

CHAPTER 9

**CHRONIC KIDNEY DISEASE-
MINERAL AND BONE DISORDERS**

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SECTION 9.1: TREATMENT OF RENAL BONE DISEASE

Calcium carbonate remained the main phosphate binder for both HD patients (91%) and PD patients (88%) over the last decade. The percentage of patients on aluminium based phosphate binder has decreased steadily to a minimal number for both HD and PD patients from 2.8% and 0.6% in 2001 to 0.14% and 0.10% in 2010 respectively. On the other hand, the use of lanthanum as phosphate binder has increased very slowly from 0.13% and 0.18% in 2006 to 1.92% and 2.42% in 2010 for both HD and PD patients since its introduction into Malaysia in 2006. There was a slightly higher percentage of PD patients taking lanthanum compared to HD patients. Calcitriol remained the main Vitamin D used in treatment of renal bone disease for both HD and PD patients. The percentage of patients on calcitriol therapy has increased in both HD and PD patients since 2001. The use of Paricalcitol has also increased slowly among HD patients from 0.29% in 2006 to 0.79% in 2010 but its usage has reduced in PD patients from 0.21% in 2006 to 0.10% in 2010. The number of patients underwent parathyroidectomy has shown a downward trend since 2006 in both HD and PD patients from 1.3% and 0.97% in 2006 to 0.87% and 0.29% in 2010 respectively. More HD patients underwent parathyroidectomy compared to PD patients. (Tables 9.1.1 and 9.1.2)

Table 9.1.1 Treatment for renal bone disease, HD patients, 2001-2010

Year	Number of patients	Number of patients On CaCO ₃	% on CaCO ₃	Number on patients on Al(OH) ₃	Number of patients on Lanthanum	Number of patients on calcitriol	% on calcitriol	Number of patients on Paricalcitol	Number of patients had Parathyroidectomy
2001	5194	4810	93	145	0	1145	22	0	0
2002	6108	5536	91	171	0	1375	23	0	0
2003	7018	6425	92	118	0	1690	24	0	0
2004	8164	7408	91	106	0	2029	25	0	0
2005	9351	8568	92	98	0	2556	27	0	43
2006	11682	10776	92	71	15	3817	33	34	152
2007	12907	11868	92	57	37	4927	38	58	181
2008	15399	14141	92	72	86	5897	38	43	174
2009	17969	16446	92	32	247	7340	41	80	167
2010	19300	17604	91	27	372	8502	44	153	169

Table 9.1.2 Treatment for renal bone disease, PD patients, 2001-2010

Year	Number of patients	Number of patients On CaCO ₃	% on CaCO ₃	Number on patients on Al(OH) ₃	Number of patients on Lanthanum	Number of patients on calcitriol	% on calcitriol	Number of patients on Paricalcitol	Number of patients had Parathyroidectomy
2001	781	588	75	5	0	84	11	0	0
2002	891	713	80	6	0	130	15	0	0
2003	1543	1306	85	15	0	311	20	0	0
2004	1842	1552	84	24	0	439	24	0	0
2005	2207	1862	84	21	0	534	24	0	8
2006	2787	2373	85	14	5	658	24	6	27
2007	3577	3142	88	8	22	1019	28	9	22
2008	4044	3495	86	14	42	1148	28	6	26
2009	3482	2945	85	12	78	1129	32	5	16
2010	3844	3391	88	4	93	1467	38	4	11

SECTION 9.2: SERUM CALCIUM AND PHOSPHATE CONTROL

The median corrected serum calcium level has remained stable for the last decade for both HD and PD patients. However, more HD patients achieved normal range serum calcium level (2.1 to 2.37 mmol/l) compared to PD patients (52% vs 37%) in 2010. (Tables and Figures 9.2.1 and 9.2.2)

Table 9.2.1: Distribution of corrected serum calcium, HD patients, 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients ≥ 2.1 & ≤ 2.37 mmol/L
2001	4618	2.4	0.2	2.4	2.2	2.5	40
2002	5485	2.3	0.3	2.3	2.2	2.5	43
2003	6466	2.3	0.2	2.3	2.2	2.4	46
2004	7536	2.3	0.2	2.3	2.2	2.4	47
2005	8630	2.3	0.2	2.3	2.2	2.4	49
2006	10881	2.3	0.2	2.3	2.1	2.4	50
2007	12275	2.2	0.2	2.2	2.1	2.4	52
2008	14478	2.3	0.2	2.3	2.1	2.4	53
2009	16851	2.3	0.2	2.3	2.2	2.4	52
2010	18400	2.3	0.2	2.3	2.2	2.4	52

Figure 9.2.1 Cumulative distribution of corrected serum calcium, HD patients, 2001-2010

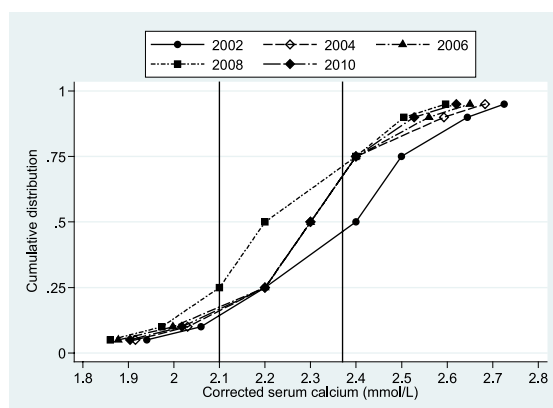


Figure 9.2.2: Cumulative distribution of corrected serum calcium, PD patients, 2001-2010

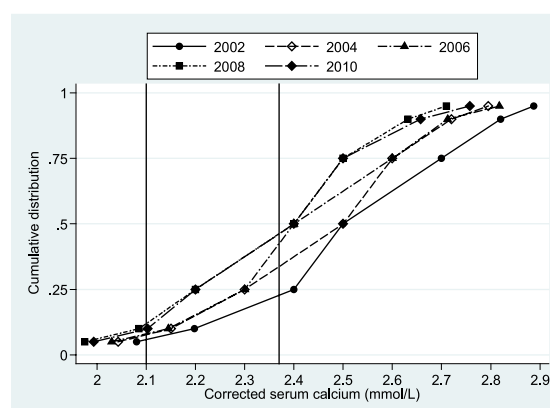


Table 9.2.2: Distribution of corrected serum calcium, PD patients, 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients ≥ 2.1 & ≤ 2.37 mmol/L
2001	744	2.5	0.3	2.5	2.4	2.7	22
2002	859	2.5	0.2	2.5	2.3	2.6	24
2003	1167	2.4	0.2	2.5	2.3	2.6	27
2004	1276	2.5	0.2	2.5	2.3	2.6	23
2005	1338	2.4	0.2	2.4	2.3	2.6	30
2006	1495	2.4	0.2	2.4	2.3	2.5	38
2007	1748	2.4	0.2	2.4	2.2	2.5	42
2008	2017	2.4	0.2	2.4	2.3	2.5	38
2009	2135	2.4	0.2	2.4	2.2	2.5	39
2010	2301	2.4	0.2	2.4	2.3	2.5	37

However, PD patients had better phosphate control compared to HD patients (median level 1.5 vs 1.7mmol/l) and larger percentage of PD patients had normal range phosphate level (1.13-1.78mmol/l) as opposed to HD patients (53 vs 46%). (Tables and Figures 9.2.3 and 9.2.4)

Table 9.2.3: Distribution of serum phosphate, HD patients, 2001-2010

Year	Number of patients	mean	SD	Median	LQ	UQ	%patients <1.13 mmol/L	%patients ≥1.13&<1.78 mmol/L	%patients ≥1.78&<2.6 mmol/L	%patients >2.6 mmol/L
2001	4765	1.9	0.5	1.8	1.5	2.2	7	40	45	8
2002	5679	1.9	0.5	1.8	1.5	2.2	7	38	45	10
2003	6588	1.8	0.5	1.8	1.5	2.2	7	41	43	9
2004	7620	1.8	0.5	1.8	1.5	2.2	8	42	42	7
2005	8834	1.8	0.5	1.7	1.4	2.1	9	45	40	6
2006	11129	1.8	0.5	1.7	1.4	2.1	9	46	39	6
2007	12424	1.8	0.5	1.7	1.4	2.1	9	47	39	5
2008	14874	1.7	0.5	1.7	1.4	2	9	48	37	5
2009	17247	1.8	0.5	1.7	1.4	2.1	8	46	39	6
2010	18637	1.8	0.5	1.7	1.4	2.1	8	46	41	6

Figure 9.2.3: Cumulative distribution of serum phosphate, HD patients, 2001-2010

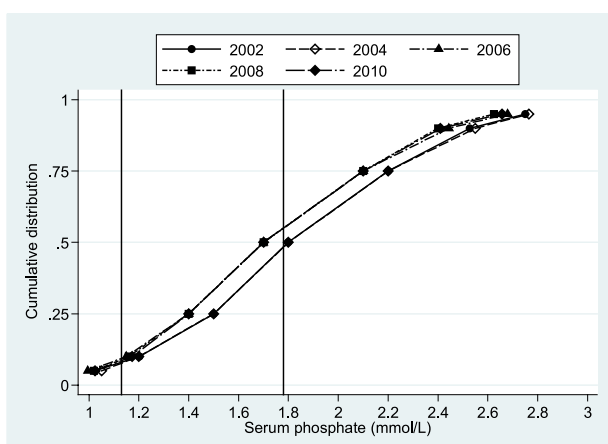


Figure 9.2.4: Cumulative distribution of serum phosphate, PD patients, 2001-2010

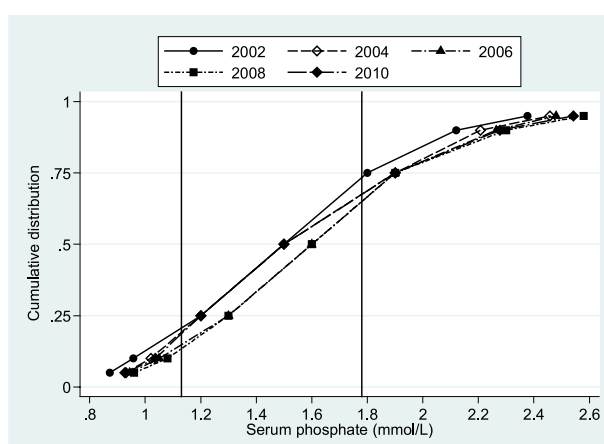


Table 9.2.4: Distribution of serum phosphate, PD patients, 2001-2010

Year	Number of patients	mean	SD	Median	LQ	UQ	%patients <1.13 mmol/L	%patients ≥1.13&<1.78 mmol/L	%patients ≥1.78&<2.6 mmol/L	%patients >2.6 mmol/L
2001	732	1.5	0.5	1.5	1.2	1.8	21	53	24	2
2002	862	1.5	0.5	1.5	1.2	1.8	21	52	25	2
2003	1173	1.6	0.5	1.5	1.2	1.9	16	53	28	3
2004	1278	1.6	0.5	1.6	1.3	1.9	15	52	29	3
2005	1343	1.6	0.5	1.6	1.3	1.9	15	52	29	3
2006	1511	1.6	0.5	1.6	1.3	1.9	13	54	29	4
2007	1757	1.6	0.5	1.6	1.3	1.9	13	55	27	5
2008	2022	1.6	0.5	1.5	1.3	1.9	15	55	25	4
2009	2147	1.6	0.5	1.5	1.2	1.9	16	53	27	4
2010	2303	1.6	0.5	1.5	1.2	1.9	16	53	27	4

The corrected calcium phosphate product had remained relatively stable for last 5 years in both HD and PD patients. About 47% of PD patients had corrected calcium phosphate product <3.5 mmol^2/L^2 compared to 34% in HD patients. Overall there was a positive trend in calcium phosphate product with higher percentage of HD and PD patients achieving corrected calcium phosphate product <3.5 mmol^2/L^2 and fewer patients with corrected calcium phosphate product ≥ 5.5 mmol^2/L^2 . (Tables and Figures 9.2.5 and 9.2.6)

Table 9.2.5: Distribution of corrected calcium x phosphate product, HD patients 2001-2010

Year	Number of patients	mean	SD	Median	LQ	UQ	Percent patients with calcium phosphate product:			
							<3.5 mmol^2/L^2	≥ 3.5 & <4.5 mmol^2/L^2	≥ 4.5 & <5.5 mmol^2/L^2	≥ 5.5 mmol^2/L^2
2001	4555	4.3	1.3	4.2	3.4	5.2	27	31	24	18
2002	5403	4.4	1.3	4.3	3.4	5.2	27	31	24	19
2003	6383	4.2	1.3	4.1	3.3	5.1	30	31	23	16
2004	7414	4.2	1.3	4.1	3.3	5	32	32	22	15
2005	8496	4	1.3	3.9	3.2	4.8	36	32	20	12
2006	10758	4	1.2	3.8	3.1	4.7	38	32	19	11
2007	12172	3.9	1.2	3.8	3.1	4.6	38	33	19	10
2008	14360	3.9	1.2	3.8	3.1	4.6	39	33	19	9
2009	16714	4	1.2	3.9	3.2	4.7	36	34	20	11
2010	18295	4	1.2	3.9	3.2	4.8	34	34	21	11

Figure 9.2.5: Cumulative distribution of corrected calcium x phosphate product, HD patients 2001-2010

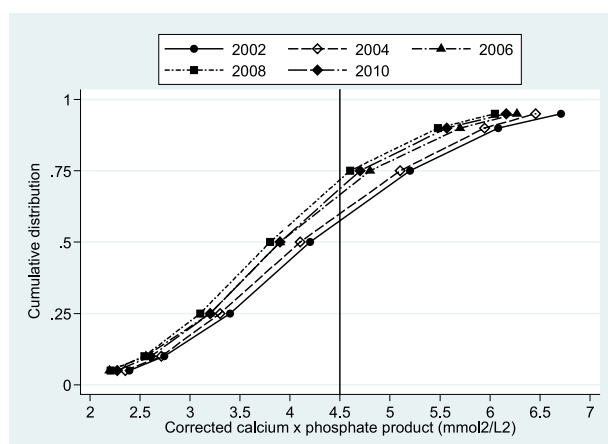


Figure 9.2.6: Cumulative distribution of corrected calcium x phosphate product, PD patients 2001-2010

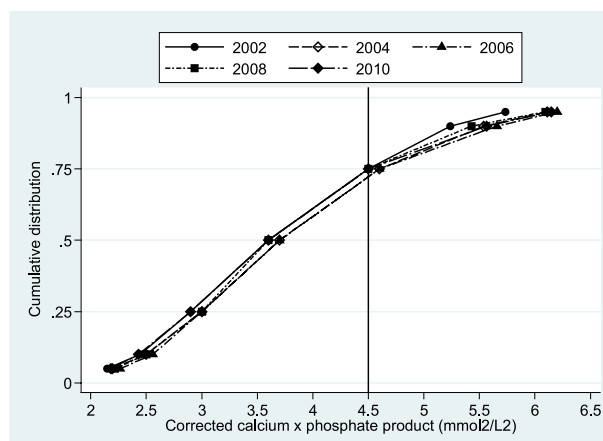


Table 9.2.6: Distribution of corrected calcium x phosphate product, PD patients 2001-2010

Year	Number of patients	mean	SD	Median	LQ	UQ	Percent patients with calcium phosphate product:			
							<3.5 mmol^2/L^2	≥ 3.5 & <4.5 mmol^2/L^2	≥ 4.5 & <5.5 mmol^2/L^2	≥ 5.5 mmol^2/L^2
2001	723	3.8	1.1	3.6	2.9	4.5	46	30	18	7
2002	856	3.8	1.2	3.6	2.9	4.5	45	29	18	8
2003	1162	3.9	1.2	3.7	3	4.6	43	29	17	10
2004	1274	4	1.2	3.8	3	4.7	41	30	18	12
2005	1333	3.9	1.3	3.7	3	4.6	43	29	17	11
2006	1494	3.9	1.2	3.7	3.1	4.6	43	31	17	9
2007	1745	3.8	1.2	3.6	3	4.5	46	29	15	10
2008	2009	3.8	1.2	3.6	3	4.5	47	28	15	10
2009	2130	3.8	1.2	3.6	2.9	4.5	46	29	15	11
2010	2289	3.8	1.2	3.6	2.9	4.5	47	29	15	10

There was wide variation in corrected serum calcium level among both HD and PD centres. The median corrected serum calcium level among 421 HD centres was 2.3 mmol/l (ranged from 1.8 to 2.5 mmol/l) in year 2010 and these figures had remained quite stable for the last 10 years. (Table 9.2.7 and Figure 9.2.7a). The median corrected serum calcium level among 25 PD centres was 2.4mmol/l (ranged from 2.2 to 2.5 mmol/l) and again this range is relatively static. (Table 9.2.8 and Figure 9.2.8a). PD patients had slightly higher median corrected serum calcium level but smaller variation compared to HD patients.

Table 9.2.7: Variation in corrected serum calcium level among HD centres, 2010

a) median serum calcium level among HD patients

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	116	2	2.1	2.3	2.3	2.4	2.5	2.6
2002	138	1.9	2.1	2.3	2.3	2.4	2.5	2.6
2003	174	2	2.1	2.2	2.3	2.4	2.5	2.5
2004	203	1.9	2.1	2.2	2.3	2.4	2.4	2.5
2005	229	1.8	2	2.2	2.3	2.4	2.4	2.5
2006	281	1.9	2.1	2.2	2.3	2.3	2.4	2.5
2007	313	1.8	2	2.2	2.2	2.3	2.4	2.5
2008	357	1.8	2.1	2.2	2.2	2.3	2.4	2.6
2009	397	1.5	2.1	2.2	2.3	2.3	2.4	2.6
2010	421	1.8	2.2	2.2	2.3	2.3	2.4	2.5

Figure 9.2.7(a): Variation in median serum calcium among HD patients, HD centres, 2010

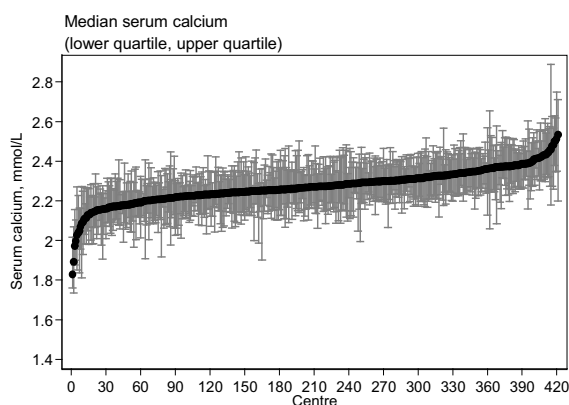


Figure 9.2.8(a): Variation in median serum calcium level among PD patients, PD centres, 2010

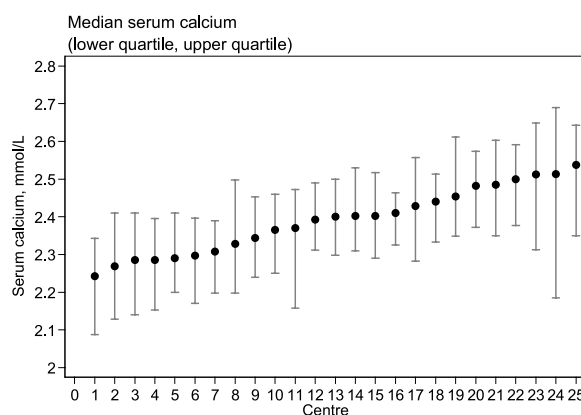


Table 9.2.8: Variation in corrected serum calcium level among PD centres, 2010

a) median serum calcium level among PD patients

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	12	2.3	2.3	2.4	2.5	2.5	2.6	2.6
2002	15	2.4	2.4	2.4	2.5	2.5	2.6	2.6
2003	18	2.2	2.2	2.4	2.4	2.5	2.6	2.6
2004	18	2.3	2.3	2.4	2.4	2.5	2.5	2.5
2005	19	2.2	2.2	2.4	2.4	2.5	2.6	2.6
2006	22	2.2	2.2	2.3	2.4	2.4	2.5	2.6
2007	22	2.2	2.2	2.3	2.3	2.4	2.4	2.5
2008	23	2.2	2.2	2.3	2.4	2.4	2.6	2.6
2009	23	2.2	2.3	2.3	2.3	2.4	2.5	2.6
2010	25	2.2	2.3	2.3	2.4	2.5	2.5	2.5

There was great centre variation among the HD and PD centres with regards to the proportion of patients achieving the normal range of corrected calcium level of 2.1 to 2.37 mmol/l; it ranged from 0 to 93% for HD centres and 15-58% for PD centers. The median was 52% for HD centres (Table and Figure 9.2.7b) and 35% for CAPD centres (Table and Figure 9.2.8b). The variation is smaller among PD centres compared to HD centres.

Table 9.2.7(b): Proportion of patients with serum calcium 2.1 to 2.37 mmol/L, HD centres, 2010

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	116	7	11	30	39.5	50	64	87
2002	138	5	17	33	44	53	66	71
2003	174	13	24	36	46.5	56	70	92
2004	203	8	20	37	47	58	71	85
2005	229	0	19	39	50	56	70	90
2006	281	13	31	41	50	60	72	90
2007	313	9	29	44	52	60	73	91
2008	357	9	29	46	54	60	74	100
2009	397	0	27	44	53	60	71	92
2010	421	0	31	45	52	61	73	93

Figure 9.2.7(b): Variation in proportion of patients with serum calcium 2.1 to 2.37 mmol/L, HD centres, 2010

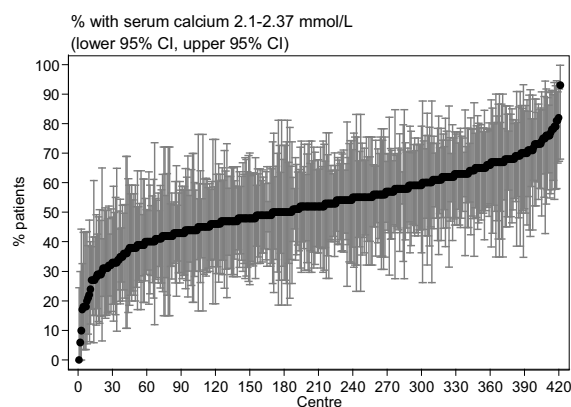


Figure 9.2.8(b): Variation in proportion of patients with serum calcium 2.1 to 2.37 mmol/L, PD centres, 2010

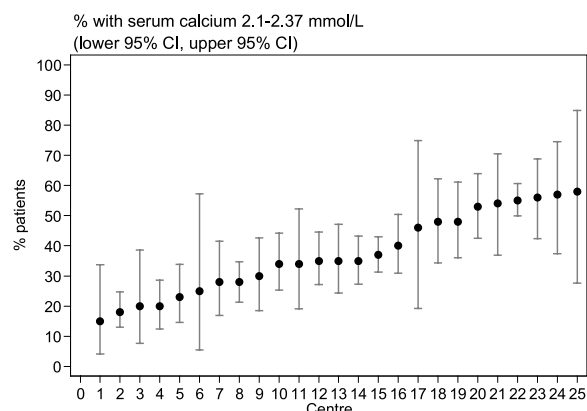


Table 9.2.8(b): Proportion of patients with serum calcium 2.1 to 2.37 mmol/L, PD centres

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	12	12	12	17	23.5	34.5	38	38
2002	15	12	12	20	25	34	41	41
2003	18	9	9	19	32	39	58	58
2004	18	11	11	18	24.5	31	53	53
2005	19	17	17	25	35	41	51	51
2006	22	16	25	35	42.5	49	60	76
2007	22	20	23	33	45	50	62	63
2008	23	9	14	30	45	53	58	65
2009	23	12	13	31	40	51	58	65
2010	25	15	18	28	35	48	57	58

There was also wide centre variation in serum phosphate level among HD centres and PD centres (Table and Figures 9.2.9a and 9.2.10a). PD patients seemed to have better phosphate control compared to HD patients. 51% of PD centres achieved the recommended target of serum phosphate level 1.13 – 1.78 mmol/l compared to 46% of HD centres. There was a great variation among the HD centres with regards to the proportion of patients with serum phosphate 1.13 – 1.78 mmol/l, ranging from 0 to 76% while the range was narrower in PD centres which was 34-67% (Table and Figures 9.2.9b and 9.2.10b).

Table 9.2.9: Variation in serum phosphate level among HD centres, 2010

a). Median serum phosphate level among HD patients

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	119	1.3	1.5	1.7	1.8	1.9	2.1	2.4
2002	145	1.3	1.5	1.8	1.9	2	2.2	2.4
2003	178	0.9	1.5	1.7	1.8	1.9	2.2	2.4
2004	204	1.4	1.5	1.7	1.8	1.9	2.1	2.3
2005	232	0.9	1.4	1.6	1.8	1.9	2.1	2.2
2006	285	0.9	1.5	1.6	1.7	1.8	2	2.3
2007	315	1	1.4	1.6	1.7	1.8	2	2.3
2008	361	1.3	1.5	1.6	1.7	1.8	2	2.5
2009	401	1.1	1.5	1.6	1.7	1.8	2	2.3
2010	426	1.3	1.5	1.7	1.7	1.8	2.1	3

Figure 9.2.9(a): Variation in median serum phosphate level among HD patients, HD centres, 2010

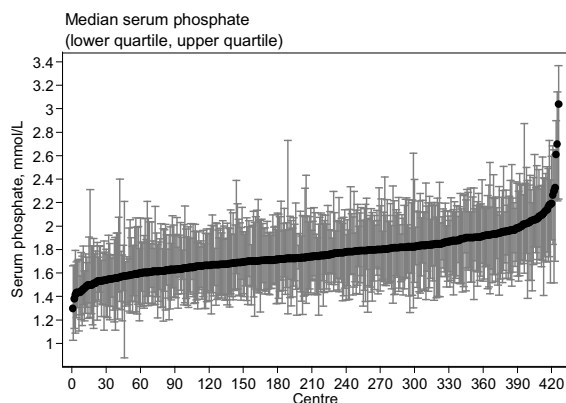
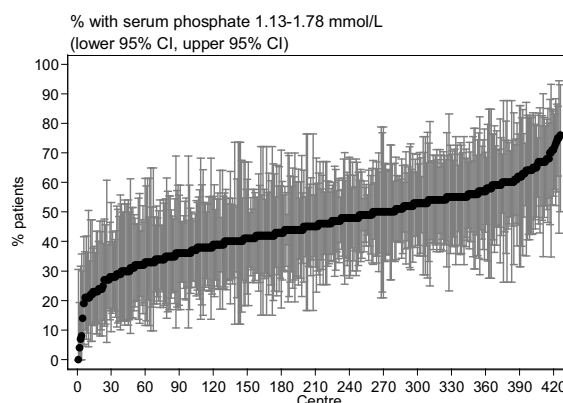


Figure 9.2.9(b): Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, HD centres, 2010



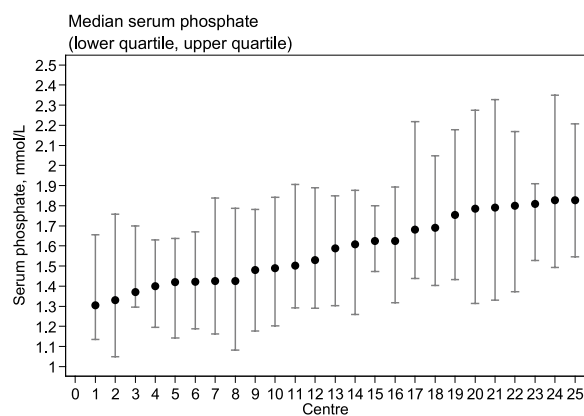
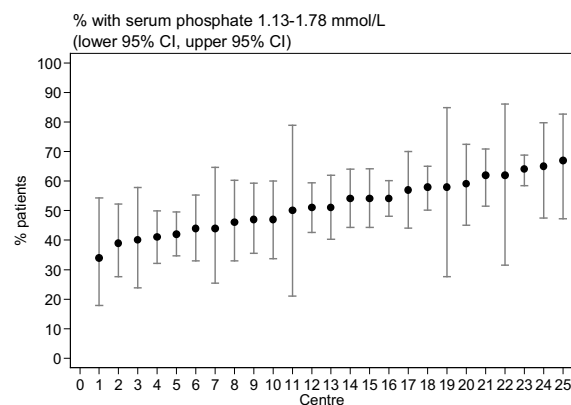
(b) Proportion of patients with serum phosphate 1.13-1.78 mmol/L, HD centres, 2010

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	119	0	17	32	39	47	62	67
2002	145	8	16	30	37	46	67	91
2003	178	9	19	31	40	48	67	93
2004	204	0	17	31	41	50	65	92
2005	232	10	23	36	43	53	70	90
2006	285	8	26	39	46	54	70	93
2007	315	20	29	39	47	54	67	92
2008	361	12	29	39	48	56	67	93
2009	401	6	26	39	47	54	66	82
2010	426	0	24	38	46	54	65	76

Table 9.2.10: Variation in serum phosphate levels among PD centres, 2001 - 2010

a). Median serum phosphate level among PD patients

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	12	1.3	1.3	1.4	1.5	1.7	1.9	1.9
2002	15	1.4	1.4	1.4	1.5	1.6	2.1	2.1
2003	18	1.3	1.3	1.5	1.5	1.6	1.7	1.7
2004	18	1.3	1.3	1.5	1.5	1.7	1.8	1.8
2005	19	1.4	1.4	1.5	1.5	1.7	1.9	1.9
2006	22	1.3	1.4	1.5	1.6	1.7	1.8	1.9
2007	22	1.3	1.4	1.5	1.6	1.7	1.9	1.9
2008	23	1.3	1.4	1.5	1.6	1.8	1.8	2.1
2009	23	1.3	1.4	1.5	1.6	1.7	1.9	2.2
2010	25	1.3	1.3	1.4	1.6	1.8	1.8	1.8

Figure 9.2.10(a): Variation in median serum phosphate level among PD patients, PD centres 2010**Figure 9.2.10(b):** Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2010**Table 9.2.10(b):** Proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2001 - 2010

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	12	42	42	48.5	54	58	77	77
2002	15	43	43	47	53	60	83	83
2003	18	43	43	52	54	58	77	77
2004	18	37	37	49	52.5	60	76	76
2005	19	38	38	46	52	58	76	76
2006	22	41	44	48	52.5	58	66	68
2007	22	39	43	48	54	57	73	78
2008	23	30	39	47	53	60	65	71
2009	23	20	39	48	52	58	66	75
2010	25	34	39	44	51	58	65	67

In 2010, the corrected serum calcium phosphate product among 421 HD centres ranged from 2.8 to 7.0 with median of 3.9 mmol/l (Tables 9.2.11 and Figure 9.2.11a). The corrected serum calcium phosphate product among 25 CAPD centres ranged from 3.1 to 4.6 mmol/l with median of 3.8 mmol/l (Tables 9.2.12 and Figure 9.2.12a). There was wider variation of corrected serum calcium phosphate product among HD centres compared to PD centres.

Table 9.2.11: Variation in corrected calcium x phosphate product HD centres, 2001-2010

a) median corrected calcium x phosphate product among HD patients

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	113	2.9	3.6	3.9	4.2	4.6	5.2	6.0
2002	138	2.9	3.5	4	4.3	4.6	5.2	5.9
2003	174	2.2	3.3	3.8	4.1	4.5	5.0	5.5
2004	201	2.9	3.4	3.8	4.1	4.4	4.9	5.6
2005	223	2.1	3.2	3.6	3.9	4.2	4.7	5.6
2006	279	1.8	3.2	3.6	3.9	4.2	4.6	5.2
2007	310	2.3	3.2	3.6	3.8	4.1	4.5	5.1
2008	354	2.7	3.2	3.6	3.8	4.1	4.5	5.7
2009	394	2.6	3.3	3.6	3.9	4.1	4.7	6.0
2010	421	2.8	3.4	3.7	3.9	4.2	4.6	7.0

Figure 9.2.11(a): Variation in median corrected calcium x phosphate product among HD patients, HD centres, 2010

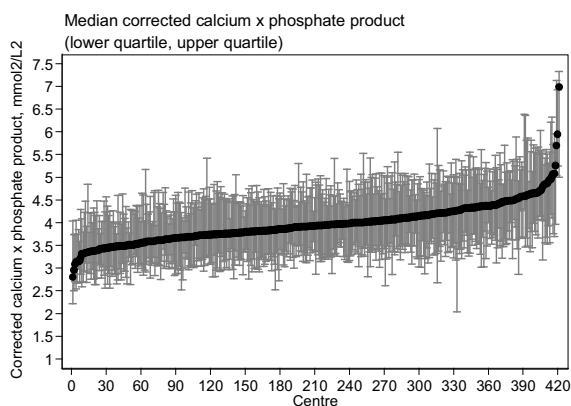


Figure 9.2.12(a): Variation in median corrected calcium x phosphate product among PD centres, to 2010

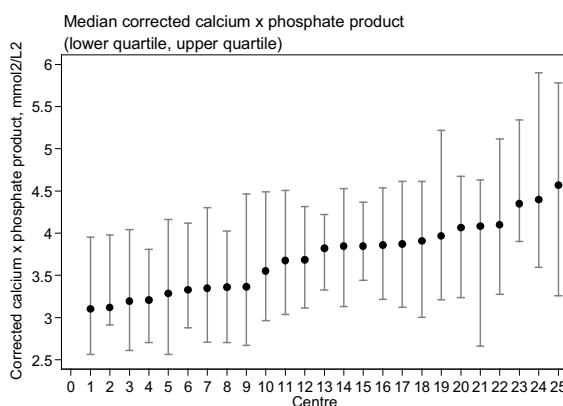


Table 9.2.12: Variation in corrected calcium x phosphate product among PD centres, 2001-2010

a) median corrected calcium x phosphate product among PD patients

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	12	3.1	3.1	3.4	3.7	3.9	4.3	4.3
2002	15	3.3	3.3	3.4	3.6	4	4.9	4.9
2003	18	3.2	3.2	3.4	3.7	3.9	4.1	4.1
2004	18	3.2	3.2	3.5	3.8	4	4.4	4.4
2005	19	3.3	3.3	3.5	3.7	4	4.3	4.3
2006	22	3	3.3	3.6	3.7	4	4.3	4.4
2007	22	3.1	3.3	3.5	3.8	4.2	4.3	4.3
2008	23	3.1	3.2	3.4	3.7	4.1	4.6	5.1
2009	23	3.3	3.3	3.5	3.7	3.9	4.6	4.8
2010	25	3.1	3.1	3.3	3.8	4	4.4	4.6

With regards to the proportion of patients with corrected calcium phosphate product less than $4.5 \text{ mmol}^2/\text{L}^2$, the median was 69% for HD centres (Table and Figure 9.2.11b) and 75% for PD centres (Table and Figure 9.2.12 b). There was again a great variation between the HD centres with regards to the proportion of patients with calcium phosphate product less than $4.5 \text{ mmol}^2/\text{L}^2$, ranging from 8% to 100%. (Table 9.2.11b). Among the PD centres, the proportion of patients with calcium phosphate product less than $4.5 \text{ mmol}^2/\text{L}^2$, ranged from 48% to 89% (Table 9.2.12b).

Table 9.2.11(b): Proportion of patients with corrected calcium x phosphate $< 4.5 \text{ mmol}^2/\text{L}^2$, HD centres

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	113	19	35	47	57	70	81	91
2002	138	17	32	48	57	68	90	100
2003	174	25	33	50	61	71	84	100
2004	201	15	38	53	64	72	88	100
2005	223	24	44	58	69	77	91	100
2006	279	30	45	61	70	79	91	100
2007	310	33	48	63	72.5	80	92	100
2008	354	26	50	65	72	81	92	100
2009	394	27	43	62	71	79	89	100
2010	421	8	43	60	69	77	87	100

Figure 9.2.11(b): Variation in proportion of patients with corrected calcium x phosphate product $< 4.5 \text{ mmol}^2/\text{L}^2$, HD centres 2010

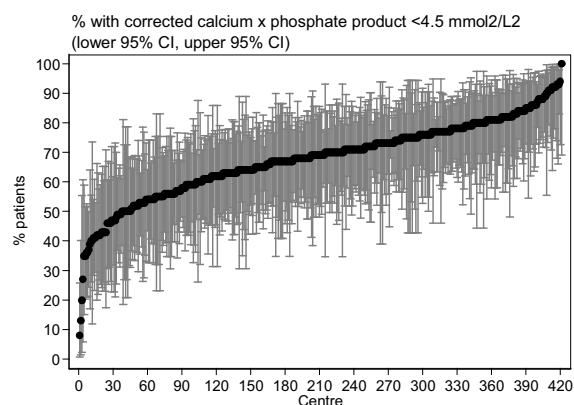


Figure 9.2.12(b): Variation in proportion of patients with corrected calcium x phosphate product $< 4.5 \text{ mmol}^2/\text{L}^2$, PD centres, 2010

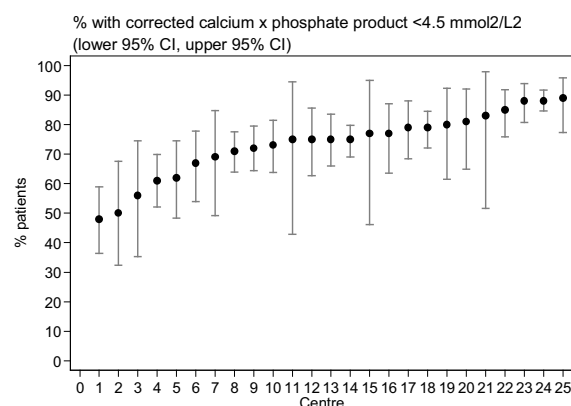


Table 9.2.12(b): Proportion of patients with corrected calcium x phosphate $< 4.5 \text{ mmol}^2/\text{L}^2$, PD centres

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	12	50	50	71.5	75	81.5	84	84
2002	15	43	43	65	78	82	88	88
2003	18	61	61	64	74.5	82	89	89
2004	18	57	57	66	72	79	89	89
2005	19	54	54	63	73	78	85	85
2006	22	53	56	67	71	79	88	96
2007	22	51	56	64	72.5	79	88	98
2008	23	40	43	63	70	81	89	97
2009	23	40	48	64	76	80	85	86
2010	25	48	50	69	75	80	88	89

SECTION 9.3: SERUM PARATHYROID HORMONE CONTROL

The intact parathyroid hormone (iPTH) level was on the rise between 2001 to 2009 but it has decreased for the first time in 2010 for both HD and PD patients. PD patients had relatively higher level of iPTH compared to HD patients. The mean iPTH level for HD patients was 234.1ng/ml with the median of 97.2ng/ml (Table and Figure 9.3.1a). For PD patients, the mean iPTH level was 261.5ng/ml with the median of 163ng/ml. (Table and Figure 9.3.2b). There was higher percentage of HD patients with iPTH level less than 150 ng/ml (59%) compared to PD patients (48%). However, there were more PD patients with iPTH ≥ 150 & ≤ 300 ng/ml than HD patients (20% vs 15%). Patients with diabetes had relatively lower iPTH level compared to patients without diabetes in both HD and PD populations, with the mean of 187.5 ng/ml vs 273.2 ng/ml for HD patients and 197.4ng/ml vs 295.6ng/ml for PD patients. (Table and Figure 9.3.1b, 9.3.1c, 9.3.2b and 9.3.2c)

Table 9.3.1(a): Distribution of iPTH, HD patients, 2001-2010

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	≥ 150 & ≤ 300 ng/ml	>300 & ≤ 500 ng/ml	>500 ng/ml
2001	2760	141.2	219.5	57	18	164.8	73	15	6	7
2002	3391	161.6	248	64	19	191	70	14	8	8
2003	4068	219.1	328.8	79	24.3	263.3	64	14	9	14
2004	4748	212.1	325.6	74.3	22.6	257.3	65	13	9	13
2005	5826	221.6	312.5	83.8	26.5	297	61	14	11	14
2006	7744	219.1	307.2	88	29	292	61	14	11	13
2007	9151	245.8	332.7	105	30.4	335.5	58	15	12	16
2008	10753	260.8	330.9	127	36	361	54	17	13	17
2009	12642	269.4	337.3	140.1	40	367.1	52	18	13	17
2010	14210	234.1	318.2	97.2	30	317.5	59	15	11	15

Figure 9.3.1(a): Cumulative distribution of iPTH, HD, 2001-2010

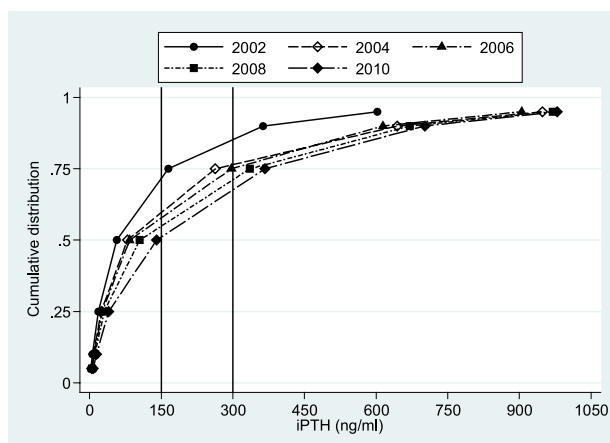


Figure 9.3.1(b): Cumulative distribution of iPTH, diabetic HD patients, 2001-2010

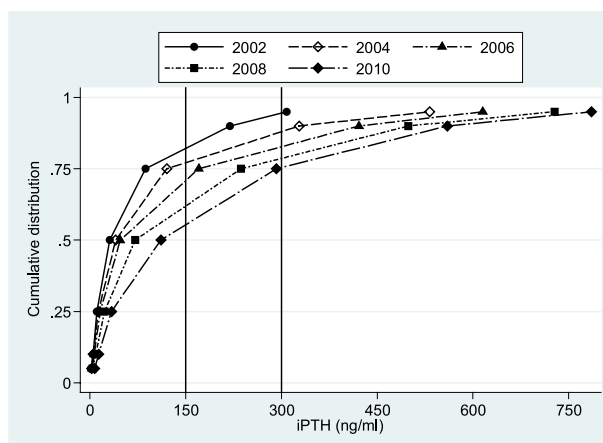
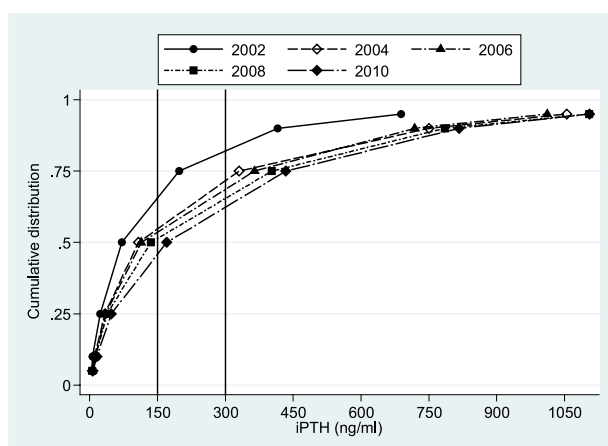
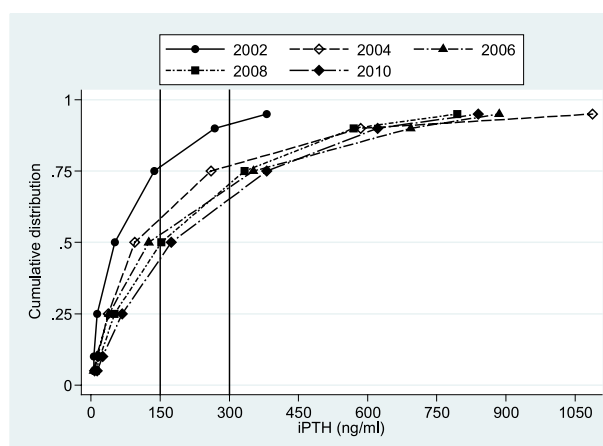


Table 9.3.1(b): Distribution of iPTH, diabetic HD patients, 2001-2010

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	≥ 150 & ≤ 300 ng/ml	>300 & ≤ 500 ng/ml	>500 ng/ml
2001	704	80.6	136	31.2	10.9	87.3	84	11	4	2
2002	938	90.9	157.4	34.9	10.9	97	83	10	4	3
2003	1204	120.1	209.3	40.2	13.3	120.3	79	10	6	5
2004	1532	111.4	193.6	38	14	114.4	80	10	5	5
2005	2107	149.5	246.1	47.4	16.1	170.5	72	12	8	8
2006	3068	155.1	253.3	54	20.8	174	72	12	8	7
2007	3679	183.2	267.5	70.7	23	236.5	66	14	10	10
2008	4592	208.9	275.3	99	29.1	286.9	59	17	12	12
2009	5636	218.2	284	111.1	33.7	292	57	18	12	12
2010	6488	187.5	266.3	74.1	25.7	253.2	64	15	11	10

Table 9.3.1(c): Distribution of iPTH, non diabetic HD patients, 2001-2010

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	≥ 150 & ≤300 ng/ml	>300 & ≤500 ng/ml	>500 ng/ml
2001	2056	162	238.1	71	23.4	198	69	16	7	8
2002	2453	188.7	270.1	84	26	235	65	15	10	10
2003	2864	260.7	359.6	108	33.5	330.5	57	16	10	17
2004	3216	260.1	362.7	102.3	30.5	338.8	58	14	11	17
2005	3719	262.5	337.8	114.1	35.5	364.5	55	15	13	17
2006	4676	261.2	331.3	122.7	39	362	54	16	13	17
2007	5472	287.9	364.1	135.1	38.7	402.8	52	15	13	19
2008	6161	299.5	362.2	155	42.7	418	49	16	14	21
2009	7006	310.6	369.6	170.5	47.8	433.5	47	17	14	21
2010	7722	273.2	351.3	125.6	36	383.5	54	15	12	19

Figure 9.3.1(c): Cumulative distribution of iPTH, non diabetic HD patients, 2001-2010**Figure 9.3.2(a):** Cumulative distribution of iPTH, PD patients, 2001-2010**Table 9.3.2(a):** Distribution of iPTH, PD patients, 2001-2010

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	≥ 150 & ≤300 ng/ml	>300 & ≤500 ng/ml	>500 ng/ml
2001	531	108	155.8	51.5	13.5	137.6	76	15	6	3
2002	681	160.6	219.1	82	26	196	67	17	8	7
2003	938	230.3	340.3	95	37.4	260	61	18	9	12
2004	1115	216.4	302.9	105	39.5	260	60	19	10	11
2005	1071	247.1	306.4	125.3	39	352	54	18	13	15
2006	1265	224.6	271.9	128	41.5	318	54	20	14	12
2007	1436	248.4	297.1	152.5	51	332.8	50	22	15	14
2008	1608	264.2	295.3	170.3	57.3	357.7	46	22	18	15
2009	1824	270.6	292.7	174.2	67.8	381	45	22	16	16
2010	1905	261.5	294.8	163	51	371	48	20	16	16

Table 9.3.2(b): Distribution of iPTH, diabetic PD patients, 2001-2010

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	≥ 150 & <300 ng/ml	>300 & <500 ng/ml	>500 ng/ml
2001	159	63.6	87.1	31	6.8	79	88	9	3	1
2002	194	98.5	158.3	52.8	15	125.8	82	12	3	3
2003	312	122.6	179.7	65.6	29	146.8	75	15	6	4
2004	358	127	187.1	63.3	24.1	145	75	15	4	5
2005	348	161.4	241.4	67	22.5	192.3	70	15	8	7
2006	434	149.5	198.4	88.9	32.5	186.5	68	19	8	5
2007	544	176.4	204.6	113	41.8	237.8	58	25	11	6
2008	692	211.3	228.4	141.2	56.3	293.8	51	24	17	8
2009	750	186.8	184.9	132	57.5	255.5	54	26	13	7
2010	661	197.4	216.8	131	42	295	54	21	16	8

Figure 9.3.2(b): Cumulative distribution of iPTH, diabetic PD patients, 2001-2010Z

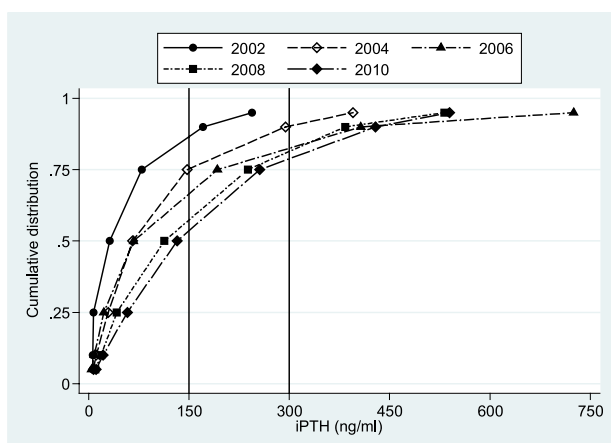


Figure 9.3.2(c): Cumulative distribution of iPTH, non diabetic PD patients, 2001-2010

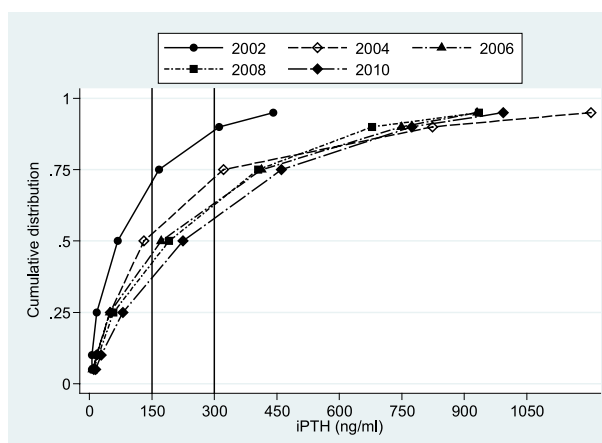


Table 9.3.2(c): Distribution of iPTH, non diabetic PD patients, 2001-2010

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	≥ 150 & <300 ng/ml	>300 & <500 ng/ml	>500 ng/ml
2001	372	127	173.9	67.5	17.2	167	72	18	7	4
2002	487	185.3	234.7	100	33	241	62	19	10	9
2003	626	284	385.8	130.8	49.9	321.5	54	19	10	17
2004	757	258.6	336.3	138	50	325	53	20	12	14
2005	723	288.3	325.3	172	48.8	413.5	47	19	15	19
2006	831	263.8	295.9	164	50	386	47	21	16	16
2007	892	292.3	334	191	57.5	404.8	44	20	18	18
2008	916	304.1	331.7	208.4	57.5	422.5	41	20	18	20
2009	1074	329.1	336.7	224.6	80	461	39	20	19	22
2010	1244	295.6	323.8	186.3	56.6	423.7	45	20	15	20

There was wide variation in iPTH level among HD centres and PD centres and the degree of variation seemed to become wider since 2001 especially among HD centres. With regards to the proportion of patients with serum iPTH level in the range 150-300 ng/ml, the median was only 15% for HD centres (Table and Figure 9.3.3b) and 20% for PD centres (Table and Figure 9.3.4b).

Table 9.3.3(a): Variation in iPTH among HD centres 2001-2010

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	71	7.2	10.4	27.9	50.2	80.5	224	543
2002	94	1.4	10.8	28.6	49.5	139	309	660.3
2003	114	4	9.6	35.5	86	193.5	375.2	624.5
2004	136	3.6	12	29.3	74.7	201.5	398.8	708
2005	166	6.1	14.5	38.7	96.1	229	419.2	626.4
2006	219	7.7	15.1	41.4	90.8	204.5	376	632.8
2007	247	11.8	20.4	45.8	117	240	428.8	615
2008	288	8.5	22.4	60.8	140.8	244.6	411	712.5
2009	334	2.6	26.9	63.6	161.1	247.5	416	956.1
2010	357	5.5	18.5	40.8	105.8	243	400.4	621

Figure 9.3.3(a): Variation in median iPTH among HD patients, HD centres 2010

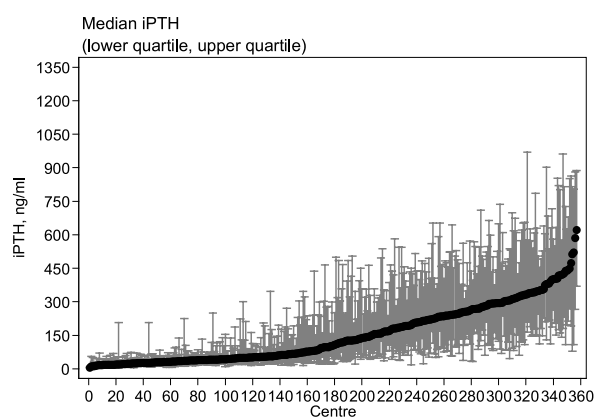


Figure 9.3.3(b): Variation in proportion of patients with iPTH 150-300ng/ml, HD centres, 2010

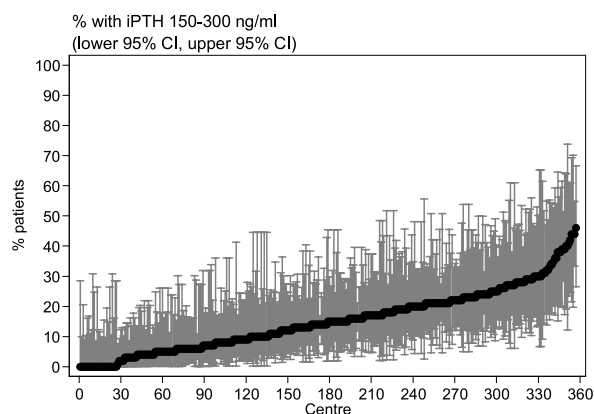


Table 9.3.3(b): Variation in proportion of patients with iPTH 150-300ng/ml, HD centres, 2001-2010

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	71	0	0	5	10	20	32	40
2002	94	0	0	2	10	22	32	45
2003	114	0	0	6	13.5	21	36	42
2004	136	0	0	5	10	19	33	50
2005	166	0	0	7	14	20	33	47
2006	219	0	0	7	14	20	30	45
2007	247	0	0	9	15	21	30	53
2008	288	0	0	9	16	23	31	44
2009	334	0	0	10	17	25	35	60
2010	357	0	0	7	15	22	34	46

Table 9.3.4: Variation in iPTH among PD centres, 2001-2010

a) Median iPTH among PD patients

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	11	15.4	15.4	42.5	59.5	91	274	274
2002	14	27.3	27.3	50	82.9	107	280.5	280.5
2003	17	22.4	22.4	70	135	175	309.5	309.5
2004	18	41	41	74.5	138.8	169.3	329.6	329.6
2005	18	25.5	25.5	85	140.6	259.5	493.3	493.3
2006	21	34.5	36.9	102.5	166.5	243	367	411
2007	22	26.3	32	107.5	202.1	290.5	440	513.9
2008	22	35	47	132	186.2	310.9	352.3	454.5
2009	22	37.5	56.5	144.5	200.4	285.8	468.8	1047
2010	24	28.5	30.4	129.8	210.8	285.2	570.5	783.2

Figure 9.3.4(a): Variation in median iPTH among PD patients, PD centres, 2010

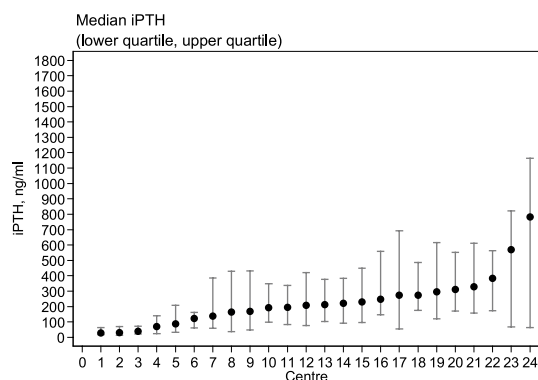


Figure 9.3.4(b): Variation in proportion of patients with iPTH 150-300ng/ml, PD centres 2010

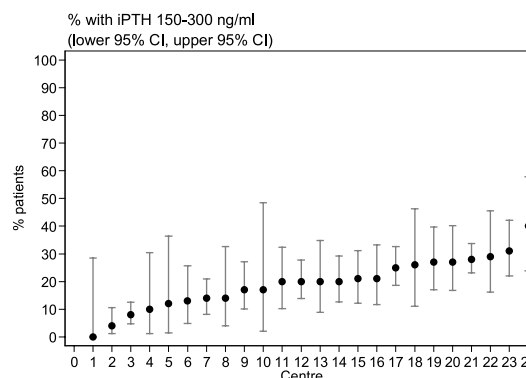


Table 9.3.4(b): Proportion of patients with iPTH 150-300ng/ml

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2001	11	0	0	9	14	19	30	30
2002	14	0	0	10	15.5	21	24	24
2003	17	2	2	12	18	22	33	33
2004	18	7	7	14	20	24	30	30
2005	18	0	0	9	15.5	23	31	31
2006	21	5	6	13	20	26	33	40
2007	22	0	3	16	21	27	31	39
2008	22	0	7	15	20.5	26	31	33
2009	22	10	12	17	22	26	28	28
2010	24	0	4	13.5	20	26.5	31	40

Conclusion

There were no major changes in the type of phosphate binders used for both HD and PD patients. About 91% of HD patients and 88% of PD patients were still taking calcium carbonate as their phosphate binder in 2010. The use of lanthanum as phosphate binder has increased slowly since 2006 whereas the aluminium based phosphate binder has decreased to 0.1%. Calcitriol remained the main vitamin D used in both HD and PD patients and its use is still on the rise. The use of Paricalcitol has also increased slowly in HD patients from 0.29% to 0.79% but its use has decreased from 0.21% in 2006 to 0.10% in 2010 in PD patients. This may be because PD patients had better calcium phosphate control therefore their iPTH level could be controlled using Calcitriol instead of Paricalcitol.

The mean corrected serum calcium level remained slightly lower in the HD patients (2.3 mmol/L) compared to CAPD patients (2.4 mmol/L), however phosphate control continued to be better in CAPD patients with the mean phosphate level of 1.6mmol/L as apposed to 1.8mmol/L in HD patients. The proportion of CAPD patients achieving target serum phosphate 1.13-1.78 mmol/l was 53% compared to 46% in HD patients. More PD patients had serum calcium phosphate product of less than 4.5 mmol²/L² compared with HD patients (median 75% vs 69%) in 2010.

The intact parathyroid hormone (iPTH) level which had been on the rise since 2001 and peaked at 2009, has appeared to decrease for the first time in 2010 for both HD and PD patients. In addition, the number of patients who underwent parathyroidectomy has continued to decrease since 2006 among both HD and PD patients. This reflects better awareness and management of renal bone disease in our dialysis patients. Interestingly, PD patients had relatively higher level of iPTH despite better calcium phosphate control compared to HD patients and patients with diabetes had lower iPTH level than patients without diabetes in both HD and PD populations.

Overall, the renal bone disease management in our dialysis populations has improved as reflected by decrease of the iPTH level for the first time in 2010. However, there were still wide centre variations especially among HD centres in the management of renal bone disease and the degree of variation seemed to become wider for the last 10 years. This could be partly due to additional new HD centers being set up every year and more patients entering haemodialysis program than PD. Therefore, perhaps we should pay more attention to patient education with regards to low phosphate dietary compliance in their chronic kidney disease stage so that they have less renal bone disease complication when they eventually enter the dialysis program.