Chapter - 9

CHRONIC KIDNEY DISEASE - MINERAL AND BONE DISORDER

Kok Lai Sun

Rozina Bt Ghazalli

Ching Chen Hua

Fan Kin Sing

Liew Yew Fong

SECTION 9.1: TREATMENT OF HYPERPHOSPHATAEMIA

Calcium carbonate remained as the main phosphate binder for both HD patients (92%) and PD patients (86%) in 2013. The second most commonly used phosphate binder was Lanthanum. Its usage had increased slowly since the introduction in 2006 and remained at 3% for both HD and PD patients. Sevelamer usage still remained low after its official launch in Malaysia in May 2011 with usage of 0.37% in HD patients and 0.71% in PD patients. The number of patients took aluminium based phosphate binder had decreased since 2004 for both HD (0.03%) and PD (0.06%) patients. (Tables 9.1.1 and 9.1.2)

Table 9.1.1: Phosphate Binder in HD patients, 2004-2013

Year	Number of patients	Number of patients On $CaCO_3$		Number of patients on $Al(OH)_3$		Number of patients On Lanthanum		Number of patients On Sevelamer Hcl	
		n	%	n	%	n	%	n	%
2004	8163	7408	91	106	1	0	0	0	0
2005	9350	8567	92	98	1	0	0	0	0
2006	11681	10775	92	71	1	15	0	0	0
2007	12907	11868	92	57	0	37	0	1	0
2008	15403	14145	92	72	0	86	1	3	0
2009	17977	16454	92	34	0	247	1	0	0
2010	19509	17805	91	27	0	377	2	6	0
2011	22296	20566	92	30	0	515	2	71	0
2012	25671	23655	92	12	0	647	3	82	0
2013	28899	26718	92	10	0	725	3	107	0

Table 9.1.2: Phosphate Binder in PD patients, 2004-2013

Year	Number of patients	Number of patients On $CaCO_3$		Number of patients on $Al(OH)_3$		Number of patients On Lanthanum		Number of patients On Sevelamer Hcl	
		n	%	n	%	n	%	n	%
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	4967	4287	86	8	0	176	4	24	0
2012	5752	4902	85	6	0	202	4	24	0
2013	6513	5584	86	4	0	221	3	46	1

The major used of Lanthanum and Sevelamer in 2013 was among the NGO patients. The usage of lanthanum from NGO had increased from 30% in 2011/2012 to 42% in 2013. Use of Lanthanum in public sector had also increased gradually from 2008 to 2011 (38%) but had decreased to 31% in 2013. For sevelamer usage, NGO centre was again the main user (68%) followed by government sector (23%) in 2013. Aluminium binder usage was minimal in both public and private sectors. (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	%
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**	**100**
2006	Public	6	40	0		41	58
	Private	1	7	0		21	30
	NGO	8	53	0		9	13
	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	26	36
	Private	19	22	0	0	12	17
	NGO	50	58	3	100	34	47
	TOTAL	**86**	**100**	**3**	**100**	**72**	**100**
2009	Public	89	36	0		10	29
	Private	61	25	0		7	21
	NGO	97	39	0		17	50
	TOTAL	**247**	**100**	**0**	**0**	**34**	**100**
2010	Public	144	38	2	33	18	67
	Private	109	29	0	0	5	19
	NGO	124	33	4	67	4	15
	TOTAL	**377**	**100**	**6**	**100**	**27**	**100**
2011	Public	222	43	10	14	19	63
	Private	134	26	23	32	2	7
	NGO	159	31	38	54	9	30
	TOTAL	**515**	**100**	**71**	**100**	**30**	**100**
2012	Public	244	38	10	12	3	25
	Private	183	28	8	10	0	0
	NGO	220	34	64	78	9	75
	TOTAL	**647**	**100**	**82**	**100**	**12**	**100**
2013	Public	228	31	25	23	4	40
	Private	192	26	9	8	5	50
	NGO	305	42	73	68	1	10
	TOTAL	**725**	**100**	**107**	**100**	**10**	**100**

SECTION 9.2: SERUM CALCIUM AND PHOSPHATE CONTROL

The median corrected serum calcium level had remained constant since 2004 for both HD (2.3 mmol/L) and PD (2.4 mmol/L) patients. 53% of HD patients achieved target serum calcium level of 2.1 to 2.37 mmol/L compared to only 42% of PD patients (Tables & Figures 9.2.1 and 9.2.2).

Table 9.2.1: Distribution of corrected serum calcium, HD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients ≥2.1 & ≤2.37 mmol/L
2004	7535	2.3	0.2	2.3	2.2	2.4	47
2005	8629	2.3	0.2	2.3	2.2	2.4	49
2006	10880	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	14481	2.3	0.2	2.3	2.1	2.4	53
2009	16858	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	21264	2.3	0.2	2.3	2.1	2.4	53
2012	24422	2.3	0.2	2.3	2.1	2.4	54
2013	27496	2.3	0.2	2.3	2.1	2.4	53

Figure 9.2.1: Cumulative distribution of corrected serum calcium, HD patients 2004-2013

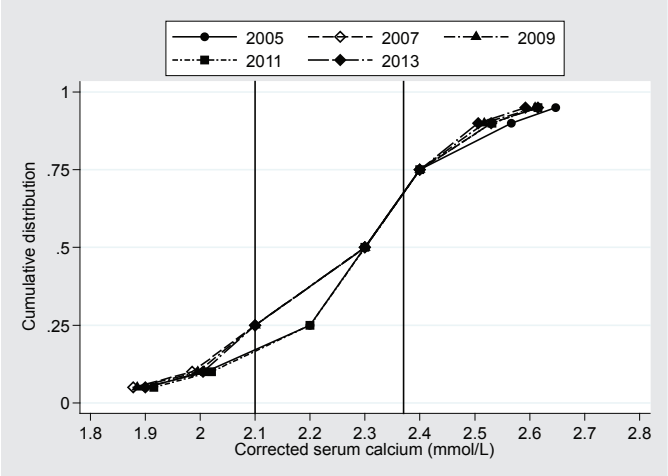

Figure 9.2.2: Cumulative distribution of corrected serum calcium, PD patients 2004-2013

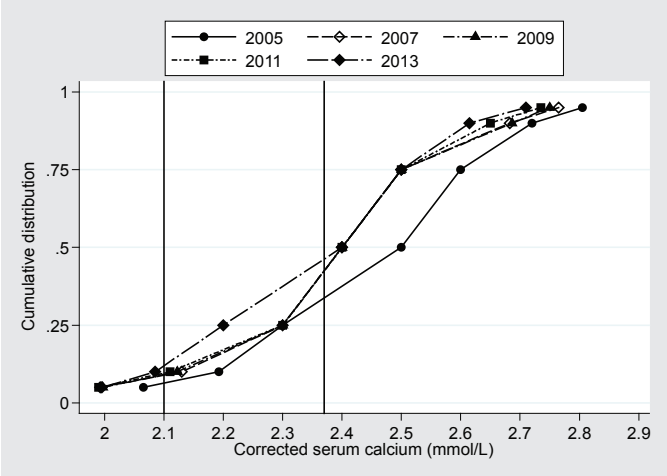

Table 9.2.2: Distribution of corrected serum calcium, PD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients ≥2.1 & ≤2.37 mmol/L
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	2448	2.4	0.2	2.4	2.3	2.5	38
2012	2787	2.4	0.2	2.4	2.2	2.5	42
2013	3159	2.3	0.2	2.3	2.2	2.5	42

PD patients had better phosphate control compared to HD patients (median level 1.5 vs 1.7mmol/L). About 26% of PD patients achieved target phosphate level recommended by KDIGO (0.8 to 1.3mmol/L) compared to only 16% in HD patients. About 43% PD patients achieved phosphate level of 1.3-1.8mmol/L and 42% HD achieved that level. Only 11% of PD patients have phosphate level ≥2.2 mmol/L as compared to HD patients (17% with phosphate level ≥ 2.2mmol/L). However, there was an improvement in HD patients since 2004 with a gradual decrease in the number of patients with phosphate ≥2.2moml/L whereas this rate was static in PD patients since 2004. (Tables & Figures 9.2.3 and 9.2.4)

Table 9.2.3: Distribution of corrected serum calcium, HD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percent patients with serum phosphate (mmol/L)				
							<0.8	≥0.8&<1.3	≥1.3&<1.8	≥1.8&<2.2	≥2.2
2004	7620	1.8	0.5	1.8	1.5	2.2	1	14	37	25	23
2005	8833	1.8	0.5	1.7	1.4	2.1	2	16	38	25	19
2006	11128	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	14877	1.7	0.5	1.7	1.4	2	1	17	41	24	17
2009	17254	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	21691	1.8	0.5	1.7	1.4	2.1	1	15	40	26	18
2012	24875	1.8	0.5	1.7	1.4	2	1	15	41	25	17
2013	28102	1.8	0.5	1.7	1.4	2	1	16	42	25	17

Figure 9.2.3: Cumulative distribution of serum phosphate, HD patients 2004-2013

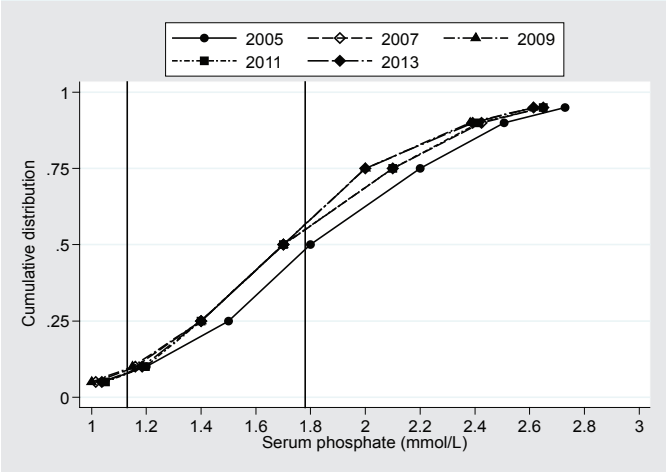

Figure 9.2.4: Cumulative distribution of serum phosphate, PD patients 2004-2013

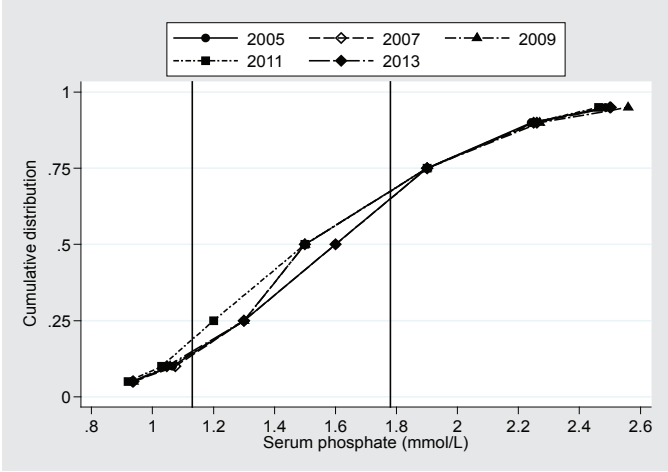

Table 9.2.4: Distribution of serum phosphate, PD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percent patients with serum phosphate (mmol/L)				
							<0.8	≥0.8&<1.3	≥1.3&<1.8	≥1.8&<2.2	≥2.2
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	2474	1.6	0.5	1.5	1.3	1.9	2	27	41	19	11
2012	2797	1.6	0.5	1.5	1.3	1.9	2	27	42	18	11
2013	3162	1.6	0.5	1.5	1.3	1.9	2	26	43	18	11

The corrected serum calcium phosphate product had remained relatively stable in both HD and PD patients. PD patients had better calcium phosphate product than HD patients. About 78% of PD patients had corrected calcium phosphate product <4.5 $mmol^2/L^2$ compared to 71% in HD patients. Overall there was a positive trend in calcium phosphate product and the percentage of patients with corrected serum calcium phosphate product ≥5.5 $mmol^2/L^2$ had remained less than 11% since 2005. (Tables and Figures 9.2.5 & 9.2.6)

Table 9.2.5: Distribution of corrected calcium x phosphate product, HD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percent patients with calcium phosphate product ($mmol^2/L^2$)			
							<3.5	>3.5 & <4.5	>4.5 & <5.5	≥5.5
2004	7414	4.2	1.3	4.1	3.3	5	32	32	22	15
2005	8495	4	1.3	3.9	3.2	4.8	36	32	20	12
2006	10757	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	14363	3.9	1.2	3.8	3.1	4.6	39	33	19	9
2009	16721	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	21114	4	1.2	3.9	3.2	4.7	36	34	20	10
2012	24204	4	1.1	3.8	3.2	4.6	37	34	19	10
2013	27283	3.9	1.1	3.8	3.2	4.6	37	34	19	9

Figure 9.2.5: Cumulative distribution of corrected calcium x phosphate product, HD patients 2004-2013

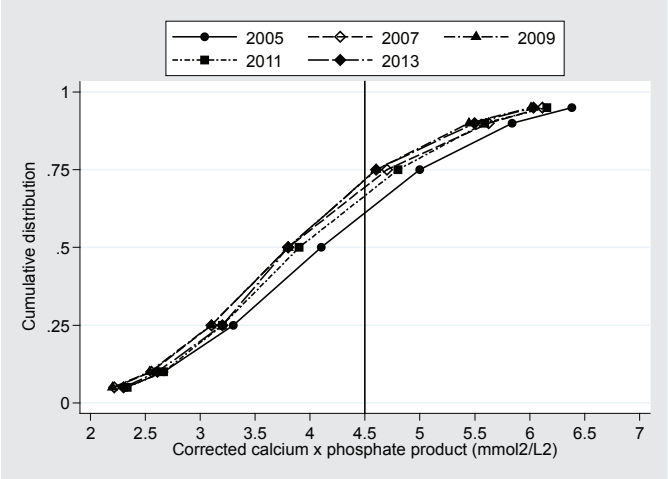

Figure 9.2.6: Cumulative distribution of corrected calcium x phosphate product, PD patients 2004-2013

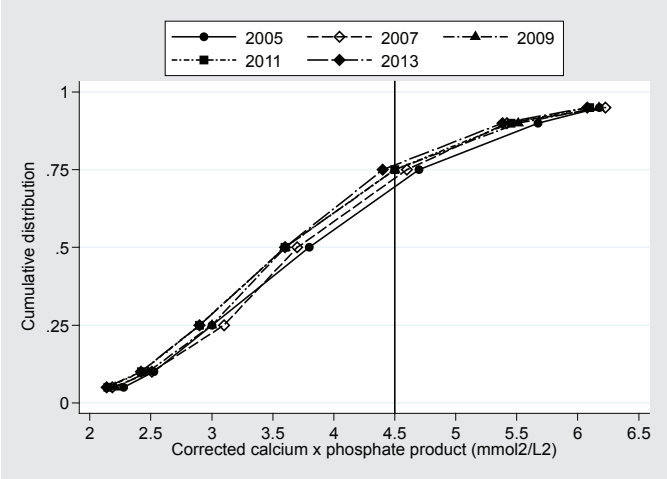

Table 9.2.6: Distribution of corrected calcium x phosphate product, PD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percent patients with calcium phosphate product ($mmol^2/L^2$)			
							<3.5	>3.5 & <4.5	>4.5 & <5.5	≥5.5
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	2441	3.8	1.2	3.6	2.9	4.5	46	29	16	9
2012	2778	3.8	1.2	3.6	2.9	4.4	48	29	15	9
2013	3139	3.7	1.2	3.5	2.9	4.4	49	29	14	8

In year 2013, corrected median serum calcium level was 2.3mml/L in HD and PD patients. The variation in corrected serum calcium level among both HD and PD centres remained wide in 2013. (Table and Figure 9.2.7a & 9.2.8a)

Table 9.2.7(a): Variation in corrected median serum calcium level among HD centres 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	203	1.9	2.1	2.2	2.3	2.4	2.4	2.5
2005	230	1.8	2	2.2	2.3	2.4	2.4	2.5
2006	276	1.9	2.1	2.2	2.3	2.3	2.4	2.5
2007	312	1.8	2	2.2	2.2	2.3	2.4	2.5
2008	360	1.8	2.1	2.2	2.3	2.3	2.4	2.6
2009	410	1.5	2.1	2.2	2.3	2.3	2.4	2.6
2010	441	1.8	2.1	2.2	2.3	2.3	2.4	2.5
2011	504	1.7	2.1	2.2	2.3	2.3	2.4	2.6
2012	549	2	2.1	2.2	2.3	2.3	2.4	2.6
2013	603	2	2.1	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 2013

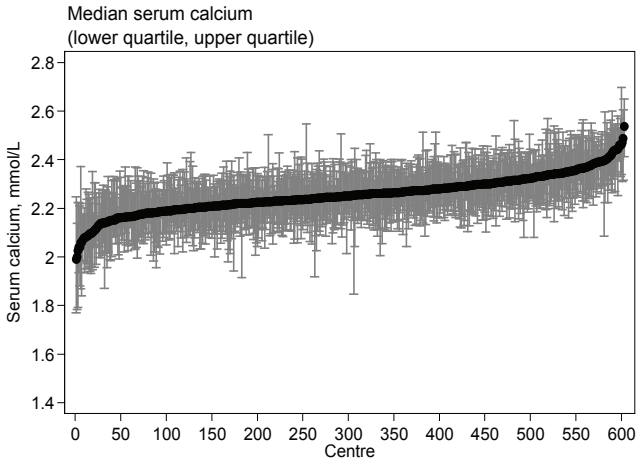

Figure 9.2.8(a): Variation in median serum calcium level among PD patients, PD centres 2013

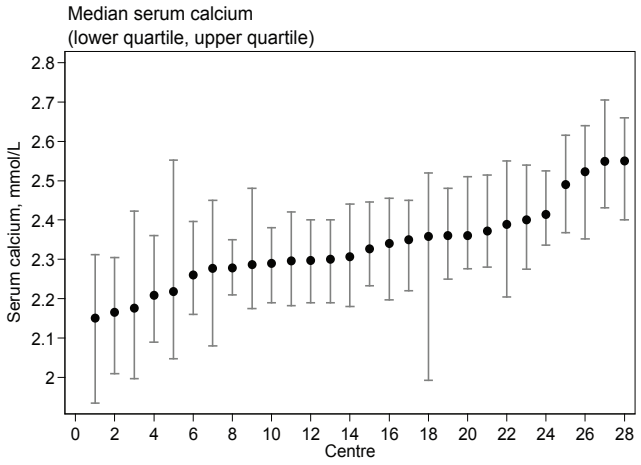

Table 9.2.8(a): Variation in corrected median serum calcium level among PD centres 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
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	2.4	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	24	2.2	2.2	2.3	2.4	2.5	2.6	2.6
2009	25	2.2	2.3	2.3	2.4	2.4	2.5	2.6
2010	26	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	2.6
2012	28	2.2	2.2	2.3	2.3	2.4	2.5	2.6
2013	28	2.2	2.2	2.3	2.3	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 achieved normal range of corrected serum calcium level (2.1 to 2.37 mmol/L); it ranged from 8 to 90% for HD centres and 10-70% for PD centers in 2013. The median was 55% for HD centres and 41.5% for PD centres. The variation was smaller among PD centres compared to HD centres. (Tables and Figures 9.2.7b & 9.2.8b)

Table 9.2.7(b): Proportion of patients with serum calcium 2.1 to 2.37 mmol/L, HD centres, 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	203	8	22	38	47	58	72	83
2005	230	0	21	39	49	57	70	91
2006	276	13	32	42	50	59	71	90
2007	312	9	30	44	52	60.5	72	93
2008	360	8	28	46	54	61	73.5	90
2009	410	0	29	43	53	60	73	86
2010	441	0	31	44	52	61	73	94
2011	504	0	32	46	54.5	62	74	90
2012	549	8	33	47	55	63	75	92
2013	603	8	33	46	55	63	73	90

Figure 9.2.7(b): Variation in proportion of patients with serum calcium 2.1 to 2.37 mmol/L, HD centres 2013

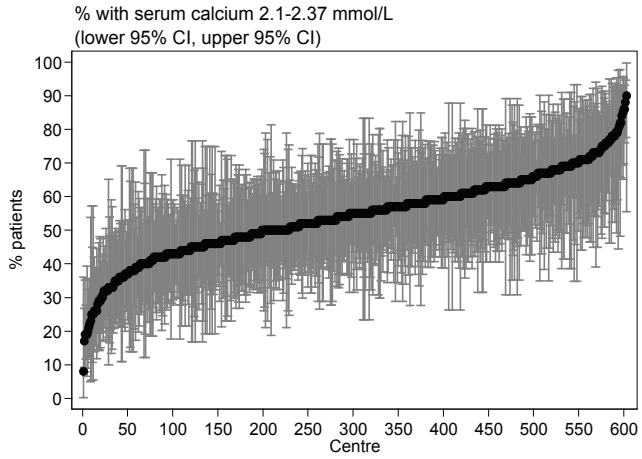

Figure 9.2.8(b): Variation in proportion of patients with serum calcium 2.1 to 2.37 mmol/L, PD centres 2013

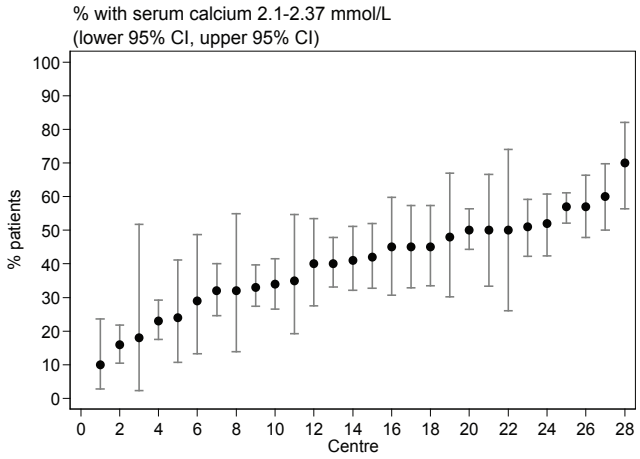

Table 9.2.8(b): Proportion of patients with serum calcium 2.1 to 2.37 mmol/L, PD centres

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	18	11	11	18	25.5	29	53	53
2005	19	17	17	25	35	43	51	51
2006	22	15	25	34	44.5	50	60	76
2007	22	19	24	33	45	51	62	63
2008	24	5	15	31	40.5	50	58	65
2009	25	12	13	29	40	51	58	63
2010	26	13	16	27	34.5	50	56	57
2011	27	8	13	31	38	46	58	63
2012	28	8	9	31.5	40.5	52	60	71
2013	28	10	16	32	41.5	50	60	70

Median serum phosphate level for HD centres was 1.7mmol/L (ranged from 1.3 to 1.9mmol/L) as opposed to median phosphate level of 1.6mmol/L (ranged from 1.1 to 2.6mmol/L) in PD centres. There was wide centre variation in serum phosphate level among HD and PD centres. Similarly, the variation was smaller among PD centres compared to HD centres. (Tables and Figures 9.2.9a & 9.2.10a)

Table 9.2.9(a): Variation in median serum phosphate level among HD centres, 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	208	1.4	1.5	1.7	1.8	1.9	2.1	2.4
2005	231	0.8	1.4	1.6	1.7	1.8	2	2.4
2006	282	1	1.5	1.6	1.7	1.8	2	2.3
2007	316	1.1	1.4	1.6	1.7	1.8	2	2.3
2008	367	1.1	1.4	1.6	1.7	1.8	2	2.5
2009	417	1.2	1.5	1.6	1.7	1.8	2	2.5
2010	447	1.3	1.5	1.7	1.8	1.8	2.1	3
2011	507	1	1.5	1.6	1.8	1.8	2	2.4
2012	561	1.1	1.5	1.6	1.7	1.8	2	2.6
2013	606	1.3	1.5	1.6	1.7	1.8	2	2.4

Figure 9.2.9(a): Variation in median serum phosphate level among HD patients, HD centres 2013

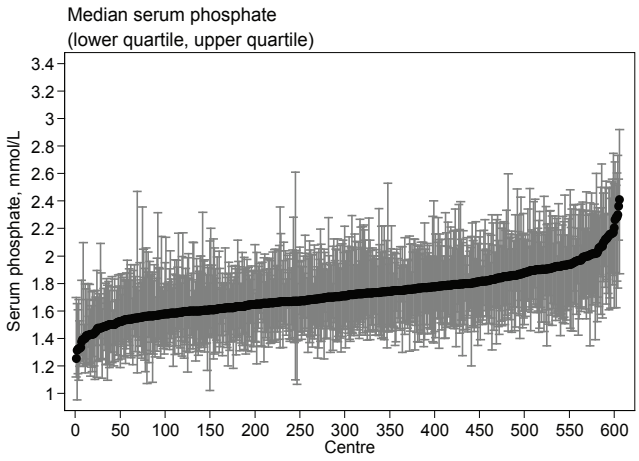

Figure 9.2.10(a): Variation in median serum phosphate level among PD patients, PD centres 2013

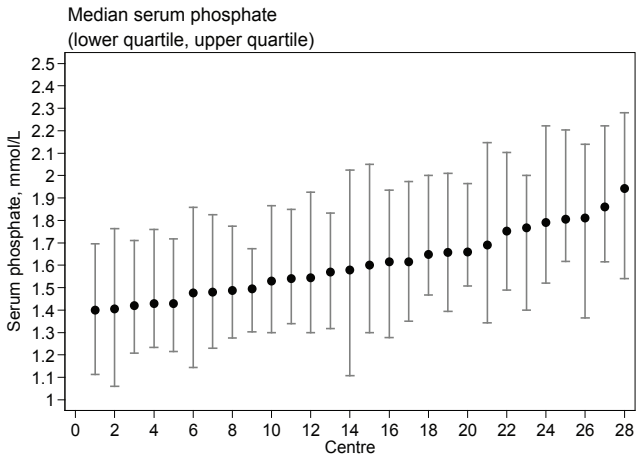

Table 9.2.10(a): Variation in median serum phosphate levels among PD centres 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	18	1.3	1.3	1.5	1.5	1.7	1.9	1.9
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	24	1.2	1.3	1.5	1.6	1.8	1.9	2.1
2009	25	1.3	1.4	1.5	1.6	1.7	1.8	2.2
2010	26	1.3	1.3	1.4	1.6	1.7	1.9	1.9
2011	27	1.3	1.3	1.5	1.6	1.7	1.8	1.9
2012	28	1.3	1.4	1.5	1.6	1.7	1.8	1.8
2013	28	1.4	1.4	1.5	1.6	1.7	1.9	1.9

There was also wide centre variation among 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 7 to 84% among HD centres (median 48%) and the range was narrower in PD centres, which was 28-78% (median 50%). (Tables and Figures 9.2.9b & 9.2.10b)

Table 9.2.9(b): Proportion of patients with serum phosphate 1.13-1.78 mmol/L, HD centres 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	208	0	18	31.5	40	50	68	92
2005	231	12	25	37	44	54	69	90
2006	282	14	26	38	46	54	70	87
2007	316	19	27	39	46	55	67	92
2008	367	10	28	41	48	56	67	87
2009	417	8	27	39	46	53	67	80
2010	447	0	24	37	46	54	67	74
2011	507	9	26	38	47	54	68	93
2012	561	8	28	40	47	55	68	89
2013	606	7	27	40	48	57	68	84

Figure 9.2.9(b): Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, HD centres 2013

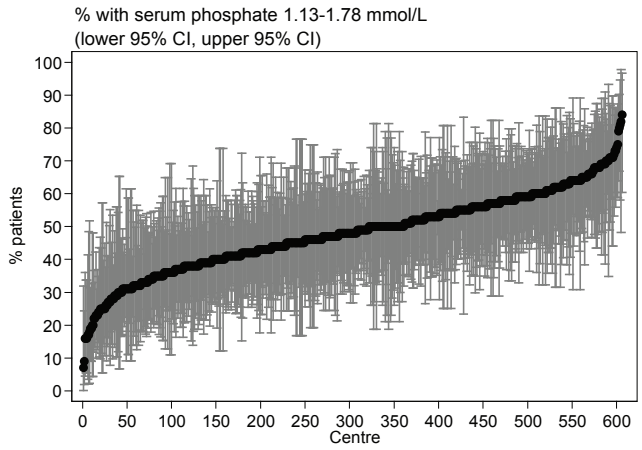

Figure 9.2.10(b): Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2013

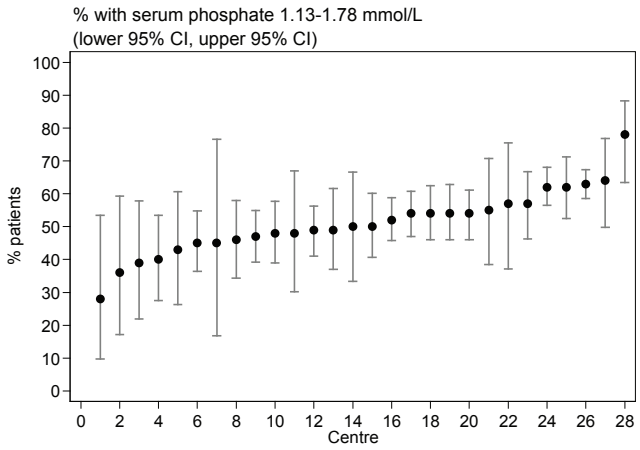

Table 9.2.10(b): Proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	18	38	38	49	52.5	60	76	76
2005	19	38	38	46	53	58	76	76
2006	22	41	44	48	52	58	66	68
2007	22	41	43	48	54.5	56	73	79
2008	24	30	39	48	52.5	59	66	71
2009	25	20	40	48	51	56	62	73
2010	26	33	38	45	51.5	60	67	68
2011	27	35	42	47	51	60	75	81
2012	28	26	36	48	52	59.5	63	72
2013	28	28	36	45.5	50	56	64	78

Proportion of patients with serum phosphate 0.8-1.3mmol/L (KDIGO recommended level) was higher in PD patients with median of 24% as compared to 14.5% in HD patients. The centre variation ranged 0% to 50% for HD centres and 5% to 36% for PD centres. (Tables and Figures 9.2.9c & 9.2.10c)

Table 9.2.9(c): Proportion of patients with serum phosphate 0.8-1.3 mmol/L, HD centres 2013

Year	Number of centres	Min	5C Centile	LQ	Median	UQ	95th Centile	Max
2004	208	0	0	7.5	13	18.5	29	46
2005	231	0	0	8	15	21	32	52
2006	282	0	3	9	15	22	33	53
2007	316	0	3	10	16	21	32	45
2008	367	0	2	9	15	22	35	60
2009	417	0	0	9	14	20	33	42
2010	447	0	0	8	14	19	29	43
2011	507	0	0	9	14	20	30	83
2012	561	0	3	8	14	20	29	42
2013	606	0	3	9	14.5	20	32	50

Figure 9.2.9(c): Variation in proportion of patients with serum phosphate 0.8-1.3 mmol/L, HD centres 2013

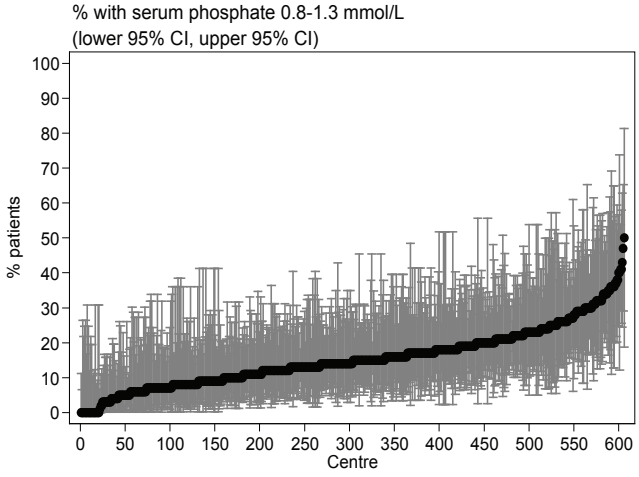

Figure 9.2.10(c): Variation in proportion of patients with serum phosphate 0.8-1.3 mmol/L, PD centres 2013

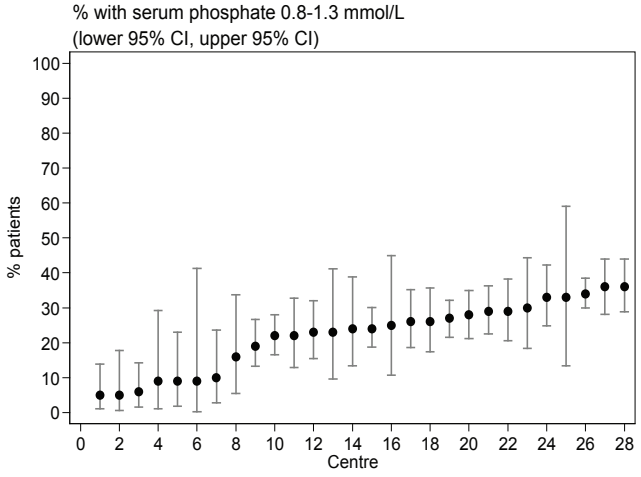

Table 9.2.10(c): Proportion of patients with serum phosphate 0.8-1.3 mmol/L, PD centres 2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	18	8	8	17	25.5	32	48	48
2005	19	8	8	16	25	31	45	45
2006	22	0	0	13	19	25	34	55
2007	22	4	5	15	20	25	35	43
2008	24	4	7	17	23.5	30.5	47	73
2009	25	4	10	19	25	31	42	47
2010	26	0	4	15	23.5	32	41	45
2011	27	0	4	16	24	32	44	46
2012	28	3	4	16	22	32	34	48
2013	28	5	5	13	24	29	36	36

The corrected serum calcium-phosphate product among 597 HD centres ranged from 2.8 to 5.8mmol^2/L^2 with median of 3.8mmol^2/L^2. The corrected serum calcium- phosphate product among 28 CAPD centres ranged from 3.2 to 4.5 mmol^2/L^2. The variation in corrected serum calcium-phosphate product remained wide in both HD and PD centres since 2004. (Tables and Figures 9.2.11a & 9.2.12a)

Table 9.2.11(a): Variation in corrected median calcium x phosphate product HD centres 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	202	2.9	3.4	3.8	4.1	4.4	4.8	5.6
2005	223	2.1	3.2	3.6	3.9	4.2	4.8	5.1
2006	274	2.1	3.2	3.6	3.9	4.1	4.6	5.2
2007	309	2.5	3.2	3.6	3.8	4.1	4.5	5
2008	359	2.7	3.2	3.6	3.8	4.1	4.4	5.7
2009	406	2.6	3.3	3.7	3.9	4.1	4.6	6.2
2010	440	2.9	3.4	3.7	3.9	4.2	4.7	6.7
2011	503	2	3.3	3.7	3.9	4.2	4.6	5.6
2012	547	2.7	3.3	3.6	3.8	4.1	4.6	5.7
2013	597	2.8	3.3	3.6	3.8	4.1	4.6	5.8

Figure 9.2.11(a): Variation in median corrected calcium x phosphate product among HD patients, HD centres 2013

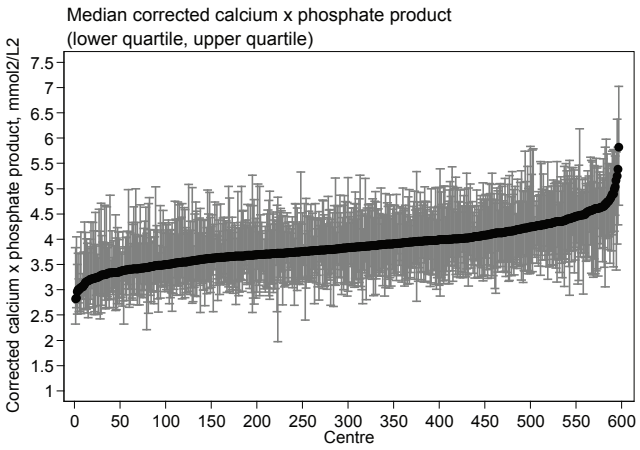

Figure 9.2.12(a): Variation in median corrected calcium x phosphate product among PD patients, PD centres 2013

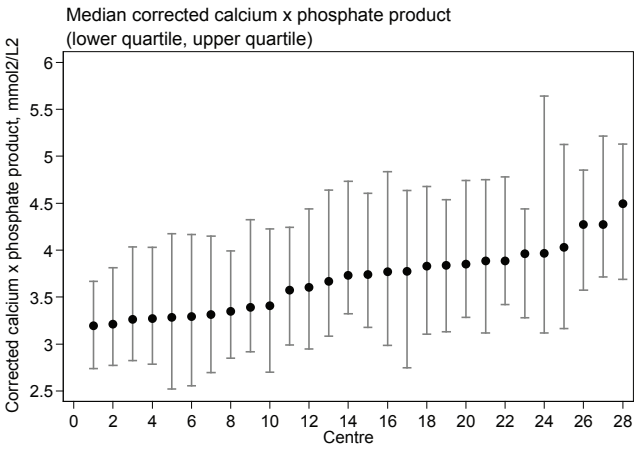

Table 9.2.12(a): Variation in corrected median calcium x phosphate product PD centres 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
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	4.2	4.4
2007	22	3.1	3.2	3.5	3.8	4.1	4.3	4.3
2008	24	2.8	3.1	3.3	3.7	4.1	4.7	5.1
2009	25	3.2	3.2	3.5	3.7	4	4.5	4.8
2010	26	3.1	3.1	3.4	3.8	4	4.5	4.6
2011	27	3	3.1	3.4	3.8	4	4.5	4.5
2012	28	3.1	3.1	3.5	3.8	4.1	4.3	4.5
2013	28	3.2	3.2	3.3	3.7	3.9	4.3	4.5

Both HD and PD centres had similar proportion of patients with corrected serum calcium- phosphate product less than 4.5 mmol^2/L^2, which was 73% for both groups in 2013. The variation in corrected serum calcium- phosphate product <4.5 mmol^2/L^2 remained wide in both HD and PD centres. It ranged from 23-100% in HD patients and 50-94% in PD patients (Tables and Figures 9.2.11b & 9.2.12b).

Table 9.2.11(b): Proportion of patients with corrected calcium x phosphate <4.5 mmol^2/L^2, HD centres 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	202	18	40	55	63	71	88	100
2005	223	24	45	58	69	77	91	100
2006	274	30	46	62	70	79	92	100
2007	309	33	48	63	73	81	91	100
2008	359	27	50	64	73	81	91	100
2009	406	20	45	62	70	79	89	100
2010	440	8	43	60	69	76.5	89	95
2011	503	18	48	61	71	79	90	100
2012	547	32	49	63	72	80	91	100
2013	597	23	48	64	73	81	90	100

Figure 9.2.11(b): Variation in proportion of patients with corrected calcium x phosphate product <4.5 mmol^2/L^2, HD centres 2013

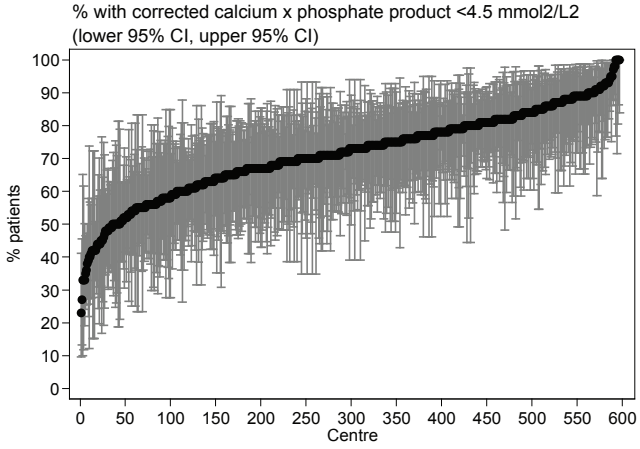

Figure 9.2.12(b): Variation in proportion of patients with corrected calcium x phosphate product <4.5 mmol^2/L^2, PD centres, 2013

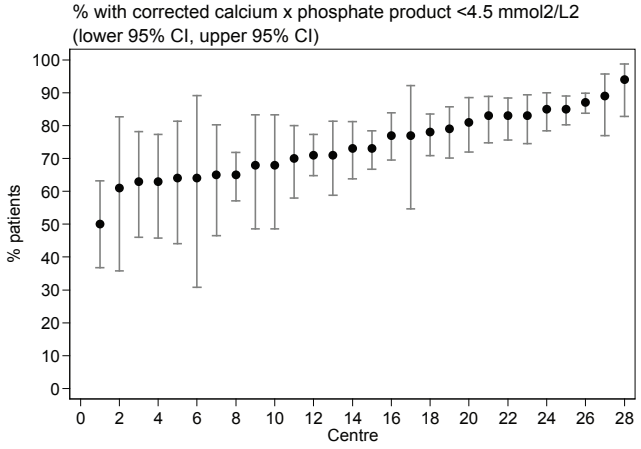

Table 9.2.12(b): Proportion of patients with corrected calcium x phosphate <4.5 mmol^2/L^2, PD 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	18	54	54	66	73	79	89	89
2005	19	53	53	67	74	78	85	85
2006	22	53	57	67	70.5	79	88	96
2007	22	51	57	64	73	80	88	98
2008	24	40	41	62	71.5	82	91	97
2009	25	40	49	65	76	79	86	86
2010	26	49	50	68	74	80	88	89
2011	27	48	50	64	73	80	92	95
2012	28	48	58	67	71	84	90	91
2013	28	50	61	65	73	83	89	94

SECTION 9.3: SERUM PARATHYROID HORMONE CONTROL

Calcitriol was the main vitamin D receptor activator (VDRA) used in treatment of hyperparathyroidism for both HD and PD patients. The percentage of patients on calcitriol had increased in HD from 46% in 2012 to 48% in 2013. On the other hand, the percentage of patients on calcitriol in PD patients had decreased from 38% in 2012 to 34% in 2013. The used of Paricalcitol had increased among HD patients from 0.51% in 2009 to 1.04 % in 2012 but had decreased to 0.73% in 2013. For the PD patients, the use of paricalcitol had increased slowly from 0.14% in 2009 and remained at 0.43% in 2013. Parathyroidectomy had remained stable at about 1% since 2006 in HD patients whereas the parathyroidectomy rate was decreasing in PD patients from 1% in 2006 to 0.42% in 2013. (Tables 9.3.1 a & b)

Table 9.3.1(a): Treatment of hyperparathyroidism in HD patients, 2004-2013

Year	Number of patients	Number of patients On Calcitriol		Number of patients on Paricalcitol		Number of patients had Para-thyroidectomy	
		n	%	n	%	n	%
2004	8163	2028	25	0	0	0	0
2005	9350	2556	27	0	0	43	0
2006	11681	3822	33	34	0	152	1
2007	12907	4950	38	60	0	181	1
2008	15403	6346	41	64	0	174	1
2009	17977	7790	43	92	1	167	1
2010	19509	9078	47	157	1	170	1
2011	22296	10762	48	139	1	177	1
2012	25671	11805	46	266	1	264	1
2013	28899	13858	48	211	1	315	1

Table 9.3.1(b): Treatment of hyperparathyroidism in PD patients, 2004-2013

Year	Number of patients	Number of patients On Calcitriol		Number of patients on Paricalcitol		Number of patients had Para-thyroidectomy	
		n	%	n	%	n	%
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	1033	29	9	0	22	1
2008	4044	1210	30	8	0	26	1
2009	3482	1232	35	5	0	16	0
2010	3844	1531	40	4	0	11	0
2011	4967	1841	37	24	0	21	0
2012	5752	2162	38	62	1	48	1
2013	6513	2202	34	28	0	38	1

In year 2013, HD patients had mean iPTH of 231.9pg/ml. 59% of HD patients had iPTH level <150pg/ml, 15% within the target level (150-300pg/ml) and 14% had iPTH above 500pg/ml. Mean iPTH was lower in diabetic HD patients than the non diabetic HD patients (197.8pg/ml vs 261.2pg/ml). The diabetic HD patients had higher proportion with iPTH level below 150pg/ml (63%) than non diabetic HD patients (56%). On the other hand, the mean iPTH was lower in PD patients at 213.5pg/ml. About 53% of PD patients had iPTH <150pg/ml, 24% achieved target iPTH (150-300pg/ml) and 9% had iPTH more than 500pg/ml. Similarly, mean iPTH was lower in diabetic PD patients than non diabetic PD patients (173.6pg/ml vs 229.3pg/ml). The diabetic PD patients had higher proportion with iPTH level below 150pg/ml (59%) than non diabetic HD patients (51%). (Tables and Figures 9.3.2a & 9.3.3a)

Table 9.3.2(a): Distribution of iPTH, HD patient 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH (pg/ml)			
							<150	≥150 & ≥300	≥300 & ≥500	≥500
2004	4747	212.1	325.6	74.3	22.6	257.5	65	13	10	
2005	5825	221.6	312.5	83.8	26.5	297	61	14	11	14
2006	7743	219.2	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	10754	260.8	330.9	127	36	361	54	17	13	17
2009	12647	269.4	337.2	140	40	367	52	18	13	17
2010	14364	235.6	319.3	98.5	30.5	319.8	58	15	11	15
2011	16411	223.3	312.4	87.1	29.2	304.3	61	14	12	14
2012	18943	291.5	340.2	167	46.6	410.4	48	18	15	19
2013	21390	231.9	315.2	98	33.7	309.3	59	15	11	14

Figure 9.3.2(a): Cumulative distribution of iPTH, HD 2004-2013

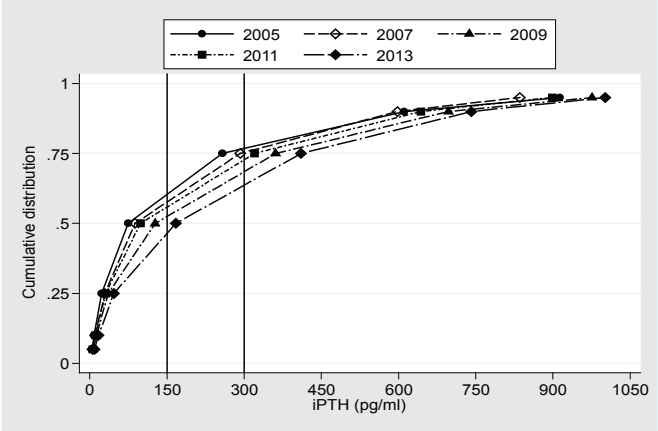

Figure 9.3.2(b): Cumulative distribution of iPTH, diabetic HD patients 2004-2013

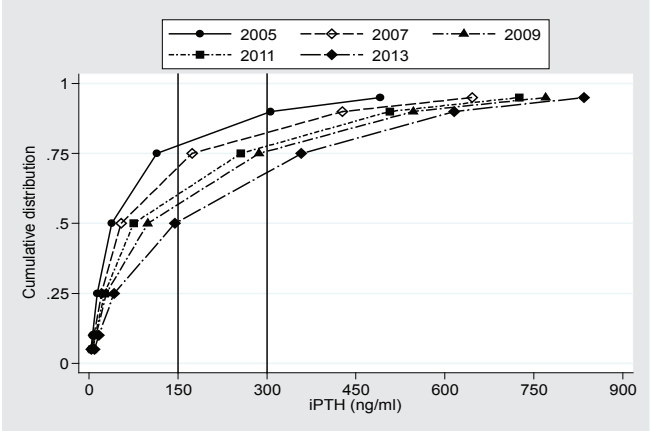

Table 9.3.2(b): Distribution of iPTH, diabetic HD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH (pg/ml)			
							<150	≥150 & ≥300	≥300 & ≥500	≥500
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	3682	183.1	267.4	70.6	23	235.5	66	14	10	10
2008	4595	208.8	275.3	98.9	29.1	286.5	59	17	12	12
2009	5646	218.3	284	111.2	33.7	292	57	18	12	12
2010	6574	189.6	268.9	75	26	255.8	64	15	11	10
2011	7552	182.7	264.5	66.9	24.6	241.5	66	13	10	10
2012	8823	249.7	290.6	145	42	358	51	19	15	15
2013	9890	197.8	269.5	82.5	31.1	266.6	63	15	11	11

Table 9.3.2(c): Distribution of iPTH, non-diabetic HD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH (pg/ml)			
							<150	≥150 & ≥300	≥300 & ≥500	≥500
2004	3215	260.1	362.7	102.5	30.5	339	58	14	11	17
2005	3718	262.5	337.8	114.3	35.5	364.5	55	15	13	17
2006	4674	261.3	331.4	122.7	39	362.5	54	16	13	17
2007	5469	288	364.2	135.2	38.8	403	52	15	13	19
2008	6159	299.6	362.2	155	42.7	418	49	16	14	21
2009	7001	310.6	369.6	170.5	47.8	433.5	47	17	14	21
2010	7790	274.5	351.6	126.9	36.5	386	54	15	12	19
2011	8859	258	344.3	108.1	34.7	357.5	56	14	13	17
2012	10120	327.9	374.3	189.8	51.2	469.1	45	17	15	23
2013	11500	261.2	347.2	114	37	352.3	56	15	12	17

Figure 9.3.2(c): Cumulative distribution of iPTH, non-diabetic HD patients 2004-2013

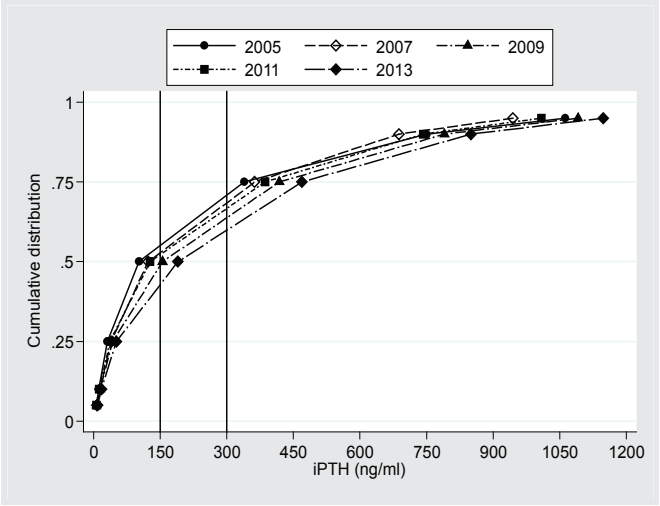

Figure 9.3.3(a): Cumulative distribution of iPTH, PD patients 2004-2013

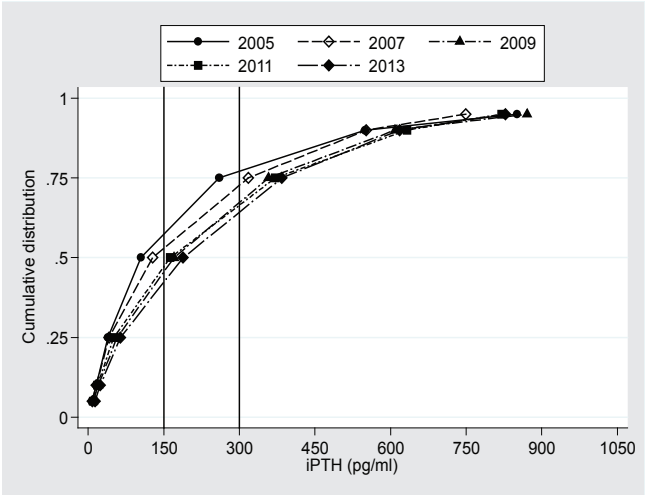

Table 9.3.3(a): Distribution of iPTH, PD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH (pg/ml)			
							<150	≥150 & ≥300	≥300 & ≥500	≥500
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	2040	249.3	282.7	160.3	50	343.3	48	23	16	14
2012	2264	274.4	292.5	188.4	64	384.3	43	22	19	15
2013	2600	213.5	251.3	134	52	284.2	53	24	14	9

Table 9.3.3(b): Distribution of iPTH, diabetic PD patients, 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH (pg/ml)			
							<150	≥150 & ≥300	≥300 & ≥500	≥500
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	662	197.1	216.8	131	41	295	55	21	16	8
2011	654	188.9	208.2	128	44	272.5	54	24	16	6
2012	679	200.2	214.8	131	56	282.5	52	25	15	7
2013	737	173.6	207.7	112.5	44.2	217	59	26	9	6

Figure 9.3.3(b): Cumulative distribution of iPTH, diabetic PD patients 2004-2013

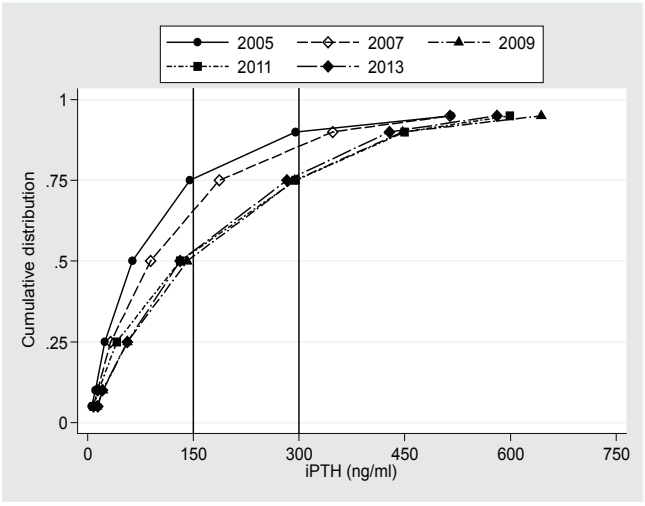

Figure 9.3.3(c): Cumulative distribution of iPTH, non diabetic PD patients 2004-2013

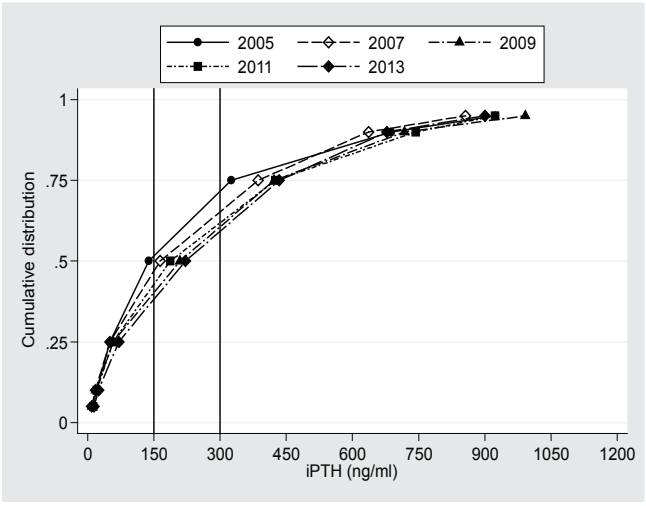

Table 9.3.3(c): Distribution of iPTH, non diabetic PD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH (pg/ml)			
							<150	≥150 & ≥300	≥300 & ≥500	≥500
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	1243	295.8	323.8	187	57	425	45	20	15	20
2011	1386	277.8	307.7	182.7	55.7	387.5	45	22	16	17
2012	1585	306.1	314.8	221.4	70	434	40	21	21	19
2013	1863	229.3	265	146.6	53.9	312.1	51	23	16	10

There was wide variation in iPTH level among HD centres and PD centres. The degree of variation seemed to become wider since 2004 and was wider in HD patients than PD patients. (Tables and Figures 9.3.4a & 9.3.5a) The median for the proportion of patients with serum iPTH level in the range 150-300 pg/ml was 13% for HD centres and 22% for PD centres (Tables and Figures 9.3.4b & 9.3.5b).

Table 9.3.4(a): Variation in iPTH among HD centres 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	137	3.6	12	29	73.8	213	392	635
2005	163	6.1	14.3	38.7	99.5	220	409.5	626.4
2006	223	7.7	16.8	41.5	93	208.3	377	629.6
2007	243	12.4	20	46.3	107.3	231	411.1	643
2008	289	8.5	22.4	57.9	138.5	243	410	712.5
2009	334	10.4	27	66.5	156	240.2	391.8	825.2
2010	365	5.5	20.4	41.8	105.8	229.5	384.8	824
2011	429	3.3	19.8	42.2	91.5	219.5	421.5	1249.3
2012	492	11.1	32.4	74.8	183	284.1	467.2	768.3
2013	519	10.3	22.5	44.8	98.5	250.1	423.9	998.5

Figure 9.3.4(a): Variation in median iPTH among HD patients, HD centres 2013

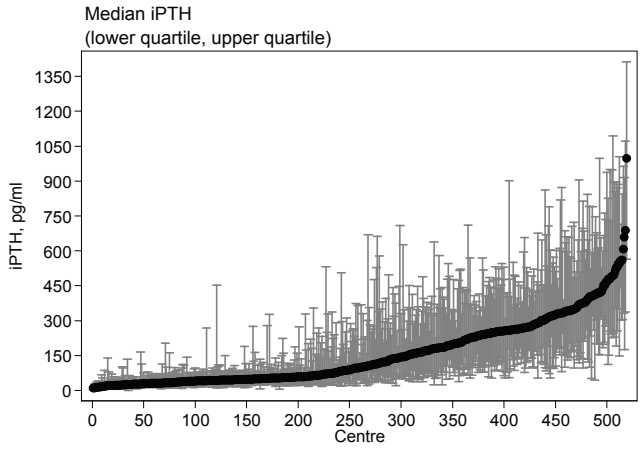

Figure 9.3.4(b): Variation in proportion of patients with iPTH 150-300pg/ml, HD centres, 2013

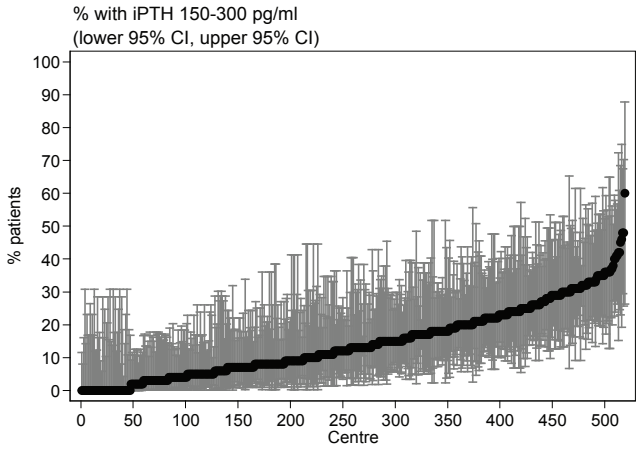

Table 9.3.4(b): Variation in proportion of patients with iPTH 150-300pg/ml, HD centres 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	137	0	0	5	10	19	38	50
2005	163	0	0	7	13	20	30	44
2006	223	0	0	7	14	20	29	47
2007	243	0	0	8	14	20	30	52
2008	289	0	0	9	16	22	31	43
2009	334	0	0	10	17	24	36	63
2010	365	0	0	7	14	21	33	45
2011	429	0	0	5	13	20	32	55
2012	492	0	3	10	17	24	33	53
2013	519	0	0	6	13	22	35	60

Table 9.3.5(a): Variation in median iPTH among PD patients 2004-2013

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	18	41	41	74.5	137.3	169.3	303.8	303.8
2005	18	25	25	85	140.6	259.5	493.3	493.3
2006	20	34.5	35.7	88.3	165.6	232.9	313.3	367
2007	22	26.3	32	107.3	202.1	241.8	445.5	513.9
2008	22	34.5	54.6	122.5	186.2	310.9	352.3	450
2009	23	40	51	129.1	197.5	315.6	475	1171
2010	24	29.4	32.7	124.5	216	287.4	517.3	688.6
2011	24	25.9	26.8	97.1	187.6	286.3	365.5	419
2012	27	35.2	46	84.8	239	324.5	437	452.5
2013	27	37	42.1	69.2	189.5	270.4	363.5	457.5

Figure 9.3.5(a): Variation in median iPTH among PD patients, PD centres, 2013

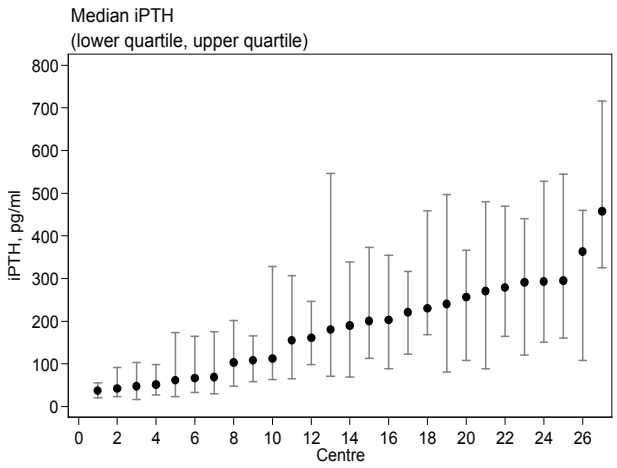

Figure 9.3.5(b): Variation in proportion of patients with iPTH 150-300pg/ml, PD centres 2013

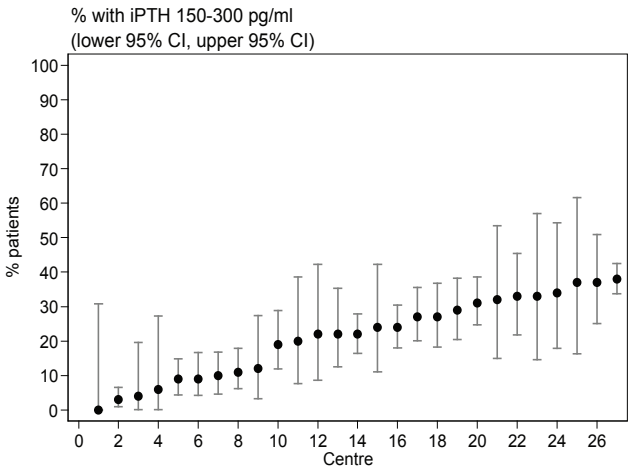

Table 9.3.5(b): Proportion of patients with iPTH 150-300pg/ml

Year	Number of centres	Min	5th Centile	LQ	Median	UQ	95th Centile	Max
2004	18	7	7	14	20	24	32	32
2005	18	0	0	11	15.5	24	33	33
2006	20	5	5.5	13	20.5	26.5	36.5	40
2007	22	0	3	15	20.5	27	32	39
2008	22	0	7	15	20.5	26	32	33
2009	23	7	11	13	22	26	28	28
2010	24	0	4	14	19.5	26	32	43
2011	24	3	6	13	22.5	27	33	38
2012	27	1	7	17	20	27	31	31
2013	27	0	3	10	22	32	37	38

Conclusion

CKD-MBD is a common problem in the dialysis population . KDIGO guidelines clearly defined the 3 major components in this disease which include laboratory abnormalities (serum calcium , serum phophorus and iPTH) , bone abnormalities and vascular calcification. We cannot ascertain the prevalence of this disease in our dialysis population because we only have data on the laboratory abnormalities. Bone biopsy and assessment for vascular calcification were not routinely performed in Malaysia.

We did not see much improvement in the laboratory parameters since 2004. Only 53% HD patients and 42% PD patients achieved target serum calcium (2.1-2.37mmol/L). KDIGO recommended serum phosphorus level of 0.8-1.3mmol/L and this was only achieved in 16% of HD patients and 26% of PD patients. Only 15% of HD patients and 24% of PD patients achieved the target iPTH level (150-300pg/ml). Our data also showed that diabetic dialysis patients had lower iPTH level than non diabetic dialysis patients.

Phosphate lowering and parathyroid suppression therapy was the mainstay of medical treatment in CKD-MBD. Calcium based phosphate binder and calcitriol were the major medical therapy used in Malaysia for the treatment. There was a slow increased in the use of non calcium based phosphate binder (lanthanum and sevelamer) and selective VDRA (paricalcitol). Parathyroidectomy had remained stable at about 1% since 2006 in HD patients whereas the parathyroidectomy rate was decreasing in PD patients from 1% in 2006 to 0.42% in 2013.

Overall, the control of calcium, phosphate and iPTH parameters in CKD-MBD was still poor among the dialysis patients with wide centre variation especially among the HD centres. We need to have strategies to improve the phosphate control. A more structured dietary counseling and medication adherence program maybe effective to help patients to achieve a better phosphate control. On the other hand, we need to increase the use of VDRA for iPTH suppression because less than half of our dialysis patients were on this therapy.