

CHAPTER 7

Chronic Kidney Disease – Mineral and Bone Disorder

Goh Bak Leong

Ching Chen Hua

Kok Lai Sun

Liew Yew Fong

Wan Ahmad Hafiz Adnan Bin Wan Md Adnan

Yudisthra A/L Ganeshadeva

SECTION 7.1: TREATMENT OF HYPERPHOSPHATAEMIA

Calcium carbonate remained as the main phosphate binder for both HD patients (90%) and PD patients (84%) in 2017. The second most commonly used phosphate binder which was Lanthanum previously, has now been over taken by Sevelamer for PD patients (5%) in 2017, while increased to 2% in HD patients in 2017, same as Lanthanum. The number of patients took aluminium based phosphate binder had decreased since 2008 for both HD and PD patients. (Tables 7.1.1 and 7.1.2)

Table 7.1.1: Phosphate Binder in HD patients, 2008-2017

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	%
2017	44618	40278	90	7	0	722	2	964	2
2016	38144	35443	93	3	0	626	2	509	1
2015	35424	32767	92	2	0	818	2	361	1
2014	32586	29975	92	6	0	786	2	212	1
2013	29147	26926	92	10	0	736	3	108	0
2012	25831	23668	92	12	0	648	3	83	0
2011	22512	20623	92	30	0	517	2	72	0
2010	19709	17921	91	27	0	381	2	6	0
2009	18052	16527	92	34	0	247	1	0	0
2008	15415	14204	92	72	0	86	1	3	0

Table 7.1.2: Phosphate Binder in PD patients, 2008-2017

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	%
2017	5402	4551	84	0	0	94	2	283	5
2016	4702	3951	84	0	0	99	2	171	4
2015	4333	3652	84	0	0	125	3	93	2
2014	3728	3208	86	3	0	119	3	41	1
2013	3260	2805	86	2	0	111	3	23	1
2012	2876	2452	85	3	0	101	4	12	0
2011	2551	2207	87	4	0	90	4	12	0
2010	2360	2085	88	2	0	52	2	1	0
2009	2212	1875	85	7	0	45	2	1	0
2008	2084	1801	86	7	0	21	1	0	0

It is interesting to note that the major used of Lanthanum and Sevelamer before 2015 was among the NGO patients. However, over the last few years, public sector has increased the usage was on par with NGO in 2017 (Table 7.1.3)

Table 7.1.3: Phosphate Binders by Sector in HD patients

Year	Sector	Lanthanum Carbonate		Sevelamer HCl		Aluminium binder	
		n	%	n	%	n	%
2017	Public	289	35	541	43	1	14
	Private	216	26	140	11	3	43
	NGO	311	38	566	45	3	43
	Total	816	100	1247	100	7	100
2016	Public	300	41	288	42	0	0
	Private	174	24	55	8	0	0
	NGO	251	35	337	50	3	100
	Total	725	100	680	100	3	100
2015	Public	363	38	162	36	1	50
	Private	232	25	45	10	0	0
	NGO	348	37	247	54	1	50
	Total	943	100	454	100	2	100
2014	Public	346	38	78	31	6	67
	Private	234	26	19	8	0	0
	NGO	325	36	156	62	3	33
	Total	905	100	253	100	9	100
2013	Public	339	40	39	30	6	50
	Private	197	23	9	7	5	42
	NGO	311	37	83	63	1	8
	Total	847	100	131	100	12	100
2012	Public	342	46	18	19	6	40
	Private	184	25	8	8	0	0
	NGO	223	30	69	73	9	60
	Total	749	100	95	100	15	100
2011	Public	313	52	19	23	23	68
	Private	140	23	26	31	2	6
	NGO	154	25	39	46	9	26
	Total	607	100	84	100	34	100
2010	Public	202	47	3	43	20	69
	Private	113	26	0	0	5	17
	NGO	118	27	4	57	4	14
	Total	433	100	7	100	29	100
2009	Public	134	46	1	100	18	44
	Private	62	21	0	0	7	17
	NGO	96	33	0	0	16	39
	Total	292	100	1	100	41	100
2008	Public	37	35	0	0	32	41
	Private	19	18	0	0	14	18
	NGO	51	48	3	100	33	42
	Total	107	100	3	100	79	100

SECTION 7.2: SERUM CALCIUM AND PHOSPHATE CONTROL

The median corrected serum calcium level had remained constant since 2008 for both HD (2.3 mmol/L) and PD (2.3-2.4 mmol/L) patients. 52% of HD patients achieved target serum calcium level of 2.1 to 2.37mmol/L compared to 42% of PD patients (Tables & Figures 7.2.1 and 7.2.2).

Table 7.2.1: Distribution of corrected serum calcium, HD patients 2008-2017

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients ≥ 2.1 & ≤ 2.37 mmol/L
2017	39759	2.2	0.2	2.3	2.1	2.4	52
2016	35836	2.2	0.2	2.2	2.1	2.4	54
2015	33367	2.2	0.2	2.3	2.1	2.4	54
2014	30633	2.3	0.2	2.3	2.1	2.4	54
2013	27300	2.3	0.2	2.3	2.1	2.4	53
2012	24031	2.3	0.2	2.3	2.1	2.4	54
2011	20950	2.3	0.2	2.3	2.1	2.4	53
2010	18478	2.3	0.2	2.3	2.2	2.4	53
2009	16559	2.3	0.2	2.3	2.2	2.4	52
2008	14319	2.3	0.2	2.3	2.1	2.4	53

Figure 7.2.1: Cumulative distribution of corrected serum calcium, HD patients 2008-2017

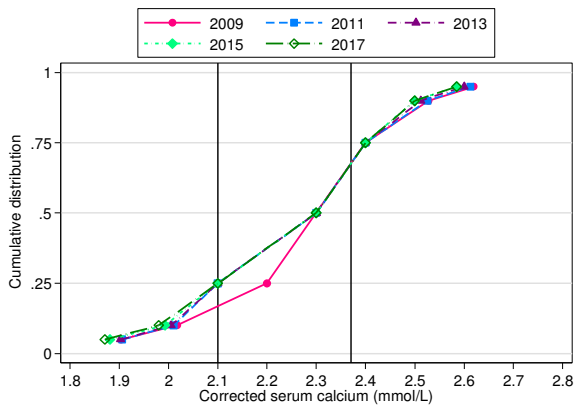


Figure 7.2.2: Cumulative distribution of corrected serum calcium, PD patients 2008-2017

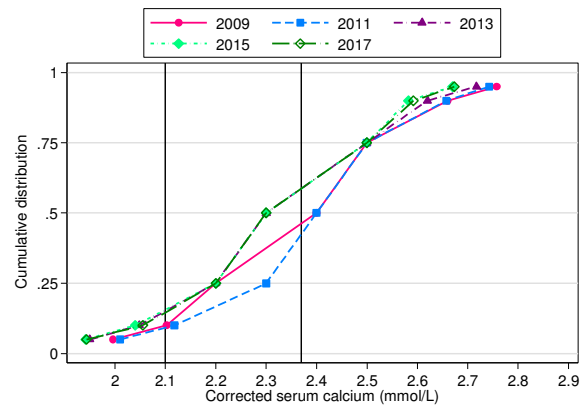


Table 7.2.2: Distribution of corrected serum calcium, PD patients 2008-2017

Year	Number of patients	Mean	SD	Median	LQ	UQ	%patients ≥ 2.1 & ≤ 2.37 mmol/L
2017	4963	2.3	0.2	2.3	2.2	2.5	42
2016	4503	2.3	0.2	2.3	2.2	2.5	46
2015	4184	2.3	0.2	2.3	2.2	2.5	44
2014	3594	2.3	0.2	2.3	2.2	2.5	43
2013	3146	2.3	0.2	2.3	2.2	2.5	42
2012	2762	2.4	0.2	2.4	2.2	2.5	43
2011	2435	2.4	0.2	2.4	2.3	2.5	38
2010	2285	2.4	0.2	2.4	2.3	2.5	37
2009	2127	2.4	0.2	2.4	2.2	2.5	39
2008	2006	2.4	0.2	2.4	2.3	2.5	38

Overall, PD patients had better phosphate control compared to HD patients (median level 1.6 vs 1.7mmol/L). In 2017, about 23% of PD patients achieved target phosphate level of 0.8 to 1.3mmol/L compared to only 14% in HD patients. About 41% PD patients achieved phosphate level of 1.3-1.8mmol/L and 42% HD achieved that level. Only 13% of PD patients have phosphate level >2.2mmol/L as compared to HD patients (16% with phosphate level > 2.2mmol/L). However, there was an improvement in HD patients since 2008 with a gradual decrease in the number of patients with phosphate >2.2mmol/L (Tables & Figures 7.2.3 and 7.2.4).

Table 7.2.3: Distribution of serum phosphate, HD patients 2008-2017

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
2017	39972	1.8	0.5	1.7	1.4	2.0	1	14	42	26	16
2016	36198	1.8	0.5	1.7	1.4	2.0	1	15	41	28	16
2015	33679	1.7	0.5	1.7	1.4	2.0	1	16	41	26	16
2014	31052	1.7	0.5	1.7	1.4	2.0	1	16	42	25	16
2013	27887	1.8	0.5	1.7	1.4	2.0	1	16	42	25	17
2012	24453	1.8	0.5	1.7	1.4	2.0	1	15	41	25	17
2011	21335	1.8	0.5	1.7	1.4	2.1	1	15	40	26	18
2010	18699	1.8	0.5	1.7	1.4	2.1	1	14	40	26	19
2009	16941	1.8	0.5	1.7	1.4	2.1	1	15	40	26	18
2008	14695	1.7	0.5	1.7	1.4	2.0	1	17	41	24	17

Figure 7.2.3: Cumulative distribution of serum phosphate, HD patients 2008-2017

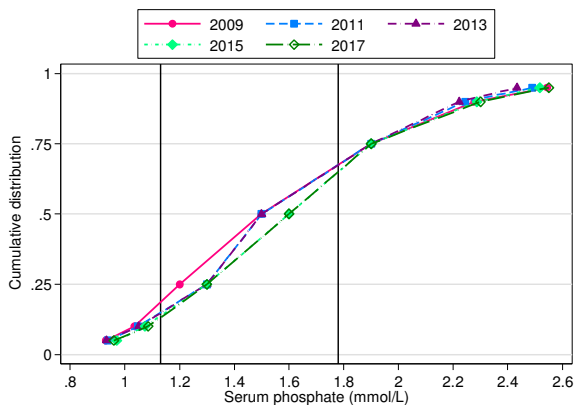


Figure 7.2.4: Cumulative distribution of serum phosphate, PD patients 2008-2017

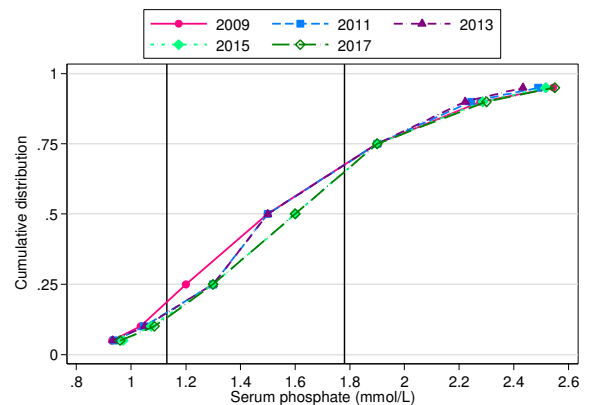


Table 7.2.4: Distribution of serum phosphate, PD patients 2008-2017

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
2017	4983	1.7	0.5	1.6	1.3	1.9	2	23	41	20	13
2016	4537	1.6	0.5	1.6	1.3	1.9	2	25	41	19	13
2015	4204	1.6	0.5	1.6	1.3	1.9	1	25	43	19	12
2014	3621	1.6	0.5	1.6	1.3	1.9	1	26	42	19	12
2013	3149	1.6	0.5	1.5	1.3	1.9	2	26	43	18	11
2012	2773	1.6	0.5	1.5	1.3	1.9	2	27	42	18	11
2011	2461	1.6	0.5	1.5	1.3	1.9	2	27	41	19	11
2010	2287	1.6	0.5	1.5	1.2	1.9	2	28	40	18	12
2009	2139	1.6	0.5	1.5	1.2	1.9	2	27	41	18	12
2008	2011	1.6	0.5	1.5	1.3	1.9	2	27	42	17	12

The corrected serum calcium phosphate product had remained relatively stable in both HD and PD patients. In 2017, PD patients had better calcium phosphate product than HD patients. About 74% of PD patients had corrected calcium phosphate product $<4.5\text{mmol}^2/\text{L}^2$ compared to 73% in HD patients. Overall there was a positive trend in calcium phosphate product and the percentage of patients with corrected serum calcium phosphate product $\geq 5.5\text{mmol}^2/\text{L}^2$ had remained less than 11% since 2008. (Tables and Figures 7.2.5 & 7.2.6)

Table 7.2.5: Distribution of corrected calcium x phosphate product, HD patients 2008-2017

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
2017	39673	3.9	1.1	3.8	3.2	4.6	37	36	18	9
2016	35648	3.9	1.1	3.8	3.2	4.6	37	35	19	9
2015	33211	3.9	1.1	3.8	3.1	4.6	38	34	19	9
2014	30475	3.9	1.1	3.8	3.1	4.6	38	34	19	9
2013	27095	4.0	1.1	3.8	3.2	4.6	37	34	19	9
2012	23824	4.0	1.1	3.8	3.2	4.6	37	34	19	10
2011	20806	4.0	1.2	3.9	3.2	4.7	36	34	20	10
2010	18364	4.1	1.2	3.9	3.2	4.8	34	34	21	11
2009	16432	4.0	1.2	3.9	3.2	4.7	36	34	20	11
2008	14204	3.9	1.2	3.8	3.1	4.6	39	33	19	9

Figure 7.2.5: Cumulative distribution of corrected calcium x phosphate product, HD patients 2008-2017

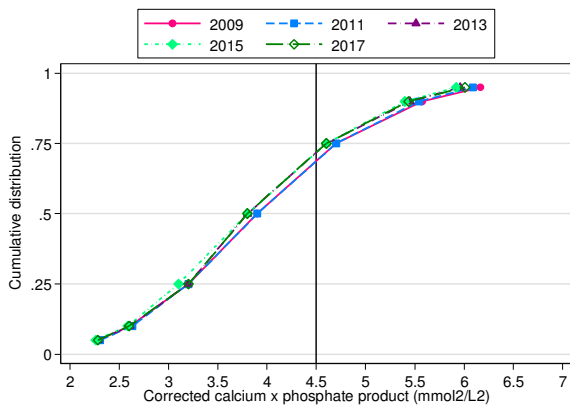


Figure 7.2.6: Cumulative distribution of corrected calcium x phosphate product, PD patients 2008-2017

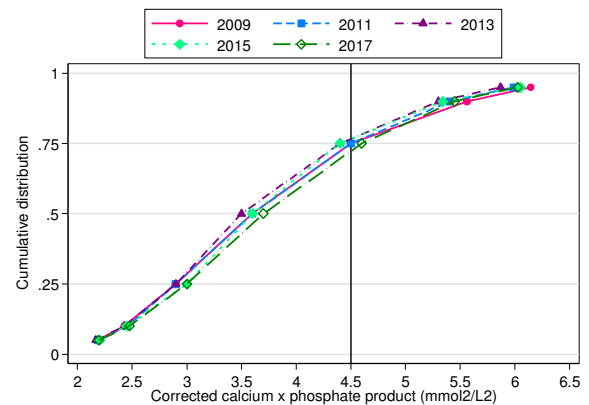


Table 7.2.6: Distribution of corrected calcium x phosphate product, PD patients 2008-2017

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
2017	4952	3.9	1.2	3.7	3.0	4.5	43	31	17	9
2016	4486	3.8	1.2	3.6	2.9	4.5	46	30	15	9
2015	4171	3.8	1.2	3.6	3.0	4.4	46	30	15	9
2014	3580	3.8	1.2	3.6	2.9	4.4	47	30	15	8
2013	3126	3.7	1.2	3.5	2.9	4.4	49	29	14	8
2012	2754	3.8	1.2	3.6	2.9	4.4	48	29	15	9
2011	2428	3.8	1.2	3.6	2.9	4.5	46	29	16	9
2010	2273	3.8	1.2	3.6	2.9	4.5	47	29	15	10
2009	2122	3.8	1.2	3.6	2.9	4.5	46	29	15	11
2008	1998	3.8	1.2	3.6	3.0	4.5	47	28	15	10

In year 2017, corrected median serum calcium level was 2.2 and 2.3mmol/L in HD and PD patients. The variation in corrected serum calcium level among both HD and PD centres remained wide in 2017. (Table and Figure 7.2.7a & 7.2.8a)

Table 7.2.7(a): Variation in corrected median serum calcium level among HD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	720	1.5	2.1	2.2	2.2	2.3	2.4	2.5
2016	696	1.8	2.1	2.2	2.2	2.3	2.4	2.5
2015	675	2.0	2.1	2.2	2.3	2.3	2.4	2.5
2014	641	2.0	2.1	2.2	2.3	2.3	2.4	2.5
2013	600	2.0	2.1	2.2	2.3	2.3	2.4	2.5
2012	546	2.0	2.1	2.2	2.3	2.3	2.4	2.6
2011	488	1.7	2.1	2.2	2.3	2.3	2.4	2.6
2010	430	1.8	2.2	2.2	2.3	2.3	2.4	2.5
2009	387	1.5	2.1	2.2	2.3	2.3	2.4	2.6
2008	346	1.9	2.1	2.2	2.2	2.3	2.4	2.7

Figure 7.2.7(a): Variation in median serum calcium level among HD patients, HD centres 2017

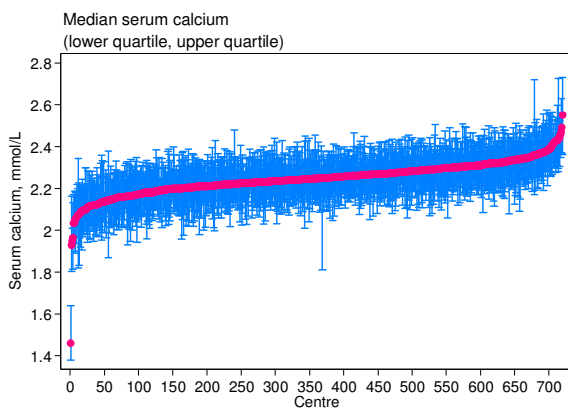


Figure 7.2.8(a): Variation in median serum calcium level among PD patients, PD centres 2017

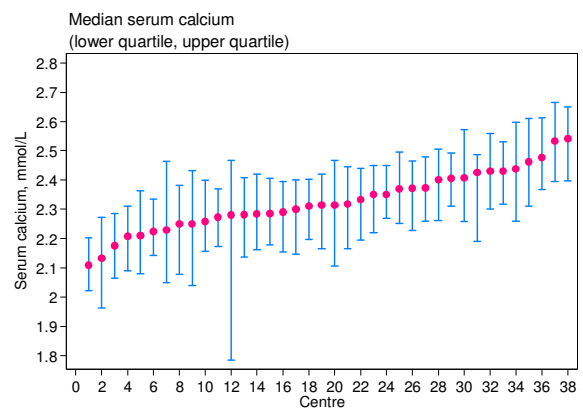


Table 7.2.8(a): Variation in corrected median serum calcium level among PD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	38	2.1	2.1	2.3	2.3	2.4	2.5	2.5
2016	37	2.1	2.2	2.3	2.3	2.4	2.4	2.5
2015	35	2.1	2.1	2.2	2.3	2.4	2.5	2.5
2014	32	2.1	2.1	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
2012	28	2.2	2.2	2.3	2.3	2.4	2.5	2.6
2011	26	2.1	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
2009	23	2.2	2.3	2.3	2.3	2.4	2.5	2.6
2008	23	2.2	2.2	2.3	2.4	2.4	2.6	2.6

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 2.37mmol/L); it ranged from 11 to 90% for HD centres in 2016 and 21-64% for PD centers in 2016. The median was 53% for HD centres and 44% for PD centres in 2017. The variation was smaller among PD centres compared to HD centres. (Tables and Figures 7.2.7b & 7.2.8b)

Table 7.2.7(b): Proportion of patients with serum calcium 2.1 to 2.37 mmol/L, HD centres, 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	720	0	35.0	46.0	53.0	60.0	70.5	93
2016	696	11	36.0	48.0	55.5	63.0	73.0	90
2015	675	10	35.0	47.0	55.0	62.0	73.0	94
2014	641	13	33.0	47.0	55.0	62.0	73.0	88
2013	600	8	33.0	47.0	55.0	63.0	74.0	90
2012	546	8	32.0	47.0	55.0	64.0	75.0	93
2011	488	0	33.0	46.0	54.0	62.0	73.0	93
2010	430	0	29.0	44.0	52.0	61.0	73.0	93
2009	387	0	27.0	44.0	53.0	61.0	71.0	90
2008	346	8	28.0	45.0	54.0	61.0	73.0	91

Figure 7.2.7(b): Variation in proportion of patients with serum calcium 2.1 to 2.37mmol/L, HD centres 2017

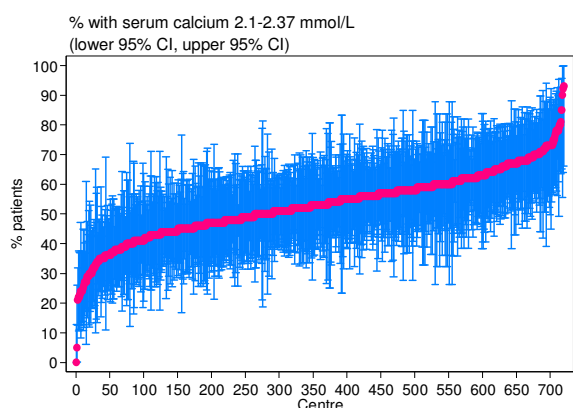


Figure 7.2.8(b): Variation in proportion of patients with serum calcium 2.1 to 2.37mmol/L, PD centres 2017

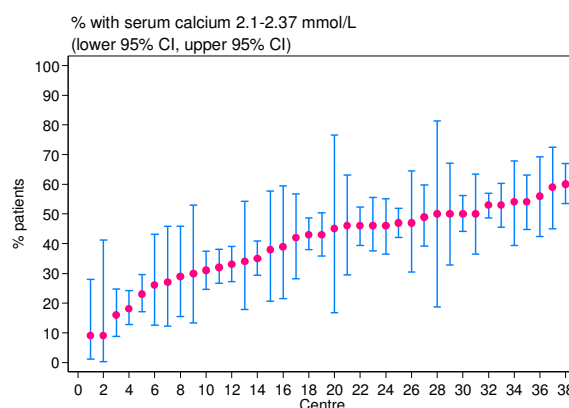


Table 7.2.8(b): Proportion of patients with serum calcium 2.1 to 2.37mmol/L, PD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	38	9	9	31.0	44.0	50.0	59	60
2016	37	21	24	39.0	49.0	52.0	57	64
2015	35	14	17	33.0	47.0	52.0	58	60
2014	32	13	16	30.0	42.0	51.0	58	64
2013	28	10	10	32.0	41.5	50.0	59	70
2012	28	6	9	31.5	42.5	50.5	61	71
2011	26	10	17	31.0	36.5	44.0	58	62
2010	25	14	18	28.0	35.0	49.0	56	58
2009	23	12	13	31.0	41.0	51.0	59	65
2008	23	13	14	32.0	44.0	53.0	59	67

Median serum phosphate level for HD centres was 1.7mmol/L (ranged from 0.7 to 2.3mmol/L) as opposed to median phosphate level of 1.6mmol/L (ranged from 1.4 to 2.1mmol/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 7.2.9a & 7.2.10a)

Table 7.2.9(a): Variation in median serum phosphate level among HD centres, 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	723	0.7	1.5	1.6	1.7	1.8	2.0	2.3
2016	696	1.2	1.5	1.6	1.7	1.8	2.0	2.3
2015	674	1.2	1.5	1.6	1.7	1.8	2.0	2.5
2014	645	1.3	1.5	1.6	1.7	1.8	2.0	2.3
2013	607	1.3	1.5	1.6	1.7	1.8	2.0	2.4
2012	555	1.1	1.5	1.6	1.7	1.8	2.0	2.6
2011	492	1.0	1.5	1.6	1.7	1.8	2.0	2.6
2010	437	1.3	1.5	1.6	1.8	1.8	2.0	2.7
2009	392	1.0	1.5	1.6	1.7	1.8	2.0	2.4
2008	352	1.2	1.5	1.6	1.7	1.8	2.0	2.5

Figure 7.2.9(a): Variation in median serum phosphate level among HD patients, HD centres 2017

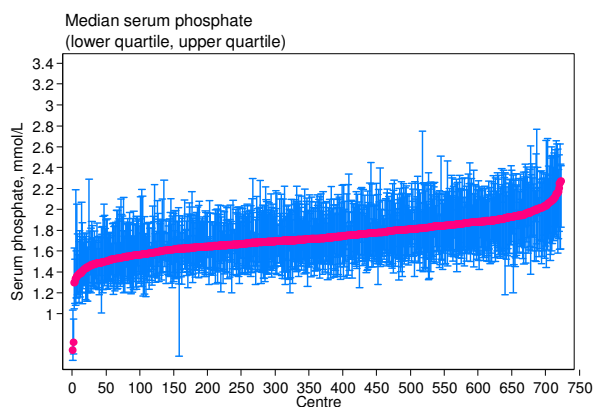


Figure 7.2.10(a): Variation in median serum phosphate level among PD patients, PD centres 2017

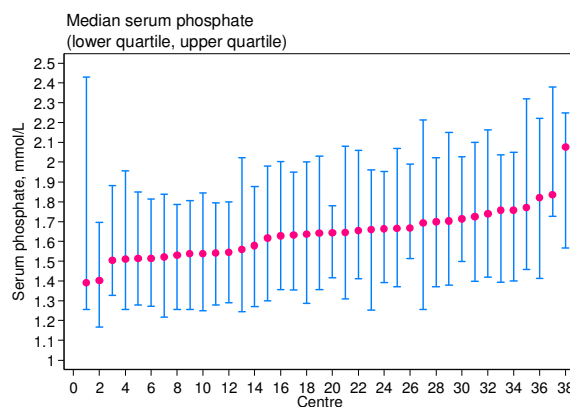


Table 7.2.10(a): Variation in median serum phosphate level among PD centres, 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	38	1.4	1.4	1.5	1.6	1.7	1.8	2.1
2016	37	1.4	1.4	1.5	1.6	1.7	1.9	1.9
2015	35	1.4	1.4	1.5	1.6	1.7	1.9	2.1
2014	32	1.4	1.4	1.5	1.6	1.8	1.9	1.9
2013	28	1.4	1.4	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
2011	26	1.3	1.3	1.5	1.6	1.7	1.9	1.9
2010	25	1.3	1.3	1.4	1.6	1.8	1.8	1.8
2009	23	1.3	1.4	1.5	1.6	1.7	1.9	2.2
2008	23	1.3	1.3	1.5	1.6	1.8	1.9	2.0

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 8 to 97% among HD centres (median 47%) and the range was narrower in PD centres, which was 26-71% (median 50%). (Tables and Figures 7.2.9b & 7.2.10b)

Table 7.2.9(b): Proportion of patients with serum phosphate 1.13-1.78 mmol/L, HD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	723	8	27	39.0	47.0	56.0	73	97
2016	696	15	28	39.0	48.0	55.5	67	87
2015	674	0	29	41.0	49.0	56.0	67	100
2014	645	14	29	40.0	49.0	56.0	67	83
2013	607	7	28	40.0	49.0	56.0	68	84
2012	555	6	29	40.0	48.0	56.0	68	100
2011	492	0	27	39.0	46.0	54.0	67	100
2010	437	4	26	38.0	46.0	54.0	67	76
2009	392	6	27	39.0	46.5	54.0	65	85
2008	352	8	29	39.0	47.0	56.0	68	86

Figure 7.2.9(b): Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, HD centres 2017

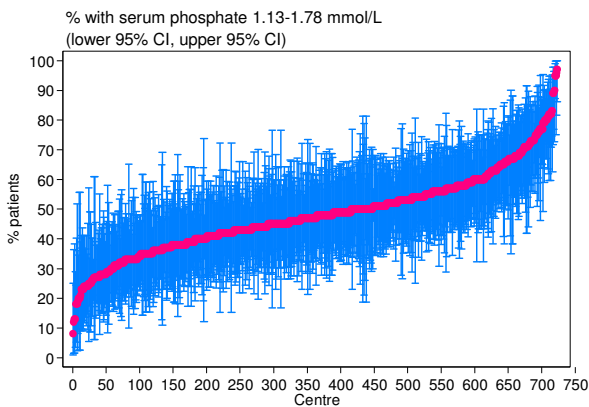


Figure 7.2.10(b): Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2017

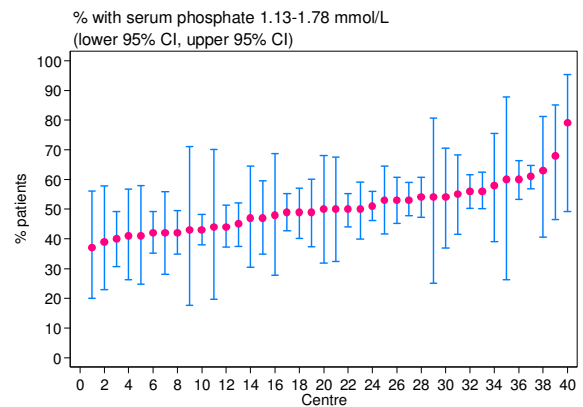


Table 7.2.10(b): Proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	38	26	32	44.0	50.0	55.0	66	71
2016	37	28	33	46.0	51.0	56.0	63	66
2015	35	17	36	45.0	51.0	57.0	65	71
2014	32	27	29	42.5	48.0	58.0	62	62
2013	28	28	36	46.5	50.5	55.0	64	77
2012	28	26	34	48.0	51.5	59.0	63	72
2011	26	35	37	47.0	52.0	60.0	77	81
2010	25	37	39	44.0	52.0	58.0	65	70
2009	23	20	38	48.0	54.0	58.0	65	69
2008	23	38	40	50.0	52.0	59.0	66	71

Proportion of patients with serum phosphate 0.8-1.3mmol/L was higher in PD patients with median of 24% as compared to 13% in HD patients. The centre variation ranged 0% to 47% for HD centres and 4% to 36% for PD centres. (Tables and Figures 7.2.9c & 7.2.10c)

Table 7.2.9(c): Proportion of patients with serum phosphate 0.8-1.3 mmol/L, HD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	723	0	3.0	8.0	13.0	19.0	29.0	47
2016	696	0	3.0	9.0	14.0	19.0	30.0	61
2015	674	0	4.0	10.0	15.0	21.0	32.0	70
2014	645	0	4.0	10.0	15.0	21.0	32.0	59
2013	607	0	3.0	9.0	14.0	20.0	32.0	48
2012	555	0	3.0	9.0	14.0	20.0	32.0	46
2011	492	0	2.0	9.0	14.0	20.0	29.0	83
2010	437	0	0.0	8.0	14.0	19.0	28.0	47
2009	392	0	2.0	9.0	14.0	21.0	31.0	46
2008	352	0	4.0	9.0	14.0	21.0	34.0	52

Figure 7.2.9(c): Variation in proportion of patients with serum phosphate 0.8-1.3 mmol/L, HD centres 2017

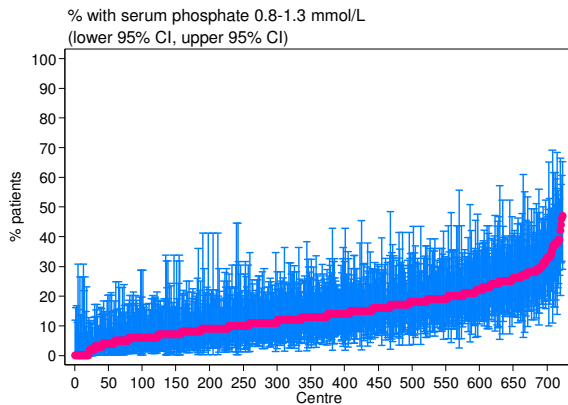


Figure 7.2.10(c): Variation in proportion of patients with serum phosphate 0.8-1.3 mmol/L, PD centres 2017

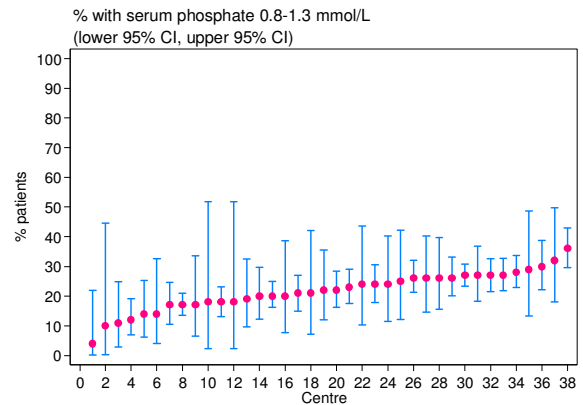


Table 7.2.10(c): Proportion of patients with serum phosphate 0.8-1.3 mmol/L, PD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	38	4	10	18.0	22.0	26.0	32	36
2016	37	6	8	16.0	24.0	28.0	35	37
2015	35	0	0	16.0	22.0	29.0	38	38
2014	32	2	4	12.0	21.5	29.0	39	40
2013	28	5	5	13.0	23.5	29.0	35	37
2012	28	3	4	16.5	21.0	31.5	35	48
2011	26	0	0	15.0	22.5	34.0	44	50
2010	25	7	8	16.0	24.0	32.0	42	43
2009	23	4	12	19.0	25.0	31.0	35	43
2008	23	0	4	15.0	22.0	30.0	38	47

The corrected serum calcium- phosphate product among 719 HD centres ranged from 2.3 to 5.2mmol²/L² with median of 3.9mmol²/L². The corrected serum calcium- phosphate product among 38 PD centres ranged from 3.1 to 4.7mmol²/L². The variation in corrected serum calcium-phosphate product remained wide in both HD and PD centres since 2008. (Tables and Figures 7.2.11a & 7.2.12a)

Table 7.2.11(a): Variation in corrected median calcium x phosphate product HD centres, 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	719	2.3	3.2	3.6	3.9	4.1	4.5	5.2
2016	696	2.2	3.2	3.6	3.9	4.1	4.5	5.0
2015	674	2.6	3.3	3.6	3.8	4.1	4.5	5.6
2014	639	2.7	3.2	3.6	3.8	4.1	4.4	5.0
2013	594	2.8	3.3	3.6	3.8	4.1	4.6	5.9
2012	543	2.7	3.3	3.6	3.8	4.1	4.5	5.7
2011	486	2.0	3.3	3.7	3.9	4.2	4.6	5.7
2010	430	3.0	3.4	3.7	3.9	4.2	4.7	6.0
2009	383	2.3	3.3	3.7	3.9	4.1	4.7	6.1
2008	343	2.7	3.1	3.6	3.8	4.1	4.5	6.2

Figure 7.2.11(a): Variation in median corrected calcium x phosphate product among HD patients, HD centres 2017

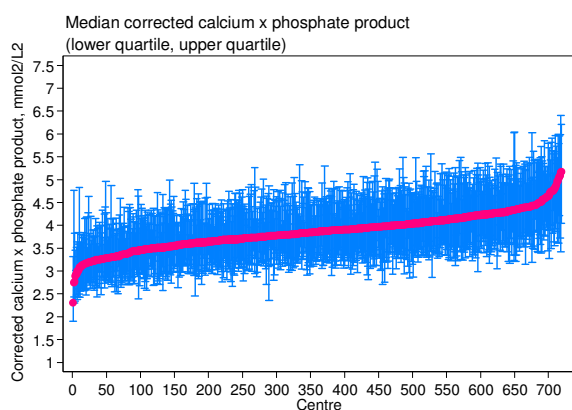


Figure 7.2.12(a): Variation in median corrected calcium x phosphate product among PD patients, PD centres 2017

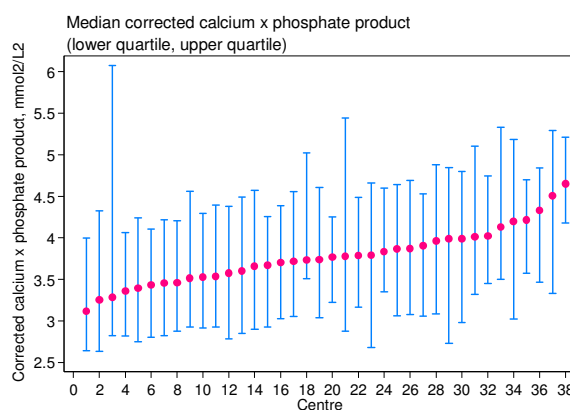


Table 7.2.12(a): Variation in corrected median calcium x phosphate product PD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	38	3.1	3.3	3.5	3.8	4.0	4.5	4.7
2016	37	3.0	3.3	3.5	3.6	4.0	4.3	4.4
2015	35	3.0	3.2	3.4	3.6	3.9	4.4	4.5
2014	32	3.1	3.2	3.4	3.7	4.1	4.5	4.7
2013	28	3.2	3.2	3.3	3.8	3.9	4.3	4.5
2012	28	3.1	3.1	3.5	3.8	4.1	4.2	4.5
2011	26	2.9	3.0	3.4	3.8	4.0	4.6	4.6
2010	25	3.1	3.2	3.3	3.8	4.0	4.4	4.6
2009	23	3.3	3.3	3.5	3.7	3.9	4.6	4.8
2008	23	3.1	3.1	3.4	3.7	4.1	4.5	4.6

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 73% in 2017. 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 30-100% in HD patients and 43-89% in PD patients (Tables and Figures 7.2.11b & 7.2.12b).

Table 7.2.11(b): Proportion of patients with corrected calcium x phosphate $<4.5 \text{ mmol}^2/\text{L}^2$, HD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	719	30	50	64.0	73.0	83.0	94	100
2016	696	36	50	64.0	74.0	82.0	92	100
2015	674	31	50	65.0	73.0	80.0	91	100
2014	639	30	52	65.0	74.0	81.0	90	100
2013	594	20	48	64.0	73.0	81.0	90	100
2012	543	29	50	63.0	72.0	80.0	92	100
2011	486	20	46	61.0	71.0	79.0	91	100
2010	430	8	44	60.0	69.0	77.0	88	100
2009	383	25	44	61.0	71.0	79.0	90	100
2008	343	12	50	63.0	72.0	82.0	93	100

Figure 7.2.11(b): Variation in proportion of patients with corrected calcium x phosphate product $<4.5 \text{ mmol}^2/\text{L}^2$, HD centres 2017

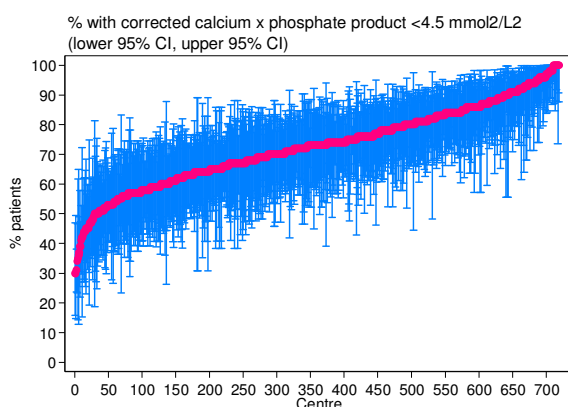


Figure 7.2.12(b): Variation in proportion of patients with corrected calcium x phosphate product $<4.5 \text{ mmol}^2/\text{L}^2$, PD centres, 2017

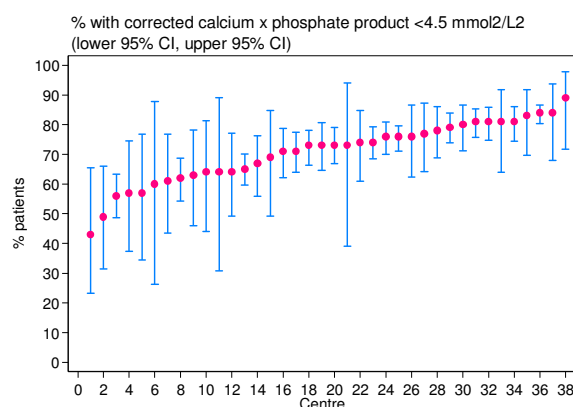


Table 7.2.12(b): Proportion of patients with corrected calcium x phosphate $<4.5 \text{ mmol}^2/\text{L}^2$, PD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	38	43	49	64.0	73.0	79.0	84	89
2016	37	52	56	67.0	76.0	80.0	89	92
2015	35	47	50	67.0	74.0	80.0	87	89
2014	32	46	49	68.0	75.0	79.5	87	89
2013	28	49	61	66.5	73.0	82.0	89	94
2012	28	46	55	66.5	71.5	83.5	90	91
2011	26	45	47	63.0	72.5	80.0	92	95
2010	25	48	50	70.0	75.0	80.0	89	89
2009	23	40	48	64.0	76.0	81.0	85	86
2008	23	46	50	65.0	70.0	81.0	91	98

SECTION 7.3: SERUM PARATHYROID HORMONE CONTROL

Calcitriol was the main vitamin D receptor activator (VDRA) used in the 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 29% in 2007 to 38% in 2016. The used of Paricalcitol remained low in 2016. Parathyroidectomy had remained stable at about 1% since 2007 in both HD and PD patients. (Tables 7.3.1 a & b)

Table 7.3.1(a): Treatment of hyperparathyroidism in HD patients, 2007-2016 (To be Updated)

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 7.3.1(b): Treatment of hyperparathyroidism in PD patients, 2007-2016 (To be Updated)

Year	Number of patients	Number of patientson 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

In year 2017, HD patients had mean iPTH of 257.2 pg/ml. Forty seven % of HD patients had iPTH level <150pg/ml, 15% within the target level (≥ 150 &<300pg/ml) and 29% had iPTH above 500pg/ml. Mean iPTH was lower in diabetic HD patients than the non diabetic HD patients (228.3pg/ml vs 299.6pg/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 in PD patients was 263.6pg/ml. About 47% of PD patients had iPTH <150pg/ml, 24% achieved target iPTH (≥ 150 &<300pg/ml) and 15% had iPTH more than 500pg/ml. Similarly, mean iPTH was lower in diabetic PD patients than non diabetic PD patients (211.3pg/ml vs 323.3pg/ml). The diabetic PD patients had higher proportion with iPTH level below 150pg/ml (52%) than non diabetic HD patients (41%). (Tables and Figures 7.3.2b, 7.3.2c , 7.3.3b & 7.3.3c)

Table 7.3.2(a): Distribution of iPTH, HD patients 2008-2017

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
2017	35595	257.2	337.2	108.3	38.8	351.1	57	15	12	17
2016	29269	265.3	344.1	111.0	38.5	372.1	56	15	12	18
2015	27471	300.8	346.9	169.6	47.2	433.8	48	17	15	21
2014	24881	296.9	356.9	159.7	44.3	417.5	49	17	14	20
2013	21360	233.6	315.7	100.0	34.2	312.0	59	15	12	14
2012	18808	291.9	340.1	167.7	46.9	410.3	47	18	15	19
2011	16276	223.5	311.9	87.6	29.5	305.0	61	14	12	14
2010	14320	235.3	319.0	98.4	30.5	319.2	58	15	11	15
2009	12518	270.0	337.2	141.1	40.4	367.4	52	18	13	17
2008	10697	261.0	330.6	127.4	36.0	361.0	53	17	13	17

Figure 7.3.2(a): Cumulative distribution of iPTH, HD patients 2008-2017

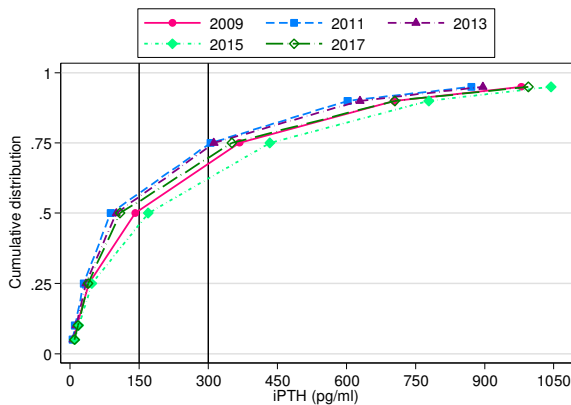


Figure 7.3.2(b): Cumulative distribution of iPTH, diabetic HD patients 2008-2017

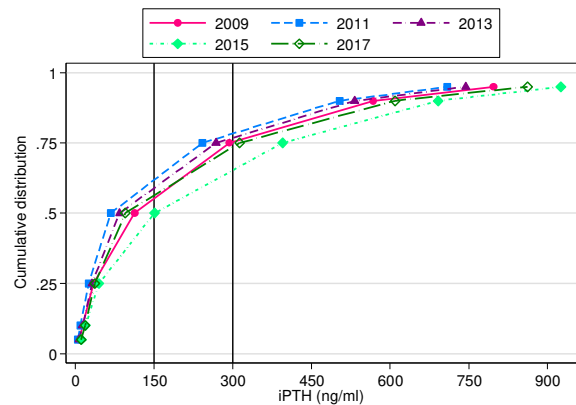


Table 7.3.2(b): Distribution of iPTH, diabetic HD patients, 2008-2017

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
2017	21162	228.3	300.3	94.8	37.3	312.7	59	15	12	14
2016	16915	235.8	308.5	95.8	36.7	331.6	58	14	12	15
2015	15336	272.2	316.1	150.9	44.7	394.7	50	17	15	18
2014	13830	266.3	321.7	144.6	41.4	376.3	51	18	15	17
2013	11448	199.8	272.3	84.0	31.7	268.1	62	15	11	11
2012	9796	252.5	296.3	144.6	42.3	362.0	51	18	15	15
2011	8193	183.2	265.5	67.5	25.0	241.6	66	13	10	10
2010	7111	190.3	270.4	75.4	26.0	256.0	64	15	11	10
2009	5968	222.2	290.9	113.0	34.0	293.3	57	19	12	12
2008	4875	211.2	279.1	99.7	29.5	288.7	59	17	12	12

Table 7.3.2(c): Distribution of iPTH, non-diabetic HD patients, 2008-2017

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
2017	14433	299.6	381.0	130.9	41.9	418.5	53	15	12	21
2016	12354	305.6	383.8	137.0	42.4	430.0	52	15	12	21
2015	12135	336.9	379.2	192.5	52.3	499.6	45	16	14	25
2014	11051	335.3	393.2	181.3	48.6	488.0	46	16	13	24
2013	9912	272.5	355.4	123.0	38.3	373.0	55	15	12	18
2012	9012	334.7	377.5	197.6	52.9	481.8	44	17	15	24
2011	8083	264.2	348.0	113.4	36.0	365.5	55	15	13	17
2010	7209	279.7	355.0	130.0	37.5	393.3	53	15	12	20
2009	6550	313.7	369.1	174.8	48.7	442.7	47	17	15	22
2008	5822	302.7	363.0	159.5	43.8	427.0	49	16	14	21

Figure 7.3.2(c): Cumulative distribution of iPTH, non-diabetic HD patients 2008-2017

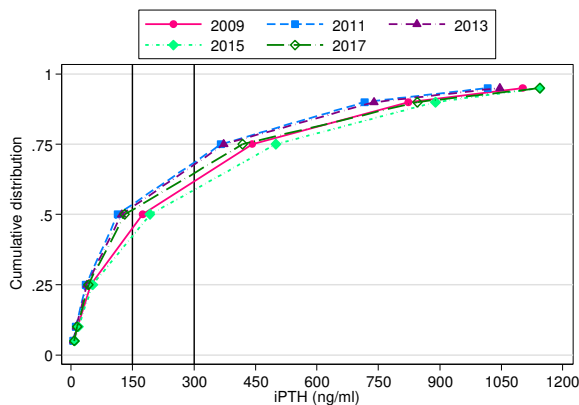


Figure 7.3.3(a): Cumulative distribution of iPTH, PD patients 2008-2017

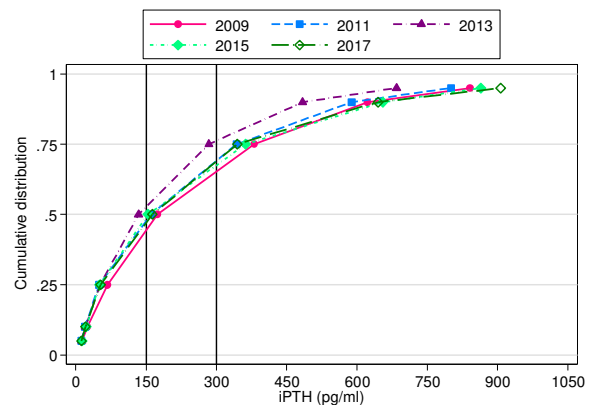


Table 7.3.3(a): Distribution of iPTH, PD patients 2008-2017

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
2017	3989	263.6	305.8	163.5	52.8	344.5	47	24	14	15
2016	3651	287.9	305.2	195.5	71.3	387.0	42	23	17	18
2015	3465	262.8	299.7	154.2	51.0	362.5	49	20	14	16
2014	2934	268.7	289.5	176.0	61.0	369.0	45	22	17	16
2013	2594	213.0	250.4	134.0	52.0	284.0	53	24	14	9
2012	2256	274.2	291.7	188.4	64.0	384.3	43	22	19	16
2011	2035	249.1	282.5	160.5	50.0	343.0	48	23	16	14
2010	1897	261.2	293.4	164.0	51.4	371.0	48	20	16	16
2009	1818	271.1	293.0	174.3	68.0	381.0	45	22	16	16
2008	1603	263.9	293.4	170.0	57.3	359.5	46	22	18	15

Table 7.3.3(b): Distribution of iPTH, diabetic PD patients, 2008-2017

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
2017	2125	211.3	239.4	140.0	46.1	282.6	52	25	13	10
2016	1959	233.8	240.0	160.0	66.0	314.4	48	25	16	11
2015	1839	211.9	241.5	125.0	45.5	288.7	55	22	13	11
2014	1541	222.8	234.1	148.2	53.3	313.0	50	23	15	11
2013	1311	177.1	208.4	113.0	45.0	228.0	58	26	10	6
2012	1090	211.9	226.3	138.5	54.1	301.0	51	24	16	9
2011	962	200.6	232.4	130.7	45.0	279.8	53	25	16	7
2010	863	204.3	225.9	131.2	41.5	298.5	54	21	15	9
2009	865	199.2	203.6	134.5	57.5	268.0	53	25	13	9
2008	769	212.6	229.5	143.0	56.0	293.9	51	24	16	8

Figure 7.3.3(b): Cumulative distribution of iPTH, diabetic PD patients, 2008-2017

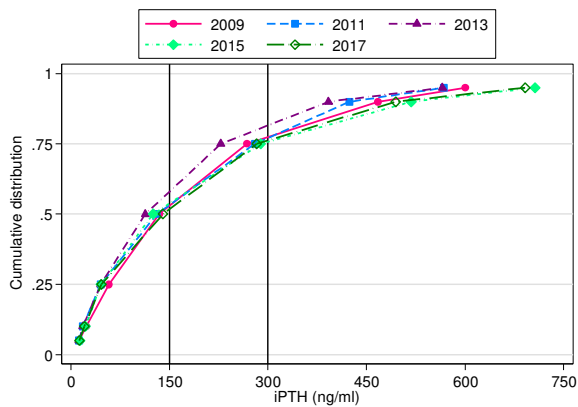


Figure 7.3.3(c): Cumulative distribution of iPTH, non diabetic PD patients, 2008-2017

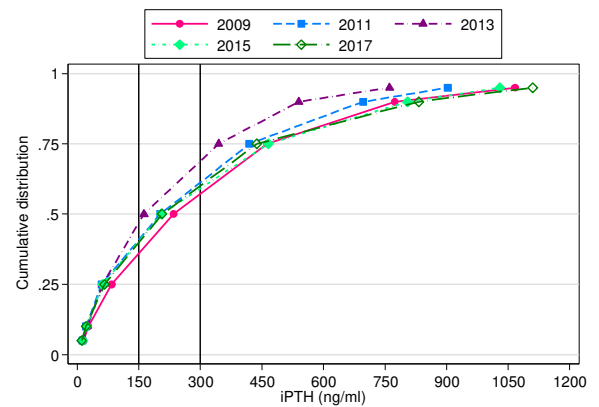


Table 7.3.3(c): Distribution of iPTH, non diabetic PD patients, 2008-2017

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
2017	1864	323.3	358.1	206.5	66.0	437.7	41	22	16	21
2016	1692	350.4	356.5	243.0	85.3	501.6	37	21	17	25
2015	1626	320.4	345.3	204.0	61.3	465.5	43	19	16	23
2014	1393	319.4	333.4	216.5	69.7	453.0	40	20	19	22
2013	1283	249.7	282.5	162.0	61.3	344.5	48	21	19	12
2012	1166	332.3	331.4	245.4	82.6	464.5	36	21	21	22
2011	1073	292.7	314.6	202.0	59.0	419.0	44	21	16	20
2010	1034	308.8	332.2	199.5	61.4	450.4	43	19	16	22
2009	953	336.3	342.4	234.3	83.8	462.5	38	20	19	23
2008	834	311.1	335.2	214.4	58.0	436.5	41	20	19	21

There was wide variation in iPTH level among HD centres and PD centres. The degree of variation seemed to become wider since 2008 and was wider in HD patients than PD patients. (Tables and Figures 7.3.4a & 7.3.5a) 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% for PD centres (Tables and Figures 7.3.4b & 7.3.5b).

Table 7.3.4(a): Variation in iPTH among HD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	702	11.4	30.4	47.7	91.5	289.0	460.5	669.8
2016	649	16.4	29.7	47.1	114.9	279.8	468.6	1271.7
2015	628	11.3	31.1	73.3	201.4	306.1	456.9	803.5
2014	593	11.7	28.8	60.1	183.1	301.0	466.0	1082.0
2013	521	10.0	22.3	44.6	97.3	252.0	426.7	998.5
2012	485	11.4	31.7	73.3	186.9	287.7	452.2	768.3
2011	423	3.3	18.8	40.5	91.7	233.5	420.7	1217.5
2010	365	5.5	18.5	39.7	102.3	242.2	394.8	629.0
2009	324	2.0	25.8	61.7	161.3	264.5	416.0	1007.9
2008	284	8.5	21.7	54.3	136.5	260.3	393.8	742.3

Figure 7.3.4(a): Variation in median iPTH among HD patients, HD centres, 2017

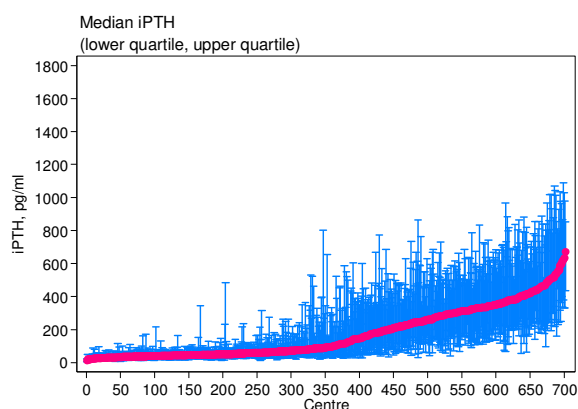


Figure 7.3.4(b): Variation in proportion of patients with iPTH 150-300pg/ml, HD centres, 2017

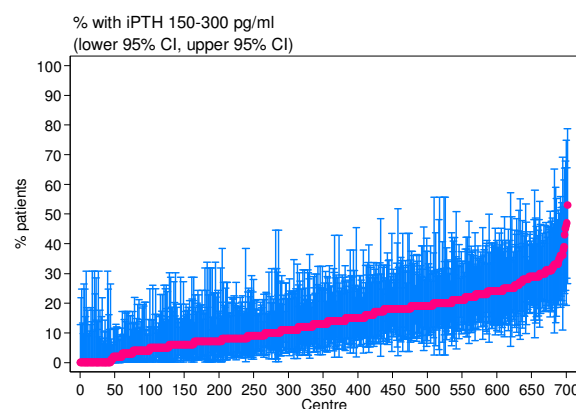


Table 7.3.4(b): Variation in proportion of patients with iPTH 150-300pg/ml, HD centres, 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	702	0	0	7.0	13.0	20.0	30	53
2016	649	0	0	7.0	13.0	21.0	30	46
2015	628	0	0	9.0	16.0	22.0	31	56
2014	593	0	2	10.0	16.0	23.0	33	54
2013	521	0	0	6.0	13.0	22.0	34	60
2012	485	0	3	10.0	17.0	24.0	33	53
2011	423	0	0	6.0	13.0	20.0	32	60
2010	365	0	0	6.0	14.0	22.0	33	48
2009	324	0	0	9.5	18.0	24.5	35	46
2008	284	0	0	8.5	15.0	23.0	31	50

Table 7.3.5(a): Variation in median iPTH among PD patients 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	35	34.6	35.3	108.0	185.0	285.0	516.9	654.3
2016	36	38.8	65.9	138.6	211.9	313.4	530.3	645.5
2015	34	38.8	42.0	115.8	202.3	296.0	490.5	521.0
2014	29	40.6	41.0	115.8	215.0	299.5	374.5	402.0
2013	26	37.0	41.7	69.2	188.3	258.5	293.0	467.0
2012	26	34.8	45.0	137.5	266.3	324.5	478.5	495.5
2011	24	25.9	26.8	99.1	201.7	290.3	421.5	434.5
2010	24	28.5	30.0	117.8	211.5	285.2	512.0	783.2
2009	22	36.0	56.5	143.5	206.8	258.5	462.5	1047.0
2008	22	33.3	62.0	130.9	208.1	310.9	363.1	454.5

Figure 7.3.5(a): Variation in median iPTH among PD patients, PD centres, 2017

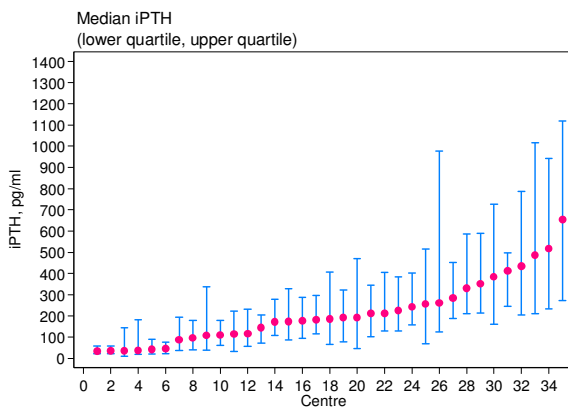


Figure 7.3.5(b): Variation in proportion of patients with iPTH 150-300pg/ml, PD centres 2017

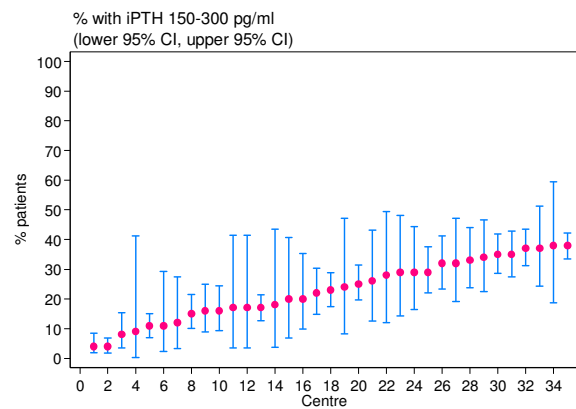


Table 7.3.5(b): Variation in proportion of patients with iPTH 150-300pg/ml, PD centres 2008-2017

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2017	35	4	4	16.0	23.0	32.0	38	38
2016	36	4	8	17.0	23.5	27.5	34	40
2015	34	6	7	13.0	19.0	28.0	36	41
2014	29	0	6	14.0	20.0	24.0	33	50
2013	26	3	4	11.0	23.0	32.0	38	38
2012	26	1	10	16.0	19.0	26.0	31	31
2011	24	3	4	13.5	22.5	29.0	31	39
2010	24	0	4	13.5	20.0	27.0	31	40
2009	22	10	11	16.0	21.5	27.0	28	28
2008	22	0	8	15.0	20.5	26.0	31	34

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 were not routinely performed in Malaysia. We observed marginal improvement in the laboratory parameters since 2008. 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 based phosphate binder (sevelamer > than lanthanum). Parathyroidectomy had remained stable at about 1% since 2008.

Overall, the control of calcium, phosphate and iPTH parameters in CKD-MBD can still be improved among the dialysis patients with wide centre variation, more among the HD centres than PD centres. We need to have strategies to improve and standardise the management of CKD-MBD among dialysis patients in Malaysia.