.3	−16.9	2.4

Table 10.3. Continued

Centre	N	% phos 1.1–1.8 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	% phos >1.8 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Sthend	119	64.7	55.7	72.8	13.5	21.9	−3.4	−19.1	12.4
Stoke	276	65.2	59.4	70.6	13.8	21.0	3.0	−8.0	14.0
Sund	159	58.5	50.7	65.9	10.1	31.5	7.8	−6.9	22.5
Swanse	322	69.3	64.0	74.1	11.2	19.6	8.6	−1.2	18.3
Truro	137	56.9	48.5	65.0	2.2	40.9	−7.0	−22.3	8.2
Tyrone	85	65.9	55.2	75.2	17.7	16.5	−4.7	−23.1	13.7
Ulster	86	66.3	55.7	75.5	19.8	14.0	5.5	−13.8	24.9
Wirral	165	66.1	58.5	72.9	10.3	23.6	11.8	−2.3	25.9
Wolve	286	62.9	57.2	68.3	11.9	25.2	3.8	−6.9	14.4
Wrexm	71	60.6	48.8	71.2	23.9	15.5	12.7	−8.7	34.1
York	167	65.3	57.8	72.1	22.8	12.0	3.1	−12.4	18.7
England	16,203	61.3	60.5	62.0	14.5	24.2	1.3	−0.1	2.7
N Ireland	670	60.3	56.5	63.9	17.9	21.8	1.4	−5.6	8.4
Wales	977	64.0	60.9	66.9	12.5	23.5	2.6	−3.1	8.3
E, W & NI	17,850	61.4	60.7	62.1	14.5	24.1	1.4	0.0	2.7

Table 10.4. Summary statistics for phosphate in peritoneal dialysis patients in 2009

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	100.0	14					
B Heart	96.3	26	1.4	0.4	1.4	1.1	1.6
B QEH	84.6	121	1.5	0.4	1.5	1.2	1.8
Bangor	100.0	29	1.5	0.3	1.5	1.4	1.5
Basldn	100.0	25	1.4	0.4	1.4	1.1	1.5
Belfast	100.0	34	1.8	0.6	1.8	1.4	2.1
Bradfd	100.0	31	1.7	0.4	1.7	1.4	2.0
Brightn	100.0	76	1.4	0.4	1.4	1.2	1.7
Bristol	100.0	68	1.7	0.5	1.6	1.4	2.0
Camb	100.0	31	1.4	0.3	1.4	1.2	1.6
Cardff	100.0	95	1.5	0.4	1.5	1.3	1.7
Carlis	100.0	13					
Carsh	99.1	110	1.6	0.4	1.6	1.3	1.8
Chelms	100.0	31	1.4	0.3	1.4	1.2	1.6
Clwyd	85.7	6					
Covnt	94.5	69	1.4	0.3	1.4	1.2	1.7
Derby	100.0	82	1.4	0.3	1.4	1.2	1.6
Derry	100.0	3					
Donc	96.7	29	1.5	0.4	1.5	1.2	1.8
Dorset	96.3	52	1.5	0.4	1.5	1.2	1.8
Dudley	98.0	49	1.7	0.5	1.7	1.4	1.9
Exeter	100.0	64	1.5	0.4	1.5	1.3	1.8
Glouc	100.0	39	1.7	0.4	1.7	1.5	1.9
Hull	98.4	62	1.6	0.4	1.6	1.3	1.8
Ipswi	100.0	42	1.8	0.5	1.7	1.4	2.0
Kent	100.0	64	1.5	0.3	1.5	1.3	1.7
L Barts	98.8	164	1.6	0.4	1.6	1.2	1.9
L Guys	100.0	44	1.6	0.4	1.6	1.3	1.9
L Kings	100.0	68	1.6	0.4	1.5	1.3	1.9
L Rfree	98.4	63	1.6	0.3	1.6	1.3	1.8
L St.G	96.6	56	1.5	0.4	1.3	1.2	1.6
L West	100.0	31	1.6	0.5	1.5	1.4	1.8
Leeds	100.0	86	1.6	0.5	1.6	1.3	1.9

Table 10.4. Continued

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Leic	98.0	145	1.6	0.4	1.6	1.3	1.8
Liv Ain	28.6	2					
Liv RI	98.8	79	1.5	0.4	1.4	1.3	1.7
M Hope	96.4	108	1.7	0.5	1.7	1.3	2.0
M RI	97.8	87	1.7	0.5	1.6	1.3	2.0
Middlbr	93.8	15					
Newc	100.0	48	1.7	0.5	1.7	1.5	1.9
Newry	100	12					
Norwch	87.3	48	1.5	0.5	1.5	1.3	1.8
Nottm	100.0	101	1.6	0.4	1.5	1.3	1.9
Oxford	100.0	93	1.7	0.4	1.6	1.4	1.9
Plymth	100.0	38	1.6	0.4	1.5	1.3	1.7
Ports	95.1	77	1.7	0.5	1.6	1.3	1.9
Prestn	100.0	65	1.7	0.4	1.6	1.3	1.9
Redng	100.0	73	1.4	0.3	1.4	1.3	1.7
Sheff	100.0	68	1.5	0.4	1.6	1.2	1.7
Shrew	96.3	26	1.6	0.4	1.7	1.4	2.0
Stevng	96.4	27	1.5	0.4	1.4	1.2	1.7
Sthend	94.1	16					
Stoke	98.6	68	1.5	0.4	1.4	1.3	1.7
Sund	100.0	24	1.6	0.4	1.7	1.5	1.9
Swanse	100.0	52	1.5	0.4	1.4	1.3	1.8
Truro	100.0	21	1.7	0.5	1.7	1.3	1.9
Tyrone	90.9	10					
Ulster	100.0	2					
Wirral	69.2	18					
Wolve	100.0	40	1.6	0.5	1.4	1.2	1.8
Wrexm	95.5	21	1.7	0.4	1.6	1.3	2.0
York	100.0	15					
England	97.4	2,898	1.6	0.4	1.5	1.3	1.8
N Ireland	98.7	75	1.7	0.5	1.6	1.4	1.9
Wales	99.0	203	1.5	0.4	1.5	1.3	1.7
E, W & NI	97.5	3,176	1.6	0.4	1.5	1.3	1.8

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

Fig. 10.1. Percentage of haemodialysis patients with phosphate within the range specified by the RA clinical audit measure (1.1–1.8 mmol/L) by centre in 2009

Fig. 10.2. Funnel plot of percentage of haemodialysis patients with phosphate within the range specified by the RA clinical audit measure (1.1–1.8 mmol/L) by centre in 2009

Fig. 10.3. Percentage of peritoneal dialysis patients with phosphate within the range specified by the RA clinical audit measure (1.1–1.8 mmol/L) by centre in 2009

Fig. 10.4. Funnel plot of percentage of peritoneal dialysis patients with phosphate within the range specified by the RA clinical audit measure (1.1–1.8 mmol/L) by centre in 2009

Fig. 10.5. 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 2000–2009

Table 10.5. Percentage of peritoneal dialysis patients within, below and above the range specified in the RA audit measure for phosphate (1.1–1.8 mmol/L) in 2009

Centre	N	% phos 1.1–1.8 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	% phos >1.8 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
B Heart	26	65.4	45.7	80.9	19.2	15.4	–16.8	–47.2	13.7
B QEH	121	71.1	62.4	78.5	9.1	19.8	4.1	–11.8	20.0
Bangor	29	93.1	76.3	98.3	0.0	6.9	17.2	–6.6	41.1
Basldn	25	72.0	51.8	86.0	16.0	12.0	–4.7	–35.2	25.9
Belfast	34	44.1	28.6	60.8	11.8	44.1	–10.2	–39.2	18.8
Bradfd	31	54.8	37.4	71.1	12.9	32.3	–19.4	–50.1	11.4
Brightn	76	76.3	65.5	84.5	9.2	14.5	8.8	–9.6	27.3
Bristol	68	55.9	44.0	67.2	8.8	35.3	–9.4	–30.6	11.8
Camb	31	90.3	73.9	96.9	9.7	0.0	14.0	–8.5	36.5
Cardff	95	75.8	66.2	83.4	6.3	17.9	0.6	–15.2	16.3
Carsh	110	68.2	58.9	76.2	8.2	23.6	–2.0	–17.9	13.9
Chelms	31	87.1	70.3	95.1	9.7	3.2	10.2	–13.1	33.5
Covnt	69	76.8	65.4	85.3	8.7	14.5	4.7	–15.1	24.5
Derby	82	84.2	74.6	90.6	7.3	8.5	9.2	–7.4	25.7
Donc	29	82.8	64.7	92.6	3.5	13.8	15.2	–11.7	42.1
Dorset	52	73.1	59.5	83.4	3.9	23.1	–16.7	–36.1	2.7
Dudley	49	67.4	53.2	78.9	4.1	28.6	–10.4	–34.0	13.1
Exeter	64	76.6	64.7	85.4	3.1	20.3	8.8	–12.0	29.6
Glouc	39	69.2	53.3	81.6	2.6	28.2	–6.5	–33.6	20.6
Hull	62	67.7	55.2	78.2	8.1	24.2	–5.1	–25.7	15.4
Ipswi	42	45.2	31.0	60.3	7.1	47.6	–15.2	–42.1	11.7
Kent	64	87.5	76.9	93.6	3.1	9.4	11.0	–6.0	28.1
L Barts	164	63.4	55.8	70.4	7.3	29.3	0.9	–12.1	13.9
L Guys	44	68.2	53.2	80.2	6.8	25.0	–9.4	–33.1	14.4
L Kings	68	64.7	52.7	75.1	10.3	25.0	–7.1	–27.4	13.2
L Rfree	63	77.8	65.9	86.4	3.2	19.1	7.1	–12.0	26.3
L St.G	56	76.8	64.0	86.0	8.9	14.3	14.8	–8.1	37.7
L West	31	71.0	53.0	84.2	6.5	22.6	1.9	–26.0	29.9
Leeds	86	64.0	53.3	73.4	7.0	29.1	–0.7	–19.8	18.4

Table 10.5. Continued

Centre	N	% phos 1.1–1.8 mmol/L	Lower 95% CI	Upper 95% CI	% phos <1.1 mmol/L	% phos >1.8 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Leic	145	69.0	61.0	76.0	7.6	23.5	7.4	−6.7	21.5
Liv RI	79	74.7	64.0	83.1	7.6	17.7	8.8	−9.5	27.1
M Hope	108	52.8	43.4	62.0	10.2	37.0	−8.8	−26.0	8.3
M RI	87	58.6	48.0	68.5	6.9	34.5	0.4	−18.7	19.4
Newc	48	62.5	48.2	74.9	6.3	31.3	4.4	−22.1	30.9
Norwch	48	70.8	56.6	81.9	12.5	16.7	−5.5	−28.0	16.9
Nottm	101	64.4	54.6	73.1	8.9	26.7	−7.5	−24.0	9.1
Oxford	93	63.4	53.2	72.6	5.4	31.2	−9.4	−26.5	7.8
Plymth	38	76.3	60.4	87.2	7.9	15.8	5.2	−19.7	30.1
Ports	78	57.7	46.5	68.1	10.3	32.1	2.0	−19.1	23.0
Prestn	65	67.7	55.5	77.9	4.6	27.7	1.0	−21.0	23.0
Redng	73	79.5	68.7	87.2	12.3	8.2	3.5	−14.2	21.1
Sheff	68	77.9	66.6	86.2	7.4	14.7	16.0	−3.8	35.7
Shrew	26	57.7	38.5	74.8	7.7	34.6	−9.0	−42.4	24.5
Stevng	27	59.3	40.3	75.8	18.5	22.2	−15.0	−46.0	15.9
Stoke	68	72.1	60.3	81.4	10.3	17.7	−4.3	−23.4	14.7
Sund	24	66.7	46.1	82.4	8.3	25.0	2.4	−38.9	43.7
Swanse	52	76.9	63.6	86.4	7.7	15.4	0.7	−20.1	21.4
Truro	21	61.9	40.3	79.7	0.0	38.1	0.4	−36.4	37.1
Wolve	40	72.5	56.8	84.1	7.5	20.0	2.9	−21.3	27.0
Wrexm	21	61.9	40.3	79.7	0.0	38.1	0.0	−38.7	38.7
England	2,898	69.1	67.4	70.8	8.0	22.9	0.5	−2.6	3.6
N Ireland	75	61.3	49.9	71.6	9.3	29.3	−6.1	−25.6	13.4
Wales	203	77.3	71.1	82.6	4.9	17.7	3.5	−7.3	14.2
E, W & NI	3,176	69.5	67.8	71.1	7.8	22.7	0.5	−2.5	3.4

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 kept below 2.5 mmol/L.’ (Module 2: Complications) [1]

The current guideline is based upon adjusted serum calcium. A variety of formulae have been proposed to permit calculation of the ‘adjusted’ total calcium (i.e. an estimation of the expected total calcium were the serum albumin normal) from the total calcium and albumin concentration, but there are no data to support the use of mathematical corrections of serum calcium among patients with ERF. There are significant problems with comparison of adjusted serum calcium as the calculated result is heavily dependent upon the methods of albumin and calcium measurement and the formula used for adjustment. Laboratories should derive the correct formula for the two methods they use but it is

apparent that this is not always done and a variety of formulae are in use, the most common being adjusted calcium = total calcium + 0.02(40−albumin) according to a recent review by the Welsh External Quality Assessment Scheme (WEQAS, 2011, personal communication to A. Dawney). This formula was used by approximately 50% of laboratories, while at least 22 other equations were used by the remainder. WEQAS proposes the establishment of master equations for the three calcium methods and two albumin methods in use across the eight analytical platforms in current use in the UK. This will facilitate achievement of measurement uniformity between laboratories and national harmonisation to an adjusted calcium reference range of 2.2–2.6 mmol/L (<http://www.pathologyharmony.co.uk/graphics/Pathology%20Harmony%20II%20%20for%20web.pdf>).

The two most common assays for measuring albumin yield discordant results, the bromocresol purple (BCP) method generally providing lower albumin values than bromocresol green (BCG). The deviation of albumin assayed by BCP and BCG dye-binding methods also appears to differ between dialysis patients and those with

normal renal function due to differing interferences with the dye-binding, bringing into question the applicability of adjustment formulae that were derived for the general population. This impacts on the adjusted calcium result and is important in multicentre and comparative studies but such studies have often compounded the problem by incorrectly applying a single formula to both BCG and BCP measurements [8]. There are data which suggest that in this situation it may be better to use uncorrected serum calcium rather than adjusted serum calcium [9, 10].

The impact of laboratory method biases and changes in formulae was highlighted in last year's report and centres with excessive proportions of patients outside the limits were advised to consult their local laboratories. The problem is illustrated by the following. For the last two years Bristol was one of the lowest achieving centres for the adjusted calcium standard and as a result an investigation took place. Local data from Bristol, Exeter, Gloucester and Truro showed that when uncorrected rather than corrected calciums were compared, Bristol changed from being lowest to the highest achiever. As many centres use BCG to measure albumin and some others routinely correct their BCP albumin to BCG before correcting calcium, an analysis was undertaken to explore the effect of converting the Bristol BCP albumins to BCG equivalents: 5.5 g/L was added to the BCP albumin to convert it to an equivalent BCG albumin before adjusting the calcium [11]. With this adjustment, Bristol's ranking on the caterpillar plots for the percentage of patients with corrected calcium >2.5 mmol/L improved from 37/52 to 22/52 for PD patients and

from 63/64 to 29/64 for HD patients. This investigation highlights the importance in the calculation and interpretation of adjusted serum calcium, of the method of albumin measurement and the adjustment formula used. While such adjustment of data cannot be condoned it does serve to highlight potential problems. The solution for centres is to work with their laboratories to ensure that the calcium results are adjusted correctly for the method in use. The current guideline for control of serum calcium does not discuss these problems or take them into account. These problems must be borne in mind when trying to interpret the following figures which compare serum adjusted calcium achieved in different renal units. These issues raise the question as to whether these comparisons between centres of achievement of the calcium guidelines are of value, and also raises questions about the guidelines themselves.

The audit measure for calcium in the 4th edition of the Renal Association Clinical Practice Guidelines does not specify a lower limit for calcium and advises that adjusted calcium should ideally be within the normal range. The guideline does however recommend that adjusted calcium should be <2.5 mmol/L. The UKRR used 2.2–2.5 mmol/L as the audit measure for adjusted calcium in 2009. The data for adjusted calcium were 94% complete for HD patients and 97% complete for PD patients overall, although there was between centre variation (tables 10.6 and 10.8). Seventy-four percent (CI 74–75%) of HD patients and 75% (CI 74–77%) of PD patients achieved adjusted calcium between 2.2–2.5 mmol/L (tables 10.7 and 10.9). The proportion of

Table 10.6 Summary statistics for adjusted calcium in haemodialysis patients in 2009

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	99	120	2.3	0.17	2.3	2.2	2.4
B Heart	95	387	2.3	0.18	2.3	2.2	2.4
B QEH	68	550	2.3	0.20	2.3	2.2	2.4
Bangor	100	74	2.3	0.17	2.35	2.3	2.4
Basldn	99	131	2.5	0.15	2.5	2.4	2.6
Belfast	99	226	2.3	0.17	2.3	2.2	2.4
Bradfd	95	167	2.4	0.15	2.4	2.3	2.5
Brightn*	73	214	2.3	0.17	2.3	2.2	2.4
Bristol	100	403	2.5	0.18	2.5	2.4	2.6
Camb	70	230	2.3	0.19	2.3	2.2	2.4
Cardff*	98	436	2.4	0.18	2.4	2.3	2.5
Carlisle	100	57	2.3	0.20	2.3	2.2	2.4
Carsh	98	599	2.3	0.20	2.3	2.2	2.4
Chelms	100	109	2.4	0.14	2.4	2.3	2.5
Clwyd	100	74	2.3	0.19	2.3	2.2	2.4

Table 10.6 Continued

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Colchr*	94	96	2.5	0.23	2.5	2.4	2.6
Covnt*	98	309	2.3	0.19	2.2	2.1	2.4
Derby	100	236	2.4	0.14	2.4	2.3	2.5
Derry	100	60	2.4	0.15	2.4	2.3	2.5
Donc	100	109	2.4	0.17	2.4	2.3	2.5
Dorset	100	215	2.4	0.18	2.4	2.3	2.5
Dudley	85	121	2.4	0.22	2.4	2.3	2.6
Exeter	100	301	2.4	0.19	2.4	2.2	2.5
Glouc	100	173	2.4	0.15	2.4	2.3	2.5
Hull	100	300	2.4	0.16	2.4	2.3	2.5
Ipswi	100	97	2.4	0.16	2.4	2.3	2.5
Kent	98	309	2.5	0.18	2.5	2.4	2.6
L Barts	100	646	2.2	0.19	2.2	2.1	2.3
L Guys	97	519	2.3	0.18	2.2	2.1	2.4
L Kings	100	370	2.3	0.22	2.3	2.2	2.4
L Rfree	83	511	2.2	0.19	2.2	2.1	2.4
L St.G	100	247	2.4	0.16	2.4	2.3	2.5
L West	97	1,155	2.4	0.16	2.4	2.3	2.5
Leeds	99	463	2.4	0.17	2.4	2.3	2.5
Leic	100	703	2.4	0.17	2.3	2.3	2.5
Liv Ain	70	95	2.5	0.15	2.5	2.4	2.6
Liv RI	99	367	2.4	0.20	2.4	2.3	2.5
M Hope	88	288	2.3	0.19	2.3	2.15	2.4
M RI	60	245	2.2	0.20	2.2	2.1	2.4
Middlbr	99	264	2.3	0.20	2.3	2.2	2.5
Newc*	100	252	2.4	0.15	2.4	2.3	2.5
Newry	99	93	2.2	0.18	2.2	2.1	2.3
Norwch	100	294	2.4	0.15	2.4	2.4	2.5
Nottm	100	379	2.4	0.17	2.4	2.3	2.5
Oxford	100	334	2.4	0.16	2.4	2.3	2.5
Plymth	99	112	2.3	0.19	2.35	2.25	2.5
Ports	100	440	2.3	0.17	2.3	2.3	2.5
Prestn*	93	415	2.3	0.19	2.3	2.2	2.4
Redng	100	248	2.3	0.17	2.35	2.2	2.4
Sheff	100	570	2.3	0.16	2.3	2.2	2.4
Shrew	100	182	2.4	0.17	2.4	2.3	2.4
Stevng	99	348	2.4	0.17	2.4	2.3	2.5
Sthend	98	119	2.4	0.18	2.4	2.3	2.5
Stoke	100	277	2.3	0.17	2.4	2.2	2.5
Sund*	96	159	2.4	0.18	2.4	2.3	2.5
Swanse	100	322	2.3	0.17	2.3	2.2	2.4
Truro	99	138	2.4	0.15	2.4	2.3	2.5
Tyrone	99	85	2.4	0.17	2.5	2.3	2.6
Ulster	100	86	2.4	0.15	2.4	2.3	2.5
Wirral	97	165	2.4	0.15	2.4	2.3	2.5
Wolve	100	287	2.3	0.19	2.3	2.2	2.4
Wrexm	100	71	2.4	0.18	2.4	2.3	2.6
York	88	149	2.4	0.15	2.4	2.3	2.5
England	94	15,854	2.3	0.19	2.3	2.2	2.5
N Ireland	99	670	2.3	0.19	2.3	2.2	2.5
Wales	99	977	2.3	0.18	2.3	2.2	2.4
E, W & NI	94	17,501	2.3	0.19	2.3	2.2	2.5

*These centres supplied uncorrected calcium and were corrected using the formula: adjusted calcium = unadjusted calcium + [(40 - albumin) × 0.02]

Table 10.7. Percentage of haemodialysis patients within, below and above the range for adjusted calcium (2.2–2.5 mmol/L) in 2009

Centre	N	% adjusted Ca 2.2–2.5 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca <2.2 mmol/L	adjusted Ca >2.5 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Antrim	120	77.5	69.2	84.1	15.8	6.7	0.2	–13.8	14.1
B Heart	387	71.8	67.2	76.1	21.7	6.5	3.3	–5.3	11.8
B QEH	550	69.1	65.1	72.8	23.3	7.6	–3.2	–9.9	3.4
Bangor	74	82.4	72.1	89.5	9.5	8.1	2.7	–14.2	19.6
Basldn	131	70.2	61.9	77.4	3.8	26.0	–16.9	–29.8	–4.0
Belfast	226	77.4	71.5	82.4	17.7	4.9	–2.7	–12.6	7.3
Bradfd	167	88.0	82.2	92.1	5.4	6.6	9.7	–0.8	20.2
Brightn	214	78.5	72.5	83.5	13.6	7.9	9.5	–1.5	20.4
Bristol	403	62.0	57.2	66.7	3.0	35.0	2.1	–6.7	10.9
Camb	230	72.6	66.5	78.0	13.0	14.4	–2.3	–13.6	9.1
Cardff	436	74.8	70.5	78.6	11.9	13.3	–2.8	–10.3	4.7
Carlisle	57	68.4	55.4	79.1	19.3	12.3	7.9	–14.0	29.7
Carsh	599	73.3	69.6	76.7	17.5	9.2	1.8	–5.0	8.6
Chelms	109	84.4	76.3	90.1	8.3	7.3	16.0	0.8	31.2
Clwyd	74	74.3	63.2	83.0	18.9	6.8	–2.2	–21.2	16.7
Colchr	96	58.3	48.3	67.8	0.0	41.7	–16.4	–33.8	0.9
Covnt	309	64.7	59.2	69.9	27.2	8.1	–11.0	–20.6	–1.4
Derby	236	80.9	75.4	85.5	4.7	14.4	5.1	–4.8	14.9
Derry	60	83.3	71.7	90.8	1.7	15.0	–3.2	–20.6	14.2
Donc	109	77.1	68.3	84.0	4.6	18.4	–7.7	–22.7	7.4
Dorset	215	75.4	69.2	80.7	6.1	18.6	6.4	–5.2	17.9
Dudley	121	60.3	51.4	68.6	9.1	30.6	–11.4	–27.8	5.0
Exeter	301	72.1	66.8	76.9	10.3	17.6	2.0	–7.8	11.8
Glouc	173	82.1	75.6	87.1	4.1	13.9	4.9	–6.9	16.8
Hull	300	77.3	72.3	81.7	4.7	18.0	6.3	–3.1	15.6
Ipswi	97	77.3	67.9	84.6	5.2	17.5	–6.0	–20.7	8.7
Kent	309	69.6	64.2	74.5	4.2	26.2	0.7	–9.0	10.5
L Barts	646	64.6	60.8	68.2	30.7	4.8	–2.5	–9.5	4.6
L Guys	519	68.8	64.7	72.6	27.0	4.2	–7.6	–14.9	–0.4
L Kings	370	81.4	77.1	85.0	13.5	5.1	–1.5	–8.7	5.8
L Rfree	511	66.9	62.7	70.9	28.4	4.7	–1.7	–9.2	5.9
L St.G	247	77.3	71.7	82.1	5.3	17.4	3.6	–7.0	14.1
L West	1,155	79.7	77.2	81.9	8.8	11.5	–1.7	–6.2	2.8
Leeds	463	74.1	69.9	77.9	5.4	20.5	–0.4	–7.9	7.2
Leic	703	79.2	76.1	82.1	9.8	11.0	2.9	–2.9	8.7
Liv Ain	95	72.6	62.8	80.6	2.1	25.3	–4.2	–20.0	11.6
Liv RI	367	73.0	68.3	77.3	9.3	17.7	4.3	–4.5	13.1
M Hope	288	68.1	62.5	73.2	25.0	6.9	–4.0	–14.3	6.4
M RI	245	60.4	54.2	66.3	35.5	4.1	–11.3	–21.9	–0.6
Middlbr	264	71.2	65.5	76.4	16.7	12.1	–3.7	–13.8	6.4
Newc	252	80.6	75.2	85.0	7.9	11.5	4.3	–5.2	13.7
Newry	93	61.3	51.1	70.6	36.6	2.2	–13.1	–30.9	4.7
Norwch	294	73.5	68.1	78.2	2.7	23.8	–2.1	–11.4	7.3
Nottm	379	75.5	70.9	79.5	5.8	18.7	6.7	–1.8	15.3
Oxford	334	79.0	74.3	83.1	6.6	14.4	7.4	–1.2	16.1
Plymth	112	75.9	67.1	82.9	11.6	12.5	–3.9	–18.3	10.5
Ports	440	81.1	77.2	84.5	10.2	8.6	2.8	–4.3	10.0
Prestn	415	71.3	66.8	75.5	18.6	10.1	3.5	–4.7	11.8
Redng	248	82.7	77.4	86.9	11.7	5.7	–0.7	–9.5	8.2
Sheff	570	79.8	76.3	82.9	14.2	6.0	1.8	–4.5	8.0
Shrew	182	84.1	78.0	88.7	4.4	11.5	10.1	–1.1	21.3
Stevng	348	75.3	70.5	79.5	7.2	17.5	–0.7	–9.2	7.8
Sthend	119	76.5	68.0	83.2	5.0	18.5	0.0	–14.2	14.2
Stoke	277	77.3	72.0	81.8	15.2	7.6	–3.1	–12.4	6.2

Table 10.7. Continued

Centre	N	% adjusted Ca 2.2–2.5 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca <2.2 mmol/L	adjusted Ca >2.5 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Sund	159	74.8	67.5	81.0	5.7	19.5	6.1	−7.3	19.4
Swanse	322	70.5	65.3	75.2	23.6	5.9	−7.1	−16.1	1.8
Truro	138	83.3	76.2	88.7	5.1	11.6	8.3	−4.3	20.9
Tyrone	85	69.4	58.9	78.3	4.7	25.9	−2.4	−20.4	15.7
Ulster	86	76.7	66.7	84.5	2.3	20.9	−11.9	−26.8	3.1
Wirral	165	80.0	73.2	85.4	6.1	13.9	2.2	−9.6	14.0
Wolve	287	70.4	64.8	75.4	23.3	6.3	−4.0	−13.7	5.8
Wrexm	71	66.2	54.5	76.2	7.0	26.8	1.4	−19.2	22.0
York	149	82.6	75.6	87.8	4.0	13.4	−3.3	−15.7	9.0
England	15,854	74.3	73.6	74.9	13.2	12.5	0.4	−0.9	1.7
N Ireland	670	74.6	71.2	77.8	14.9	10.5	−4.7	−10.6	1.3
Wales	977	73.3	70.4	76.0	15.8	11.0	−3.4	−8.5	1.7
E, W & NI	17,501	74.2	73.6	74.9	13.4	12.4	0.0	−1.2	1.2

Table 10.8. Summary statistics for adjusted calcium in peritoneal dialysis patients in 2009

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	100	14					
B Heart	96	26	2.3	0.17	2.3	2.2	2.4
B QEH	85	121	2.3	0.15	2.3	2.2	2.4
Bangor	100	29	2.4	0.15	2.4	2.3	2.5
Basldn	100	25	2.5	0.13	2.5	2.4	2.6
Belfast	100	34	2.3	0.10	2.3	2.2	2.4
Bradfd	100	31	2.4	0.13	2.4	2.3	2.5
Brightn*	100	76	2.4	0.14	2.4	2.3	2.5
Bristol	100	68	2.5	0.16	2.5	2.4	2.6
Camb	100	31	2.3	0.19	2.3	2.2	2.4
Cardff*	100	95	2.4	0.19	2.4	2.3	2.5
Carlisle	100	13					
Carsh	99	110	2.4	0.15	2.4	2.2	2.4
Chelms	100	31	2.5	0.17	2.5	2.3	2.6
Clwyd	86	6					
Covnt*	99	72	2.3	0.14	2.25	2.2	2.4
Derby	100	82	2.4	0.11	2.4	2.4	2.5
Derry	100	3					
Donc	97	29	2.5	0.16	2.5	2.4	2.6
Dorset	98	53	2.4	0.17	2.4	2.3	2.5
Dudley	98	49	2.4	0.17	2.4	2.3	2.5
Exeter	100	64	2.3	0.18	2.3	2.2	2.4
Glouc	100	39	2.4	0.15	2.4	2.3	2.5
Hull	98	62	2.5	0.12	2.5	2.4	2.5
Ipswi	100	42	2.4	0.14	2.4	2.3	2.5
Kent	100	64	2.5	0.14	2.5	2.4	2.6
L Barts	99	164	2.4	0.20	2.3	2.2	2.45
L Guys	100	44	2.4	0.16	2.3	2.2	2.5
L Kings	100	68	2.3	0.15	2.3	2.2	2.4
L Rfree	98	63	2.3	0.20	2.3	2.2	2.4
L St.G	97	56	2.5	0.12	2.5	2.4	2.6
L West	100	31	2.4	0.14	2.4	2.3	2.5
Leeds	100	86	2.4	0.15	2.4	2.4	2.5

Table 10.8. Continued

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Leic	97	144	2.4	0.17	2.4	2.3	2.5
Liv Ain	29	2					
Liv RI	99	79	2.4	0.18	2.4	2.3	2.5
M Hope	96	108	2.3	0.19	2.3	2.2	2.4
M RI	98	87	2.3	0.15	2.3	2.2	2.4
Newc*	100	48	2.5	0.17	2.45	2.4	2.6
Newry	100	12					
Norwch	89	49	2.5	0.10	2.5	2.4	2.5
Norwch	89	49					
Nottm	100	101	2.5	0.15	2.5	2.5	2.6
Oxford	100	93	2.5	0.17	2.5	2.4	2.6
Plymth	100	38	2.4	0.17	2.4	2.3	2.5
Ports	95	77	2.4	0.18	2.4	2.3	2.5
Prestn*	89	58	2.3	0.14	2.3	2.2	2.4
Redng	100	73	2.4	0.15	2.4	2.3	2.5
Sheff	100	68	2.3	0.15	2.3	2.2	2.4
Shrew	100	27	2.3	0.16	2.3	2.3	2.4
Stevng	96	27	2.4	0.16	2.4	2.3	2.5
Sthend	94	16					
Stoke	99	68	2.4	0.16	2.4	2.3	2.5
Sund*	100	24	2.6	0.31	2.4	2.4	2.7
Swanse	100	52	2.2	0.13	2.2	2.1	2.3
Truro	100	21	2.4	0.20	2.4	2.3	2.6
Tyrone	91	10					
Ulster	100	2					
Wirral	69	18					
Wolve	100	40	2.3	0.21	2.3	2.2	2.4
Wrexm	95	21	2.5	0.15	2.5	2.4	2.6
York	100	15					
England	97	2,896	2.4	0.18	2.4	2.3	2.5
N Ireland	99	75	2.3	0.14	2.4	2.2	2.4
Wales	99	203	2.4	0.18	2.4	2.2	2.5
E, W & NI	97	3,174	2.4	0.18	2.4	2.3	2.5

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

*These centres supplied uncorrected calcium and were corrected using the formula: adjusted calcium = unadjusted calcium + [(40-albumin) × 0.02]

Table 10.9. Percentage of peritoneal dialysis patients within, below and above the range for adjusted calcium (2.2–2.5 mmol/L) in 2009

Centre	N	% adjusted Ca 2.2–2.5 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca <2.2 mmol/L	adjusted Ca >2.5 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
B Heart	26	69.2	49.5	83.8	19.2	11.5	–5.8	–37.3	25.7
B QEH	121	77.7	69.4	84.2	14.1	8.3	2.0	–12.5	16.5
Bangor	29	65.5	46.9	80.3	10.3	24.1	–24.1	–51.2	2.9
Basldn	25	68.0	47.8	83.1	0.0	32.0	–12.0	–42.6	18.6
Belfast	34	91.2	76.0	97.1	5.9	2.9	17.3	–3.6	38.2
Bradfd	31	90.3	73.9	96.9	6.5	3.2	9.7	–13.2	32.5
Brightn	76	79.0	68.4	86.7	2.6	18.4	–9.8	–24.9	5.3

Table 10.9. Continued

Centre	N	% adjusted Ca 2.2–2.5 mmol/L	Lower 95% CI	Upper 95% CI	% adjusted Ca <2.2 mmol/L	adjusted Ca >2.5 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Bristol	68	67.7	55.7	77.7	1.5	30.9	6.5	−14.3	27.4
Camb	31	74.2	56.3	86.5	19.4	6.5	−10.0	−35.4	15.4
Cardff	95	74.7	65.1	82.5	8.4	16.8	−7.2	−22.2	7.9
Carsh	110	81.8	73.5	88.0	7.3	10.9	7.3	−6.9	21.4
Chelms	31	67.7	49.7	81.7	3.2	29.0	−1.5	−30.3	27.4
Covnt	72	75.0	63.8	83.6	23.6	1.4	−10.3	−27.5	6.9
Derby	82	87.8	78.8	93.3	0.0	12.2	6.5	−8.4	21.4
Donc	29	65.5	46.9	80.3	3.5	31.0	−4.8	−34.7	25.2
Dorset	53	77.4	64.2	86.7	5.7	17.0	−8.3	−28.0	11.3
Dudley	49	81.6	68.3	90.2	2.0	16.3	6.1	−15.8	27.9
Exeter	64	75.0	63.0	84.1	17.2	7.8	3.8	−16.8	24.5
Glouc	39	76.9	61.3	87.5	7.7	15.4	1.2	−24.8	27.1
Hull	62	77.4	65.4	86.2	1.6	21.0	1.7	−17.3	20.8
Ipswi	42	81.0	66.3	90.2	4.8	14.3	−2.4	−23.3	18.5
Kent	64	60.9	48.6	72.1	1.6	37.5	3.0	−19.0	24.9
L Barts	164	75.6	68.5	81.6	10.4	14.0	−0.3	−11.9	11.2
L Guys	44	88.6	75.5	95.2	4.6	6.8	13.1	−7.0	33.2
L Kings	68	77.9	66.6	86.2	14.7	7.4	−9.4	−25.9	7.1
L Rfree	63	65.1	52.6	75.8	22.2	12.7	−9.6	−29.8	10.6
L St.G	56	73.2	60.2	83.2	0.0	26.8	5.2	−17.7	28.1
L West	31	80.7	63.1	91.0	6.5	12.9	6.8	−18.5	32.2
Leeds	86	76.7	66.7	84.5	4.7	18.6	−5.0	−21.1	11.1
Leic	144	77.1	69.5	83.2	4.2	18.8	0.2	−12.4	12.7
Liv RI	79	77.2	66.7	85.2	3.8	19.0	1.9	−15.2	19.1
M Hope	108	73.2	64.0	80.7	19.4	7.4	1.7	−13.8	17.3
M RI	87	79.3	69.5	86.6	19.5	1.2	2.4	−13.6	18.4
Newc	48	64.6	50.2	76.7	4.2	31.3	−23.8	−45.6	−2.0
Norwch	49	77.6	63.8	87.1	0.0	22.5	8.5	−13.8	30.7
Nottm	101	56.4	46.6	65.8	2.0	41.6	4.6	−13.1	22.3
Oxford	93	63.4	53.2	72.6	3.2	33.3	−5.5	−22.9	12.0
Plymth	38	68.4	52.2	81.1	7.9	23.7	−13.8	−38.2	10.6
Ports	77	71.4	60.4	80.4	6.5	22.1	−7.4	−25.7	10.8
Prestn	58	84.5	72.8	91.7	5.2	10.3	−1.5	−18.6	15.6
Redng	73	89.0	79.6	94.4	4.1	6.9	7.7	−7.2	22.7
Sheff	68	79.4	68.2	87.4	14.7	5.9	0.5	−17.2	18.3
Shrew	27	81.5	62.5	92.1	7.4	11.1	4.8	−22.9	32.5
Stevng	27	70.4	51.0	84.4	7.4	22.2	−1.1	−31.1	29.0
Stoke	68	72.1	60.3	81.4	7.4	20.6	−5.7	−24.6	13.2
Sund	24	58.3	38.3	75.9	4.2	37.5			
Swanse	52	69.2	55.5	80.2	28.9	1.9	−8.7	−30.3	12.9
Truro	21	47.6	27.9	68.2	14.3	38.1	−25.5	−61.4	10.5
Wolve	40	77.5	62.1	87.9	17.5	5.0	6.1	−17.0	29.2
Wrexm	21	71.4	49.2	86.6	0.0	28.6	14.3	−23.4	52.0
England	2,896	75.0	73.4	76.5	8.2	16.9	−0.6	−3.5	2.3
N Ireland	75	86.7	77.0	92.7	6.7	6.7	11.1	−4.6	26.8
Wales	203	71.9	65.4	77.7	12.8	15.3	−7.8	−18.5	2.9
E, W & NI	3,174	75.1	73.5	76.6	8.4	16.5	−0.8	−3.6	1.9

HD patients with hypercalcaemia was 12% compared to 13% in 2008 and the proportion with hypocalcaemia was 13% compared to 12% in 2008. The proportion of PD patients with hypercalcaemia was 17% similar to 2008 (16%) and the proportion with hypocalcaemia was 8% the same as in 2008 (tables 10.7 and 10.9, figures 10.6 to 10.9). The changes in the percentages above, below and within range for the period 2000 to 2009 for England, Northern Ireland and Wales combined are shown in figure 10.10. The percentage of patients achieving the audit standard for calcium seems to have reached a plateau for both HD and PD patients.

As for phosphate, there was significant between centre variation in unadjusted analyses for the proportion of

patients below, within and above the range specified by the clinical performance measure (figures 10.6–10.10). There was greater variation in the proportion of patients within range for adjusted calcium than phosphate, most notably for HD patients. The funnel plot shows a greater number of centres outlying the 3SD limit indicating over dispersion in the data possibly due to differences in calcium analysis between centres. The latest guidance from the Renal Association [7], finalised in December 2010, continues to suggest maintenance of serum calcium within the normal range and ideally between 2.2 and 2.5 mmol/L, avoiding hypercalcaemic episodes and calcium concentrations below 2.2 mmol/L; hence the audit measure will remain unchanged for next year's report.

Fig. 10.6. Percentage of haemodialysis patients with adjusted calcium within range (2.2–2.5 mmol/L) by centre in 2009

Fig. 10.7. Funnel plot of percentage of haemodialysis patients with adjusted calcium within range (2.2–2.5 mmol/L) by centre in 2009

Fig. 10.8. Percentage of peritoneal dialysis patients with adjusted calcium within range (2.2–2.5 mmol/L) by centre in 2009

Fig. 10.9. Funnel plot of percentage of peritoneal dialysis patients with adjusted calcium within range (2.2–2.5 mmol/L) by centre in 2009

Fig. 10.10. Longitudinal change in percentage of patients with adjusted calcium <2.2 mmol/L, 2.2–2.5 mmol/L and >2.5 mmol/L by dialysis modality 2000–2009

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]

The data for parathyroid hormone were 85% complete for HD patients and 87% complete for PD patients overall, although there was between centre variation (tables 10.10 and 10.12). Twenty-eight percent (CI 27–29%) of

HD patients and 32% (30–33%) of PD patients achieved a parathyroid hormone between 16–32 pmol/L (tables 10.11 and 10.13). The proportion of HD patients with a parathyroid hormone above the upper limit of the range was 41% and the proportion with parathyroid hormone below the lower limit of the range was 31%. The proportion of PD patients with parathyroid hormone above the upper limit of the range was 38% and the proportion with parathyroid hormone below the lower limit of the range was 31% (tables 10.11 and 10.13, figures 10.11 to 10.14). Again there was significant between centre variation in unadjusted analyses for the proportion of patients below, within and above the range specified by the clinical performance measure.

Table 10.10. Summary statistics for PTH in haemodialysis patients in 2009

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	99	120	26	23	19	11	32
B Heart	89	362	37	36	27	13	47
B QEH	65	523	21	14	21	9	33
Bangor	100	74	31	48	19	10	28
Basldn	99	131	30	27	21	11	43
Belfast	95	217	40	43	28	12	49
Bradfd	91	160	34	38	21	11	44
Brightn	83	241	37	38	26	10	51
Bristol	97	391	32	35	21	11	41
Camb	47	155					
Cardff	96	428	36	35	26	13	48
Carlisle	100	57	34	28	27	15	47
Carsh	5	29					
Chelms	100	109	49	40	34	22	64
Clwyd	93	69	30	28	21	10	41
Colchr	99	101	35	31	25	13	46
Covnt	97	306	37	44	24	13	46
Derby	99	234	30	33	22	13	37
Derry	97	58	50	36	40	23	66
Donc	98	107	38	37	24	14	54
Dorset	98	210	30	36	19	7	41
Dudley	73	104	37	48	19	10	40
Exeter	98	297	21	23	14	5	26
Glouc	99	172	24	22	19	9	33
Hull	97	293	49	71	30	12	60
Ipswi	98	95	39	36	29	17	48
Kent	0	1					
L Barts	99	639	47	48	32	16	60
L Guys	93	500	46	52	28	11	62
L Kings	98	362	43	37	34	15	62
L Rfree	80	496	37	40	27	15	47
L St.G	94	231	47	42	34	17	64
L West	89	1,059	56	61	35	17	75
Leeds	97	456	29	30	20	10	38
Leic	97	685	43	44	31	13	58
Liv Ain	57	77	40	44	24	10	50
Liv RI	97	358	39	37	28	14	50

Table 10.10. Continued

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
M Hope	75	247					
M RI	50	205	43	37	34	16	57
Middlbr	93	250	44	48	31	15	51
Newc	98	246	33	30	25	13	44
Newry	98	92	37	33	28	17	46
Norwch	96	283	31	29	25	14	39
Nottm	100	379	36	43	25	13	43
Oxford	96	323	47	40	37	15	67
Plymth	98	111	19	20	14	5	26
Ports	90	398	42	50	23	10	53
Prestn	87	391	33	33	23	12	42
Redng	100	248	29	28	23	13	37
Sheff	98	558	40	34	31	16	56
Shrew	96	175	36	46	20	11	42
Stevng	97	340	60	52	48	29	76
Sthend	90	109	53	46	40	20	70
Stoke	95	263	46	47	31	18	61
Sund	95	157	46	37	35	19	65
Swanse	72	232	43	42	30	17	59
Truro	98	136	26	29	18	8	35
Tyrone	99	85	36	26	30	21	41
Ulster	100	86	26	24	19	10	31
Wirral	63	107	32	31	23	13	41
Wolve	97	278	19	25	12	6	23
Wrexm	99	70	22	19	19	8	32
York	76	129	37	33	26	14	53
England	85	14,274	39.0	39.3	27.4	13.8	51.0
N Ireland	97	658	35.0	34.0	26.0	13.0	45.0
Wales	88	873	36.0	38.0	26.0	13.0	46.0
E, W & NI	85	15,805	38.1	38.0	27.0	13.8	49.5

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

M Hope excluded due to technical difficulties with data extraction

Table 10.11. Percentage of haemodialysis patients within, below and above the range for PTH (16–32 pmol/L) in 2009

Centre	N	% PTH 16–32 pmol/L	Lower 95% CI	Upper 95% CI	% PTH <16 pmol/L	% PTH >32 pmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Antrim	120	33.3	25.5	42.2	42.5	24.2	−0.3	−16.0	15.5
B Heart	362	26.2	22.0	31.0	30.1	43.7	3.3	−5.0	11.7
B QEH	523	33.8	29.9	38.0	39.6	26.6	−3.9	−12.0	4.2
Bangor	74	37.8	27.6	49.3	41.9	20.3	11.8	−8.2	31.7
Basldn	131	31.3	24.0	39.7	36.6	32.1	−0.4	−15.5	14.8
Belfast	217	25.8	20.4	32.0	31.3	42.9	0.4	−10.4	11.1
Bradfd	160	22.5	16.7	29.6	41.3	36.3	−7.0	−19.7	5.7
Brightn	241	27.0	21.8	32.9	31.5	41.5	3.1	−6.7	13.0
Bristol	391	30.7	26.3	35.4	36.6	32.7	−2.3	−10.9	6.3
Cardff	428	29.0	24.9	33.5	30.6	40.4	1.2	−6.9	9.3
Carlisle	57	28.1	18.0	41.0	28.1	43.9	−5.7	−26.8	15.4
Chelms	109	29.4	21.6	38.6	16.5	54.1	−2.6	−19.3	14.2
Clwyd	69	21.7	13.6	33.0	40.6	37.7	−2.5	−21.5	16.6

Table 10.11. Continued

Centre	N	% PTH 16–32 pmol/L	Lower 95% CI	Upper 95% CI	% PTH <16 pmol/L	% PTH >32 pmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Colchr	101	31.7	23.4	41.4	32.7	35.6	1.6	−15.6	18.7
Covnt	306	27.5	22.7	32.7	31.7	40.9	3.8	−5.5	13.2
Derby	234	37.6	31.6	44.0	32.1	30.3	1.9	−9.6	13.5
Derry	58	22.4	13.5	34.9	15.5	62.1	−16.8	−39.4	5.8
Donc	107	31.8	23.7	41.2	30.8	37.4	−0.2	−18.5	18.2
Dorset	210	26.7	21.1	33.1	42.4	31.0	2.4	−9.2	14.0
Dudley	104	23.1	16.0	32.1	43.3	33.7	−7.6	−24.2	9.0
Exeter	297	28.3	23.5	33.7	53.2	18.5	1.6	−8.1	11.3
Glouc	172	27.9	21.7	35.1	44.8	27.3	−17.1	−31.1	−3.1
Hull	293	20.1	15.9	25.1	31.4	48.5	−6.3	−15.5	3.0
Ipswi	95	34.7	25.9	44.8	23.2	42.1	−1.1	−18.9	16.8
L Barts	639	25.7	22.4	29.2	24.6	49.8	2.1	−4.3	8.5
L Guys	500	22.6	19.2	26.5	31.4	46.0	−3.3	−10.5	3.8
L Kings	362	21.6	17.6	26.1	27.1	51.4	−6.9	−15.1	1.4
L Rfree	496	33.1	29.1	37.3	26.8	40.1	2.6	−5.0	10.2
L St.G	231	28.1	22.7	34.3	20.4	51.5	−3.1	−14.6	8.3
L West	1,059	24.1	21.6	26.8	23.3	52.6	1.6	−3.4	6.6
Leeds	456	29.4	25.4	33.7	39.5	31.1	0.1	−7.8	8.0
Leic	685	22.8	19.8	26.1	28.9	48.3	0.1	−5.9	6.0
Liv Ain	77	28.6	19.6	39.6	32.5	39.0	−4.4	−23.1	14.3
Liv RI	358	27.9	23.5	32.8	26.8	45.3	1.4	−7.3	10.1
M Hope	247								
M RI	205	22.4	17.2	28.7	23.9	53.7	0.1	−10.5	10.7
Middlbr	250	27.2	22.0	33.1	26.0	46.8	0.4	−10.0	10.9
Newc	246	28.9	23.5	34.8	34.2	37.0	−2.7	−13.4	8.0
Newry	92	37.0	27.7	47.2	21.7	41.3	0.5	−18.2	19.2
Norwch	283	39.9	34.4	45.8	26.9	33.2	2.7	−8.0	13.3
Nottm	379	31.1	26.7	36.0	29.6	39.3	0.4	−8.5	9.2
Oxford	323	20.4	16.4	25.2	25.1	54.5	−1.8	−10.2	6.6
Plymth	111	27.9	20.4	37.0	52.3	19.8	0.4	−15.2	16.0
Ports	398	21.6	17.8	25.9	36.4	42.0	1.2	−6.3	8.6
Prestn	391	34.8	30.2	39.6	31.7	33.5	5.9	−2.6	14.4
Redng	248	36.3	30.5	42.5	31.5	32.3	−2.6	−14.0	8.8
Sheff	558	27.6	24.1	31.5	24.2	48.2	−0.5	−7.5	6.4
Shrew	175	28.6	22.4	35.7	38.9	32.6	1.1	−11.5	13.7
Stevng	340	22.4	18.2	27.1	10.3	67.4	−10.5	−19.3	−1.6
Sthend	109	30.3	22.4	39.5	13.8	56.0	7.1	−8.3	22.6
Stoke	263	30.8	25.5	36.6	20.5	48.7	6.4	−3.9	16.8
Sund	157	26.1	19.8	33.5	19.8	54.1	−2.9	−16.1	10.4
Swanse	232	29.7	24.2	35.9	23.7	46.6	3.9	−6.1	14.0
Truro	136	28.7	21.7	36.8	44.9	26.5	−0.9	−15.2	13.3
Tyrone	85	38.8	29.1	49.5	16.5	44.7	−0.5	−19.8	18.9
Ulster	86	37.2	27.7	47.9	40.7	22.1	−11.5	−31.4	8.3
Wirral	107	35.5	27.0	45.0	33.6	30.8	−0.8	−17.9	16.4
Wolve	278	24.8	20.1	30.2	60.1	15.1	2.0	−7.4	11.4
Wrexm	70	32.9	22.9	44.6	45.7	21.4	9.0	−10.8	28.7
York	129	30.2	22.9	38.7	27.9	41.9	1.8	−13.7	17.3
England	14,027	27.6	26.9	28.3	30.9	41.5	−0.4	−1.8	1.0
N Ireland	658	31.6	28.2	35.3	29.9	38.5	−2.6	−9.3	4.1
Wales	873	29.7	26.7	32.8	31.7	38.6	3.2	−2.3	8.7
E, W & NI	15,558	27.9	27.2	28.6	30.9	41.2	−0.3	−1.6	1.0

M Hope excluded due to technical difficulties with data extraction

Table 10.12. Summary statistics for PTH in peritoneal dialysis patients in 2009

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	100	14					
B Heart	81	22	41	36	29	19	56
B QEH	73	104	19	14	16	6	27
Bangor	100	29	22	22	18	9	32
Basldn	100	25	32	30	21	13	49
Belfast	97	33	53	40	36	23	77
Bradfd	87	27	51	61	28	9	78
Brightn	97	74	35	36	25	15	39
Bristol	91	62	32	35	26	8	40
Camb	100	31	33	21	26	17	44
Cardff	99	94	44	37	32	17	67
Carlisle	85	11					
Carsh	4	4					
Chelms	100	31	40	27	36	21	50
Clwyd	86	6					
Covnt	90	66	33	35	23	10	48
Derby	100	82	20	14	17	11	25
Derry	100	3					
Donc	100	30	42	29	43	20	57
Dorset	81	44	19	20	9	6	26
Dudley	86	43	31	43	14	6	42
Exeter	100	64	25	21	21	10	31
Glouc	87	34	29	33	18	9	35
Hull	84	53	29	25	22	12	37
Ipswi	100	42	42	29	34	23	51
Kent	0	0					
L Barts	98	163	33	31	24	12	43
L Guys	95	42	41	36	29	16	58
L Kings	100	68	53	40	44	21	80
L Rfree	98	63	28	20	23	11	41
L St.G	93	54	37	35	27	14	41
L West	100	31	50	33	45	20	71
Leeds	99	85	32	25	26	15	40
Leic	92	136	33	31	25	11	46
Liv Ain	0	0					
Liv RI	95	76	26	26	23	10	35
M Hope	79	89					
M RI	98	87	43	36	33	18	60
Middlbr	63	10					
Newc	98	47	24	27	15	7	34
Newry	100	12					
Norwch	76	42	31	34	18	11	38
Nottm	100	101	36	35	24	10	49
Oxford	94	87	44	40	35	16	59
Plymth	97	37	32	30	23	13	37
Ports	78	63	49	53	36	17	62
Prestn	98	64	28	25	21	15	30
Redng	99	72	28	37	16	9	38
Sheff	87	59	39	30	31	21	55
Shrew	100	27	44	41	32	10	66
Stevng	86	24	53	31	48	29	76
Sthend	76	13					
Stoke	86	59	48	37	39	22	61
Sund	88	21	25	26	22	9	30
Swansea	94	49	37	19	35	23	46

Table 10.12. Continued

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Truro	90	19					
Tyrone	100	11					
Ulster	100	2					
Wirral	58	15					
Wolve	100	40	20	18	15	8	26
Wrexm	95	21	26	16	24	15	29
York	93	14					
England	86	2,557	35.3	31.6	26.6	13.9	47.3
N Ireland	99	75	42.0	38.0	28.0	19.0	46.0
Wales	97	199	36.0	30.0	30.0	16.0	48.0
E, W & NI	87	2,831	34.3	30.2	26.1	13.8	46.0

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

M Hope excluded due to technical difficulties with data extraction

Table 10.13. Percentage of peritoneal dialysis patients within, below and above the range for PTH (16–32 pmol/L) in 2009

Centre	N	% PTH 16–32 pmol/L	Lower 95% CI	Upper 95% CI	% PTH <16 pmol/L	% PTH >32 pmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
B Heart	22	45.5	26.5	65.9	18.2	36.4	5.5	−31.8	42.7
B QEH	104	35.6	27.0	45.2	47.1	17.3	7.5	−9.8	24.7
Bangor	29	27.6	14.4	46.2	48.3	24.1	−6.9	−38.1	24.4
Basldn	25	32.0	16.9	52.2	36.0	32.0	−8.0	−41.3	25.3
Belfast	33	36.4	21.9	53.7	12.1	51.5	9.1	−18.6	36.8
Bradfd	27	18.5	7.9	37.5	37.0	44.4	1.3	−25.2	27.7
Brightn	74	43.2	32.5	54.7	25.7	31.1	4.6	−16.2	25.3
Bristol	62	27.4	17.8	39.8	38.7	33.9	7.4	−12.0	26.8
Camb	31	32.3	18.3	50.3	19.4	48.4	0.7	−28.4	29.8
Cardff	94	28.7	20.5	38.7	22.3	48.9	10.5	−5.1	26.0
Chelms	31	29.0	15.9	47.1	12.9	58.1	−0.7	−29.3	27.9
Covnt	66	27.3	17.9	39.2	37.9	34.9	−8.3	−29.7	13.1
Derby	82	52.4	41.7	63.0	36.6	11.0	10.3	−10.1	30.7
Donc	30	23.3	11.6	41.5	16.7	60.0	−17.3	−47.3	12.7
Dorset	44	25.0	14.4	39.7	59.1	15.9	3.6	−19.9	27.0
Dudley	43	14.0	6.4	27.8	51.2	34.9	−5.6	−26.6	15.4
Exeter	64	37.5	26.6	49.9	39.1	23.4	4.2	−18.3	26.6
Glouc	34	23.5	12.2	40.5	41.2	35.3	−3.7	−31.2	23.7
Hull	53	28.3	17.8	41.8	37.7	34.0	2.4	−19.4	24.2
Ipswi	42	40.5	26.9	55.7	2.4	57.1	5.1	−21.4	31.5
L Barts	163	30.7	24.1	38.2	33.1	36.2	−1.1	−13.6	11.4
L Guys	42	35.7	22.8	51.1	23.8	40.5	11.2	−13.6	36.0
L Kings	68	20.6	12.6	31.8	16.2	63.2	−9.0	−27.8	9.9
L Rfree	63	27.0	17.5	39.2	34.9	38.1	−15.3	−36.2	5.6
L St.G	54	31.5	20.6	44.9	29.6	38.9	12.7	−9.1	34.6
L West	31	19.4	9.0	36.9	12.9	67.7	−18.8	−45.4	7.9
Leeds	85	38.8	29.1	49.5	25.9	35.3	−3.4	−22.9	16.2
Leic	136	29.4	22.4	37.6	33.1	37.5	8.0	−5.5	21.5
Liv RI	76	34.2	24.5	45.5	38.2	27.6	6.7	−12.3	25.8
M Hope	89								
M RI	87	31.0	22.2	41.5	18.4	50.6	7.7	−9.5	24.9
Newc	47	23.4	13.5	37.5	51.1	25.5	−13.2	−38.3	11.9
Norwch	42	33.3	20.8	48.7	40.5	26.2	7.8	−17.7	33.2
Nottm	101	23.8	16.5	33.0	38.6	37.6	0.9	−14.3	16.1

Table 10.13. Continued

Centre	N	% PTH 16–32 pmol/L	Lower 95% CI	Upper 95% CI	% PTH <16 pmol/L	% PTH >32 pmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Oxford	87	24.1	16.3	34.2	24.1	51.7	−1.6	−18.1	14.8
Plymth	37	40.5	26.1	56.8	29.7	29.7	16.9	−10.5	44.3
Ports	63	25.4	16.2	37.5	19.1	55.6	9.0	−9.7	27.7
Prestn	64	50.0	38.0	62.0	28.1	21.9	7.1	−16.3	30.6
Redng	72	23.6	15.2	34.8	47.2	29.2	−19.6	−39.3	0.1
Sheff	59	42.4	30.5	55.2	15.3	42.4	26.7	6.4	47.1
Shrew	27	25.9	12.9	45.3	29.6	44.4	−3.1	−33.4	27.2
Stevng	24	29.2	14.6	49.8	8.3	62.5	3.4	−28.0	34.7
Stoke	59	30.5	20.1	43.3	8.5	61.0	−1.7	−23.7	20.3
Sund	21	33.3	16.8	55.3	47.6	19.1			
Swanse	49	32.7	21.1	46.8	10.2	57.1	−3.1	−27.0	20.8
Wolve	40	32.5	19.9	48.3	52.5	15.0	−14.7	−40.7	11.4
Wrexm	21	47.6	27.9	68.2	28.6	23.8	32.6	−2.2	67.5
England	2,468	31.2	29.4	33.1	31.7	37.1	1.5	−1.8	4.9
N Ireland	75	40.0	29.6	51.4	18.7	41.3	4.3	−15.6	24.2
Wales	199	32.2	26.0	39.0	24.6	43.2	7.3	−4.1	18.7
E, W & NI	2,742	31.6	29.8	33.3	30.8	37.7	2.0	−1.1	5.2

Blank cells denote a centre with low patient numbers last year precluding calculation of the change in target attainment
M Hope excluded due to technical difficulties with data extraction

Mineral and bone variables – discussion

There are convincing observational data that hyperphosphataemia is associated with increased mortality in dialysis patients but the data linking calcium and parathyroid hormone to patient survival are less clear [12–16]. A recent cohort study has demonstrated that simultaneous achievement of all three audit measures does appear to be associated with better outcomes [17].

The UKRR has consistently demonstrated between centre variation in achievement of audit measures for bone and mineral parameters but little is understood

about the causes of this ‘centre effect’. The complexity of the clinical processes required to manage mineral and bone disorders is probably further confounded by case-mix. Finally it is important to consider data quality and the potential for measurement bias particularly in light of the variability in assay methods for parathyroid hormone where substantial differences exist in both calibration and in the detection of the various fragments that accumulate in renal failure. However, detecting these centre level differences is an important step in understanding the factors associated with exceptional

Fig. 10.11. Percentage of haemodialysis patients with PTH within range (16–32 pmol/L) by centre in 2009

Fig. 10.12. Funnel plot of percentage of haemodialysis patients with PTH within range (16–32 pmol/L) by centre in 2009

Fig. 10.13. Percentage of peritoneal dialysis patients with PTH within range (16–32 pmol/L) by centre in 2009

Fig. 10.14. Funnel plot of percentage of peritoneal dialysis patients with PTH within range (16–32 pmol/L) by centre in 2009

performance. The latest version of the Renal Association Clinical Practice Guidelines, finalised in December 2010, suggests the maintenance of serum PTH between 2 and 9 times the upper limit of the normal range. There is some evidence of changing practice in this regard already with a rise in the percentage of HD patients with a PTH >32 pmol/L over the last 4 years.

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]

Bicarbonate data were 85% complete for HD patients and 87% complete for PD patients (tables 10.14 and 10.16). Seventy-two percent (CI 71–72%) of HD patients and 83% (CI 82–84%) of PD patients achieved the audit measure for bicarbonate and there was significant inter-centre variation for both HD and PD (tables 10.15 and 10.17, figures 10.15 and 10.16). There was even greater between centre variation in the proportion of patients with bicarbonate values above and below the specified range for the audit measure (tables 10.15 and 10.17). The UKRR has previously conducted a limited survey into the possible underlying causes of this variation. The study predominantly looked at measures of sample

Table 10.14. Summary statistics for serum bicarbonate in haemodialysis patients by centre in 2009

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	99	120	24	3	25	23	26
B Heart	82	334	24	3	24	23	26
B QEH	97	780	24	3	24	23	26
Bangor	100	74	24	3	24	22	26
Basldn	99	131	23	3	23	21	25
Belfast	99	226	23	2	23	21	24
Bradfd	95	167	24	4	23	22	26
Brightn	97	283	22	3	22	20	23
Bristol	100	403	23	3	23	22	25
Camb	67	220	24	3	24	22	26
Cardff	85	380	22	3	22	20	24
Carlisle	100	57	23	3	23	21	25
Carsh	97	595	24	3	24	22	26
Chelms	100	109	26	2	26	24	27
Clwyd	100	74	21	3	21	19	23
Colchr	99	101	26	2	26	25	28
Covnt	94	296	24	4	25	22	27
Derby	100	236	21	3	21	19	23
Derry	100	60	21	2	22	20	23
Donc	100	109	22	2	22	21	24
Dorset	100	215	23	3	23	21	24
Dudley	77	110	25	3	25	22	26
Exeter	99	300	23	2	23	21	24
Glouc	100	173	26	3	26	24	27
Hull	99	298	22	2	22	20	23
Ipswi	99	96	22	3	21	19	24
Kent	100	313	21	2	21	19	22
L Barts	100	645	24	3	24	22	26
L Guys	83	446	23	3	23	21	25
L Kings	100	370	25	3	25	23	27
L Rfree	82	506	24	3	23	22	26
L St.G	100	247	28	3	28	26	30
L West	0	1					
Leeds	99	463	22	3	22	20	24

Table 10.14. Continued

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Leic	99	702	24	3	24	22	26
Liv Ain	70	95	24	3	23	22	25
Liv RI	99	367	24	4	24	21	26
M Hope	4	14					
M RI	59	241	24	4	24	21	26
Middlbr	98	262	26	3	26	24	28
Newc	100	252	25	3	25	22	27
Newry	99	93	22	2	22	21	24
Norwch	99	293	22	3	22	20	24
Nottm	81	308	24	3	24	22	26
Oxford	99	333	25	4	25	22	27
Plymth	100	113	22	3	22	20	23
Ports	100	440	23	3	23	22	25
Prestn	82	366	23	3	24	21	25
Redng	100	248	26	3	26	24	27
Sheff	100	570	25	3	25	23	27
Shrew	100	182	23	3	23	21	25
Stevng	99	348	23	3	23	22	25
Sthend	98	119	24	3	24	22	26
Stoke	0	0					
Sund	99	163	23	3	23	21	24
Swanse	100	322	25	3	25	23	27
Truro	98	136	22	2	22	21	23
Tyrone	99	85	25	3	24	23	26
Ulster	100	86	20	2	20	18	21
Wirral	98	167	24	3	24	22	26
Wolve	100	286	20	3	20	18	22
Wrexm	100	71	22	3	22	20	24
York	95	160	23	3	23	21	25
England	84	14,169	24	3	24	21	26
N Ireland	99	670	23	3	23	21	25
Wales	93	921	23	4	23	21	26
E, W & NI	85	15,760	24	3	24	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) by centre in 2009

Centre	N	% bicarb 20–26 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb <20 mmol/L	% bicarb >26 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Antrim	120	80.0	71.9	86.2	1.7	18.3	−4.0	−16.8	8.8
B Heart	334	74.6	69.6	78.9	4.2	21.3	7.2	−1.7	16.1
B QEH	780	76.0	72.9	78.9	4.9	19.1	2.1	−3.8	8.1
Bangor	74	70.3	59.0	79.6	6.8	23.0	−0.7	−20.4	18.9
Basldn	131	77.9	70.0	84.2	9.9	12.2	−1.2	−14.5	12.1
Belfast	226	85.0	79.7	89.1	8.9	6.2	4.9	−4.3	14.1
Bradfd	167	70.1	62.7	76.5	10.8	19.2	−0.2	−13.2	12.7
Brightn	283	76.3	71.0	80.9	20.5	3.2	−3.0	−12.2	6.2
Bristol	403	81.4	77.3	84.9	10.4	8.2	−0.7	−7.6	6.3
Camb	220	72.3	66.0	77.8	5.0	22.7	−2.6	−14.3	9.1
Cardff	380	69.7	64.9	74.2	22.1	8.2	−4.1	−12.6	4.4
Carlisle	57	84.2	72.4	91.6	3.5	12.3	6.8	−11.1	24.6

Table 10.15. Continued

Centre	N	% bicarb 20–26 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb <20 mmol/L	% bicarb >26 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Carsh	595	72.4	68.7	75.9	5.9	21.7	6.6	−0.4	13.6
Chelms	109	59.6	50.2	68.4	0.9	39.5	−7.7	−25.1	9.6
Clwyd	74	66.2	54.8	76.0	31.1	2.7	−16.6	−35.3	2.1
Colchr	101	59.4	49.6	68.5	0.0	40.6	1.5	−16.6	19.7
Covnt	296	64.5	58.9	69.8	7.1	28.4	n/a	n/a	n/a
Derby	236	71.6	65.5	77.0	26.7	1.7	−10.3	−20.4	−0.3
Derry	60	75.0	62.6	84.3	21.7	3.3	1.9	−19.5	23.4
Donc	109	83.5	75.3	89.3	11.9	4.6	4.9	−10.7	20.5
Dorset	215	84.7	79.2	88.9	9.3	6.1	6.8	−3.3	16.9
Dudley	110	69.1	59.9	77.0	6.4	24.6	−1.9	−18.5	14.8
Exeter	300	84.7	80.1	88.3	9.0	6.3	4.6	−3.6	12.8
Glouc	173	62.4	55.0	69.3	0.6	37.0	−11.1	−24.7	2.4
Hull	298	82.6	77.8	86.5	16.4	1.0	3.6	−4.8	12.0
Ipswi	96	64.6	54.6	73.5	27.1	8.3	−10.4	−27.4	6.6
Kent	313	68.7	63.3	73.6	29.1	2.2	−6.0	−15.4	3.5
L Barts	645	75.2	71.7	78.4	6.2	18.6	−2.5	−8.8	3.8
L Guys	446	78.3	74.2	81.8	8.5	13.2	−4.4	−11.3	2.6
L Kings	370	61.6	56.6	66.4	3.5	34.9	−20.4	−28.7	−12.1
L Rfree	506	71.2	67.0	74.9	9.1	19.8	−1.9	−9.2	5.3
L St.G	247	31.6	26.1	37.6	0.8	67.6	−11.5	−23.3	0.3
Leeds	463	71.3	67.0	75.2	21.2	7.6	−4.8	−12.3	2.7
Leic	702	70.9	67.5	74.2	7.1	21.9	5.8	−0.7	12.3
Liv Ain	95	82.1	73.1	88.6	7.4	10.5	3.4	−11.0	17.8
Liv RI	367	67.0	62.1	71.7	9.3	23.7	−3.6	−12.7	5.4
M RI	241	68.9	62.8	74.4	8.3	22.8	1.2	−9.4	11.8
Middlbr	262	52.3	46.2	58.3	1.9	45.8	−0.5	−11.9	10.9
Newc	252	55.2	49.0	61.2	9.9	34.9	−16.6	−27.6	−5.7
Newry	93	85.0	76.2	90.9	12.9	2.2	15.2	−0.8	31.1
Norwch	293	77.5	72.3	81.9	16.7	5.8	6.6	−2.8	16.0
Nottm	308	75.0	69.9	79.5	4.6	20.5	9.5	−0.4	19.3
Oxford	333	59.2	53.8	64.3	8.7	32.1	−8.0	−17.7	1.7
Plymth	113	75.2	66.5	82.3	20.4	4.4	4.6	−10.8	20.0
Ports	440	80.7	76.7	84.1	8.0	11.4	1.7	−5.4	8.8
Prestn	366	74.6	69.9	78.8	10.1	15.3	−2.7	−11.1	5.7
Redng	248	63.3	57.1	69.1	1.2	35.5	−8.5	−19.4	2.5
Sheff	570	66.0	62.0	69.7	3.9	30.2	−6.1	−13.1	1.0
Shrew	182	79.1	72.6	84.4	11.0	9.9	8.5	−3.4	20.4
Stevng	348	83.9	79.7	87.4	6.0	10.1	7.7	−0.1	15.6
Sthend	119	72.3	63.6	79.6	10.9	16.8	0.0	−15.0	15.0
Sund	163	81.6	74.9	86.8	11.7	6.8	7.8	−4.4	19.9
Swanse	322	61.8	56.4	67.0	1.9	36.3	−7.9	−17.5	1.8
Truro	136	86.0	79.1	90.9	13.2	0.7	26.8	13.4	40.1
Tyrone	85	74.1	63.8	82.3	3.5	22.4	14.1	−4.3	32.5
Ulster	86	50.0	39.6	60.4	50.0	0.0	12.0	−7.8	31.8
Wirral	167	75.5	68.4	81.4	5.4	19.2	13.8	0.5	27.0
Wolve	286	58.0	52.2	63.6	40.6	1.4	−7.8	−18.3	2.8
Wrexm	71	74.7	63.3	83.4	19.7	5.6	−1.4	−20.1	17.2
York	160	74.4	67.1	80.5	10.0	15.6	2.3	−12.2	16.7
England	14,169	71.6	70.9	72.4	9.7	18.7	−0.6	−2.0	0.8
N Ireland	670	77.3	74.0	80.3	13.9	8.8	6.2	0.0	12.4
Wales	921	67.1	64.0	70.1	14.3	18.6	−5.9	−11.4	−0.3
E, W & NI	15,760	71.6	70.9	72.3	10.2	18.2	−0.6	−2.0	0.7

n/a data unavailable for last year due to low patient numbers

Table 10.16. Summary statistics for serum bicarbonate in peritoneal dialysis patients by centre in 2009

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	93	13					
B Heart	93	25	26	2	26	24	27
B QEH	76	108	25	3	25	23	27
Bangor	100	29	26	3	26	24	28
Basldn	100	25	26	2	26	25	27
Belfast	100	34	24	3	24	23	27
Bradfd	100	31	27	2	27	24	29
Brightn	93	71	24	3	24	21	26
Bristol	99	67	24	3	24	22	26
Camb	100	31	27	3	27	26	29
Cardff	99	94	23	3	22	20	25
Carlis	100	13					
Carsh	92	102	27	3	27	26	29
Chelms	100	31	26	3	27	25	28
Clwyd	86	6					
Covnt	93	68	25	3	26	24	28
Derby	100	82	25	3	25	23	27
Derry	100	3					
Donc	87	26	25	3	25	23	28
Dorset	96	52	24	3	24	22	27
Dudley	96	48	25	3	25	23	27
Exeter	100	64	26	4	26	24	28
Glouc	100	39	26	3	26	25	28
Hull	98	62	25	3	26	24	28
Ipswi	100	42	24	3	24	23	26
Kent	100	64	23	3	23	21	25
L Barts	98	162	26	3	26	25	28
L Guys	100	44	24	3	24	22	26
L Kings	100	68	26	3	26	24	28
L Rfree	98	63	25	3	25	23	28
L St.G	97	56	28	3	29	27	30
L West	0	0					
Leeds	100	86	25	3	25	23	27
Leic	97	144	27	3	27	25	29
Liv Ain	29	2					
Liv RI	99	79	24	3	24	22	26
M Hope	7	8					
M RI	99	88	26	3	26	24	27
Middlbr	94	15					
Newc	98	47	25	3	25	24	28
Newry	92	11					
Norwch	89	49	23	3	23	21	25
Nottm	44	44					
Oxford	68	63	25	4	25	22	28
Plymth	100	38	24	2	24	22	25
Ports	85	69	26	3	26	24	27
Prestn	89	58	25	3	25	22	27
Redng	100	73	26	3	26	25	29
Sheff	100	68	26	3	26	24	28
Shrew	100	27	27	3	27	26	30
Stevng	89	25	25	3	26	23	27
Sthend	94	16					
Stoke	7	5					
Sund	100	24	24	3	24	23	25
Swanse	100	52	27	3	27	25	29
Truro	95	20	26	4	26	23	30

Table 10.16. Continued

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Tyrone	91	10					
Ulster	100	2					
Wirral	65	17					
Wolve	100	40	24	3	24	23	26
Wrexm	95	21	25	2	25	24	27
York	100	15					
England	86	2,564	25	3	26	23	28
N Ireland	96	73	24	3	25	23	27
Wales	99	202	24	3	25	22	27
E, W & NI	87	2,839	25	3	25	23	28

Blank cells denote low patient numbers or poor data completeness

Table 10.17. Percentage of peritoneal dialysis patients within, below and above the range for bicarbonate (22–30 mmol/L) by centre in 2009

Centre	N	% bicarb 22–30 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb <22 mmol/L	% bicarb >30 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
B Heart	25	96.0	76.5	99.4	4.0	0.0	6.7	−11.4	24.9
B QEH	108	80.6	72.0	87.0	15.7	3.7	−7.5	−20.6	5.7
Bangor	29	79.3	61.0	90.4	10.3	10.3	−2.8	−29.8	24.1
Basldn	25	100.0	0.0	100.0	0.0	0.0	16.7	−0.9	34.2
Belfast	34	88.2	72.5	95.5	11.8	0.0	5.6	−14.6	25.9
Bradfd	31	100.0	0.0	100.0	0.0	0.0	22.6	3.2	42.0
Brightn	71	66.2	54.5	76.2	32.4	1.4	−5.6	−25.2	14.0
Bristol	67	79.1	67.8	87.2	20.9	0.0	−6.8	−23.5	9.8
Camb	31	87.1	70.3	95.1	0.0	12.9	−5.0	−24.2	14.2
Cardff	94	63.8	53.7	72.9	36.2	0.0	−6.7	−23.8	10.5
Carsh	102	82.4	73.7	88.6	3.9	13.7	1.4	−12.3	15.2
Chelms	31	90.3	73.9	96.9	6.5	3.2	13.4	−8.8	35.6
Covnt	68	86.8	76.5	93.0	10.3	2.9	3.4	−14.0	20.9
Derby	82	85.4	76.0	91.5	13.4	1.2	5.4	−10.2	21.0
Donc	26	88.5	69.7	96.2	11.5	0.0			
Dorset	52	75.0	61.6	84.9	25.0	0.0	−20.9	−38.0	−3.8
Dudley	48	81.3	67.7	90.0	14.6	4.2	−11.9	−29.5	5.6
Exeter	64	84.4	73.3	91.4	10.9	4.7	11.5	−7.5	30.5
Glouc	39	92.3	78.7	97.5	5.1	2.6	7.5	−12.0	27.0
Hull	62	90.3	80.1	95.6	9.7	0.0	10.6	−5.2	26.4
Ipswi	42	83.3	69.0	91.8	16.7	0.0	−2.1	−21.9	17.7
Kent	64	60.9	48.6	72.1	39.1	0.0	−8.2	−29.5	13.2
L Barts	162	85.2	78.9	89.9	4.9	9.9	1.1	−8.7	10.8
L Guys	44	75.0	60.3	85.6	20.5	4.6	−6.6	−28.7	15.4
L Kings	68	89.7	79.9	95.0	5.9	4.4	−0.4	−13.6	12.7
L Rfree	63	81.0	69.4	88.9	15.9	3.2	−1.7	−18.8	15.3
L St.G	56	76.8	64.0	86.0	1.8	21.4	−5.2	−25.4	15.0
Leeds	86	90.7	82.5	95.3	7.0	2.3	5.3	−7.6	18.2
Leic	144	83.3	76.3	88.6	5.6	11.1	−1.2	−12.3	9.8
Liv RI	79	82.3	72.3	89.2	15.2	2.5	3.0	−12.8	18.7
M RI	88	87.5	78.8	92.9	8.0	4.6	−0.4	−13.1	12.3
Newc	47	91.5	79.4	96.8	6.4	2.1	7.8	−10.2	25.7
Norwch	49	69.4	55.3	80.6	30.6	0.0	20.3	−4.0	44.6
Oxford	63	79.4	67.6	87.6	14.3	6.4	−2.3	−20.0	15.4
Plymth	38	84.2	69.0	92.7	15.8	0.0	−0.2	−20.9	20.4
Ports	69	89.9	80.2	95.1	8.7	1.5	−1.5	−14.9	11.8

Table 10.17. Continued

Centre	N	% bicarb 22–30 mmol/L	Lower 95% CI	Upper 95% CI	% bicarb <22 mmol/L	% bicarb >30 mmol/L	Change from 2008		
							% within range	95% LCL	95% UCL
Prestn	58	82.8	70.8	90.5	12.1	5.2	−0.2	−19.3	18.9
Redng	73	84.9	74.8	91.5	8.2	6.9	−7.1	−20.6	6.4
Sheff	68	86.8	76.5	93.0	5.9	7.4	−2.0	−16.3	12.4
Shrew	27	88.9	70.7	96.4	0.0	11.1	1.4	−20.3	23.1
Stevng	25	84.0	64.3	93.9	12.0	4.0	−7.2	−29.9	15.5
Sund	24	83.3	63.1	93.6	16.7	0.0			
Swanse	52	88.5	76.6	94.7	5.8	5.8	3.7	−12.9	20.3
Truro	20	85.0	62.4	95.1	10.0	5.0	0.4	−27.1	27.9
Wolve	40	87.5	73.3	94.7	12.5	0.0	−3.4	−20.2	13.4
Wrexm	21	95.2	72.9	99.3	4.8	0.0	−4.8	−16.7	7.2
England	2,564	83.5	82.0	84.9	11.7	4.8	0.1	−2.6	2.8
N Ireland	73	84.9	74.8	91.5	15.1	0.0	3.4	−12.4	19.1
Wales	202	75.7	69.4	81.2	21.3	3.0	−3.5	−13.9	7.0
E, W & NI	2,839	83.0	81.6	84.3	12.5	4.5	−0.1	−2.6	2.5

Blank cells denote low patient numbers last year precluding calculation of change in target attainment

processing and of dialysis treatment. It did not adjust for case-mix and was unable to detect any significant differences between centres. However, it is possible that there may be unmeasured processes including dialysis and oral bicarbonate prescription that might account for the variation observed [18].

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

Fig. 10.15. Funnel plot for percentage of haemodialysis patients within the range for bicarbonate (20–26 mmol/L) by centre in 2009

Fig. 10.16. Funnel plot for percentage of peritoneal dialysis patients within the range for bicarbonate (22–30 mmol/L) by centre in 2009

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 84% complete for HD patients and 82% complete for PD patients. As there are no specific audit measures for total cholesterol, summary data are presented for each dialysis centre (tables 10.18 and 10.19, figures 10.17 and 10.18). There are a number of case-mix factors (comorbidity, inflammation,

Table 10.18. Summary statistics for total cholesterol in haemodialysis patients by centre in 2009

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	100	121	3.6	1.1	3.4	3.0	4.1
B Heart	93	377	4.2	1.1	4.1	3.5	4.8
B QEH	78	633	3.9	1.0	3.7	3.2	4.5
Bangor	95	70	4.2	1.1	4.2	3.4	5.0
Basldn	99	131	3.8	1.2	3.6	3.0	4.5
Belfast	82	187	3.9	1.0	3.8	3.2	4.3
Bradfd	88	154	4.1	1.0	4.0	3.5	4.6
Brightn	14	41					
Bristol	93	376	4.0	1.2	3.9	3.2	4.7
Camb	68	223	3.8	1.1	3.6	2.9	4.5
Cardff	92	411	3.9	1.1	3.8	3.1	4.6
Carlisle	100	57	4.3	1.0	4.3	3.7	4.8
Carsh	80	489	4.2	1.1	4.1	3.4	4.8
Chelms	90	98	3.7	1.0	3.6	2.9	4.3
Clwyd	100	74	3.9	0.8	3.8	3.3	4.4
Colchr	88	90	3.9	1.2	3.7	3.1	4.5
Covnt	0	0					
Derby	89	209	3.9	1.1	3.7	3.2	4.4
Derry	100	60	3.6	0.8	3.7	3.1	4.0
Donc	98	107	3.9	1.1	3.7	3.1	4.4
Dorset	94	202	4.0	1.0	3.9	3.3	4.5
Dudley	67	96	3.6	0.9	3.6	3.1	4.2
Exeter	93	280	4.0	1.2	3.9	3.2	4.6
Glouc	91	157	3.9	1.0	3.8	3.1	4.6
Hull	90	271	4.1	1.1	3.9	3.2	4.8
Ipswi	87	84	4.0	1.1	3.8	3.3	4.5
Kent	97	306	3.9	1.0	3.8	3.2	4.6
L Barts	100	646	4.1	1.1	3.9	3.3	4.7
L Guys	92	494	4.0	1.1	3.9	3.3	4.6
L Kings	97	360	4.1	1.0	4.0	3.4	4.6
L Rfree	83	511	4.0	1.1	3.8	3.2	4.6
L St.G	98	243	4.0	1.0	3.9	3.3	4.7
L West	97	1,159	3.6	0.9	3.5	3.0	4.1
Leeds	98	458	3.9	1.0	3.8	3.2	4.5
Leic	90	634	3.9	1.1	3.8	3.2	4.4
Liv Ain	40	55					
Liv RI	7	27					
M Hope	82	270	3.7	1.0	3.6	3.1	4.3
M RI	51	206	3.9	1.0	3.8	3.2	4.6
Middlbr	98	262	4.2	1.2	4.0	3.4	5.0
Newc	100	252	3.8	1.0	3.6	3.1	4.4
Newry	99	93	3.5	1.3	3.3	2.7	3.9

Table 10.18. Continued

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Norwch	99	293	4.0	1.0	3.8	3.3	4.6
Nottm	99	377	4.0	1.0	3.9	3.3	4.6
Oxford	87	290	3.8	1.0	3.8	3.0	4.4
Plymth	89	100	4.1	1.1	3.9	3.5	4.6
Ports	65	288	4.1	1.3	3.9	3.1	4.8
Prestn	98	440	4.0	1.0	3.9	3.3	4.5
Redng	96	238	3.8	0.9	3.8	3.2	4.4
Sheff	92	524	3.9	1.1	3.7	3.1	4.5
Shrew	99	181	4.0	1.0	3.9	3.3	4.5
Stevng	18	63					
Sthend	96	116	4.0	1.1	3.9	3.3	4.7
Stoke	99	274	3.8	0.9	3.8	3.1	4.4
Sund	97	160	3.8	1.0	3.7	3.1	4.5
Swanse	93	300	4.1	1.1	4.0	3.3	4.8
Truro	99	138	3.9	1.1	3.8	3.2	4.4
Tyrone	100	86	3.8	0.9	3.8	3.1	4.5
Ulster	100	86	3.6	0.8	3.7	3.0	4.1
Wirral	86	147	3.9	1.0	3.8	3.1	4.5
Wolve	96	276	4.1	1.1	4.0	3.4	4.7
Wrexm	85	60	4.0	0.9	4.0	3.5	4.6
York	88	149	4.5	1.0	4.4	3.8	5.2
England	83	14,012	3.9	1.1	3.8	3.2	4.5
N Ireland	94	633	3.7	1.0	3.6	3.0	4.2
Wales	93	915	4.0	1.1	3.9	3.2	4.7
E, W & NI	84	15,560	3.9	1.1	3.8	3.2	4.5

Blank cells denote low patient numbers or poor data completeness

Table 10.19. Summary statistics for total cholesterol in peritoneal dialysis patients by centre in 2009

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Antrim	100	14					
B Heart	96	26	4.8	1.21	4.55	3.9	5.4
B QEH	85	121	4.57	1.2	4.4	3.6	5.4
Bangor	100	29	4.87	1.22	4.6	3.8	5.8
Basldn	100	25	4.34	0.9	4.3	3.8	4.7
Belfast	100	34	4.46	1.14	4.19	3.9	4.9
Bradfd	94	29	4.3	1.25	3.9	3.7	5
Brightn	33	25					
Bristol	88	60	4.74	1.94	4.5	3.8	5.05
Camb	97	30	4.11	0.99	3.9	3.4	4.8
Cardff	96	93	4.46	1.22	4.2	3.6	5.3
Carlisle	100	13					
Carsh	28	31					
Chelms	90	28	4.18	1.03	3.94	3.38	4.86
Clwyd	71	5					
Covnt	0	0					
Derby	84	69	4.49	1.18	4.5	3.6	5.3
Derry	100	3					
Donc	37	11					
Dorset	89	48	4.33	1.14	4.15	3.55	5
Dudley	68	34	3.97	1.24	3.65	3.1	4.7
Exeter	95	61	4.53	1.37	4.3	3.8	5
Glouc	79	31	4.4	1.15	4.2	3.5	4.9

Table 10.19. Continued

Centre	% completeness	Patients with data N	Mean	SD	Median	Lower quartile	Upper quartile
Hull	81	51	5.01	1.83	4.8	4.2	6
Ipswi	100	42	3.98	0.98	3.85	3.25	4.78
Kent	100	64	4.68	1.18	4.75	3.8	5.35
L Barts	99	164	4.62	1.16	4.4	3.9	5.3
L Guys	93	41	4.72	1.05	4.6	4	5.2
L Kings	100	68	4.42	0.75	4.4	3.9	4.9
L Rfree	98	63	4.37	0.97	4.3	3.6	4.9
L St.G	91	53	4.91	1.67	4.5	3.8	5.6
L West	100	31	4.68	0.96	4.7	4	5.3
Leeds	97	83	4.41	1.27	4.2	3.6	5
Leic	94	139	4.37	1.19	4.2	3.6	5
Liv Ain	0	0					
Liv RI	0	0					
M Hope	78	87	4.46	1.25	4.3	3.5	5.3
M RI	94	84	4.53	1.23	4.5	3.75	5
Middlbr	44	7					
Newc	100	48	4.42	1.24	4.2	3.45	5.3
Newry	100	12					
Norwch	91	50	4.85	1.26	4.8	4	5.9
Nottm	97	98	4.52	1.17	4.4	3.7	5.1
Oxford	87	81	4.59	1.17	4.6	3.7	5.3
Plymth	97	37	4.9	1.4	4.5	3.9	5.5
Ports	77	62	4.39	1.39	4.07	3.47	5.23
Prestn	97	63	4.31	0.97	4.35	3.78	4.86
Redng	99	72	4.67	1.38	4.4	3.75	5.4
Sheff	65	44	4.23	1.11	4.1	3.4	5
Shrew	93	25	5.02	1.31	4.9	4.3	5.7
Stevng	64	18					
Sthend	76	13					
Stoke ^a	100	69					
Sund	75	18					
Swanse	86	43	4.38	1.09	4.3	3.6	4.9
Truro	86	18					
Tyrone	64	7					
Ulster	100	2					
Wirral	62	16					
Wolve	95	38	4.4	1.1	4.1	3.5	5.3
Wrexm	95	21	4.4	1.1	4.2	3.6	5.3
York	93	14					
England	81	2,150	4.5	1.2	4.3	3.7	5.2
N Ireland	95	72	4.4	1.3	4.2	3.6	4.9
Wales	93	191	4.5	1.2	4.3	3.6	5.2
E, W & NI	82	2,370	5.1	1.4	4.9	4.2	5.9

Blank cells denote low patient numbers or poor data completeness

^aStoke excluded due to technical difficulties extracting data

Fig. 10.17. Median total cholesterol in haemodialysis patients by centre in 2009

Fig. 10.18. Median total cholesterol in peritoneal dialysis patients by centre in 2009

malnutrition) which may account for any inter-centre variation in addition to differences in prescription of lipid lowering medication and other therapies known to influence serum lipid concentration e.g. steroids, sevelamer etc.

Conflicts of interest: none

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