

CHAPTER 9

CHRONIC KIDNEY DISEASE
– MINERAL AND BONE DISORDER

Fan Kin Sing
Rozina Ghazalli
Ching Chen Hua
Liew Yew Fong

SECTION 9.1: TREATMENT OF HYPERPHOSPHATAEMIA

Calcium carbonate remained the main phosphate binder for both HD patients (92%) and PD patients (86%) and this percentage remained static for the past decade. The number of patients taking aluminium based phosphate binder had decreased steadily to less than 1% for both HD and PD patients from 2.8% and 0.7% in 2002 to 0.15% and 0.16% in 2011 respectively. On the other hand, Lanthanum usage had increased slowly from 0.13% and 0.18% in 2006 to 2.26% and 3.46% in 2011 for both HD and PD patients respectively since its introduction into Malaysia in 2006. Sevelamer was officially launched in Malaysia in May 2011. Its usage was 0.39% in HD and 0.83% in PD patients. (Tables 9.1.1 and 9.1.2)

Table 9.1.1: Phosphate Binder in HD patients, 2002-2011

Year	Number of patients	Number of patients on CaCO ₃		Number on patients on Al(OH) ₃		Number of patients on Lanthanum		Number of patients on Sevelamer Hcl	
		n	%	n	%	n	%	n	%
2002	6108	5536	91	171	3	0	0	0	0
2003	7018	6425	92	118	2	0	0	0	0
2004	8164	7408	91	106	1	0	0	0	0
2005	9351	8568	92	98	1	0	0	0	0
2006	11682	10776	92	71	1	15	0	0	0
2007	12907	11868	92	57	0	37	0	1	0
2008	15399	14141	92	72	0	86	1	3	0
2009	17968	16445	92	34	0	247	1	0	0
2010	19509	17805	91	27	0	377	2	6	0
2011	22742	20854	92	35	0	514	2	88	0

Table 9.1.2: Phosphate Binder in PD patients, 2002-2011

Year	Number of patients	Number of patients on CaCO ₃		Number on patients on Al(OH) ₃		Number of patients on Lanthanum		Number of patients on Sevelamer Hcl	
		n	%	n	%	n	%	n	%
2002	891	713	80	6	1	0	0	0	0
2003	1543	1306	85	15	1	0	0	0	0
2004	1842	1552	84	24	1	0	0	0	0
2005	2207	1862	84	21	1	0	0	0	0
2006	2787	2373	85	14	1	5	0	2	0
2007	3577	3142	88	8	0	22	1	1	0
2008	4044	3495	86	14	0	42	1	0	0
2009	3482	2945	85	12	0	78	2	1	0
2010	3844	3391	88	4	0	93	2	2	0
2011	5087	4376	86	8	0	176	3	42	1

Among the HD patients taking Lanthanum, about 35-45% of them were from public or government HD centres. About 50-60% of usage were from NGO centres between 2006 to 2008 but its usage decreased from 39% in 2009 to 20% in 2011. On the other hand, the usage from private sectors had increased from 7% in 2006 to 27% in 2011. For Sevelamer usage, majority were from NGO sectors (51%), followed by Private sectors (35%) and public sectors (14%). (Table 9.1.3)

Table 9.1.3: Phosphate Binders by Sector in HD patients

Year	Sector	Lanthanum Carbonate		Sevelamer Hcl		Aluminium binder	
		n	%	n	%	n	%
2002	Public	0		0		113	66
	Private	0		0		23	13
	NGO	0		0		35	20
	Total	0	0	0	0	171	99
2003	Public	0		0		70	59
	Private	0		0		30	25
	NGO	0		0		18	15
	Total	0	0	0	0	118	99
2004	Public	0		0		49	46
	Private	0		0		31	29
	NGO	0		0		26	25
	Total	0	0	0	0	106	100
2005	Public	0		0		54	55
	Private	0		0		20	20
	NGO	0		0		24	24
	Total	0	0	0	0	98	99
2006	Public	6	40	0		42	59
	Private	1	7	0		21	30
	NGO	8	53	0		8	11
	Total	15	100	0	0	71	100
2007	Public	13	35	0	0	25	44
	Private	1	3	1	100	3	5
	NGO	23	62	0	0	29	51
	Total	37	100	1	100	57	100
2008	Public	17	20	0	0	25	35
	Private	19	22	0	0	13	18
	NGO	50	58	3	100	34	47
	Total	86	100	3	100	72	100
2009	Public	90	36	0		11	32
	Private	61	25	0		7	21
	NGO	96	39	0		16	47
	Total	247	100	0	0	34	100
2010	Public	146	39	2	33	18	67
	Private	111	29	0	0	5	18
	NGO	120	32	4	67	4	15
	Total	377	100	6	100	27	100
2011	Public	225	44	10	14	19	63
	Private	136	26	25	35	2	7
	NGO	153	30	36	51	9	30
	Total	514	100	71	100	30	100

SECTION 9.2: SERUM CALCIUM AND PHOSPHATE CONTROL

The median corrected serum calcium level had remained constant for the last decade for both HD (2.3 mmol/L) and PD (2.4 mmol/L) patients. Furthermore, more than 50% of HD patients achieved normal range serum calcium level (2.18 to 2.37 mmol/L) since 2006 compared to only 40% of PD patients (53% vs. 38% in 2001). (Table & Figure 9.2.1 and 9.2.2)

Table 9.2.1: Distribution of corrected serum calcium, HD patients, 2002-2011

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients ≥ 2.18 & ≤ 2.37 mmol/L
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	16850	2.3	0.2	2.3	2.2	2.4	52
2010	18655	2.3	0.2	2.3	2.2	2.4	52
2011	21696	2.3	0.2	2.3	2.1	2.4	53

Figure 9.2.1: Cumulative distribution of corrected serum calcium, HD patients, 2002-2011

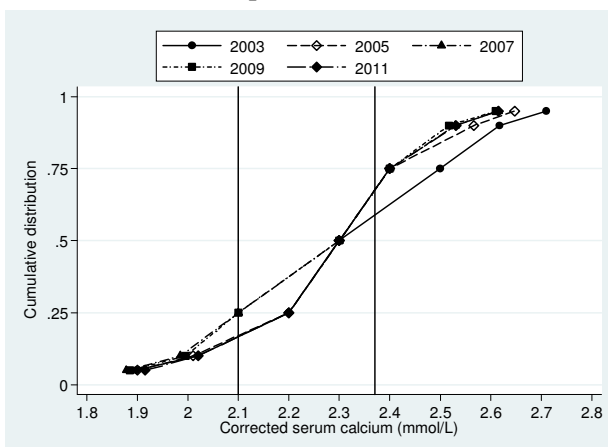


Figure 9.2.2: Cumulative distribution of corrected serum calcium, PD patients, 2002-2011

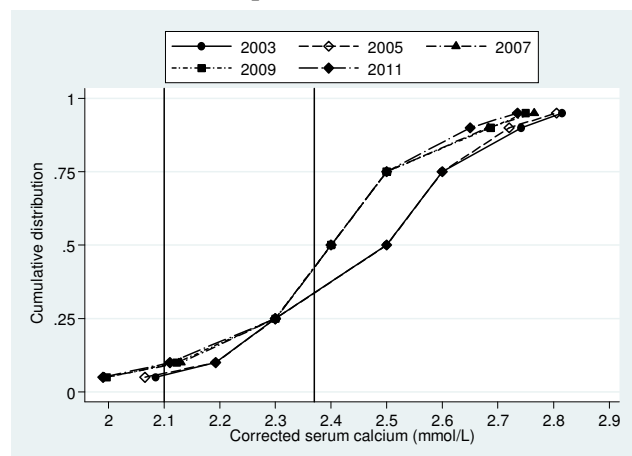


Table 9.2.2: Distribution of corrected serum calcium, PD patients, 2002-2011

Year	Number of patients	Mean	SD	Median	LQ	UQ	%patients ≥ 2.18 & ≤ 2.37 mmol/L
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
2011	2506	2.4	0.2	2.4	2.3	2.5	38

Overall, PD patients seemed to have better phosphate control compared to HD patients (median level 1.5 vs. 1.7mmol/L). About 27% of PD patients achieved target phosphate level recommended by KDIGO (0.8 to 1.3mmol/L) compared to only 15% in HD patients. More HD patients had higher range of phosphate level (>1.8mmol/l) as compared to PD patients (44% vs. 31%). (Tables & Figures 9.2.3 and 9.2.4)

Table 9.2.3: Distribution of serum phosphate, HD patients, 2002-2011

Year	Number of patients	mean	SD	Median	LQ	UQ	% patients	% patients	% patients	% patients	% patients
							<0.8 mmol/L	≥0.8& <1.3 mmol/L	≥1.3& <1.8 mmol/L	≥1.8& <2.2 mmol/L	>2.2 mmol/L
2002	5679	1.9	0.5	1.8	1.5	2.2	1	12	34	27	26
2003	6588	1.8	0.5	1.8	1.5	2.2	2	13	36	26	24
2004	7620	1.8	0.5	1.8	1.5	2.2	1	14	37	25	23
2005	8834	1.8	0.5	1.7	1.4	2.1	2	16	38	25	19
2006	11129	1.8	0.5	1.7	1.4	2.1	1	17	39	25	18
2007	12424	1.8	0.5	1.7	1.4	2.1	1	16	40	25	18
2008	14874	1.7	0.5	1.7	1.4	2	1	17	41	24	17
2009	17246	1.8	0.5	1.7	1.4	2.1	1	15	40	26	18
2010	18880	1.8	0.5	1.7	1.4	2.1	1	15	40	26	19
2011	22127	1.8	0.5	1.7	1.4	2.1	1	15	40	26	18

Figure 9.2.3: Cumulative distribution of serum phosphate, HD patients, 2002-2011

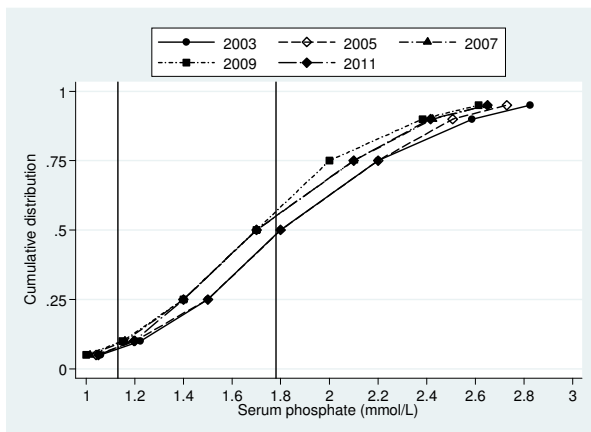


Figure 9.2.4: Cumulative distribution of serum phosphate, PD patients, 2002-2011

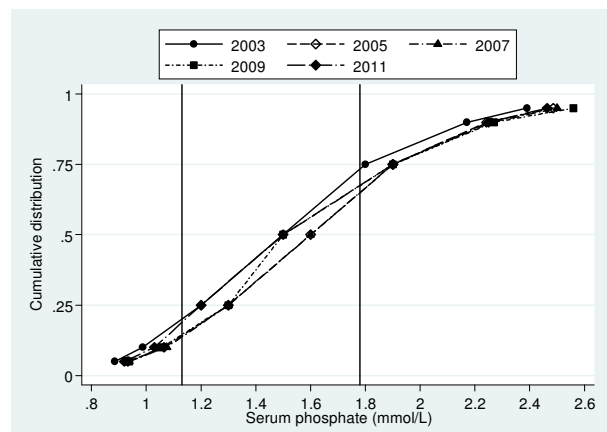


Table 9.2.4: Distribution of serum phosphate, PD patients, 2002-2011

Year	Number of patients	mean	SD	Median	LQ	UQ	% patients	% patients	% patients	% patients	% patients
							<0.8 mmol/L	≥0.8& <1.3 mmol/L	≥1.3& <1.8 mmol/L	≥1.8& <2.2 mmol/L	>2.2 mmol/L
2002	862	1.5	0.5	1.5	1.2	1.8	3	30	42	16	9
2003	1173	1.6	0.5	1.5	1.2	1.9	2	29	40	19	10
2004	1278	1.6	0.5	1.6	1.3	1.9	2	27	39	20	11
2005	1343	1.6	0.5	1.6	1.3	1.9	2	26	40	20	12
2006	1511	1.6	0.5	1.6	1.3	1.9	2	24	43	19	12
2007	1757	1.6	0.5	1.6	1.3	1.9	2	23	44	18	13
2008	2022	1.6	0.5	1.5	1.3	1.9	2	27	42	17	12
2009	2147	1.6	0.5	1.5	1.2	1.9	2	27	41	18	12
2010	2303	1.6	0.5	1.5	1.2	1.9	2	28	40	18	11
2011	2535	1.6	0.5	1.5	1.3	1.9	2	27	41	19	12

The corrected serum calcium phosphate product had remained relatively stable for last 5 years in both HD and PD patients. PD patients had better calcium phosphate product than HD patients. About 45% of PD patients had corrected calcium phosphate product <3.5 mmol²/L² compared to 36% in HD patients. Overall there was a positive trend in calcium phosphate product and fewer patients had corrected serum calcium phosphate product ≥5.5 mmol²/L². (Tables & Figures 9.2.5 and 9.2.6)

Table 9.2.5: Distribution of corrected calcium x phosphate product, HD patients 2002-2011

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
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	16713	4	1.2	3.9	3.2	4.7	36	34	20	11
2010	18535	4	1.2	3.9	3.2	4.8	34	34	21	11
2011	21543	4	1.2	3.9	3.2	4.7	36	34	20	11

Figure 9.2.5: Cumulative distribution of corrected calcium x phosphate product, HD patients 2002-2011

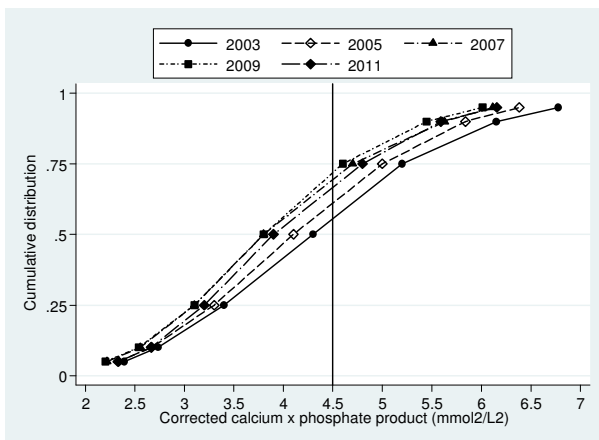


Figure 9.2.6: Cumulative distribution of corrected calcium x phosphate product, PD patients 2002-2011

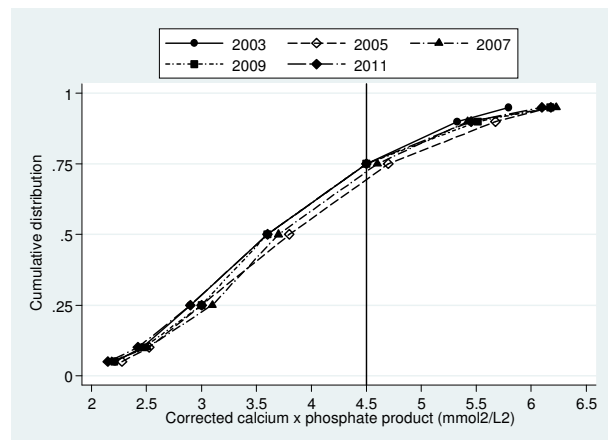


Table 9.2.6: Distribution of corrected calcium x phosphate product, PD patients 2002-2011

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
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
2011	2499	3.8	1.2	3.6	3	4.6	45	28	17	9

There was actually wider variation in serum calcium level among both HD and PD centres in 2011 even though the median calcium level remained static. In 2011, the median corrected serum calcium level among 496 HD centres was 2.3 mmol/L (ranged from 1.6 to 2.6 mmol/L), (Table and Figure 9.2.7a) and the median corrected serum calcium level among 27 PD centres was 2.4mmol/L (ranged from 2.1 to 2.5 mmol/L). (Table and Figure 9.2.8a) PD centres had slightly higher median corrected serum calcium level but smaller variation compared to HD centres. This is probably because there were more new HD centres than PD centres being set up each year.

Table 9.2.7(a): Variation in corrected median serum calcium level among HD centres 2002-2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2002	139	1.9	2.1	2.2	2.3	2.4	2.5	2.6
2003	171	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	233	1.8	2	2.2	2.3	2.4	2.4	2.5
2006	277	1.9	2.1	2.2	2.3	2.3	2.4	2.5
2007	315	1.8	2	2.2	2.3	2.3	2.4	2.5
2008	364	1.8	2.1	2.2	2.2	2.3	2.4	2.6
2009	398	1.5	2.1	2.2	2.3	2.3	2.4	2.6
2010	435	1.8	2.1	2.2	2.3	2.3	2.4	2.5
2011	496	1.6	2.1	2.2	2.3	2.3	2.4	2.6

Figure 9.2.7(a): Variation in median serum calcium among HD patients, HD centres, 2011

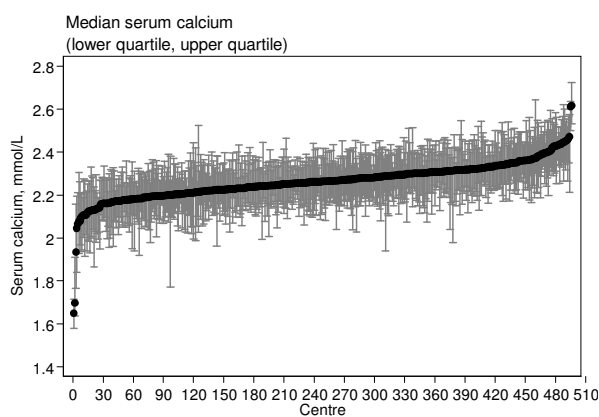


Figure 9.2.8(a): Variation in median serum calcium level among PD patients, PD centres, 2011

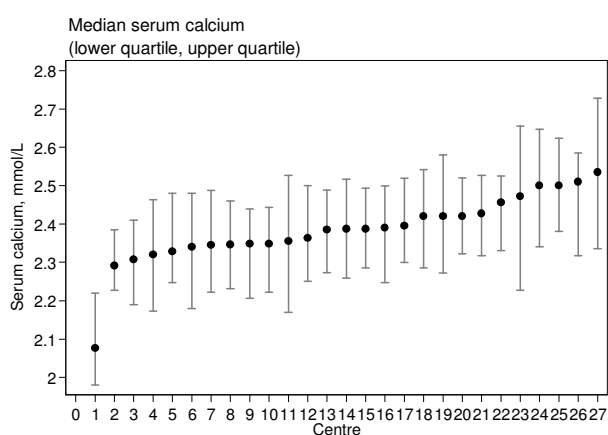


Table 9.2.8(a): Variation in corrected median serum calcium level among PD centres 2002-2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
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	2.5	2.6	2.6
2009	24	2.2	2.3	2.3	2.4	2.4	2.5	2.6
2010	25	2.2	2.3	2.3	2.4	2.5	2.5	2.5
2011	27	2.1	2.3	2.3	2.4	2.4	2.5	2.5

There was also large centre variation among the HD and PD centres with regards to the proportion of patients achieving normal range of corrected serum calcium level (2.1 to 2.37 mmol/L); it ranged from 0 to 89% for HD centres and 8-62% for PD centers for 2011. The median was 54% for HD centres and 37% for PD centres. The variation was smaller among PD centres compared to HD centres. (Tables and Figures 9.2.7b and 9.2.8b)

Table 9.2.7(b): Proportion of patients with serum calcium 2.1 to 2.37 mmol/L, HD centres, 2002- 2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2002	139	5	17	33	43	53	69	71
2003	171	11	24	35	45	56	70	91
2004	203	7	22	37	47	58	72	83
2005	233	0	19	38	49	56	70	91
2006	277	13	30	42	50	59	73	90
2007	315	9	29	44	52	61	72	93
2008	364	8	29	46	54	60	73	100
2009	398	0	27	44	53	61	72	93
2010	435	6	32	44	53	61	72	93
2011	496	0	32	46	54	62	74	89

Figure 9.2.7(b): Variation in proportion of patients with serum calcium 2.1 to 2.37 mmol/L, HD centres, 2011

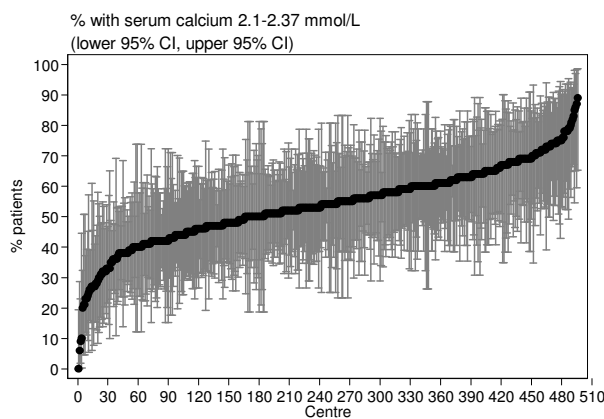


Figure 9.2.8(b): Variation in proportion of patients with serum calcium 2.1 to 2.37 mmol/L, PD centres, 2011

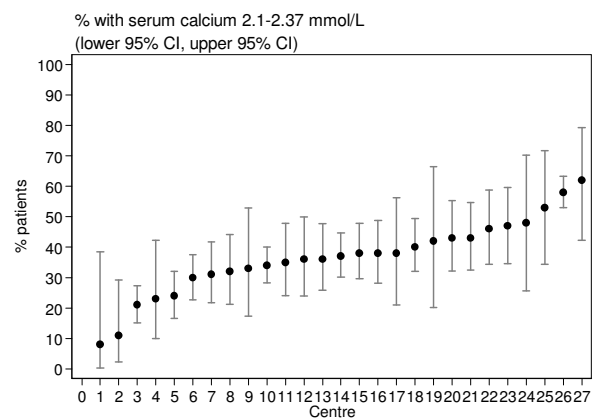


Table 9.2.8(b): Proportion of patients with serum calcium 2.1 to 2.37 mmol/L, PD centres

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
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	59	76
2007	22	19	23	33	45	50	62	63
2008	23	9	15	30	44	52	58	65
2009	24	12	13	30.5	41	51	58	63
2010	25	15	18	28	35	50	57	58
2011	27	8	11	31	37	43	58	62

Similarly, there was also wide centre variation in serum phosphate level among HD and PD centres. Again, there was smaller centre variation among PD centres compared to HD centres. Median serum phosphate level for PD centres was 1.6mmol/l (ranged from 1.3 to 1.9 mmol/l) as opposed to median phosphate level of 1.8mmol/l (ranged from 1.0 to 2.5mmol/l) in HD centres. (Tables and Figures 9.2.9a and 9.2.10a)

Table 9.2.9(a): Variation in median serum phosphate level among HD centres, 2002- 2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2002	147	1.3	1.5	1.8	1.9	2	2.2	2.4
2003	176	0.9	1.5	1.7	1.8	1.9	2.2	2.4
2004	208	1.4	1.5	1.7	1.8	1.9	2.1	2.4
2005	234	0.9	1.4	1.6	1.7	1.9	2	2.2
2006	282	1	1.5	1.6	1.7	1.8	2.1	2.2
2007	317	1.1	1.4	1.6	1.7	1.8	2	2.3
2008	368	1.1	1.4	1.6	1.7	1.8	2	2.5
2009	404	1.1	1.5	1.6	1.7	1.8	2	2.3
2010	441	1.3	1.5	1.6	1.7	1.9	2	2.8
2011	498	1	1.5	1.6	1.8	1.8	2	2.5

Figure 9.2.9(a): Variation in median serum phosphate level among HD patients, HD centres, 2011

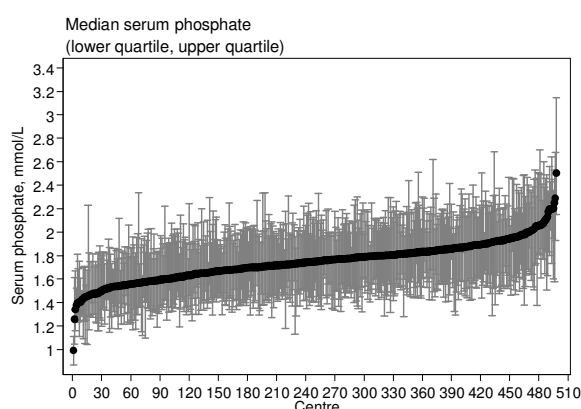


Figure 9.2.10(a): Variation in median serum phosphate level among PD patients, PD centres 2011

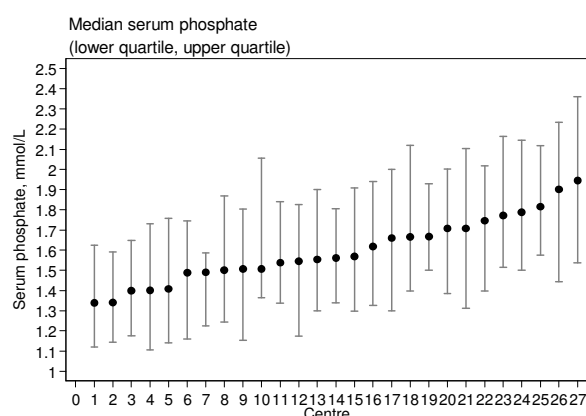


Table 9.2.10(a): Variation in median serum phosphate levels among PD centres 2002-2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
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	1.8	1.9
2008	23	1.3	1.4	1.5	1.6	1.8	1.8	2.1
2009	24	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	1.9
2011	27	1.3	1.3	1.5	1.6	1.7	1.9	1.9

There was also wide centre variation among both the HD and PD centres with regards to the proportion of patients achieving the recommended serum phosphate level of 1.13 – 1.78 mmol/L; this ranged from 0 to 100% among HD centres (median 47%) and the range was narrower in PD centres, which was 35-81% (median 53%). (Tables and Figures 9.2.9b and 9.2.10b).

Table 9.2.9(b): Proportion of patients with serum phosphate 1.13-1.78 mmol/L, HD centres, 2002-2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2002	147	9	17	29	36	47	66	90
2003	176	9	19	31	40	48	64	92
2004	208	0	18	31	41	50	68	92
2005	234	11	25	36	43	53	71	90
2006	282	14	26	39	45.5	54	68	88
2007	317	18	28	39	47	55	67	92
2008	368	12	28	39	48	56	67	93
2009	404	7	27	38	47	53	65	81
2010	441	4	24	38	46	54	65	82
2011	498	0	26	38	47	54	68	100

Figure 9.2.9(b): Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, HD centres, 2011

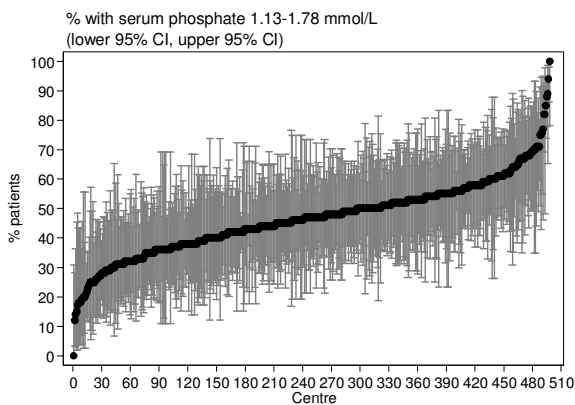


Figure 9.2.10(b): Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2011

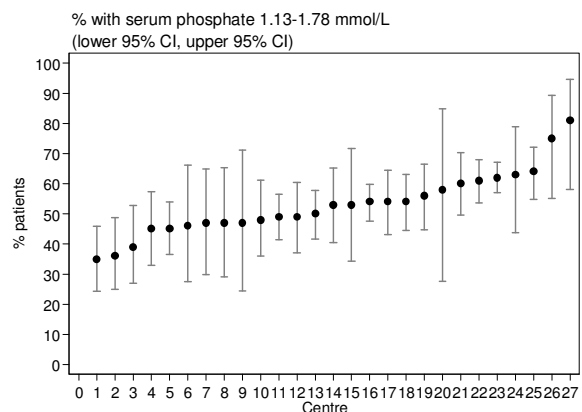


Table 9.2.10(b): Proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2002-2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	9 th Centile	Max
2002	15	43	43	47	53	60	83	83
2003	18	43	43	52	54	58	77	77
2004	18	37	37	49	53	59	76	76
2005	19	38	38	46	53	58	76	76
2006	22	39	44	48	52.5	58	66	68
2007	22	39	43	50	54	57	73	78
2008	23	30	39	48	52	60	65	71
2009	24	20	39	48.5	52.5	57	66	75
2010	25	35	38	44	50	58	66	69
2011	27	35	36	47	53	60	75	81

KDIGO published in 2009 recommended to lower the elevated phosphate level toward the normal range (0.8-1.3 mmol/L). If we use this recommended phosphate range, the centres variation ranged 0% to 83% (median 14%) for HD centres and 0% to 47% (median 22%) for PD centres with median of only 14% and 22% respectively. (Tables and Figures 9.2.9c and 9.2.10c)

Table 9.2.9(c): Proportion of patients with serum phosphate 0.8-1.3 mmol/L, HD centres, 2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2002	147	0	0	6	12	18	28	56
2003	176	0	0	7	12	17.5	31	45
2004	208	0	0	7	13	18.5	29	46
2005	234	0	0	8	15	21	32	52
2006	282	0	3	9	15	22	33	50
2007	317	0	3	10	16	21	31	48
2008	368	0	3	9	15	22	33	55
2009	404	0	0	9	14	20.5	31	41
2010	441	0	0	8	14	19	29	47
2011	498	0	0	9	14	19	30	83

Figure 9.2.9(c): Variation in proportion of patients with serum phosphate 0.8-1.3 mmol/L, HD centres, 2011

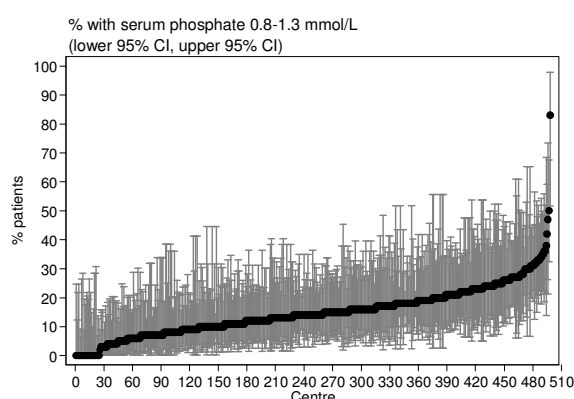


Figure 9.2.10(c): Variation in proportion of patients with serum phosphate 0.8-1.3 mmol/L, PD centres 2011

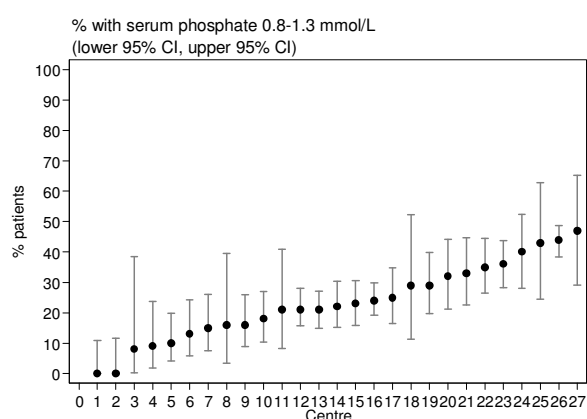


Table 9.2.10(c): Proportion of patients with serum phosphate 0.8-1.3 mmol/L, PD centres, 2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2002	15	0	0	18	30	36	50	50
2003	18	12	12	23	28	34	42	42
2004	18	8	8	17	25.5	32	48	48
2005	19	8	8	16	25	29	44	44
2006	22	0	0	14	18	25	35	54
2007	22	4	4	18	19	25	34	43
2008	23	4	7	19	23	30	36	47
2009	24	4	9	19	25	30.5	43	46
2010	25	4	8	15	25	32	43	44
2011	27	0	0	15	22	33	44	47

In 2011, the corrected serum calcium- phosphate product among 495 HD centres ranged from 2.0 to 5.6 with median of 3.9 mmol/L. The corrected serum calcium- phosphate product among 27 CAPD centres ranged from 3.0 to 4.6 mmol/L with median of 3.8 mmol/L. There was wider variation in corrected serum calcium- phosphate product among HD centres compared to PD centres and the degree of variation remained wide for last 10 years with no sign of improvement despite availability of greater variety of phosphate binders in Malaysia for past 5 years. (Tables & Figures 9.2.11a and 9.2.12a)

Table 9.2.11: Variation in corrected median calcium x phosphate product HD centres 2002-2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2002	139	2.9	3.5	4	4.3	4.6	5.1	6
2003	171	2.2	3.3	3.8	4.1	4.5	4.9	5.5
2004	202	2.9	3.3	3.8	4.1	4.4	4.9	5.6
2005	226	2.1	3.2	3.6	3.9	4.2	4.8	5.6
2006	275	2.1	3.2	3.6	3.9	4.1	4.6	5.2
2007	313	2.5	3.2	3.6	3.8	4.1	4.5	5
2008	362	2.4	3.2	3.6	3.8	4.1	4.5	5.7
2009	396	2.6	3.3	3.6	3.9	4.1	4.7	5.9
2010	434	2.8	3.4	3.7	3.9	4.2	4.7	6.3
2011	495	2	3.3	3.7	3.9	4.2	4.7	5.6

Figure 9.2.11(a): Variation in median corrected calcium x phosphate product among HD patients, HD centres, 2011

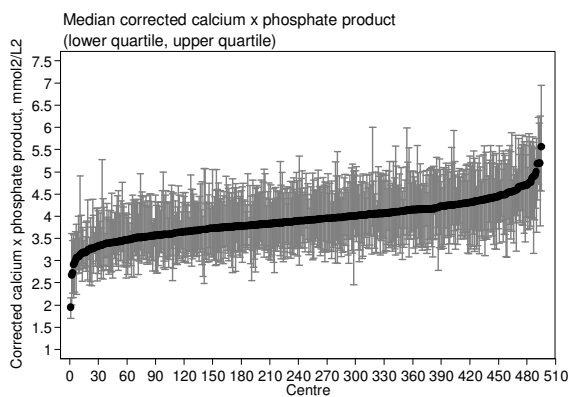


Figure 9.2.12(a): Variation in median corrected calcium x phosphate product among PD centres, to 2011

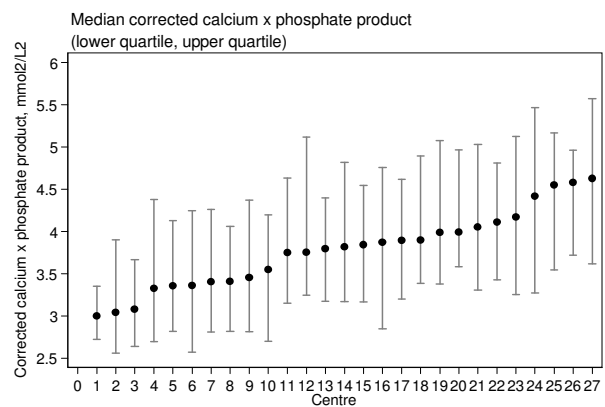


Table 9.2.12(a): Variation in corrected median calcium x phosphate product PD centres 2002-2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
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	3.1	3.4	3.7	4.1	4.6	5.1
2009	24	3.3	3.3	3.5	3.7	4	4.6	4.8
2010	25	3.1	3.2	3.4	3.8	4	4.5	4.6
2011	27	3	3	3.4	3.8	4.1	4.6	4.6

With regards to the proportion of patients with corrected serum calcium- phosphate product less than $4.5 \text{ mmol}^2/\text{L}^2$, the median was 70% for HD centres and 71% for PD centres. There was again a wide variation between HD centres with regards to the proportion of patients with calcium- phosphate product less than $4.5 \text{ mmol}^2/\text{L}^2$; it ranged from 23% to 100%. This variation was smaller among the PD centres, which ranged from 45% to 95% (Tables & Figures 9.2.11b and 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
2002	139	18	32	48	57	67	90	100
2003	171	25	33	50	61	71	84	100
2004	202	15	39	53	63	71	88	100
2005	226	24	45	58	68	77	91	100
2006	275	30	46	62	70	79	91	100
2007	313	33	48	63	73	81	92	100
2008	362	26	50	64	72	81	90	100
2009	396	27	44	62	70.5	79	89	96
2010	434	8	43	60	70	77	88	94
2011	495	23	47	61	70	79	90	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 2011

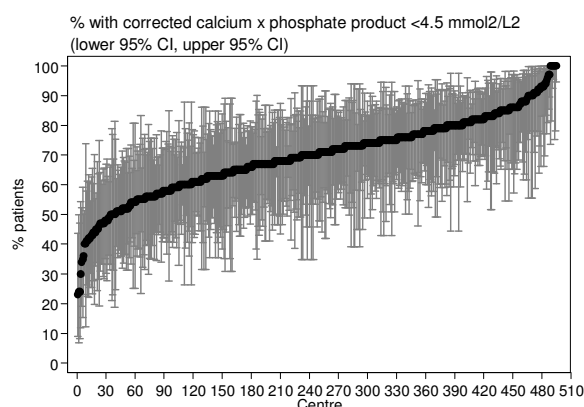


Figure 9.2.12(b): Variation in proportion of patients with corrected calcium x phosphate product $< 4.5 \text{ mmol}^2/\text{L}^2$, PD centres, 2011

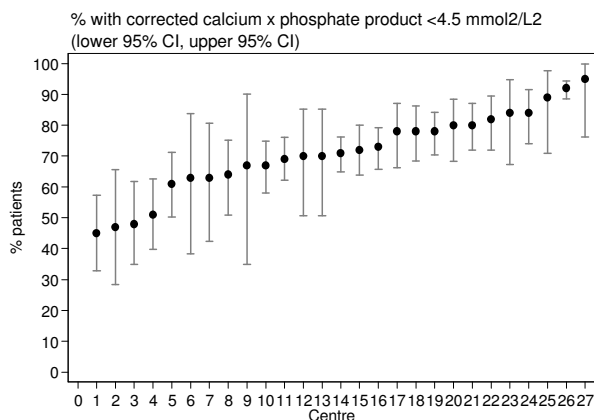


Table 9.2.12(b): Proportion of patients with corrected calcium x phosphate $< 4.5 \text{ mmol}^2/\text{L}^2$, PD

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
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	52	56	67	71	79	88	96
2007	22	51	58	64	72.5	79	88	98
2008	23	40	43	63	71	81	89	97
2009	24	40	48	66	76.5	80	85	86
2010	25	48	48	68	75	81	89	89
2011	27	45	47	63	71	80	92	95

SECTION 9.3: SERUM PARATHYROID HORMONE CONTROL

Calcitriol remained the main Vitamin D used in treatment of hyperparathyroidism for both HD and PD patients. The percentage of patients taking calcitriol had increased in both HD and PD patients since 2002 from 23% and 15% respectively to 46% and 35% in 2011. The use of Paricalcitol had also increased slowly among HD patients from 0.29% in 2006 to 0.58% in 2011 and also among PD patients from 0.21% in 2006 to 0.47% in 2011. The number of patients who had undergone parathyroidectomy had shown a downward trend since 2006 for both HD and PD patients from 1.3% and 0.97% in 2006 to 0.78% and 0.49% in 2011 respectively. More HD patients underwent parathyroidectomy than PD patients. (Tables 9.3.1 a & b)

Table 9.3.1(a): Treatment of hyperparathyroidism in HD patients, 2002-2011

Year	Number of patients	Number of patients on calcitriol		Number of patients on Paricalcitol		Number of patients had Para-thyroidectomy	
		n	%	n	%	n	%
2002	6108	1375	23	0	0	0	0
2003	7018	1690	24	0	0	0	0
2004	8164	2029	25	0	0	0	0
2005	9351	2556	27	0	0	43	0
2006	11682	3817	33	34	0	152	1
2007	12907	4927	38	58	0	181	1
2008	15399	5897	38	43	0	174	1
2009	17968	7339	41	82	0	167	1
2010	19509	8561	44	154	1	170	1
2011	22742	10486	46	132	1	178	1

Table 9.3.1(b): Treatment of hyperparathyroidism in PD patients, 2002-2011

Year	Number of patients	Number of patients on calcitriol		Number of patients on Paricalcitol		Number of patients had Para-thyroidectomy	
		n	%	n	%	n	%
2002	891	130	15	0	0	0	0
2003	1543	311	20	0	0	0	0
2004	1842	439	24	0	0	0	0
2005	2207	534	24	0	0	8	0
2006	2787	658	24	6	0	27	1
2007	3577	1019	28	9	0	22	1
2008	4044	1148	28	6	0	26	1
2009	3482	1129	32	5	0	16	0
2010	3844	1467	38	4	0	11	0
2011	5087	1800	35	24	0	25	0

The intact parathyroid hormone (iPTH) level had been increasing between 2002 to 2009 but it started to decrease for the first time in 2010 and continued to decrease further in 2011 for both HD and PD patients. HD patients had relatively lower level of iPTH level compared to PD patients. The mean iPTH level for HD patients was 222.9 pg/ml with the median of 86.9 pg/ml, and the mean was 248.4 pg/ml with the median of 157.5 pg/ml for PD patients. There was higher percentage of HD patients with iPTH level less than 150 pg/ml (61%) compared to PD patients (48%). However, there were more PD patients with iPTH \geq 150 & \leq 300 pg/ml than HD patients (22% vs. 14%). (Tables & Figures 9.3.2a and 9.3.3a)

Patients with diabetes had relatively lower iPTH level compared to patients without diabetes in both HD and PD populations, with the mean of 182.4 pg/ml vs. 258.1pg/ml for HD patients and 189.2 pg/ml vs. 277.6 pg/ml for PD patients. A greater percentage of diabetes patients had iPTH level less than 150 pg/ml compared to non-diabetes for both HD and PD patients. (Table and figure 9.3.2b, 9.3.2c, 9.3.3b and 9.3.3c)

Table 9.3.2(a): Distribution of iPTH, HD patients, 2002-2011

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 pg/ml	\geq 150 & \leq 300 pg/ml	>300 & \leq 500 pg/ml	>500 pg/ml
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	14364	235.6	319.3	98.5	30.5	319.8	58	15	11	15
2011	16712	222.9	312.6	86.9	29.2	302.4	61	14	12	14

Figure 9.3.2(a): Cumulative distribution of iPTH, HD, 2002-2011

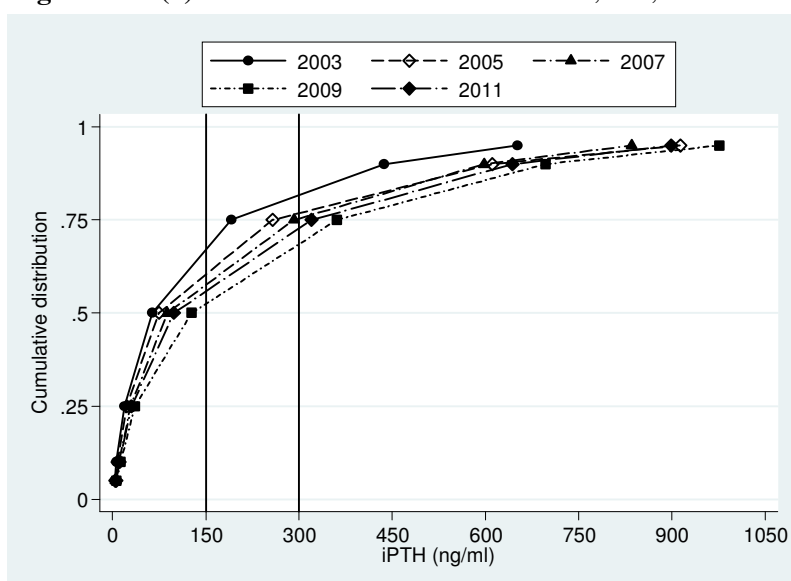


Table 9.3.2(b): Distribution of iPTH, diabetic HD patients, 2002-2011

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 pg/ml	≥150 & ≤300 pg/ml	>300 & ≤500 pg/ml	>500 pg/ml
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	3069	155	253.2	54	20.8	173.5	72	12	8	7
2007	3681	183.1	267.4	70.7	23	235.5	66	14	10	10
2008	4593	208.9	275.3	99	29.1	286.5	59	17	12	12
2009	5640	218.3	284.1	111.1	33.7	292	57	18	12	12
2010	6570	189.7	269	75	26	255.8	64	15	11	10
2011	7540	182.4	263.7	66.9	24.6	241.5	66	13	10	10

Figure 9.3.2(b): Cumulative distribution of iPTH, diabetic HD patients, 2002-2011

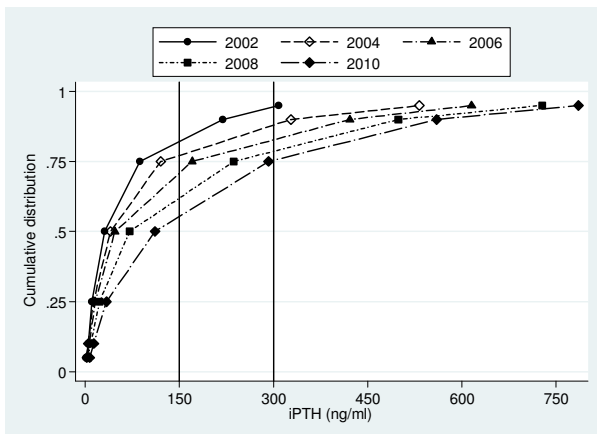


Figure 9.3.2(c): Cumulative distribution of iPTH, non-diabetic HD patients, 2002-2011

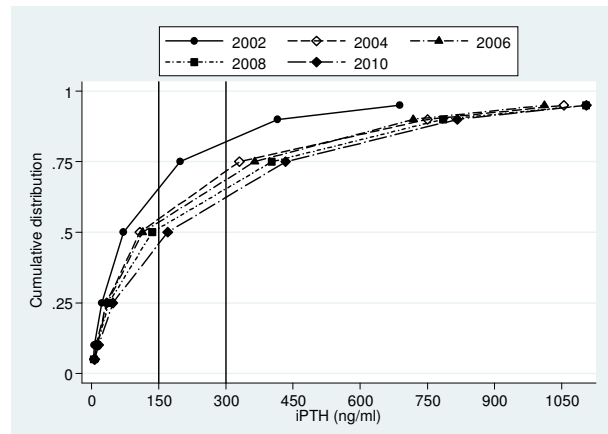


Table 9.3.2(c): Distribution of iPTH, non-diabetic HD patients, 2002-2011

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 pg/ml	≥150 & ≤300 pg/ml	>300 & ≤500 pg/ml	>500 pg/ml
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	4675	261.2	331.4	122.8	39	362.5	54	16	13	17
2007	5470	288	364.2	135.1	38.7	403	52	15	13	19
2008	6160	299.5	362.2	155	42.6	418	49	16	14	21
2009	7002	310.6	369.5	170.5	47.8	433.5	47	17	14	21
2010	7794	274.4	351.6	126.7	36.5	386	54	15	12	19
2011	8871	258.1	344.7	108.1	34.7	357.5	56	14	13	17

Table 9.3.3(a): Distribution of iPTH, PD patients 2002-2011

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 pg/ml	≥150 & ≤300 pg/ml	>300 & ≤500 pg/ml	>500 pg/ml
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
2011	2093	248.4	283.7	157.5	48.7	342	48	22	15	14

Figure 9.3.3(a): Cumulative distribution of iPTH, PD patients 2002-2011

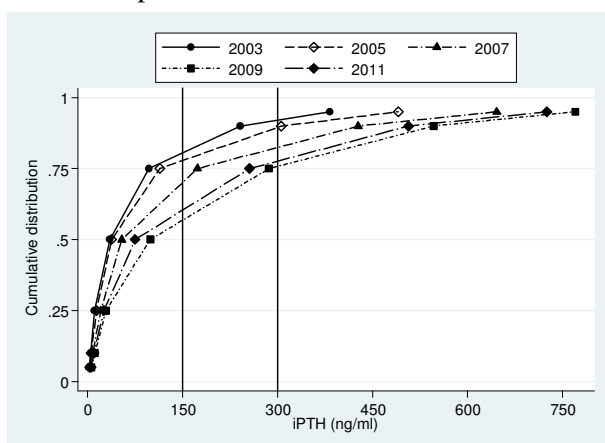


Figure 9.3.3(b): Cumulative distribution of iPTH, diabetic PD patients 2002-2011

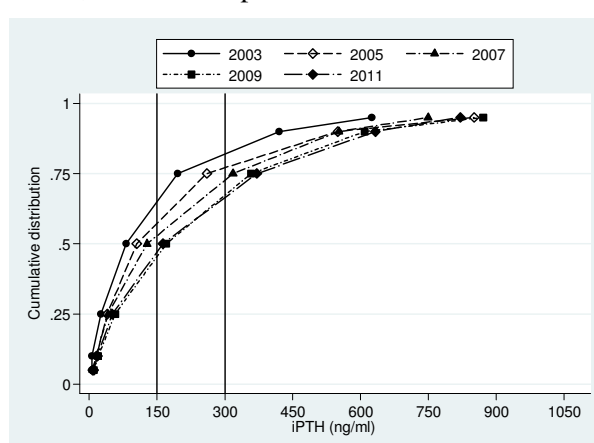


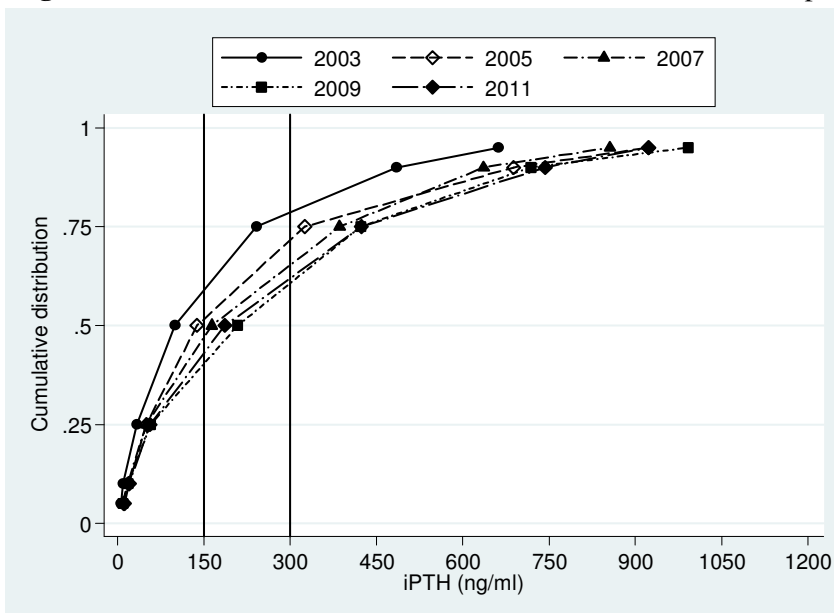
Table 9.3.3(b): Distribution of iPTH, diabetic PD patients 2002-2011

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 pg/ml	≥150 & ≤300 pg/ml	>300 & ≤500 pg/ml	>500 pg/ml
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
2011	653	189.2	208.2	128	44	272.5	54	24	16	6

Table 9.3.3(c): Distribution of iPTH, non diabetic PD patients, 2002-2011

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 pg/ml	≥150 & ≤300 pg/ml	>300 & ≤500 pg/ml	>500 pg/ml
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
2011	1387	277.6	307.7	182.7	55.6	387.5	45	22	16	17

Figure 9.3.3(c): Cumulative distribution of iPTH, non diabetic PD patients, 2002-2011



There was wide variation in iPTH level among HD centres and PD centres. The degree of variation seemed to become wider since 2002 especially among HD centres as compared to PD centres. (Tables & Figures 9.3.4a & 9.3.5a) With regards to the proportion of patients with serum iPTH level in the range 150-300 ng/ml, the median was 22% for PD centres and only 13% for HD centres (Tables & Figures 9.3.4b and 9.3.5b).

Table 9.3.4: Variation in iPTH among HD centres 2002-2011

Table 9.3.4(a): Median in iPTH among HD centres 2002-2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2002	95	1.4	11.9	28.4	50.4	139	309.8	660.3
2003	114	4.2	10	35.2	83.2	182.7	375.2	624.5
2004	137	3.6	12	30	73.8	211.5	398.8	708
2005	170	6.1	14.3	37	95.3	229	409.5	626.4
2006	219	7.7	15.9	42	88.8	201.6	377.6	632.8
2007	244	11.8	19	45.5	115.5	238.3	411.1	643
2008	292	8.8	22.4	58.3	138.5	239.1	417.3	712.5
2009	331	2.6	26.7	66.6	155	246.9	402.8	1073.9
2010	364	5.5	20.4	40.9	104.8	238.7	384.8	629
2011	429	3.3	19.1	41.8	92	224.8	420.1	1217.5

Figure 9.3.4(a): Variation in median iPTH among HD patients, HD centres 2011

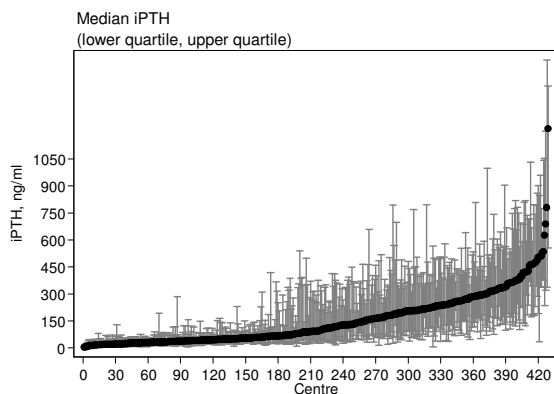


Figure 9.3.4(b): Variation in proportion of patients with iPTH 150-300pg/ml, HD centres, 2011

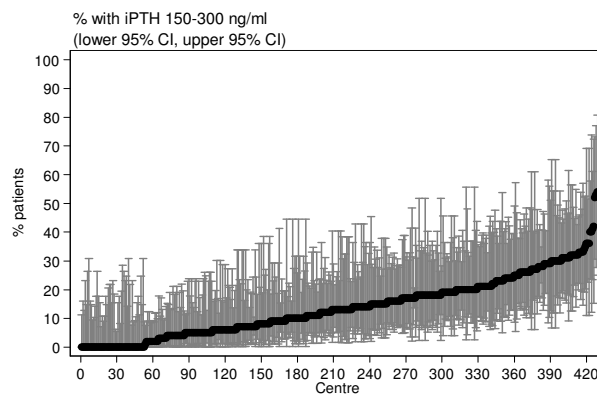


Table 9.3.4(b): Proportion of patients with iPTH 150-300pg/ml, HD centres, 2002-2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2002	95	0	0	0	10	22	32	45
2003	114	0	0	6	13.5	21	36	42
2004	137	0	0	6	10	19	36	50
2005	170	0	0	7	13	20	33	47
2006	219	0	0	7	13	20	30	46
2007	244	0	0	8	14	21	31	53
2008	292	0	0	9	16	23	31	43
2009	331	0	0	10	17	24	35	63
2010	364	0	0	7	15	21	34	43
2011	429	0	0	5	13	20	32	54

Table 9.3.5: Variation in iPTH among PD patients 2002-2011

Table 9.3.5(a): Median iPTH among PD patients 2002-2011

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
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	262	493.3	493.3
2006	21	35.3	36.9	102.5	166.5	243	367	376.8
2007	22	26.3	32	107.5	204.1	290.5	431	513.9
2008	22	34.5	47	120.3	185.9	310.9	352.3	450
2009	23	38.5	51	129.1	197.5	285.8	434.8	1047
2010	24	29.4	31.8	131.3	213.5	287.8	570.5	783.2
2011	25	25.9	26.8	94.3	199.1	281	421.5	477.6

Figure 9.3.5(a): Variation in median iPTH among PD patients, PD centres, 2011

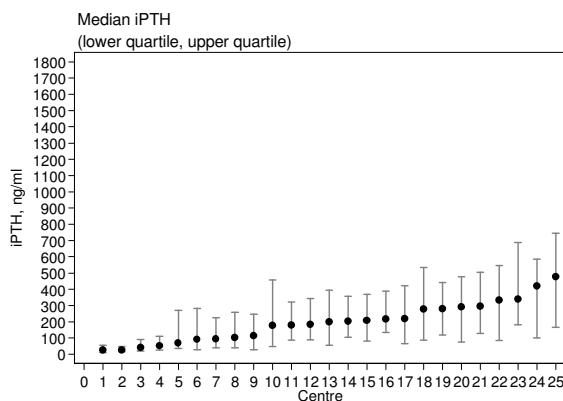


Figure 9.3.5(b): Variation in proportion of patients with iPTH 150-300pg/ml, PD centres 2011

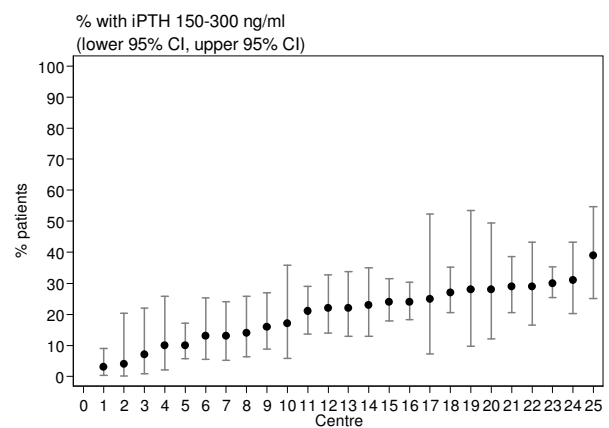


Table 9.3.5(b): Proportion of patients with iPTH 150-300pg/ml

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
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	32	40
2007	22	0	3	15	21	27	31	39
2008	22	0	7	15	19.5	27	31	34
2009	23	0	11	15	23	26	28	28
2010	24	0	4	13.5	20	26	31	43
2011	25	3	4	13	22	28	31	39

Conclusion

There were no major changes in the trend of phosphate binder usage among both HD and PD patients except there were small but definite increase in number of patients taking non-calcium non-aluminium based phosphate binders since 2006. About 91% of HD and 86% of PD patients are still taking calcium carbonate as phosphate binder in 2011 and this percentage had remained relatively constant for last 10 years. The use of lanthanum as phosphate binder continued to increase slowly since 2006 from 0.13% and 0.18% in 2006 to 2.26% and 3.46% in 2011 for both HD and PD patients respectively whereas the use of aluminium based phosphate binder continued to decrease for both HD and PD patients from 2.8% and 0.7% in 2002 to 0.15% and 0.16% in 2011 respectively. Slightly more PD patients are taking lanthanum compared to HD patients. Sevelamer was officially launched in May 2011 and its usage was about 0.39% among HD patients and 0.83% among PD patients.

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 phosphate control and lower calcium-phosphate product compared to HD patients, enabling more calcitriol to be used for iPTH suppression instead of paricalcitol.

The mean corrected serum calcium level remained slightly lower in the HD patients (2.3 mmol/L) compared to PD patients (2.4 mmol/L), however phosphate control remained better in CAPD patients with the mean phosphate level of 1.6mmol/L as opposed to 1.8mmol/L in HD patients. The median proportion of CAPD patients achieving target serum phosphate 1.13-1.78 mmol/l was 53% compared to 46% in HD patients. If we use KDIGO recommendation of target phosphate level (0.8-1.3 mmol/L), the median proportion of HD and PD patients who achieved this target was only 14% and 22% respectively. More PD patients had serum calcium phosphate product of less than 4.5 mmol²/L² compared with HD patients (median 75% vs. 69%) in 2011.

The intact parathyroid hormone (iPTH) level which had been on the rise since 2001 had peaked in 2009 and it started to decrease since 2010 for both HD and PD patients. In addition, the number of patients who underwent parathyroidectomy had continued to decrease since 2006 among both HD and PD patients. This reflects better awareness and management of mineral 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 had improved as reflected by reducing trend of iPTH level since 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 past 10 years. This could be partly due to additional new HD centers being set up every year and more new patients entering HD program than PD. These new HD patients might have abnormal serum calcium and phosphate level which had not been properly addressed during their earlier CKD stages, hence resulting in high phosphate and iPTH level at entry into the dialysis program. Therefore, we should strengthen our management of mineral bone disease in pre-dialysis stage, by paying more attention in correcting calcium-phosphate abnormality and emphasising patient education with regards to low phosphate dietary compliance.