Chapter 9: Serum Calcium, Phosphate, Parathyroid Hormone, Albumin, Aluminium and Cholesterol Achievement on Replacement Therapy

Ed Lamb, Alex Hodsman, Dirk van Schalkwyk, David Ansell and Graham Warwick

Summary

- In the UK there is a continuing year-on-year trend towards improvement in serum phosphate control in dialysis patients although overall it still remains poor. The RA target (<1.8 mmol/L) was achieved in 65% of patients overall, (71% of PD patients, 63% of HD patients).

- Seventy-six percent of UK dialysis patients achieve a corrected calcium concentration within the RA target range. As with serum phosphate, there is a trend of continuing year-on-year improvement.

- Nearly two-thirds (69%) of patients achieve a calcium × phosphate product within the KDOQI guidelines (<4.4 $mmol^2/L^2$): again, achievement seems to have improved year-on-year. Control was better in PD patients compared to HD patients (73% versus 67% achieving the standard).

- There remains large between-centre variation in the ability of renal centres to achieve the UK Renal Association target for plasma PTH. As seen in previous years, overall achievement was poor (median 63%, range 47–92% compliance with the standard).

- Most transplant patients achieve good phosphate and calcium control (99%, range 95–100%) and the percentage of patients achieving serum calcium concentrations within the target range was 84% (range 43–97%). Nearly all (99%) of transplant patients achieved calcium × phosphate product concentrations within the KDOQI target range.

- There would appear to be wide variation in clinical practice with respect to aluminium monitoring with a suggestion that few centres are following current UK RA guidelines.

- Overall in the UK 83% of HD, 70% of PD and 62% of transplant patients achieve a total cholesterol concentration <5 mmol/L. The percentage of patients with cholesterol <5 mmol/L has increased significantly year-on-year in all three modalities.

Introduction

Disorders of mineral metabolism are a common complication of CKD. Bone disease is a significant cause of morbidity and there is increasingly convincing evidence that vascular calcification and the high rates of cardiovascular morbidity and mortality seen in patients with CKD may also be linked to abnormal mineral metabolism. In light of this, KDIGO have issued a consensus statement to provide a unifying classification of these abnormalities which is now termed CKD-MBD (CKD – Mineral and Bone disorder)[1].

There have now been several recent large observational cohort studies which have shown an association between hyperphosphataemia and increased mortality in dialysis patients[2,3,4]. However, there are no prospective trials showing that improving phosphate control prolongs survival. These observational studies have also shown some association with calcium concentrations and survival but this relationship is much less clearly defined.

The achievement of audit standards in this area is recognised to be poor worldwide. It remains poor overall in the UK although the UK is the first country to demonstrate a year on year improvement in serum phosphate[5].

Growing interest has stemmed from the introduction of new treatments which may aid in modifying markers of mineral metabolism and potentially prolong patient survival. The nature of any definite survival benefit from non-calcium containing phosphate binders, new vitamin D sterols[6] and calcimimetics remains to be defined with the results of the DCOR study of sevalamer versus calcium based phosphate binders proving negative. However, it seems likely that some or all of these newer therapeutic agents will lead to improved control of calcium phosphate balance and hopefully patient survival.

Methods

This chapter analyses the prevalent RRT cohort for 2005. The definition of the cohort is found in the appendix at the end of the chapter. The number preceding the centre name in each figure indicates the percentage of missing data for that centre. Data from Northern Ireland are included for the first time this year.

The Registry extracts quarterly data electronically from UK renal units. Quarterly values are extracted for the last two quarters for calcium and phosphate, the last three quarters for iPTH and the entire year for cholesterol and aluminium. Patients who do not have these data are excluded from the analyses. Patients are analysed both as a complete cohort and also divided by RRT modality into groups. Some analyses are also performed on a combined dialysis group. The completeness of data are analysed at unit and country level. All patients are included in analyses but units with less than 50% completeness are excluded from the caterpillar plots showing unit performance. Data are also excluded from plots when there are less than 20 patients with data both at unit and country level.

These data are analysed to calculate summary statistics (maximum, minimum, mean and median values in addition to standard deviation and quartile ranges). These data are represented as caterpillar plots showing median values and quartile ranges. Where applicable, the percentage achieving the Renal Association or other surrogate standard is also calculated and represented as caterpillar plots with 95% confidence intervals. For the percentage achieving standards, chi-squared testing is used to identify significant variability between centres. Longitudinal analysis has also been performed for some data to calculate overall changes in achievement of standards annually from 1998 to 2005.

Serum phosphate

The Renal Association Standard states:

> ***Serum phosphate (measured before a dialysis session in HD patients) should be below 1.8 mmol/L.***

The Renal Association sets no standard for the lower limit of serum phosphate in contrast to the KDOQI guidelines[7] which set a lower limit of 1.13 mmol/L: the KDOQI upper limit is 1.78 mmol/L, consistent with the Renal Association standard. The draft 4th edition of the Renal Association standards propose a lower limit of serum phosphate of 1.1 mmol/L.

Data completeness

The completeness of data by modality is shown in Table 9.1.

Achievement of serum phosphate

Serum phosphate control amongst dialysis patients remains poor with 65% of patients overall achieving the Renal Association standard. In general, the phosphate control is better on peritoneal dialysis (71% achieve the standard), compared to haemodialysis (63% achieve the standard) (Figures 9.1 and 9.2). Encouragingly the year-on-year improvement in phosphate control noted in previous *Registry* reports seems to have continued (Figure 9.3). The variation between units is wide (Figures 9.1 and 9.2). For both HD ($\chi^2 = 397$, $p < 0.001$) and PD ($\chi^2 = 102$, $p < 0.001$) modalities, the percentage of patients with a serum phosphate below 1.8 mmol/L differed significantly between centres. Amongst patients who had received a transplant, phosphate control was good (median 1.01 mmol/L, mean inter-quartile range 0.87 to 1.18 mmol/L, Figure 9.4) with all units achieving the target in at least 97% of patients. There was no evidence of significant variation between units ($\chi^2 = 61$, $p = 0.1395$).

Table 9.1: Data completeness by centre for serum phosphate

	HD	PD	Tx
Antrim	99	89	90
B Heart	96	100	83
B QEH	97	94	89
Bangor	96	100	0
Basldn	99	100	85
Belfast	94	94	96
Bradfd	100	100	92
Brightn	66	86	72
Bristol	100	100	98
Camb	69	100	94
Cardff	97	97	95
Carlis	93	100	86
Carsh	88	96	88
Chelms	99	97	56
Clwyd	92	92	100
Covnt	98	97	74
Derby	99	94	0
Dorset	100	97	64
Dudley	83	94	93
Exeter	99	100	92
Glouc	99	97	98
Hull	99	96	89
Ipswi	100	98	95
L Barts	0	0	0
L Guys	88	99	93
L H&CX	99	98	97
L Kings	100	100	93
L Rfree	93	97	72
Leeds	100	98	93
Leic	98	96	81
Livrpl	98	98	91
ManWst	81	89	84
Middlbr	98	100	96
Newc	100	98	97
Newry	99	93	70
Norwch	100	100	94
Nottm	99	100	88
Oxford	99	99	97
Plymth	99	97	92
Ports	99	88	83
Prestn	100	100	87
Redng	99	100	92
Sheff	99	99	98
Shrew	98	98	97
Stevng	93	100	67
Sthend	97	95	80
Sund	96	100	99
Swanse	97	99	98
Truro	99	100	94
Tyrone	98	100	59
Ulster	100	100	100
Wirral	7	0	n/a
Wolve	99	98	86
Wrexm	82	85	n/a
York	100	96	97
Eng	91	91	85
NI	96	93	88
Wls	95	96	96
UK	91	91	86

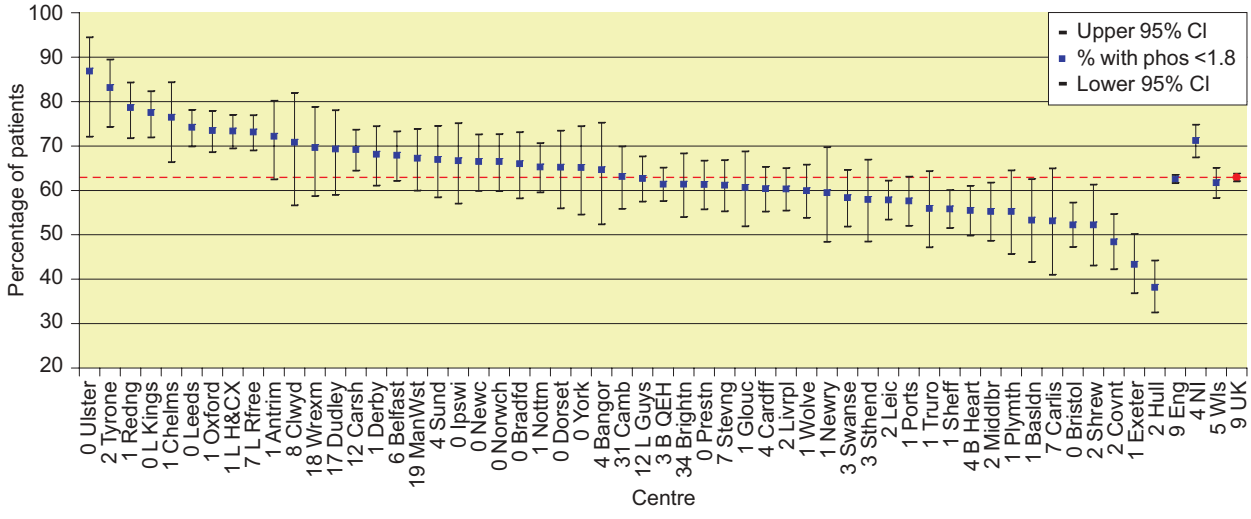

Figure 9.1: Percentage of HD patients with serum PO_4 <1.8 mmol/L

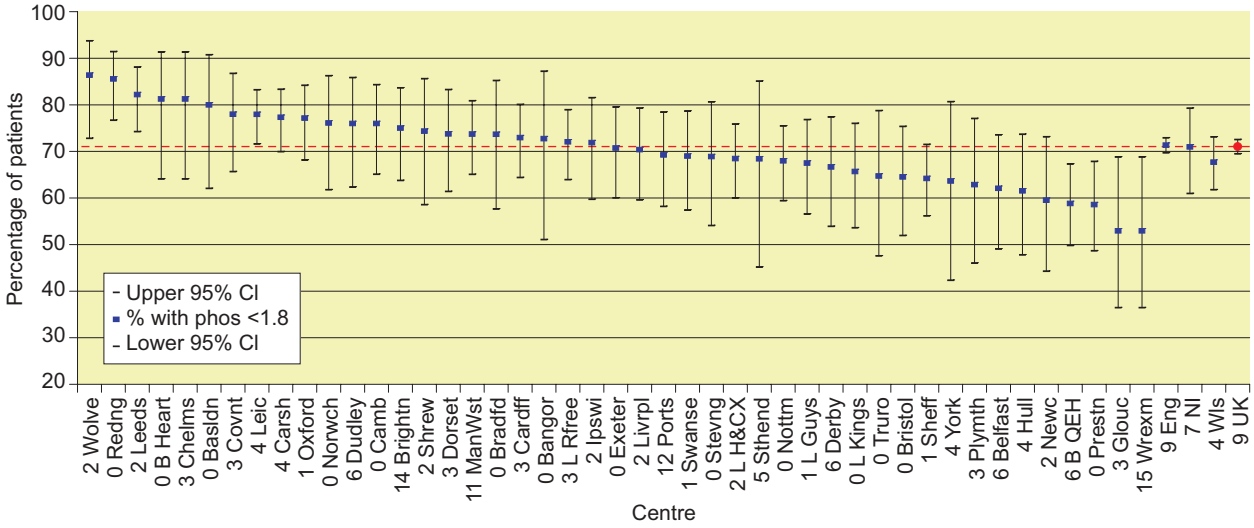

Figure 9.2: Percentage of PD patients with PO_4 <1.8 mmol/L

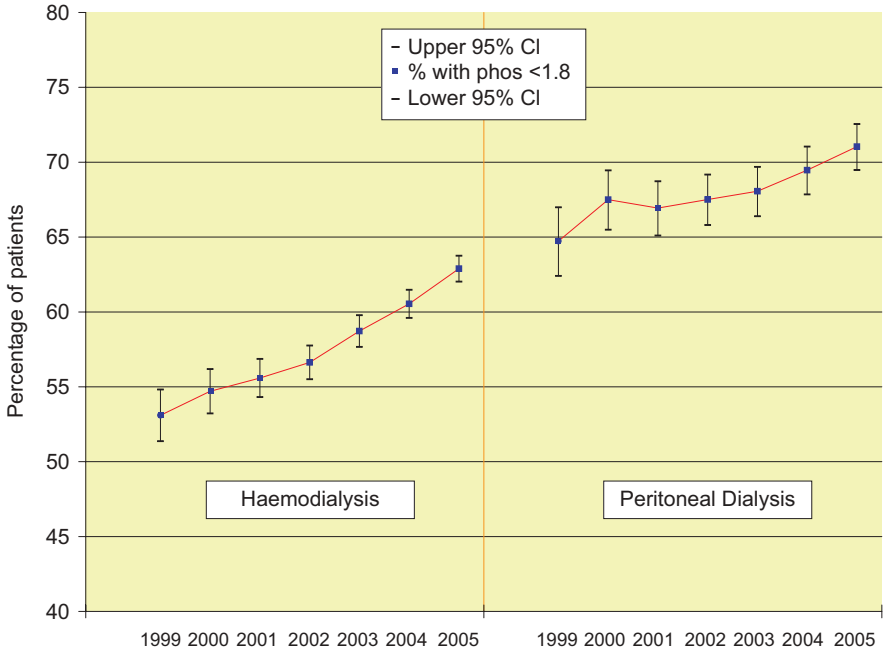

Figure 9.3: Change in percentage of patients achieving serum phosphate 1999–2005

Identification of outliers in achievement of serum phosphate

The Registry is currently exploring different methods of analysing and presenting performance data for achievement of RA standards. Use of a funnel plot helps to demonstrate centre performance against unit size (defined by number of patients) and prediction of outlier limits by plotting the threshold of 2 (95% limit) and 3 (99.8% limit) standard deviations (sd) from the UK mean. These limits correspond to p values of 0.05 and 0.002 respectively. This helps to identify renal units that are performing statistically 'better' or 'worse' than average. With 50 centres, one unit may each fall above and below the 2 sd line by chance, but none should fall outside the 3 sd line by chance.

This year for the first time, achievement of the phosphate standard in haemodialysis patients is presented using a funnel plot. This is an exploratory analysis into the usefulness of these data for renal units. Figure 9.5 shows that 8 units have 'better' than expected performance

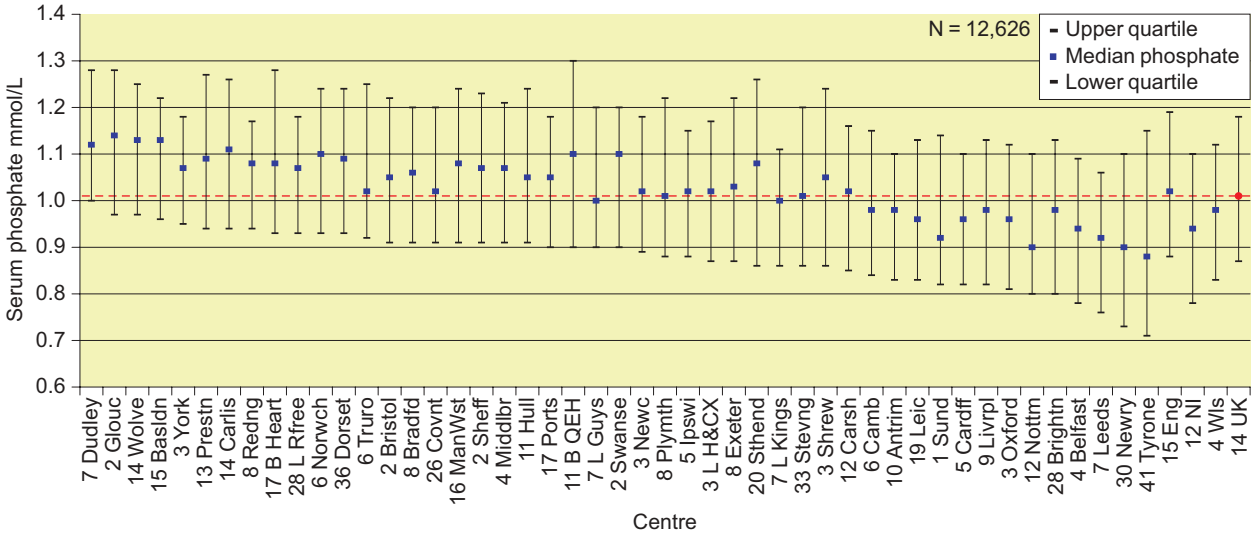

Figure 9.4: Median serum phosphate for transplant patients

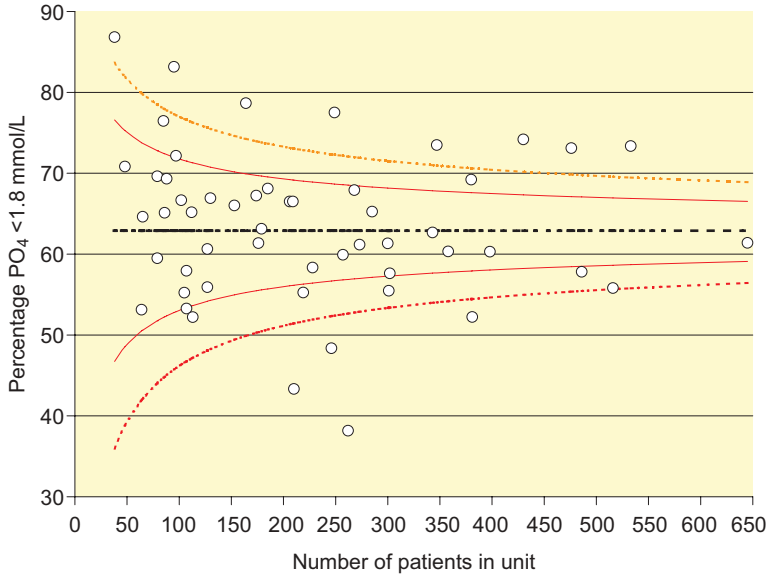

Figure 9.5: Funnel plot for percentage of HD patients with PO_4 <1.8 mmol/L

although there are also 4 units that have 'worse' than expected performance against the line of 3 sd.

In last years report the UKRR demonstrated that older patients have a better achievement of the phosphate standard (Report 2005 Chapter 13), so a part of the demonstrated variation in Figure 9.5, may be accounted for by the difference in the median age of patients as these data are unadjusted for age. Table 9.2 can be used to assist individual units to identify themselves by cross-referencing unit size (X axis) with the percentage of patients with phosphate <1.8 mmol/L (Y axis) in Figure 9.5.

These data should help exploration and promote discussion of the reasons for differences in these outlying units. Although these differences are statistically significant, it should be stressed that it cannot be automatically assumed that this means they are clinically important.

Table 9.2: Percentage of HD patients achieving PO_4 <1.8 mmol/L by unit for 2005

Treatment centre	Total	% in RA ref range	Treatment centre	Total	% in RA ref range
Antrim	97	72	L Rfree	476	73
B Heart	301	55	Leeds	430	74
B QEH	645	61	Leic	486	58
Bangor	65	65	Livrpl	398	60
Basldn	107	53	ManWst	174	67
Belfast	268	68	Middlbr	219	55
Bradfd	153	66	Newc	209	67
Brightn	176	61	Newry	79	59
Bristol	381	52	Norwch	206	65
Camb	179	63	Oxford	347	73
Cardff	358	60	Plymth	105	55
Carlis	64	53	Ports	302	58
Carsh	380	69	Prestn	300	61
Chelms	85	76	Redng	164	79
Clwyd	48	71	Sheff	516	56
Covnt	246	48	Shrew	113	52
Derby	185	68	Stevng	273	61
Dorset	112	65	Sthend	107	58
Dudley	88	69	Sund	130	67
Exeter	210	43	Swanse	228	58
Glouc	127	61	Truro	127	56
Hull	262	38	Tyrone	95	83
Ipswi	102	67	Ulster	38	87
L Guys	343	63	Wolve	257	60
L H&CX	533	73	Wrexm	79	70
L Kings	249	78	York	86	65

Serum calcium

The Renal Association Standard states:

> ***Serum calcium, adjusted for albumin concentration, should be between 2.2 and 2.6 mmol/L, in HD (pre-dialysis sample) and in PD patients.***

Comparative audit in this area remains difficult, due to differences in analytical methods between units (and even between satellite units managed by one clinical team), different mathematical methods being applied to correct serum calcium for serum albumin concentration and different methods in analysing serum albumin (see the Registry reports 1999–2003). However, as discussed in previous Registry reports, since nephrologists in each unit will be making clinical decisions based on their local corrected calcium results, these data are in some sense the most valid and this data has been chosen for illustration. Some units provide data already corrected for albumin concentration and these are analysed directly; uncorrected calcium data provided by some units is corrected using a formula in widespread use[8]:

$$\text{Corrected calcium} = \text{uncorrected calcium} + [(40 - \text{albumin}) \times 0.02]$$

Data completeness

The completeness of data by modality is shown in Table 9.3.

Achievement of serum calcium

The median corrected calcium is 2.3 mmol/L (mean inter-quartile range 2.26 to 2.49 mmol/L) for HD patients and 2.40 mmol/L for PD patients (mean inter-quartile range 2.30 to 2.51 mmol/L) with 76% of dialysis patients (75% HD and 79% PD) achieving a concentration within the Renal Association target range (Figure 9.6). There has been a general trend towards improved performance over the period

Table 9.3: Data completeness by centre for corrected calcium

	HD	PD	Tx		HD	PD	Tx
Antrim	99	89	90	Livrpl	98	98	91
B Heart	96	100	84	ManWst	82	89	84
B QEH	97	94	90	Middlbr	98	100	96
Bangor	96	100	n/a	Newc	100	100	97
Basldn	99	100	92	Newry	99	93	70
Belfast	94	94	95	Norwch	100	100	94
Bradfd	100	100	97	Nottm	99	100	88
Brightn	66	85	72	Oxford	99	99	97
Bristol	100	100	98	Plymth	99	100	94
Camb	69	100	94	Ports	99	88	89
Cardff	97	97	96	Prestn	100	100	89
Carlis	93	100	91	Redng	99	100	93
Carsh	88	96	89	Sheff	99	99	98
Chelms	99	97	67	Shrew	98	98	97
Clwyd	92	92	100	Stevng	93	100	66
Covnt	98	97	83	Sthend	97	95	83
Derby	99	94	n/a	Sund	96	100	99
Dorset	99	98	95	Swanse	97	99	98
Dudley	83	94	93	Truro	99	100	94
Exeter	99	100	92	Tyrone	98	100	59
Glouc	99	97	99	Ulster	100	100	100
Hull	99	96	89	Wirral	7	n/a	n/a
Ipswi	100	98	95	Wolve	99	100	96
L Barts	0	0	0	Wrexm	82	85	0
L Guys	88	99	93	York	95	100	59
L H&CX	99	98	97	Eng	91	91	86
L Kings	100	100	94	NI	96	93	88
L Rfree	93	97	72	Wls	95	96	96
Leeds	98	98	92	UK	91	91	87
Leic	98	96	81				

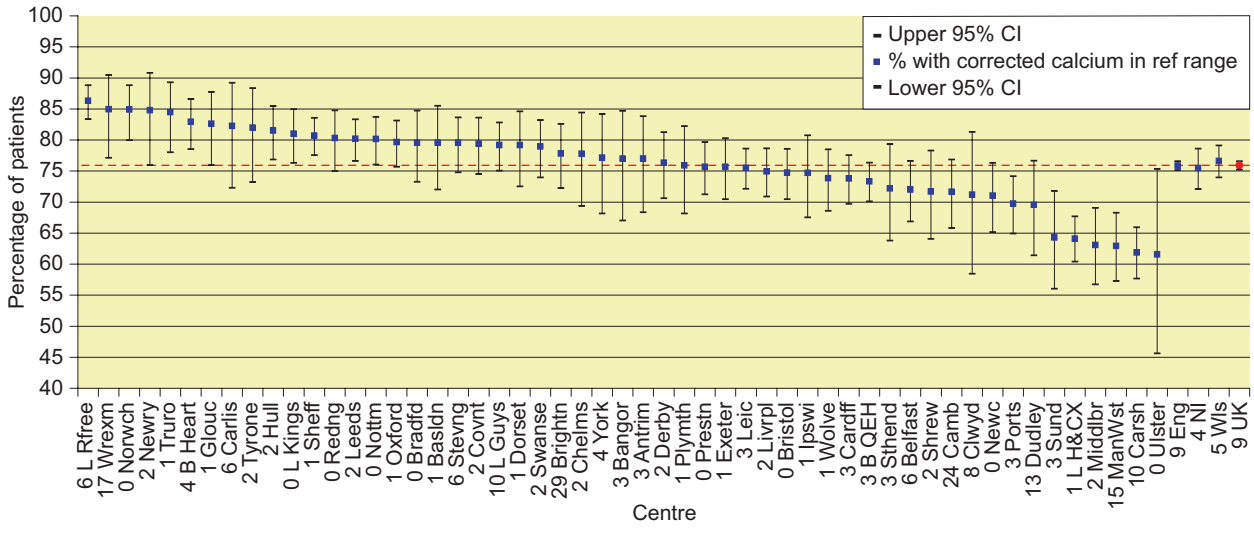

Figure 9.6: Percentage of dialysis patients with corrected calcium within 2.2–2.6 mmol/L

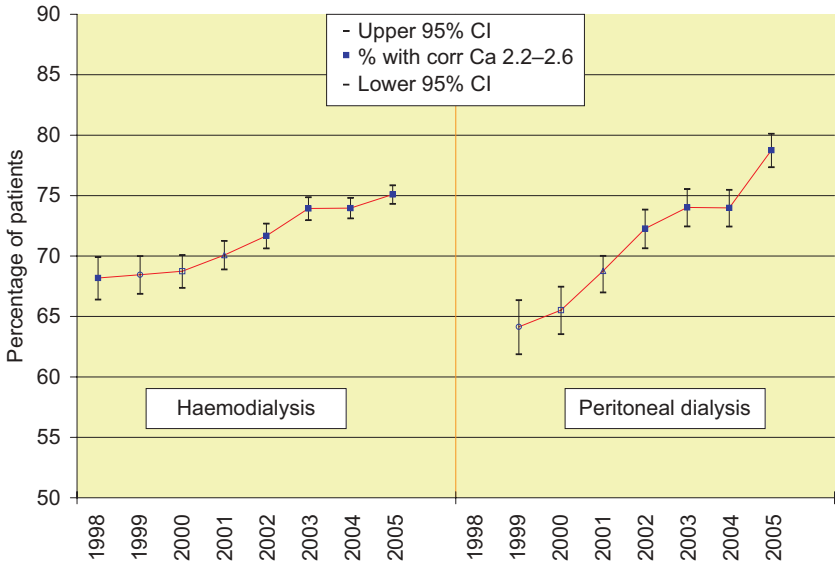

Figure 9.7: Change in percentage of patients achieving serum corrected Ca 2.2–2.6 mmol/L, 1998–2005

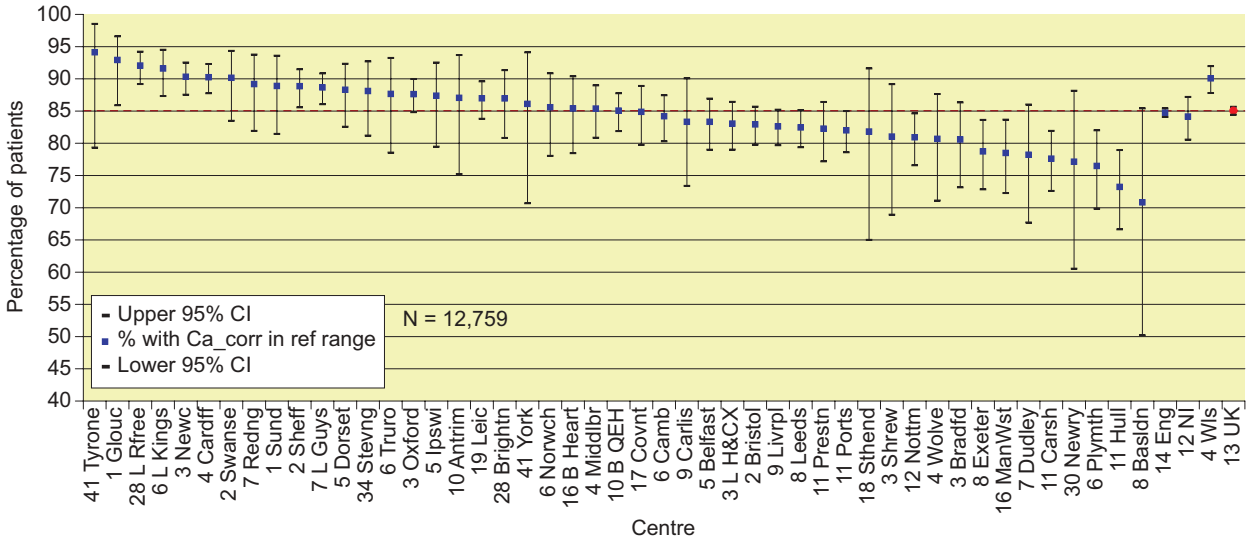

Figure 9.8: Percentage of patients with corrected calcium 2.2–2.6 mmol/L: transplant

1998–2005 with a quite marked improvement in the PD population in particular in the last year (Figure 9.7). The variation between units is wide: for both HD ($\chi^2 = 299$, $p < 0.0001$) and PD ($\chi^2 = 96$, $p = 0.0002$) modalities, the percentage of patients with serum corrected calcium within the RA target range differed significantly between centres.

Achievement of the calcium target amongst patients who had received a transplant was better than that amongst dialysis patients, with 85% of transplant patients achieving corrected calcium concentrations within the target range (Figures 9.8 and 9.9). The percentage of transplant patients with a serum corrected calcium within the RA target range differed significantly between centres ($\chi^2 = 191$, $p < 0.0001$).

Serum calcium × phosphate product

The Renal Association has no standard for the serum calcium × phosphate product.

The Renal Association currently has no standard for the serum calcium × phosphate product, but the draft 4th edition of the Renal Association guidelines recommends that the product should be less than 4.8 $mmol^2/L^2$. The KDOQI guidelines recommend the product should be less than 4.4 $mmol^2/L^2$ (= 55 mg^2/dl^2). Two thirds (69%) of patients achieve this but the range of 49–84% between units remains wide (Figure 9.10). Control is better on PD, with 73% (range 47–89%) of patients achieving the standard when compared with 67% of

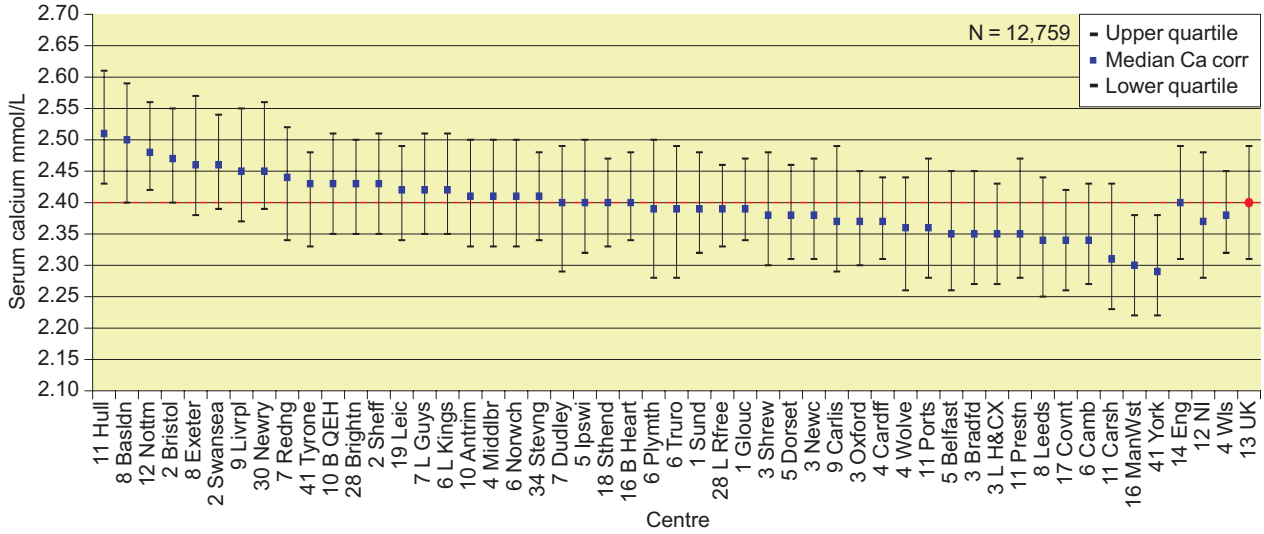

Figure 9.9: Median serum corrected calcium concentration: transplant

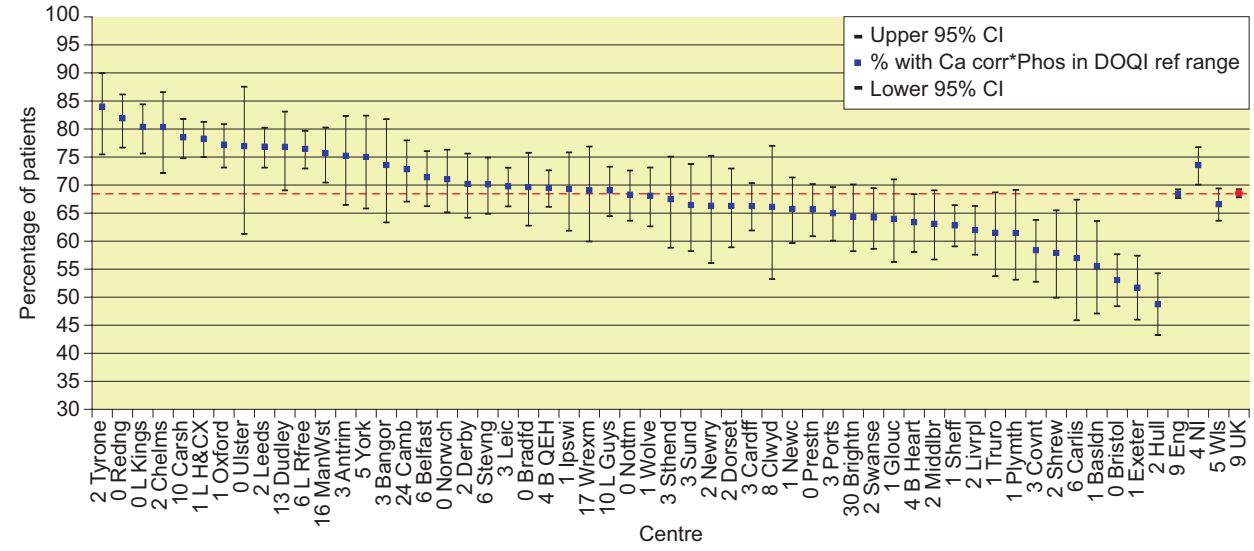

Figure 9.10: Percentage achieving KDOQI Ca × PO_4 target: dialysis

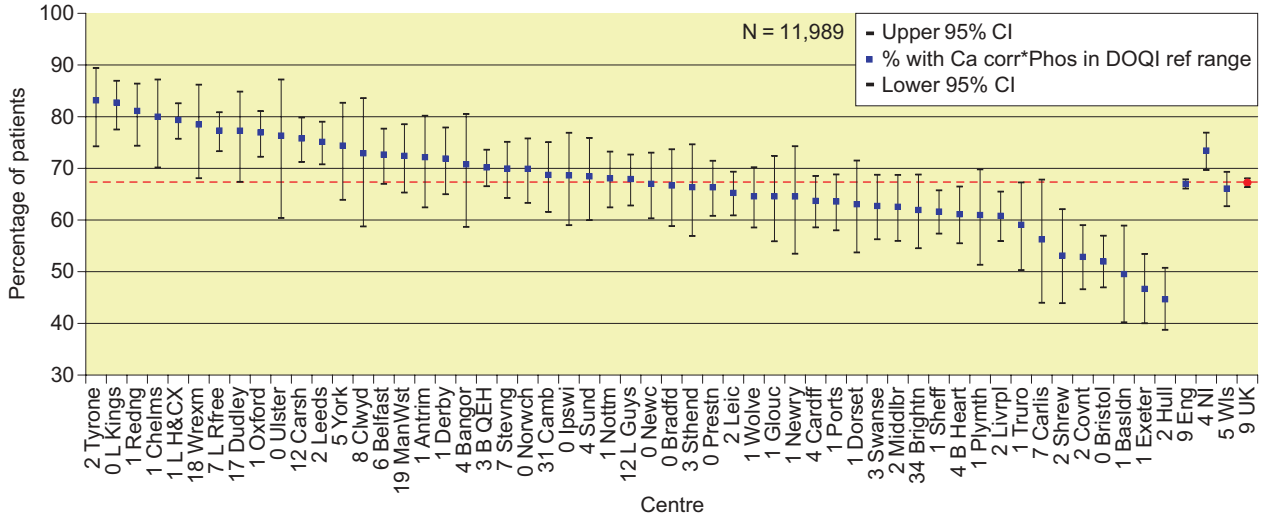

Figure 9.11: Percentage of patients achieving Ca × PO_4 target: HD

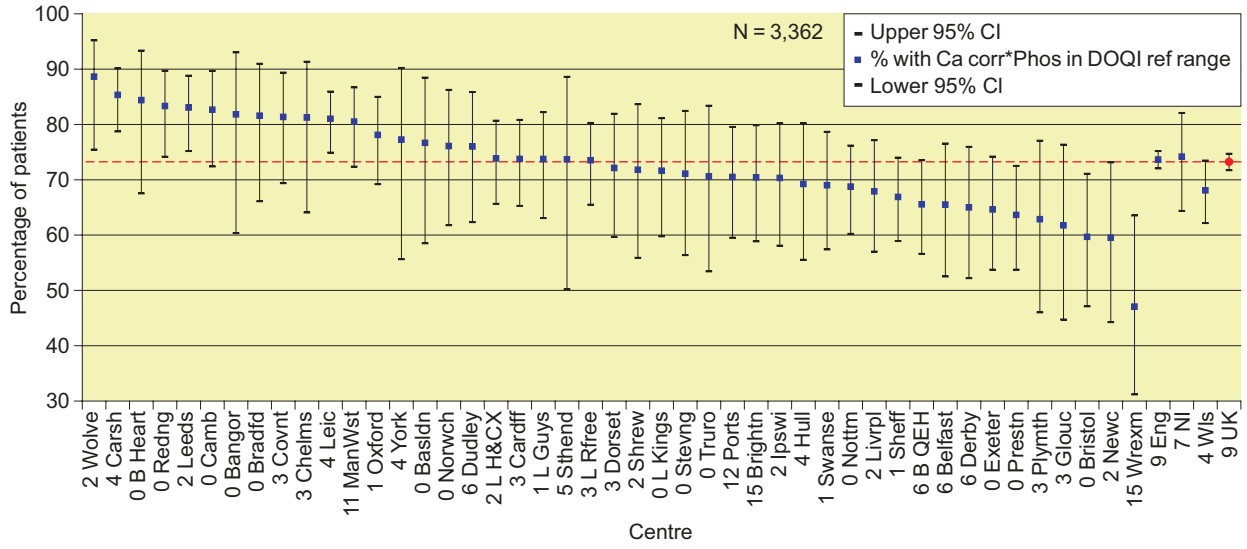

Figure 9.12: Percentage of patients achieving KDOQI for Ca × PO_4: PD

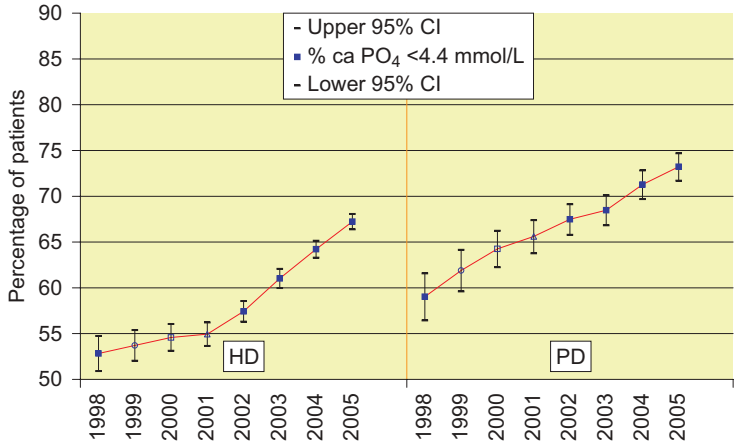

Figure 9.13: Change in percentage of patients achieving KDOQI target for Ca × PO_4 target 1998–2005

patients on HD (range 45–83%) and this is shown in Figures 9.11 and 9.12. The variation between units was significant for both HD ($\chi^2 = 417$, $p < 0.001$) and PD ($\chi^2 = 120$, $p < 0.001$) modalities. There is evidence of a year-on-year improvement in attainment of this standard (Figure 9.13).

Serum parathyroid hormone

The Renal Association Standard states:

> ***Parathyroid hormone (PTH) concentration should be less than four times the upper limit of normal of the assay used in patients being managed for chronic renal failure or after transplantation and in patients who have been on HD or PD for longer than three months.***

Comparison of serum PTH values from different units is difficult due to the variety of methods and reference ranges in use. To enable some form of comparative audit, the Registry has expressed all results in pmol/L, and chosen an upper limit of four times the median upper lab value: this equates to 32 pmol/L. This is also similar to the upper limit of the KDOQI guidelines (31 pmol/L). In the UK, no lower limit for PTH is specified although KDOQI recommends a limit of 15 pmol/L.

Data completeness

The completeness of data by modality is shown in Table 9.4.

Achievement of serum iPTH

The median PTH for all dialysis patients was 22 pmol/L although the range of medians was

Table 9.4: Data completeness by centre for PTH

	HD	PD	Tx		HD	PD	Tx
Antrim	98	78	12	Livrpl	86	94	45
B Heart	85	84	30	ManWst	78	86	75
B QEH	68	79	51	Middlbr	93	93	9
Bangor	93	95	100	Newc	97	93	34
Basldn	99	100	46	Newry	86	93	16
Belfast	91	85	20	Norwch	97	87	14
Bradfd	97	95	34	Nottm	99	96	71
Brightn	49	74	19	Oxford	88	89	36
Bristol	98	94	81	Plymth	75	47	18
Camb	63	97	28	Ports	96	44	9
Cardff	84	96	19	Prestn	98	99	40
Carlis	90	100	15	Redng	95	98	50
Carsh	64	71	13	Sheff	96	85	10
Chelms	95	85	11	Shrew	96	95	28
Clwyd	90	75	29	Stevng	94	96	29
Covnt	83	74	21	Sthend	94	75	13
Derby	0	0	0	Sund	97	100	99
Dorset	92	89	27	Swanse	96	93	31
Dudley	23	38	15	Truro	99	100	45
Exeter	96	98	23	Tyrone	92	40	9
Glouc	95	89	26	Ulster	97	100	50
Hull	90	76	28	Wirral	1	0	n/a
Ipswi	93	97	29	Wolve	98	100	77
L Barts	0	0	0	Wrexm	60	63	n/a
L Guys	84	98	33	York	99	96	36
L H&CX	57	97	56	Eng	76	75	32
L Kings	90	84	10	NI	92	83	17
L Rfree	0	1	0	Wls	86	89	21
Leeds	99	98	22	UK	77	76	31
Leic	93	79	37				

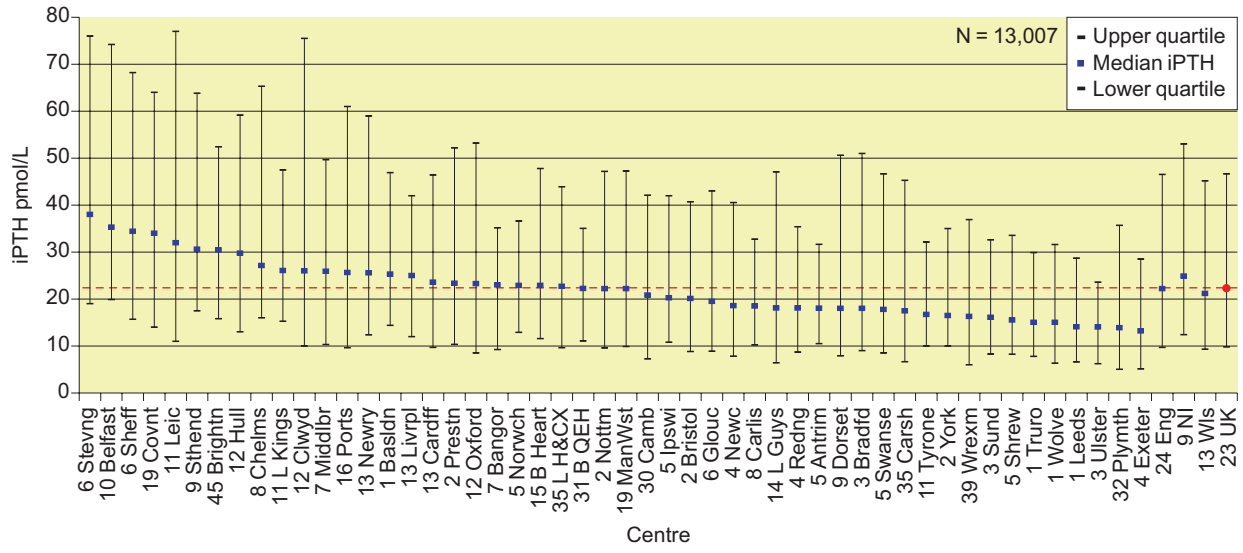

Figure 9.14: Median PTH: dialysis

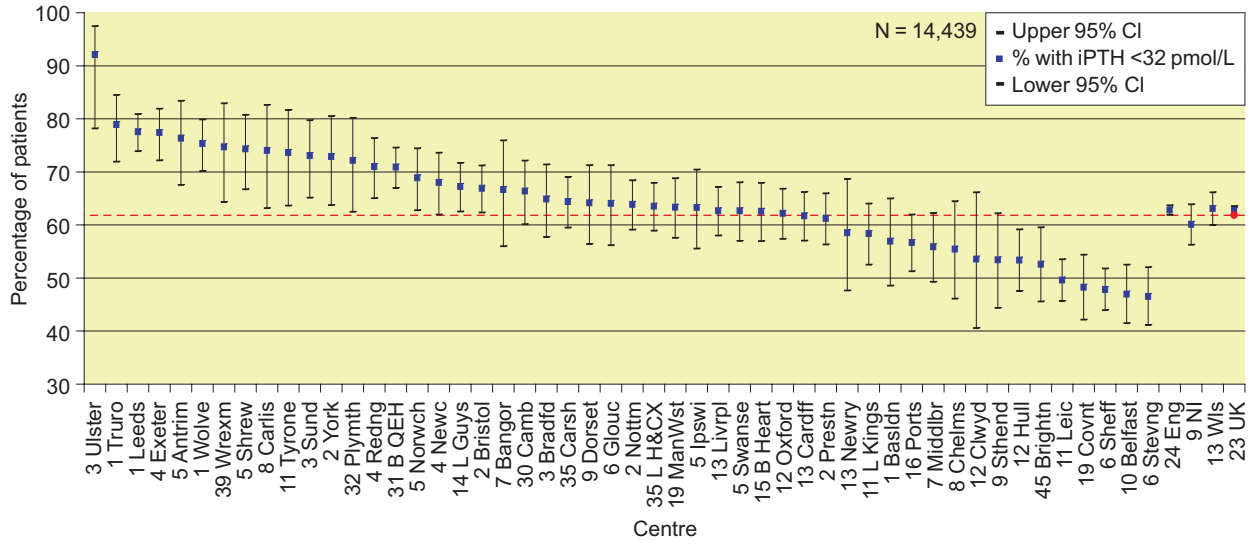

Figure 9.15: Percentage with iPTH <32 pmol/L: dialysis

wide (13 to 38 pmol/L), with four centres achieving a median concentration above the upper limit set for all patients which indicates that fewer than 50% of patients were within target (Figure 9.14). Median PTH appeared to be slightly higher overall amongst PD (25, inter-quartile range 12–47, range of medians 15 to 48 pmol/L) patients compared to HD (22, inter-quartile range 10–47, range of medians 13 to 38 pmol/L) patients. Overall, 63% of dialysis patients (61% PD; 63% HD) achieved the RA standard, but the spread of data was remarkable, ranging from 47 to 92% compliance with the standard (Figure 9.15). This analysis is almost certainly compromised by the wide variations in analytical recovery of PTH in commercial assays and also the lack of security around the reference limits that laboratories have selected as being appropriate for their assays[9]. Laboratory standardisation of these measurements remains under discussion.

Albumin

The RA has no standard for the serum albumin.

The RA Standards document recognises the importance of serum albumin as a marker of outcome, but does not recommend setting an audit standard for serum albumin, predominantly due to lack of standardisation of albumin assays between laboratories. Serum albumin concentration is influenced significantly by the dye used in the assay method; either bromocresol green (BCG) or bromocresol purple (BCP) and has been discussed at length in previous reports.

For the Registry report in previous years, centres have been separated by methodology of albumin measurements. This year data was analysed on quarterly median albumin by each HD satellite unit or main unit (n = 181 centres), over a 7 year period. Except where albumin methodologies were changed, median albumin results remained unchanged over time to within 1 g/L. As there would have been a large shift in patients over this time period, this probably indicates that differences between centres in median albumin are accounted for by laboratory methodologies.

In the 2005 Report Chapter 10, it was commented on that continued presentation of albumin achievement data in the Registry annual report was of limited value. Unless there were strong calls from the renal community with an opposing viewpoint, these data would not be published in the following years report. For this reason the data on median albumin by centre are not shown.

The Registry continues to collect individual patient data on albumin which will be incorporated in analyses of patient outcome, as 'within patient' fall in serum albumin remains an important surrogate marker of patient survival.

Aluminium

The Renal Association Standard states:

> ***Serum aluminium concentration should be measured every three months in all patients on HD and in all PD patients receiving oral aluminium hydroxide.***

During 2005 the Registry received aluminium data from 13,168 HD samples and 3,690 PD samples. Overall, 36% of HD patients and 9% of PD patients (compared to 39% of HD patients and 15% of PD patients in 2004) had a serum aluminium concentration checked once during the year. However, there was enormous variation in reported compliance with this standard with 15 centres reporting no aluminium data for HD patients and a further 13 centres reporting data in <10% of their patients. Amongst PD patients, 30 centres reported no aluminium data and a further 12 centres, data in <10% of their patients.

It is possible that the Registry is not capturing all of the aluminium monitoring that is taking place, not least because aluminium measurement is not generally available in local laboratories and there may therefore be practical limitations in respect of data transmission back to the renal unit database. However, it also seems probable that many renal centres have abandoned routine monitoring of aluminium in dialysis patients or have at least deviated from the RA standard recommendations in terms of frequency of testing. Generally it is acknowledged that aluminium-related bone disease is a diminishing problem and water treatment facilities in HD units are tested on a monthly basis for aluminium. The KDOQI guidelines are slightly less stringent than the RA guidelines, with the recommendation that serum aluminium should be measured at least yearly and every three months in patients receiving aluminium-containing medications[7]. The draft 4th Edition of the RA guidelines advises limiting serum aluminium concentration monitoring to patients receiving oral aluminium hydroxide.

Cholesterol

The Renal Association Standard states:

> ***Primary prevention:***
> ***Statins should be considered in dialysis patients with a 10-year risk of coronary disease >30% to achieve a total cholesterol concentration <5 mmol/L or a 30% reduction from baseline.***
>
> ***Secondary prevention:***
> ***In patients in whom lipid-lowering drug treatment is used, total cholesterol should be reduced by 30% or to below 5 mmol/L, whichever reduction is the greater.***

Data completeness

The completeness of data by modality is shown in Table 9.5.

Achievement of serum cholesterol

The Registry collects serum total cholesterol data, audited against a target concentration of 5 mmol/L. New data items added to the quarterly Registry extraction downloads from renal systems include HDL cholesterol and use of 'statins'. These new data items will greatly enhance the interpretation of the cholesterol data.

Amongst HD patients the median serum cholesterol was 3.9 mmol/L (inter-quartile range 3.3–4.6 mmol/L) and 83% of patients achieved the target of <5 mmol/L, although this ranged between units from 71% to 92% (Figure 9.16). Amongst PD patients the median serum cholesterol was 4.4 mmol/L (inter-quartile range 3.7–5.1 mmol/L) and 70% of patients achieved the target of <5 mmol/L, although this ranged between units from 54% to 89% (Figure 9.17). Amongst transplant recipients the median serum cholesterol was 4.7 mmol/L (inter-quartile range 4.1–5.3 mmol/L) and 62% of patients achieved the target of <5 mmol/L, although this ranged between units from 38% to 80% (Figure 9.18).

Chi-square testing indicates that the difference between centres for all three treatment modalities is significant ($p < 0.0001$). As in previous years, cholesterol concentrations are lower in HD patients than PD patients and higher in transplant patients than in dialysis patients (Figure 9.19).

Table 9.5: Percentage of patients with complete returns of cholesterol values by modality

	HD	PD	Tx		HD	PD	Tx
Antrim	98	83	55	Livrpl	15	0	23
B Heart	43	94	55	ManWst	77	83	87
B QEH	96	97	92	Middlbr	98	100	79
Bangor	79	100	100	Newc	95	98	98
Basldn	99	100	96	Newry	99	93	80
Belfast	91	95	97	Norwch	100	100	94
Bradfd	87	97	95	Nottm	97	95	84
Brightn	31	58	42	Oxford	91	89	77
Bristol	92	84	95	Plymth	92	89	96
Camb	63	100	90	Ports	65	44	64
Cardff	82	98	88	Prestn	100	98	86
Carlis	88	100	95	Redng	95	97	97
Carsh	73	72	56	Sheff	93	72	97
Chelms	66	82	44	Shrew	98	100	75
Clwyd	54	33	100	Stevng	47	78	63
Covnt	2	2	1	Sthend	95	90	85
Derby	67	25	0	Sund	96	100	99
Dorset	92	94	91	Swanse	96	99	99
Dudley	29	68	63	Truro	97	100	63
Exeter	95	84	92	Tyrone	98	100	59
Glouc	94	91	74	Ulster	100	100	100
Hull	87	48	66	Wirral	0	0	n/a
Ipswi	90	95	93	Wolve	92	87	90
L Barts	0	0	1	Wrexm	76	75	0
L Guys	93	100	93	York	85	96	89
L H&CX	99	98	98	Eng	76	76	75
L Kings	94	94	90	NI	95	93	86
L Rfree	89	94	66	Wls	83	92	90
Leeds	86	86	94	UK	77	78	76
Leic	81	92	83				

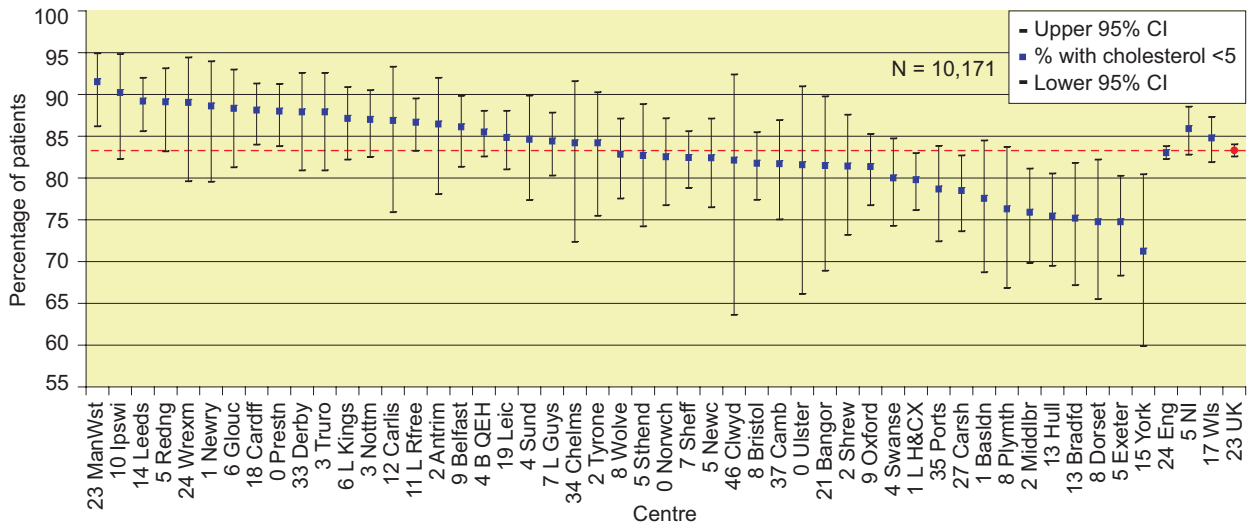

Figure 9.16: Percentage of patients with cholesterol <5: HD

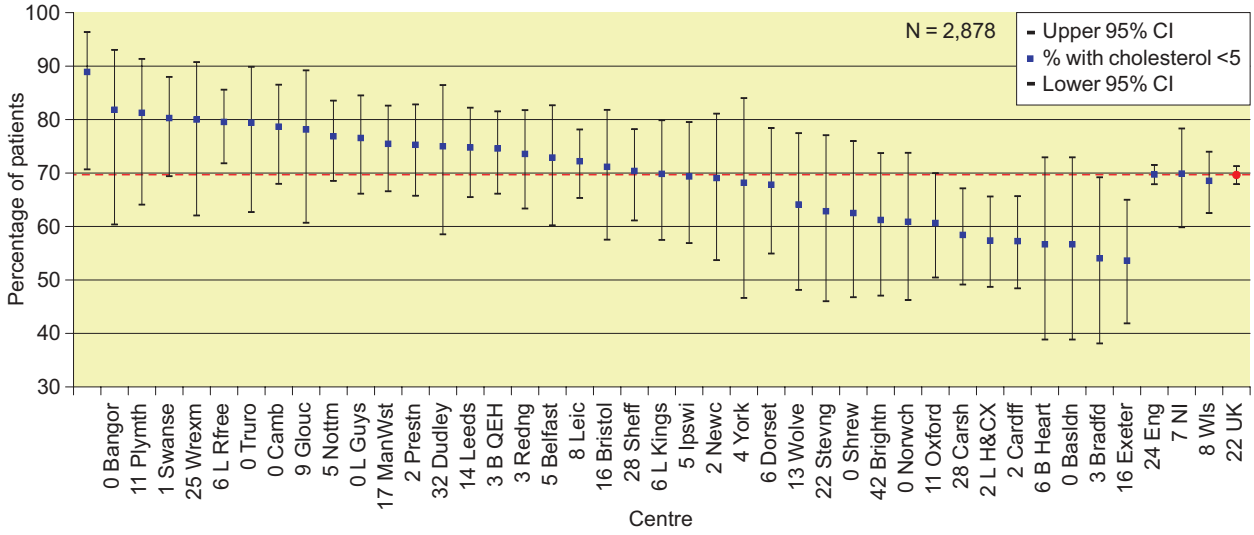

Figure 9.17: Percentage of patients with cholesterol <5: PD

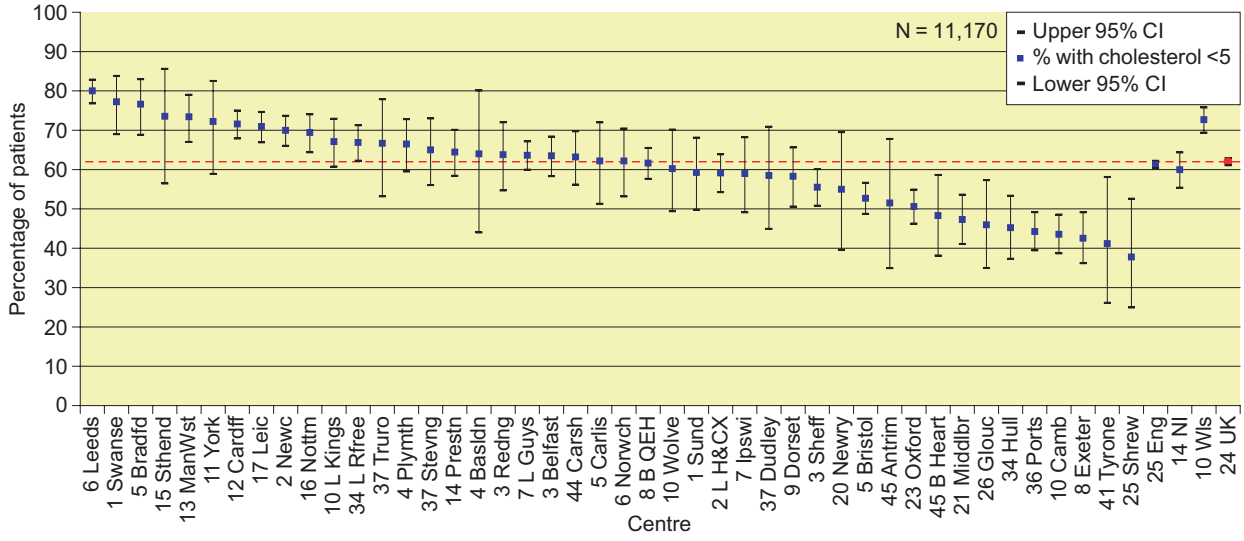

Figure 9.18: Percentage of patients with cholesterol <5: Tx

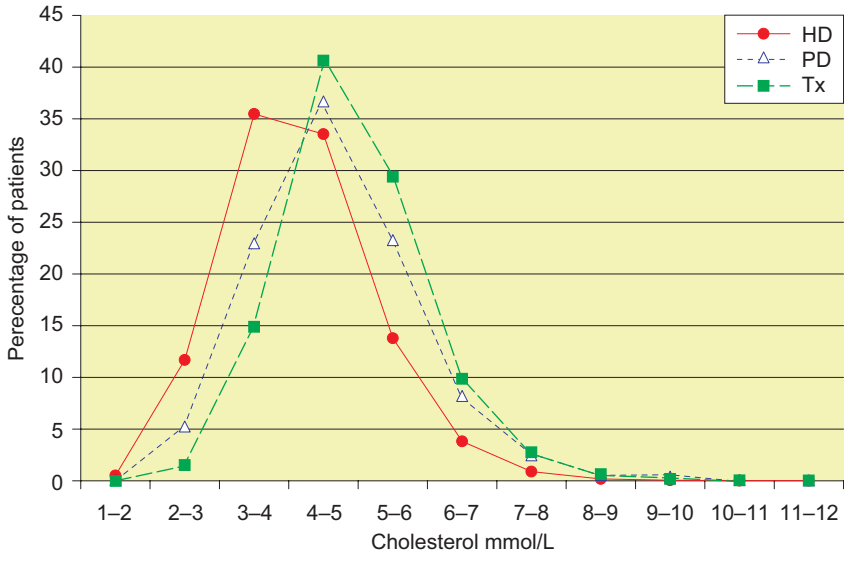

Figure 9.19: Distribution of serum cholesterol by modality

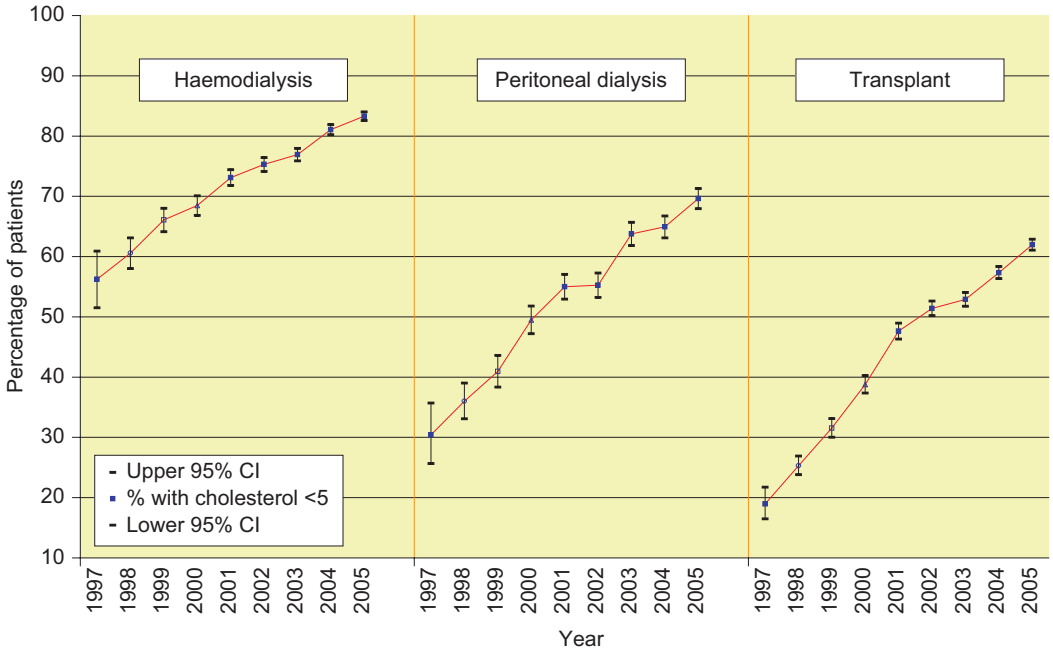

Figure 9.20: Percentage of patients with cholesterol <5 by modality 1997–2005

In all three treatment modalities there have been marked year-on-year improvements in the percentage of patients achieving the target concentration (Figure 9.20). As discussed above, the Registry does not currently collect prescribing data to enable this to be linked to a lipid-lowering treatment effect and these data are confounded by the known associations between chronic disease, inflammation, malnutrition and hypocholesterolaemia. Likewise, higher cholesterol concentrations in transplant recipients may reflect improved appetite or the hypercholesterolaemic influence of steroids, calcineurin inhibitors and sirolimus.

References

1. Moe S, Dreuke T, Cummingham J, Goodman W, Martin K, Olgaard K, Ott S, Sprague S, Lamiere N, Eknoyan G. Kidney Disease: Improving Global Outcomes. Definition, evaluation and classification of Renal Osteodystrophy. A position statement from Kidney Disease; Improving Global Outcomes www.kdigo.org. *Kidney Int* 2006;69:1945–53.
2. Block GA, Klassen PS, Lazurus JM, Ofsthun N, Lowrie EG, Chertow GM. Mineral metabolism, mortality and morbidity in maintenance haemodialysis. *J Am Soc Nephrol* 2004;15:2208–18.
3. Kalantar-Zadeh K, Kuwae N, Regidor GL, Kovesdy CP, Kilpatrick RD, Shinaberger CS, McAllister CJ, Budoff MJ, Salusky IB, Kopple JD. Survival predictability of time-varying indicators of bone disease in maintenance haemodialysis patients. *Kidney Int* 2006; 70:771–80.
4. Stevens LA, Djurdjev O, Cardew S, Cameron EC, Levin A. Calcium, Phosphate and parathyroid hormone levels in combination and as a function of dialysis duration predict mortality: Evidence for the complexity of the association between mineral metabolism and outcomes. *J Am Soc Nephrol* 2004;15: 770–9.
5. UK Renal Registry Report 2005. UK Renal Registry, Bristol, UK. Editors: D Ansell, T Feest, A Williams, C Winearls.
6. Teng M, Wolf M, Lowrie E, Ofsthun N. Survival of patients undergoing haemodialysis with paracalcitol or calcitriol therapy. *N Engl J Med* 2003;349:446.
7. Eknoyan G, Levin A, Levin NW. K/DOQI Clinical practice guidelines for bone metabolism and disease in chronic kidney disease. *Am J Kidney Dis* 2003;42: (suppl.3):1–201.
8. Ansell D, Feest TG. The Third Annual Report of the UK Renal Registry. 2000, Bristol, UK. 2000.
9. Sturgeon CM, Ellis AR, Al-Sadie R. UK NEQAS [Edinburgh], Annual Review 2005. [Report available on request from UK NEQAS (Edinburgh).]

Appendix for definition of prevalent cohort for biochemistry chapter

Definition of prevalent cohort

- Prevalent patients are defined as all patients (including the incident cohort for that year) alive on 31st December for that year
- Dataset called **Qtreat**

Qtreat

- Usual UKRR checking programs run on dataset
- Exclusion criteria applied to create dataset **Qtemp**

Exclusion criteria are:

- Patients who had died before the first day of the quarter
- Patients on dialysis with a treatment centre of elsewhere (not identified)
- Patients receiving treatment at a non-Registry site
- Patients with no date of starting ERF treatment
- Patients who had been receiving treatment for a negative number of days i.e. incorrect starting dates or incorrect patient number on data sent in
- Patients who had recovered before the start of the quarter
- Where data on a patient are submitted from more than one centre, only data from the primary centre are used

Qtemp

- Further exclusion criteria applied to Qtemp to create dataset called **Quarter**

Exclusion criteria are:

- Patients who have transferred out of the centre (qhcent) by the end of the quarter
- Patients who had not yet transferred in to the centre (qhcent) by the end of the quarter
- Patients who had recovered by the end of the quarter
- Patients who had stopped treatment by the end of the quarter
- Patients who had died by the end of the quarter
- Patients who were lost to follow up by the end of the quarter

Quarter

- Further exclusion criteria applied to quarter to create dataset called **Bichem**

Exclusion criteria are:

- Patients who had been on ERF treatment for $\leqslant$90 days at the end of the quarter
- Patients who changed treatment modality in the quarter
- Patients who transferred into the centre (qhcent) at some time in the quarter