

CHAPTER 09

Chronic Kidney Disease - Mineral and Bone Disorder

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SECTION 9.1: TREATMENT OF HYPERPHOSPHATAEMIA

Calcium carbonate remained as the main phosphate binder for both HD patients (93%) and PD patients (84%) in 2016. The second most commonly used phosphate binder was Lanthanum. Sevelamer usage still remained low after its official launch in Malaysia in May 2011. There were 3% of HD patients still prescribed Al(OH)₃ in 2016. This is most certainly from non MOH setting as Al(OH)₃ was already removed from MOH formulary for some years now. None of the PD patients were on Al(OH)₃. (Tables 9.1.1 and 9.1.2)

Table 9.1.1: Phosphate Binder in HD patients, 2007-2016

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	%
2007	12906	11921	92	57	0	37	0	1	0
2008	15402	14205	92	72	0	86	1	3	0
2009	17976	16514	92	34	0	247	1	0	0
2010	19584	17915	91	27	0	381	2	6	0
2011	22310	20619	92	30	0	517	2	72	0
2012	25670	23656	92	12	0	648	3	83	0
2013	29115	26909	92	10	0	736	3	108	0
2014	32470	29974	92	6	0	786	2	212	1
2015	35338	32757	93	2	0	818	2	359	1
2016	38082	35453	93	3	0	626	2	509	1

Table 9.1.2: Phosphate Binder in PD patients, 2007-2016

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	%
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	4291	86	8	0	176	4	24	0
2012	5752	4902	85	6	0	202	4	24	0
2013	6511	5584	86	4	0	221	3	46	1
2014	7424	6387	86	6	0	238	3	82	1
2015	7979	6748	85	0	0	236	3	182	2
2016	7481	6288	84	0	0	171	2	307	4

It is interesting to note that the major use of Lanthanum and Sevelamer in 2015 was among the NGO patients. (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	%
2007	Public	6	40	0		40	56
	Private	1	7	0		21	30
	NGO	8	53	0		10	14
	Total	15	100	0	0	71	100
2008	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
2009	Public	17	20	0	0	26	36
	Private	18	21	0	0	11	15
	NGO	51	59	3	100	35	49
	Total	86	100	3	100	72	100
2010	Public	90	36	0		11	32
	Private	60	24	0		5	15
	NGO	97	39	0		18	53
	Total	247	100	0	0	34	100
2011	Public	149	39	2	33	18	67
	Private	106	28	0	0	5	19
	NGO	126	33	4	67	4	15
	Total	381	100	6	100	27	100
2012	Public	222	43	10	14	20	67
	Private	133	26	24	33	2	7
	NGO	162	31	38	53	8	27
	Total	517	100	72	100	30	100
2013	Public	243	38	10	12	3	25
	Private	176	27	8	10	0	0
	NGO	229	35	65	78	9	75
	Total	648	100	83	100	12	100
2014	Public	226	31	20	19	4	40
	Private	202	27	10	9	5	50
	NGO	308	42	78	72	1	10
	Total	736	100	108	100	10	100
2015	Public	228	29	40	19	3	50
	Private	232	30	17	8	1	17
	NGO	326	41	155	73	2	33
	Total	786	100	212	100	6	100
2016	Public	239	29	72	20	1	50
	Private	232	29	44	12	0	0
	NGO	343	42	243	68	1	50
	Total	814	100	359	100	2	100

SECTION 9.2: SERUM CALCIUM AND PHOSPHATE CONTROL

The median corrected serum calcium level had remained constant for the last 10 years. 54% of HD patients achieved target serum calcium level of 2.1 to 2.37mmol/L compared to only 46% of PD patients (Tables & Figures 9.2.1 and 9.2.2).

Table 9.2.1: Distribution of corrected serum calcium, HD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients ≥ 2.1 & ≤ 2.37 mmol/L
2007	12274	2.2	0.2	2.2	2.1	2.4	52
2008	14480	2.3	0.2	2.3	2.1	2.4	53
2009	16857	2.3	0.2	2.3	2.2	2.4	52
2010	18710	2.3	0.2	2.3	2.2	2.4	52
2011	21277	2.3	0.2	2.3	2.1	2.4	53
2012	24421	2.3	0.2	2.3	2.1	2.4	54
2013	27697	2.3	0.2	2.3	2.1	2.4	54
2014	31203	2.3	0.2	2.3	2.1	2.4	54
2015	34128	2.2	0.2	2.3	2.1	2.4	54
2016	36649	2.2	0.2	2.2	2.1	2.4	54

Figure 9.2.1: Cumulative distribution of corrected serum calcium, HD patients 2007-2016

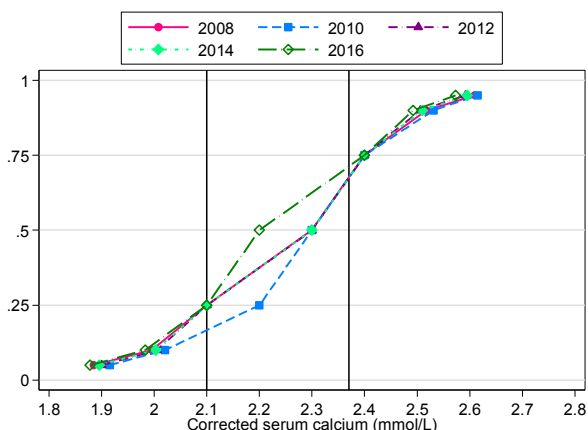


Figure 9.2.2: Cumulative distribution of corrected serum calcium, PD patients 2007-2016

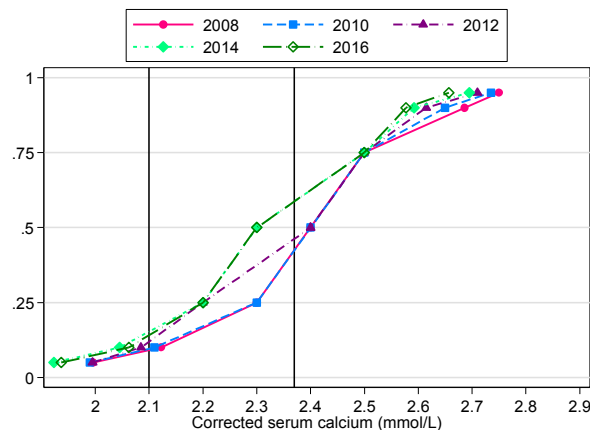


Table 9.2.2: Distribution of corrected serum calcium, PD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients ≥ 2.1 & ≤ 2.37 mmol/L
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	3158	2.3	0.2	2.3	2.2	2.5	42
2014	3610	2.3	0.2	2.3	2.2	2.5	43
2015	4202	2.3	0.2	2.3	2.2	2.5	44
2016	4547	2.3	0.2	2.3	2.2	2.5	46

Overall, PD patients had better phosphate control compared to HD patients (median level 1.6 vs 1.7mmol/L). In 2016, about 25% of PD patients achieved target phosphate level recommended by KDIGO (0.8 to 1.3mmol/L) compared to only 15% in HD patients. About 41% of patients achieved phosphate level of 1.3-1.8mmol/L. Only 13% of PD patients have phosphate level > 2.2 mmol/L as compared to HD patients (16% with phosphate level > 2.2 mmol/L). (Tables & Figures 9.2.3 and 9.2.4)

Table 9.2.3: Distribution of serum phosphate, HD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	%patients <0.8 mmol/L	%patients ≥0.8&<1.3 mmol/L	%patients ≥1.3&<1.8 mmol/L	%patients ≥1.8&<2.2 mmol/L	%patients ≥2.2 mmol/L
2007	12423	1.8	0.5	1.7	1.4	2.1	1	16	40	25	18
2008	14876	1.7	0.5	1.7	1.4	2.0	1	17	41	24	17
2009	17253	1.8	0.5	1.7	1.4	2.1	1	15	40	26	18
2010	18939	1.8	0.5	1.7	1.4	2.1	1	15	40	26	19
2011	21704	1.8	0.5	1.7	1.4	2.1	1	15	40	26	18
2012	24874	1.8	0.5	1.7	1.4	2.0	1	15	41	25	17
2013	28308	1.8	0.5	1.7	1.4	2.0	1	16	42	25	17
2014	31624	1.7	0.5	1.7	1.4	2.0	1	17	41	25	16
2015	34459	1.7	0.5	1.7	1.4	2.0	1	16	41	26	16
2016	37051	1.8	0.5	1.7	1.4	2.0	1	15	41	27	16

Figure 9.2.3: Cumulative distribution of serum phosphate, HD patients 2007-2016

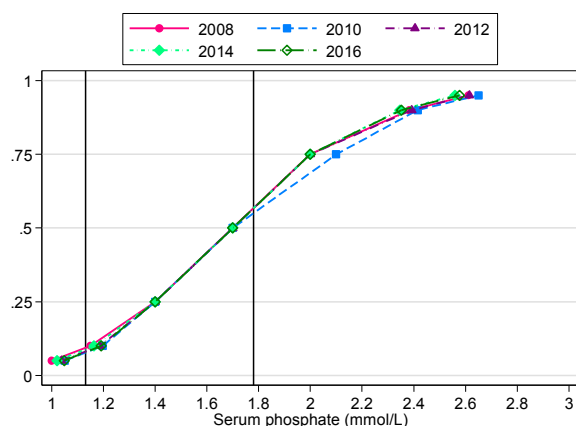


Figure 9.2.4: Cumulative distribution of serum phosphate, PD patients 2007-2016

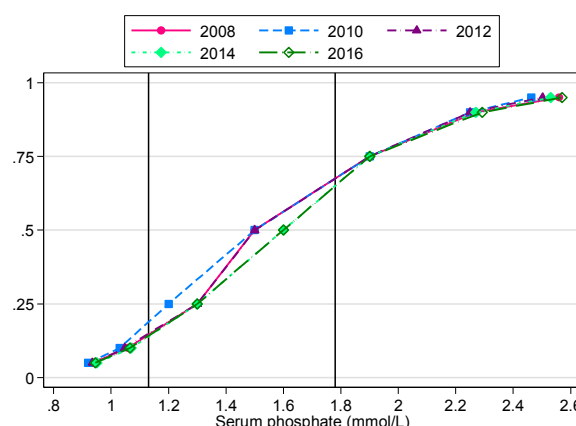


Table 9.2.4: Distribution of serum phosphate, PD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	%patients <0.8 mmol/L	%patients ≥0.8&<1.3 mmol/L	%patients ≥1.3&<1.8 mmol/L	%patients ≥1.8&<2.2 mmol/L	%patients ≥2.2 mmol/L
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	3161	1.6	0.5	1.5	1.3	1.9	2	26	43	18	11
2014	3638	1.6	0.5	1.6	1.3	1.9	1	26	42	19	12
2015	4222	1.6	0.5	1.6	1.3	1.9	2	25	42	19	12
2016	4582	1.6	0.5	1.6	1.3	1.9	2	25	41	19	13

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 76% of PD patients had corrected calcium phosphate product <4.5mmol²/L² compared to 72% in HD patients. Overall there was a positive trend in calcium phosphate product and the percentage of patients with corrected serum calcium phosphate product >5.5mmol²/L² had remained less than 9% in 2016. (Tables and Figures 9.2.5 & 9.2.6)

Table 9.2.5: Distribution of corrected calcium x phosphate product, HD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <3.5 mmol ² /L ²	% patients ≥3.5 & <4.5 mmol ² /L ²	% patients ≥4.5 & <5.5 mmol ² /L ²	% patients ≥5.5 mmol ² /L ²
2007	12171	3.9	1.2	3.8	3.1	4.6	38	33	19	10
2008	14362	3.9	1.2	3.8	3.1	4.6	39	33	19	9
2009	16720	4.0	1.2	3.9	3.2	4.7	36	34	20	11
2010	18590	4.1	1.2	3.9	3.2	4.8	34	34	21	11
2011	21127	4.0	1.2	3.9	3.2	4.7	36	34	20	10
2012	24203	4.0	1.1	3.8	3.2	4.6	37	34	19	10
2013	27482	3.9	1.1	3.8	3.2	4.6	37	34	19	9
2014	31030	3.9	1.1	3.8	3.1	4.6	39	34	19	9
2015	33956	3.9	1.1	3.8	3.1	4.6	38	34	19	9
2016	36448	3.9	1.1	3.8	3.2	4.6	37	35	19	9

Figure 9.2.5: Cumulative distribution of corrected calcium x phosphate product, HD patients 2007-2016

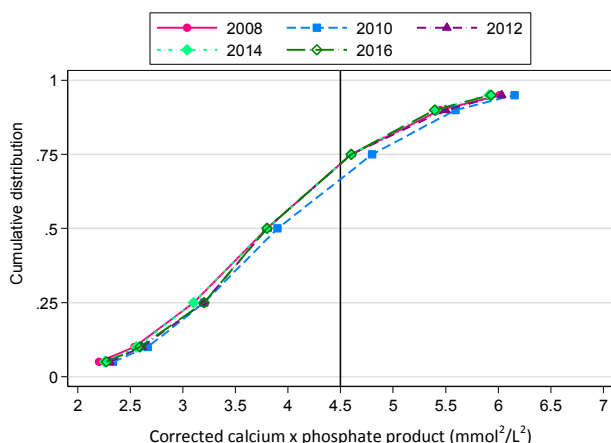


Figure 9.2.6: Cumulative distribution of corrected calcium x phosphate product, PD patients 2007-2016

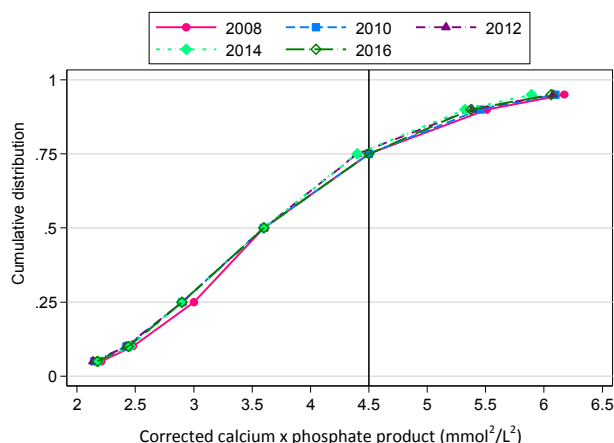


Table 9.2.6: Distribution of corrected calcium x phosphate product, PD patients 2007-2016

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
2007	1745	3.8	1.2	3.6	3.0	4.5	46	29	15	10
2008	2009	3.8	1.2	3.6	3.0	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	3138	3.7	1.2	3.5	2.9	4.4	49	29	14	8
2014	3596	3.8	1.2	3.6	2.9	4.4	47	30	15	8
2015	4189	3.8	1.2	3.6	3.0	4.4	46	30	15	9
2016	4529	3.8	1.2	3.6	2.9	4.5	46	30	15	9

In year 2016, corrected median serum calcium level was 2.2-2.3mmol/L in PD and HD patients. The variation in corrected serum calcium level among both HD and PD centres remained wide in 2016. (Table and Figure 9.2.7a & 9.2.8a)

Table 9.2.7(a): Variation in corrected median serum calcium level among HD centres, 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	300	1.7	2	2.2	2.2	2.3	2.4	2.5
2008	346	1.9	2.1	2.2	2.2	2.3	2.4	2.7
2009	387	1.5	2.1	2.2	2.3	2.3	2.4	2.6
2010	427	1.8	2.1	2.2	2.3	2.3	2.4	2.5
2011	488	1.7	2.1	2.2	2.3	2.3	2.4	2.6
2012	546	2.0	2.1	2.2	2.3	2.3	2.4	2.6
2013	600	2.0	2.1	2.2	2.3	2.3	2.4	2.5
2014	640	2.0	2.1	2.2	2.3	2.3	2.4	2.5
2015	670	2.0	2.1	2.2	2.3	2.3	2.4	2.5
2016	696	1.8	2.1	2.2	2.2	2.3	2.4	2.5

Figure 9.2.7(a): Variation in median serum calcium among HD patients, HD centres 2016

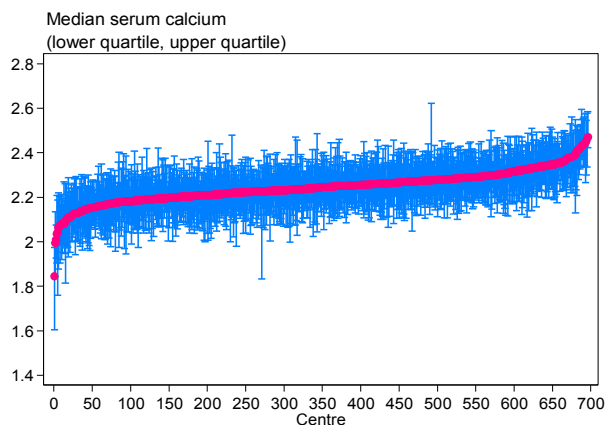


Figure 9.2.8(a): Variation in median serum calcium level among PD patients, PD centres 2016

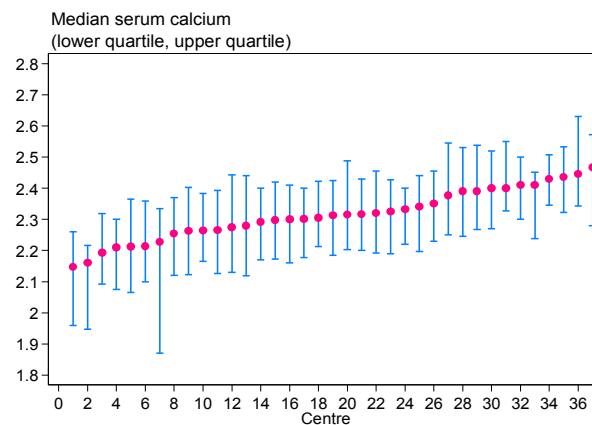


Table 9.2.8(a): Variation in corrected median serum calcium level among PD centres, 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	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
2011	26	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	2.1	2.2	2.3	2.3	2.4	2.5	2.5
2014	32	2.1	2.1	2.3	2.3	2.4	2.5	2.6
2015	35	2.1	2.1	2.2	2.3	2.4	2.5	2.5
2016	37	2.1	2.2	2.3	2.3	2.4	2.4	2.5

There was also large centre variation among the HD and PD centres with regards to the proportion of patients who achieved normal range of corrected serum calcium level (2.1 to 2.37mmol/L); it ranged from 11 to 94% for HD centres and 21-64% for PD centers in 2016. The median was 55.5% for HD centres and 49% 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, 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	300	8	26	44.5	52	61	73	88
2008	346	8	28	45	54	61	73	91
2009	387	0	27	44	53	61	71	90
2010	427	0	29	44	52	61	73	93
2011	488	0	33	46	54	62	73	93
2012	546	8	32	47	55	64	75	93
2013	600	8	33	47	55	63	74	90
2014	640	13	33	47	55	62	73	88
2015	670	10	35	47	55	62	73	94
2016	696	11	36	48	55.5	63	73	90

Figure 9.2.7(b): Variation in proportion of patients with serum calcium 2.1 to 2.37mmol/L, HD centres 2016

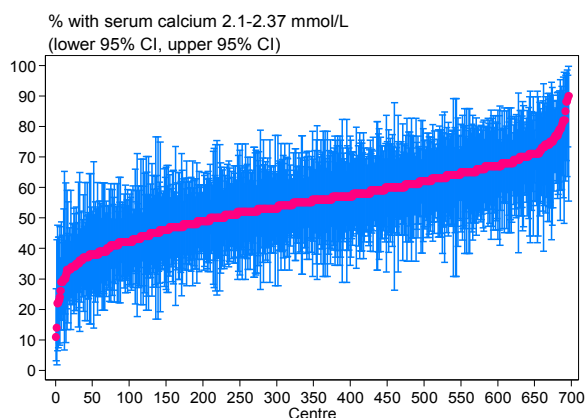


Figure 9.2.8(b): Variation in proportion of patients with serum calcium 2.1 to 2.37mmol/L, PD centres 2016

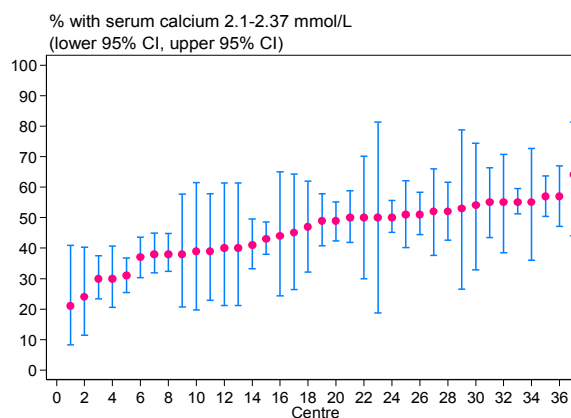


Table 9.2.8(b): Proportion of patients with serum calcium 2.1 to 2.37mmol/L, PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	18	29	31	44	51	62	63
2008	23	13	14	32	44	53	59	67
2009	23	12	13	31	41	51	59	65
2010	25	14	18	28	35	49	56	58
2011	26	9	10	31	36.5	44	58	62
2012	28	6	9	31.5	42.5	50.5	61	71
2013	28	10	10	32	41.5	50	59	70
2014	32	13	16	30	42	51	58	58
2015	35	14	17	33	47	52	58	60
2016	37	21	24	39	49	52	57	64

Median serum phosphate level for HD centres was 1.7mmol/L (ranged from 1.2 to 2.3mmol/L) as opposed to median phosphate level of 1.6mmol/L (ranged from 1.4 to 1.9mmol/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, 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	306	0.9	1.5	1.6	1.7	1.8	2	2.6
2008	352	1.2	1.5	1.6	1.7	1.8	2	2.5
2009	392	1.0	1.5	1.6	1.7	1.8	2	2.4
2010	433	1.3	1.5	1.6	1.8	1.8	2	2.7
2011	492	1.0	1.5	1.6	1.8	1.8	2	2.6
2012	555	1.1	1.5	1.6	1.7	1.8	2	2.6
2013	607	1.3	1.5	1.6	1.7	1.8	2	2.4
2014	644	1.3	1.5	1.6	1.7	1.8	2	2.3
2015	669	1.2	1.5	1.6	1.7	1.8	2	2.3
2016	696	1.2	1.5	1.6	1.7	1.8	2	2.3

Figure 9.2.9(a): Variation in median serum phosphate level among HD patients, HD centres 2016

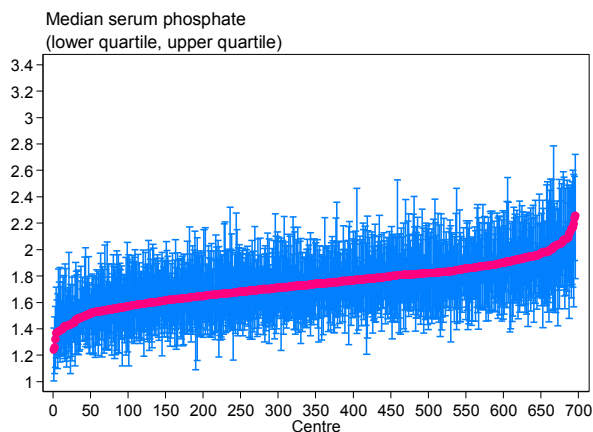


Figure 9.2.10(a): Variation in median serum phosphate level among PD patients, PD centres 2016

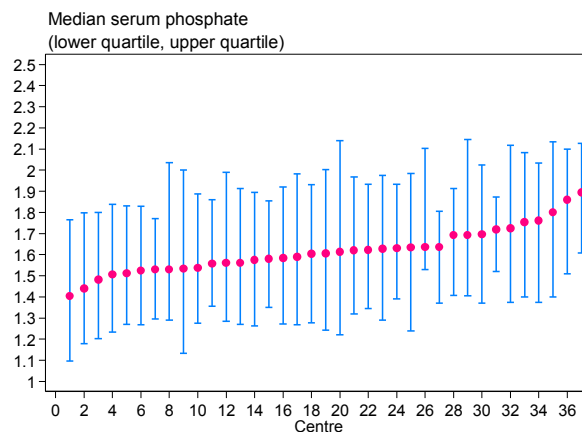


Table 9.2.10(a): Variation in median serum phosphate levels among PD centres, 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	1.3	1.4	1.5	1.6	1.8	2.0	2.4
2008	23	1.3	1.3	1.5	1.6	1.8	1.9	2.0
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
2011	26	1.3	1.3	1.5	1.6	1.7	1.9	1.9
2012	28	1.3	1.4	1.5	1.6	1.7	1.9	1.9
2013	28	1.4	1.4	1.5	1.6	1.7	1.9	1.9
2014	32	1.4	1.4	1.5	1.6	1.8	1.9	2.0
2015	35	1.4	1.4	1.5	1.6	1.7	1.9	2.1
2016	37	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 15 to 87% among HD centres (median 48%) and the range was narrower in PD centres, which was 28-66% (median 51%). (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 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	306	15	28	38	46	55	67	87
2008	352	8	29	39	47	56	68	86
2009	392	6	27	39	46.5	54	65	85
2010	433	4	26	38	46	54	67	76
2011	492	0	27	39	46	54	67	100
2012	555	6	29	40	48	56	68	100
2013	607	7	28	40	49	56	68	84
2014	644	14	29	40	49	56	67	83
2015	669	10	29	41	49	56	67	100
2016	696	15	28	39.5	48	55.5	67	87

Figure 9.2.9(b): Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, HD centres 2016

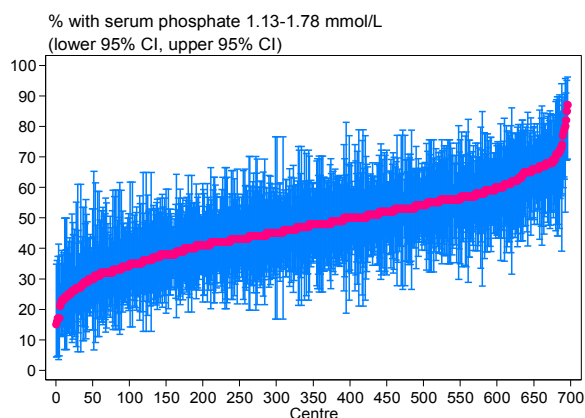


Figure 9.2.10(b): Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2016

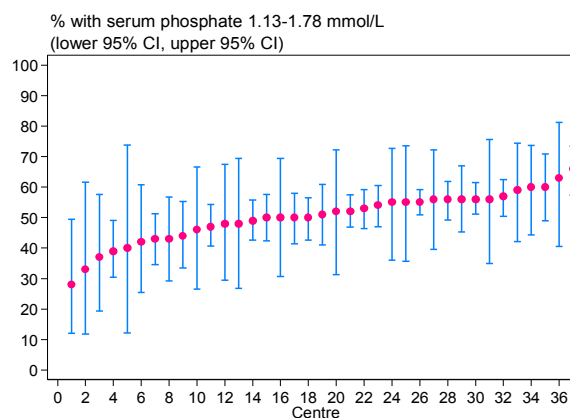


Table 9.2.10(b): Proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	29	40	47	54	56	73	79
2008	23	38	40	50	52	59	66	71
2009	23	20	38	48	54	58	65	69
2010	25	37	39	44	52	58	65	70
2011	26	35	36	47	54	60	77	81
2012	28	26	34	48	51.5	59	63	72
2013	28	28	36	46.5	50.5	55	64	77
2014	32	27	29	42.5	48	58	62	62
2015	35	17	36	45	51	57	65	71
2016	37	28	33	46	51	56	63	66

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% in HD patients. The centre variation ranged 0% to 61% for HD centres and 6% to 37% 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 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	306	0	4	10	15	21	31	61
2008	352	0	4	9	14	21	34	52
2009	392	0	2	9	14	21	31	46
2010	433	0	0	8	14	19	28	47
2011	492	0	2	9	14	20	29	83
2012	555	0	3	9	14	20	32	46
2013	607	0	3	9	14	20	32	48
2014	644	0	4	10	15	21	32	59
2015	669	0	4	10	15	21	32	70
2016	696	0	3	9	14	19	30	61

Figure 9.2.9(c): Variation in proportion of patients with serum phosphate 0.8-1.3 mmol/L, HD centres 2016

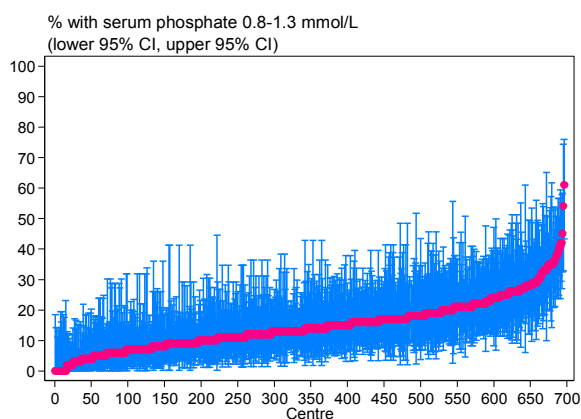


Figure 9.2.10(c): Variation in proportion of patients with serum phosphate 0.8-1.3 mmol/L, PD centres 2016

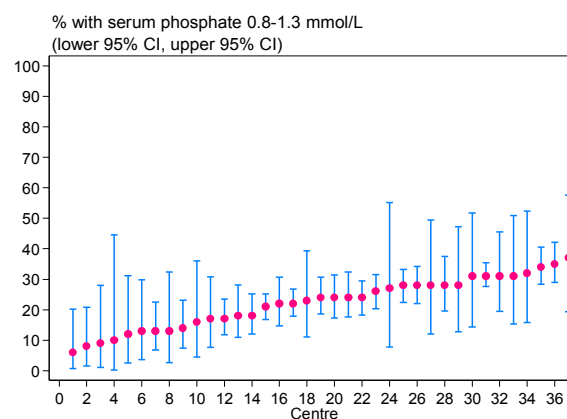


Table 9.2.10(c): Proportion of patients with serum phosphate 0.8-1.3 mmol/L, PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	4	6	15	19	24	35	45
2008	23	0	4	15	22	30	38	47
2009	23	4	12	19	25	31	35	43
2010	25	7	8	16	24	32	42	43
2011	26	0	0	15	22.5	34	44	50
2012	28	3	4	16.5	21	31.5	35	48
2013	28	5	5	13	23.5	29	35	37
2014	32	2	4	12	21.5	28	39	40
2015	35	0	0	16	22	29	38	38
2016	37	6	8	16	24	28	35	37

The corrected serum calcium-phosphate product among 696 HD centres ranged from 2.2 to 5.0mmol²/L² with median of 3.9mmol²/L². The corrected serum calcium-phosphate product among 35 CAPD centres ranged from 3 to 4.5mmol²/L². The variation in corrected serum calcium-phosphate product remained wide in both HD and PD centres. (Tables and Figures 9.2.11a & 9.2.12a).

Table 9.2.11(a): Variation in corrected median calcium x phosphate product HD centres, 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	299	2.2	3.1	3.6	3.9	4.1	4.6	5.4
2008	343	2.7	3.1	3.6	3.8	4.1	4.5	6.2
2009	383	2.3	3.3	3.7	3.9	4.1	4.7	6.1
2010	427	3.0	3.4	3.7	3.9	4.2	4.7	6.0
2011	486	2.0	3.3	3.7	3.9	4.2	4.6	5.7
2012	543	2.7	3.3	3.6	3.8	4.1	4.5	5.7
2013	594	2.8	3.3	3.6	3.8	4.1	4.6	5.9
2014	638	2.7	3.2	3.6	3.8	4.1	4.4	5.0
2015	669	2.6	3.3	3.6	3.8	4.1	4.5	5.2
2016	696	2.2	3.2	3.6	3.9	4.1	4.5	5.0

Figure 9.2.11(a): Variation in median corrected calcium x phosphate product among HD patients, HD centres 2016

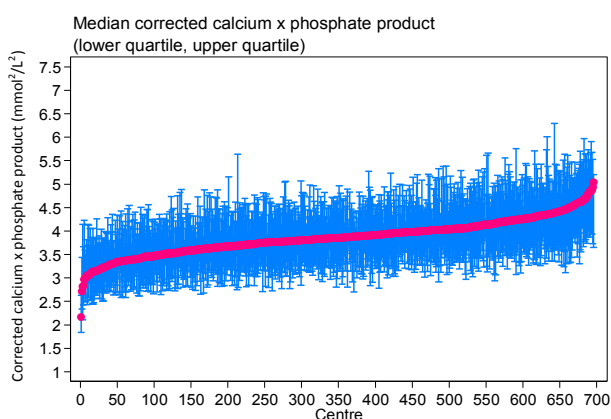


Figure 9.2.12(a): Variation in median corrected calcium x phosphate product among PD patients, PD centres 2016

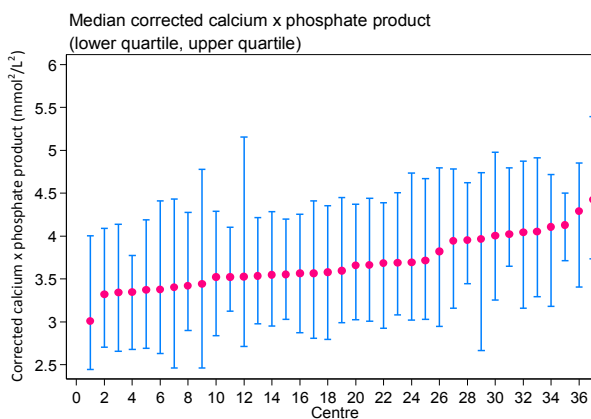


Table 9.2.12(a): Variation in corrected median calcium x phosphate product PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	3.1	3.2	3.5	3.7	4.2	4.6	4.6
2008	23	3.1	3.1	3.4	3.7	4.1	4.5	4.6
2009	23	3.3	3.3	3.5	3.7	3.9	4.6	4.8
2010	25	3.1	3.2	3.3	3.8	4	4.4	4.6
2011	26	2.9	3	3.4	3.8	4	4.6	4.6
2012	28	3.1	3.1	3.5	3.8	4.1	4.2	4.5
2013	28	3.2	3.2	3.3	3.8	3.9	4.3	4.5
2014	32	3.1	3.2	3.4	3.7	4.1	4.5	4.7
2015	35	3	3.2	3.4	3.6	3.9	4.3	4.5
2016	37	3	3.3	3.5	3.6	4	4.3	4.4

Both HD and PD centres had similar proportion of patients with corrected serum calcium- phosphate product less than $4.5 \text{ mmol}^2/\text{L}^2$, with both has median of 74% and 76% in 2016. The variation in corrected serum calcium- phosphate product $<4.5 \text{ mmol}^2/\text{L}^2$ remained wide in both HD and PD centres. It ranged from 36-100% in HD patients and 52-92% 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 <math><4.5 \text{ mmol}^2/\text{L}^2</math>, HD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	299	29	47	62	72	81	92	100
2008	343	12	50	63	72	82	93	100
2009	383	25	44	61	71	79	90	100
2010	427	8	43	60	69	77	88	100
2011	486	20	46	61	71	79	91	100
2012	543	29	50	63	72	80	92	100
2013	594	20	48	64	73	81	90	100
2014	638	30	52	65	74	81	90	100
2015	669	31	51	65	73	80	91	100
2016	696	36	50	64	74	82	92	100

Figure 9.2.11(b): Variation in proportion of patients with corrected calcium x phosphate product <math><4.5 \text{ mmol}^2/\text{L}^2</math>, HD centres 2016

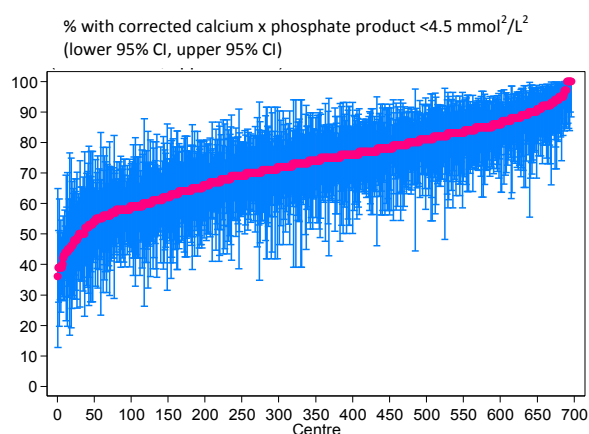


Figure 9.2.12(b): Variation in proportion of patients with corrected calcium x phosphate product <math><4.5 \text{ mmol}^2/\text{L}^2</math>, PD centres, 2016

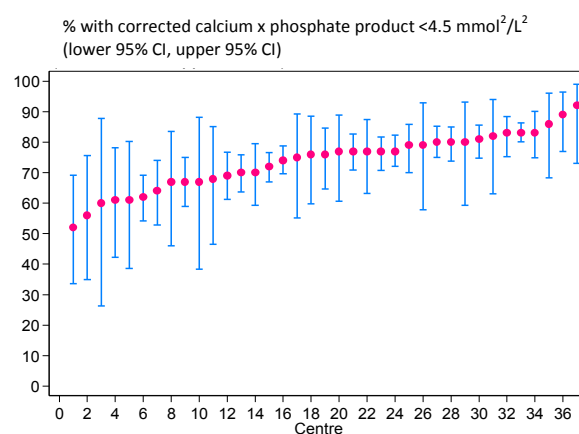


Table 9.2.12(b): Proportion of patients with corrected calcium x phosphate <math><4.5 \text{ mmol}^2/\text{L}^2</math>, PD 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	24	40	50	65	70.5	78.5	88	96
2008	23	35	50	62	73	78	88	98
2009	23	46	50	65	70	81	91	98
2010	23	40	48	64	76	81	85	86
2011	25	48	50	70	75	80	89	89
2012	26	45	47	64	72	80	92	95
2013	28	46	55	66.5	71.5	83.5	90	91
2014	28	49	61	66.5	73	82	89	94
2015	35	47	52	67	74	80	87	89
2016	37	52	56	67	76	80	89	92

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 38% in 2007 to 55% in 2016. Similarly, the percentage of patients on calcitriol in PD patients had increased from 22% in 2007 to 42% in 2016. The use of Paricalcitol remained low in 2016. Parathyroidectomy had remained stable at about 1% since 2007 in both HD and PD patients. (Tables 9.3.1 a & b).

In year 2016, HD patients had mean iPTH of 264pg/ml. 56% of HD patients had iPTH level <150pg/ml, 16% within the target level (>150&<300pg/ml) and 18% had iPTH above 500pg/ml. Mean iPTH was lower in diabetic HD patients than the non-diabetic HD patients (233pg/ml vs 290pg/ml). The diabetic HD patients had higher proportion with iPTH level below 150pg/ml (59%) than non-diabetic HD patients (53%). On the other hand, the mean iPTH was higher in PD patients at 287pg/ml. About 42% of PD patients had iPTH <150pg/ml, 23% achieved target iPTH (>150&<300pg/ml) and 18% had iPTH more than 500pg/ml. Similarly, mean iPTH was lower in diabetic PD patients than non-diabetic PD patients (213pg/ml vs 318pg/ml). The diabetic PD patients had higher proportion with iPTH level below 150pg/ml (49%) than non-diabetic PD patients (42%). (Tables and Figures 9.3.2a & 9.3.3a)

Table 9.3.1(a): Treatment of hyperparathyroidism in HD patients, 2007-2016

Year	Number of patients	Number of Patients on calcitriol		Number of patients on Paricalcitol		Number of patients had Para-thyroidectomy	
		n	%	n	%	n	%
2007	12906	4953	38	60	0	180	1
2008	15402	6346	41	67	0	174	1
2009	17976	7790	43	93	1	167	1
2010	19584	9094	46	160	1	171	1
2011	22310	10765	48	139	1	177	1
2012	25670	11804	46	266	1	264	1
2013	29115	13977	48	212	1	317	1
2014	32470	16826	52	232	1	313	1
2015	35338	19065	54	165	0	248	1
2016	38082	21085	55	204	1	272	1

Table 9.3.1(b): Treatment of hyperparathyroidism in PD patients, 2007-2016

Year	Number of patients	Number of Patients on calcitriol		Number of patients on Paricalcitol		Number of patients had Para-thyroidectomy	
		n	%	n	%	n	%
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	6511	2202	34	28	0	38	1
2014	7424	2720	37	10	0	54	1
2015	7979	2961	37	15	0	42	1
2016	7481	2827	38	11	0	42	1

Table 9.3.2(a): Distribution of iPTH, HD patient 2007-2016

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
2007	9150	245.8	332.7	104.8	30.4	335.0	58	15	12	16
2008	10753	260.8	330.9	127.0	36.0	361.0	54	17	13	17
2009	12646	269.4	337.2	140.1	40.0	367.0	52	18	13	17
2010	14409	235.3	319.0	98.1	30.4	319.3	58	15	11	15
2011	16421	223.3	312.4	87.3	29.3	304.3	61	14	12	14
2012	18942	291.5	340.2	167.0	46.6	410.4	48	18	15	19
2013	21510	233.3	315.7	99.6	34.0	311.5	59	15	12	14
2014	25128	296.9	357.5	158.7	44.1	417.5	49	17	14	20
2015	27833	300.5	347.9	168.1	46.8	433.3	48	16	15	21
2016	29632	264.6	344.2	110.0	38.3	370.7	56	15	12	18

Figure 9.3.2(a): Cumulative distribution of iPTH, HD 2007-2016

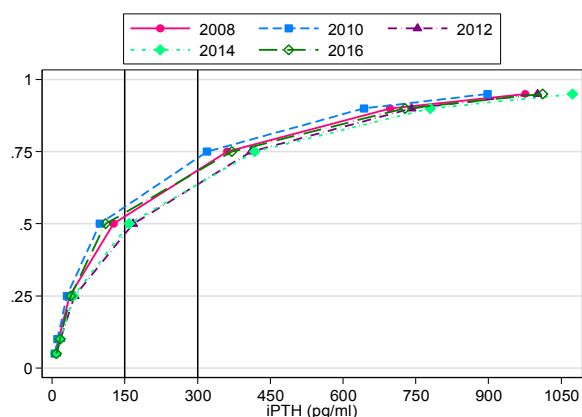


Figure 9.3.2(b): Cumulative distribution of iPTH, diabetic HD patients 2007-2016

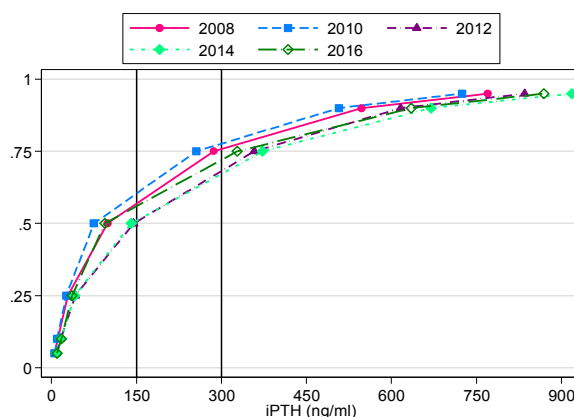


Table 9.3.2(b): Distribution of iPTH, diabetic HD patients, 2007-2016

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
2007	3683	183.0	267.4	70.6	23.0	235.5	66	14	10	10
2008	4596	208.9	275.3	99.0	29.1	286.9	59	17	12	12
2009	5648	218.3	284.0	111.3	33.8	292.0	57	18	12	12
2010	6601	189.6	268.7	75.0	26.0	255.8	64	15	11	10
2011	7567	182.6	264.3	67.0	24.7	241.4	66	14	10	10
2012	8835	249.6	290.5	145.0	42.0	358.0	51	19	16	15
2013	10004	198.8	269.6	83.4	31.5	268.5	62	15	11	11
2014	11712	262.3	316.9	140.8	41.0	372.5	51	17	15	16
2015	12627	268.8	313.5	147.0	44.1	390.5	50	17	15	17
2016	13443	233.9	306.4	94.0	36.5	328.0	59	14	12	15

Table 9.3.2(c): Distribution of iPTH, non-diabetic HD patients, 2007-2016

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
2007	5467	288.1	364.2	135.2	38.8	403.5	52	15	13	19
2008	6157	299.6	362.2	155.0	42.9	418.0	49	16	14	21
2009	6998	310.6	369.6	170.5	47.8	433.5	47	17	14	21
2010	7808	274.0	351.4	126.3	36.5	385.5	54	15	12	19
2011	8854	258.1	344.4	108.1	34.7	357.7	56	14	13	17
2012	10107	328.1	374.5	189.8	51.2	469.6	45	17	15	23
2013	11506	263.3	348.2	116.2	37.4	354.7	56	15	12	17
2014	13416	327.2	387.1	176.8	47.0	472.4	47	16	14	23
2015	15206	326.8	372.1	185.1	49.5	481.0	46	16	14	24
2016	16189	290.1	370.7	126.0	40.1	406.8	53	15	12	20

Figure 9.3.2(c): Cumulative distribution of iPTH, non-diabetic HD patients 2007-2016

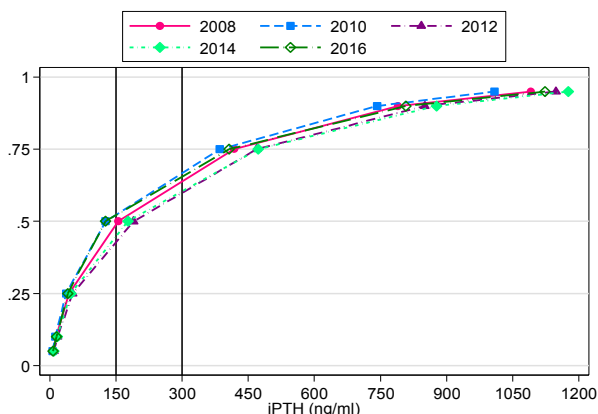


Figure 9.3.3(a): Cumulative distribution of iPTH, PD patients 2007-2016

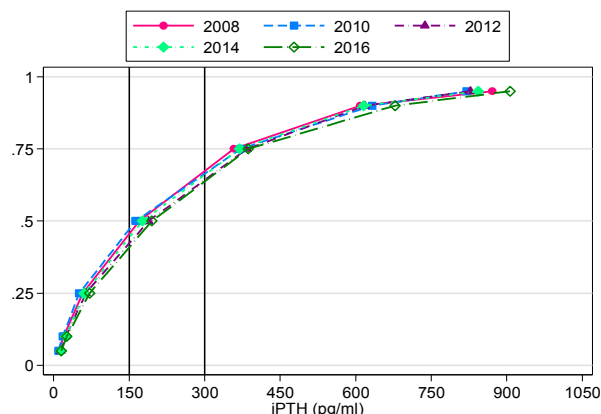


Table 9.3.3(a): Distribution of iPTH, PD patients 2007-2016

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
2007	1436	248.4	297.1	152.5	51.0	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	381.0	45	22	16	16
2010	1905	261.5	294.8	163.0	51.0	371.0	48	20	16	16
2011	2040	249.3	282.7	160.3	50.0	343.3	48	23	16	14
2012	2264	274.4	292.5	188.4	64.0	384.3	43	22	19	15
2013	2600	213.5	251.3	134.0	52.0	284.2	53	24	14	9
2014	2939	268.9	289.6	176.5	61.0	369.5	45	22	17	16
2015	3478	263.1	300.1	154.3	51.0	362.7	49	20	14	16
2016	3672	287.9	305.3	195.3	71.4	386.7	42	23	17	18

Table 9.3.3(b): Distribution of iPTH, diabetic PD patients, 2007-2016

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
2007	544	176.4	204.6	113.0	41.8	237.8	58	25	11	6
2008	693	211.5	228.3	142.0	56.5	293.9	51	24	17	8
2009	751	187.3	185.1	132.0	57.5	257.2	54	26	13	7
2010	663	197.5	216.8	131.0	41.0	297.2	54	21	16	8
2011	655	188.8	208.0	128.0	44.0	272.5	54	24	16	6
2012	680	200.5	214.8	131.3	56.0	282.5	52	25	15	7
2013	738	173.8	207.7	112.5	44.2	217.5	59	26	9	6
2014	797	218.6	220.0	144.0	65.0	304.0	51	24	16	10
2015	970	200.1	214.8	128.3	51.0	272.5	55	24	12	9
2016	1067	213.1	203.9	152.0	68.0	291.5	49	27	16	9

Figure 9.3.3(b): Cumulative distribution of iPTH, diabetic PD patients, 2007-2016

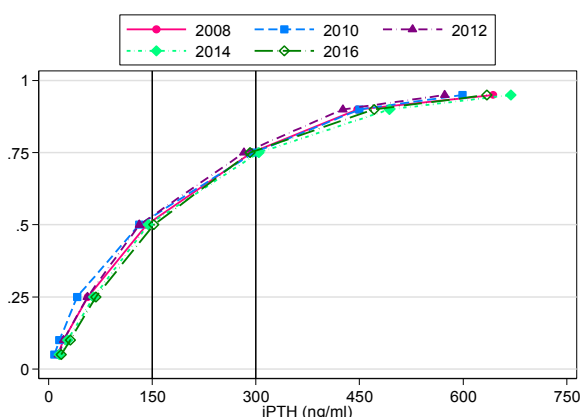


Figure 9.3.3(c): Cumulative distribution of iPTH, non-diabetic PD patients, 2007-2016

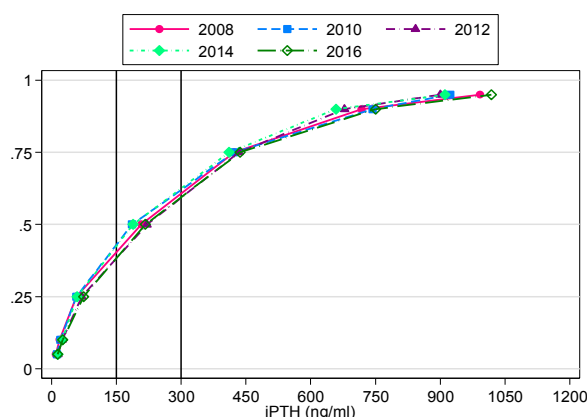


Table 9.3.3(c): Distribution of iPTH, non-diabetic PD patients, 2007-2016

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
2007	892	292.3	334.0	191.0	57.5	404.8	44	20	18	18
2008	915	304.0	331.9	208.0	57.5	423.0	42	20	18	20
2009	1073	329.0	336.8	224.2	80.0	460.0	40	20	19	22
2010	1242	295.7	323.9	186.3	57.0	422.4	45	20	15	20
2011	1385	277.9	307.8	182.7	55.7	387.5	45	22	16	17
2012	1584	306.1	314.9	220.7	69.8	434.0	40	21	21	19
2013	1862	229.2	265.0	146.3	53.9	312.0	51	23	16	10
2014	2142	287.6	309.5	188.5	58.5	411.0	43	21	17	19
2015	2508	287.4	323.9	172.0	50.9	408.7	47	19	15	19
2016	2605	318.5	333.4	217.0	73.4	436.0	40	22	17	21

There was wide variation in iPTH level among HD centres and PD centres. The degree of variation seemed to become wider since 2007 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 23.5% for PD centres (Tables and Figures 9.3.4b & 9.3.5b).

Table 9.3.4(a): Variation in iPTH among HD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	245	8.1	20.0	46.0	121.0	252.5	470.1	615.0
2008	284	8.5	21.7	54.3	136.5	260.3	393.8	742.3
2009	324	2.0	25.8	61.7	161.3	264.5	416.0	1007.9
2010	363	5.5	18.5	39.7	105.8	243.0	394.8	629.0
2011	423	3.3	18.8	40.5	91.7	233.5	420.7	1217.5
2012	485	11.4	31.7	73.3	186.9	287.7	452.2	768.3
2013	521	10.0	22.3	44.6	97.3	252.0	426.7	998.5
2014	592	11.7	29.3	60.4	183.6	301.2	466.0	1082
2015	626	11.3	31.1	73.3	201.4	306.1	461.4	803.5
2016	649	16.4	29.7	47.1	114.9	279.8	468.6	1271.7

Figure 9.3.4(a): Variation in median iPTH among HD patients, HD centres, 2016

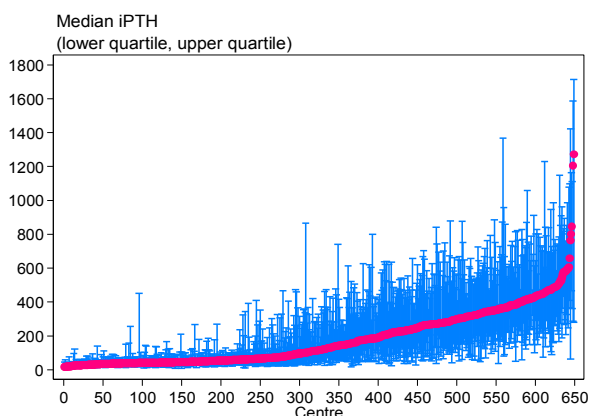


Figure 9.3.4(b): Variation in proportion of patients with iPTH 150-300pg/ml, HD centres, 2016

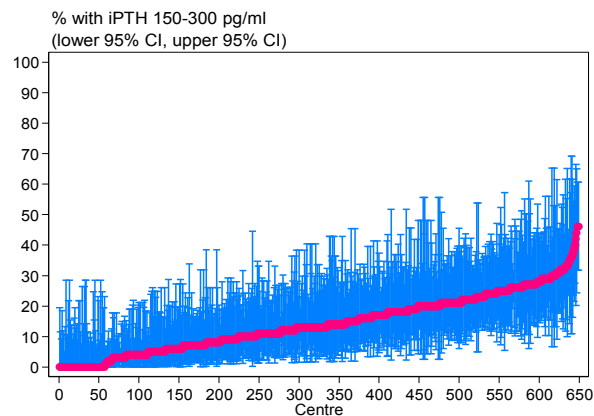


Table 9.3.4(b): Variation in proportion of patients with iPTH 150-300pg/ml, HD centres, 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	245	0	0	8	14	22	29	53
2008	284	0	0	9	15	23	31	50
2009	324	0	0	9.5	18	25	35	46
2010	363	0	0	6	14	22	33	48
2011	423	0	0	6	13	20	32	60
2012	485	0	3	10	17	24	33	53
2013	521	0	0	6	13	22	34	60
2014	592	0	2	10	16	23	33	54
2015	626	0	0	9	16	22	31	56
2016	649	0	0	7	13	21	30	46

Table 9.3.5(a): Variation in median iPTH among PD patients 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	22	24.6	32.0	108.8	203.7	239.2	440.0	523.8
2008	22	33.3	62.0	130.9	208.1	310.9	363.1	454.5
2009	22	36.0	56.5	143.5	206.8	258.5	462.5	1047
2010	24	28.5	30.0	117.8	211.5	285.2	512.0	783.2
2011	24	25.9	26.8	99.1	201.7	290.3	421.5	434.5
2012	26	34.8	45.0	137.5	266.3	324.5	478.5	495.5
2013	26	37.0	41.7	69.2	188.3	258.5	293.0	467.0
2014	29	40.6	41.0	115.8	215.0	306.0	374.5	385.0
2015	34	38.8	42.0	115.8	202.3	296.0	490.5	521.0
2016	36	38.8	65.9	138.6	211.9	313.4	530.3	645.5

Figure 9.3.5(a): Variation in median iPTH among PD patients, PD centres, 2016

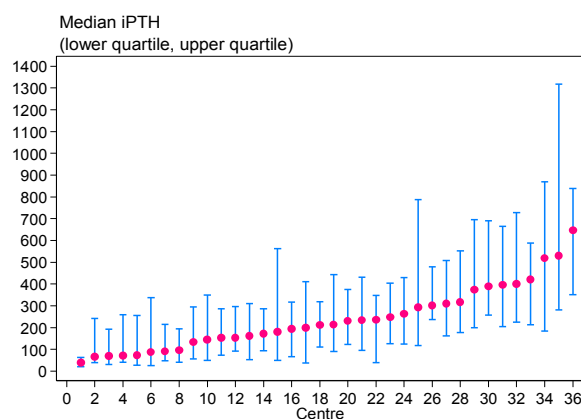


Figure 9.3.5(b): Variation in proportion of patients with iPTH 150-300pg/ml, PD centres 2016

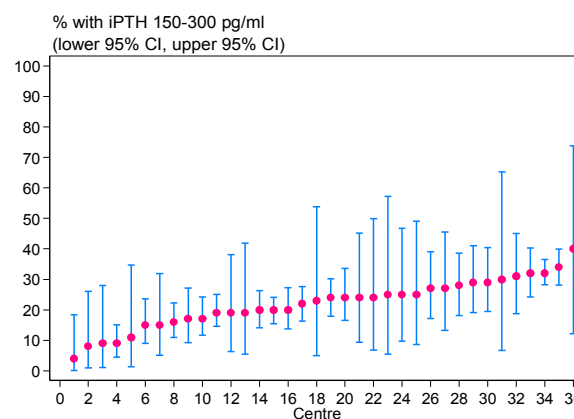


Table 9.3.5(b): Variation in proportion of patients with iPTH 150-300pg/ml, PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	22	0	3	16	21	25	31	39
2008	22	0	8	15	20.5	26	31	34
2009	22	10	11	16	21.5	27	28	28
2010	24	0	4	13.5	20	27	31	40
2011	24	3	4	13.5	22.5	29	31	39
2012	26	1	10	16	19	26	31	31
2013	26	3	4	11	23	32	38	38
2014	29	0	6	14	20	24	33	50
2015	34	6	7	13	19	28	36	41
2016	36	4	8	17	23.5	27.5	34	40

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 phosphorus 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 are not routinely performed in Malaysia. We did not see much improvement in the laboratory parameters for the last 10 years. 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 increase in the use of non-calcium base phosphate binder (lanthanum and sevelamer). Parathyroidectomy had remained stable at about 1% since 2007.

Overall, the control of calcium, phosphate and iPTH parameters in CKD-MBD needs improvement. In view of the rather wide variation in the blood parameters outcome, we need to have strategies to improve and standardise the management of CKD-MBD among dialysis patients in Malaysia.