

CHAPTER 9

MANAGEMENT OF RENAL BONE DISEASE IN DIALYSIS PATIENTS

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9.1: Treatment of Renal Bone Disease

Since 1997 the majority of dialysis patients on both HD (>90%) and CAPD (75-84%) received calcium carbonate as a phosphate binder. The usage of aluminium phosphate binders fell sharply since 1997 to 1% in 2004. Vitamin D was used in increasing numbers in both HD and CAPD patients. (table 9.1.1 & 9.1.2)

Table 9.1.1: Treatment for Renal Bone Disease, HD patients 1997-2004

Year	No. of subjects	No. of subjects on CaCO ₃	% on CaCO ₃	No. of subjects on Al(OH) ₃	% on Al(OH) ₃	No. of subjects on Vitamin D	% on Vitamin D
1997	1695	1543	91	417	25	694	41
1998	2141	1956	91	343	16	652	30
1999	2996	2693	90	244	8	770	26
2000	4392	3977	91	239	5	1084	25
2001	5194	4810	93	145	3	1145	22
2002	6108	5536	91	171	3	1375	23
2003	7043	6430	91	118	2	1692	24
2004	8151	7332	90	106	1	2009	25

Table 9.1.2: Treatment for Renal Bone Disease, CAPD patients 1997-2004

Year	No. of subjects	No. of subjects on CaCO ₃	% on CaCO ₃	No. of subjects on Al(OH) ₃	% on Al(OH) ₃	No. of subjects on Vitamin D	% on Vitamin D
1997	476	393	83	57	12	114	24
1998	541	425	79	46	9	110	20
1999	610	450	74	36	6	75	12
2000	662	522	79	15	2	96	15
2001	781	588	75	5	1	84	11
2002	891	713	80	6	1	130	15
2003	1237	1040	84	10	1	238	19
2004	1341	1125	84	18	1	304	23

9.2: Serum Calcium and Phosphate Control

The median corrected serum calcium level was 2.4 to 2.5 mmol/l in CAPD patients and 2.3 mmol/l amongst HD patients.

Table 9.2.1: Distribution of corrected Serum Calcium, HD patients 1997-2004

Year	No. of Subjects	Mean	SD	Median	LQ	UQ	% patients ≥ 2.2 & ≤ 2.6 mmol/L
1997	1633	2.3	.3	2.3	2.2	2.5	57
1998	2060	2.3	.3	2.3	2.2	2.5	60
1999	2732	2.3	.3	2.3	2.2	2.5	59
2000	3704	2.4	.3	2.3	2.2	2.5	61
2001	4618	2.4	.2	2.4	2.2	2.5	64
2002	5485	2.3	.3	2.3	2.2	2.5	60
2003	6471	2.3	.2	2.3	2.2	2.4	62
2004	7466	2.3	.2	2.3	2.2	2.4	62

Figure 9.2.1: Cumulative distribution of corrected Serum Calcium, HD patients 1997-2004

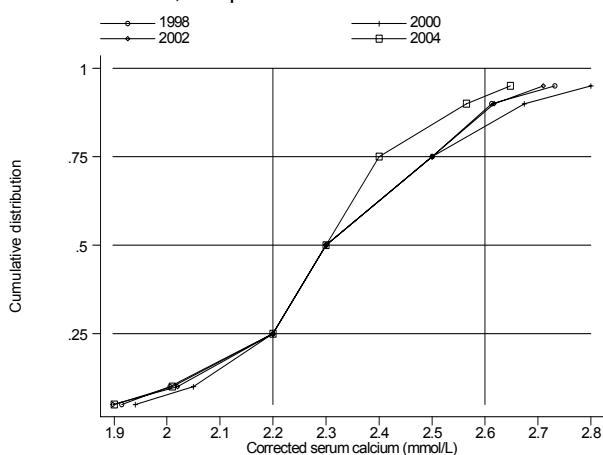


Figure 9.2.2: Cumulative distribution of corrected Serum Calcium, CAPD patients 1997-2004

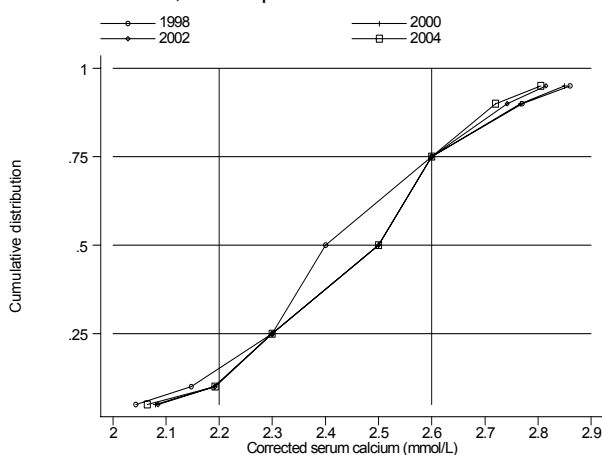


Table 9.2.2: Distribution of corrected Serum Calcium, CAPD patients 1997-2004

Year	No. of Subjects	Mean	SD	Median	LQ	UQ	% patients ≥ 2.2 & ≤ 2.6 mmol/L
1997	469	2.5	.3	2.5	2.3	2.6	57
1998	535	2.4	.3	2.4	2.3	2.6	59
1999	593	2.5	.2	2.5	2.3	2.6	63
2000	635	2.5	.2	2.5	2.3	2.6	60
2001	744	2.5	.3	2.5	2.4	2.7	56
2002	859	2.5	.2	2.5	2.3	2.6	63
2003	1169	2.4	.2	2.5	2.3	2.6	62
2004	1277	2.5	.2	2.5	2.3	2.6	66

The median serum phosphate levels were lower among patients on CAPD (1.5 to 1.6 mmol/l) compared to HD patients(1.8-1.9 mmol/l). (table and fig 9.2.3 & 9.2.4)

Table 9.2.3: Distribution of Serum Phosphate, HD patients 1997-2004

Year	No of Subjects	Mean	SD	Median	LQ	UQ	% patients ≥ 1.6 & < 1.8 mmol/L	% patients ≥ 1.8 & < 2.2 mmol/L	% patients ≥ 2.2 & ≤ 2.6 mmol/L
1997	1649	1.9	.5	1.9	1.6	2.3	16	27	19
1998	2051	1.9	.5	1.9	1.6	2.2	16	33	17
1999	2861	1.9	.5	1.9	1.5	2.2	15	28	18
2000	4080	1.9	.6	1.8	1.5	2.2	16	29	15
2001	4765	1.9	.5	1.8	1.5	2.2	17	27	16
2002	5679	1.9	.5	1.8	1.5	2.2	17	27	17
2003	6593	1.8	.5	1.8	1.5	2.2	17	26	15
2004	7545	1.8	.5	1.8	1.5	2.2	17	25	15

Figure 9.2.3: Cumulative distribution of Serum Phosphate, HD patients 1997-2004

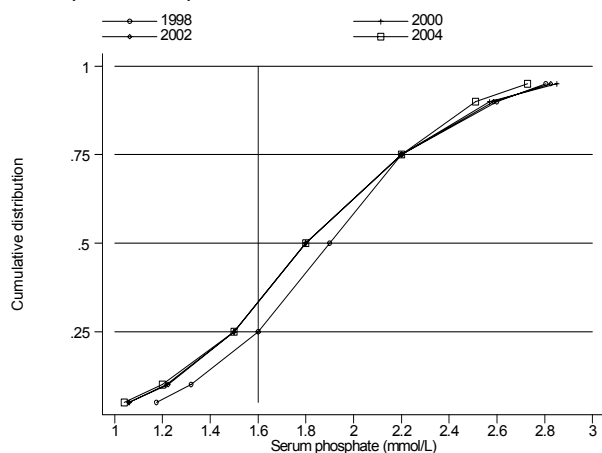


Figure 9.2.4: Cumulative distribution of Serum Phosphate, CAPD patients 1997-2004

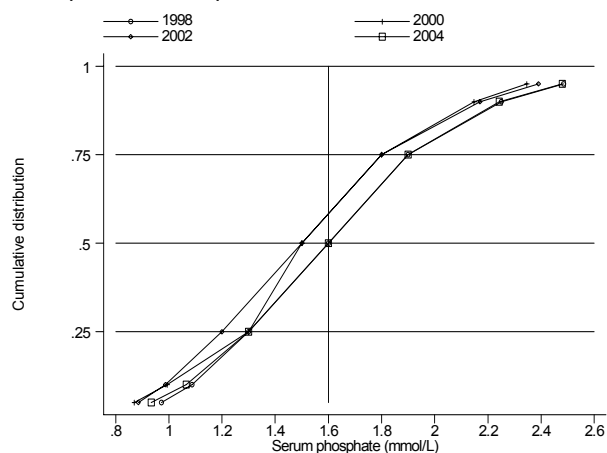


Table 9.2.4: Distribution of Serum Phosphate, CAPD patients 1997-2004

Year	No of Subjects	Mean	SD	Median	LQ	UQ	% patients ≥ 1.6 & < 1.8 mmol/L	% patients ≥ 1.8 & < 2.2 mmol/L	% patients ≥ 2.2 & ≤ 2.6 mmol/L
1997	470	1.6	.4	1.5	1.3	1.8	17	20	6
1998	537	1.6	.5	1.6	1.3	1.9	17	20	8
1999	583	1.6	.5	1.6	1.3	1.9	16	22	7
2000	633	1.5	.5	1.5	1.3	1.8	14	19	6
2001	732	1.5	.5	1.5	1.2	1.8	14	17	5
2002	862	1.5	.5	1.5	1.2	1.8	15	16	7
2003	1175	1.6	.5	1.5	1.2	1.9	14	19	8
2004	1279	1.6	.5	1.6	1.3	1.9	16	20	8

The mean serum calcium phosphate product was higher among HD patients compared to CAPD patients (4.1 to 4.5 compared to 3.8 to 4.0).

Table 9.2.5: Distribution of corrected calcium x phosphate product, HD patients 1997-2004

Year	No of Subjects	Mean	SD	Median	LQ	UQ	% patients <3.5 mmol ² /L ²	% patients ≥3.5 & <4 mmol ² /L ²	% patients ≥4 & <4.5 mmol ² /L ²	% patients ≥4.5 & <5 mmol ² /L ²	% patients ≥5 & <5.5 mmol ² /L ²	% patients ≥5.5 mmol ² /L ²
1997	1615	4.5	1.3	4.5	3.6	5.3	23	14	15	17	12	20
1998	2020	4.5	1.2	4.4	3.7	5.2	21	15	18	15	13	19
1999	2698	4.4	1.3	4.3	3.4	5.2	27	14	15	14	11	18
2000	3651	4.4	1.3	4.3	3.5	5.2	25	15	16	15	10	19
2001	4555	4.3	1.3	4.2	3.4	5.2	27	16	16	13	11	18
2002	5403	4.4	1.3	4.3	3.4	5.2	27	16	15	13	10	19
2003	6388	4.2	1.3	4.1	3.3	5.1	30	16	15	13	10	16
2004	7345	4.2	1.3	4.1	3.3	5	32	16	15	12	10	15

Figure 9.2.5: Cumulative distribution of corrected Calcium x Phosphate product, HD patients 1997-2004

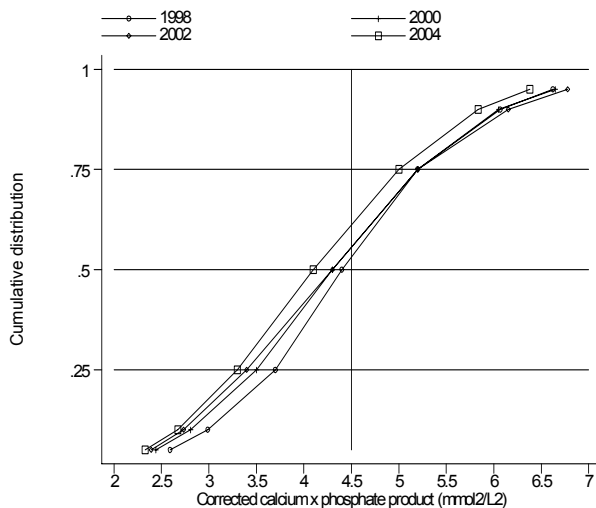


Figure 9.2.6: Cumulative distribution of corrected Calcium x Phosphate product, CAPD patients 1997-2004

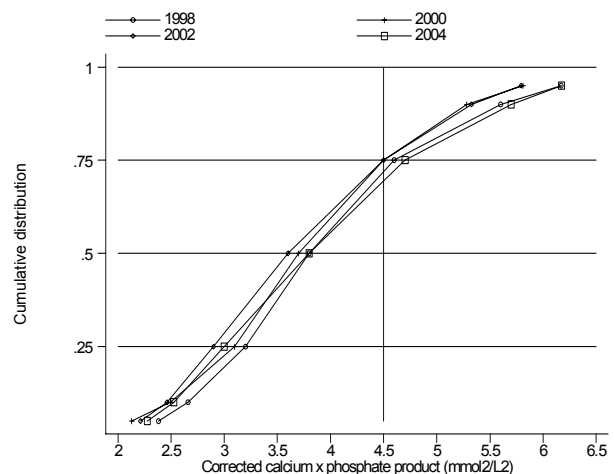


Table 9.2.6: Distribution of corrected calcium x phosphate product, CAPD patients 1997-2004

Year	No of Subjects	Mean	SD	Median	LQ	UQ	% patients <3.5 mmol ² /L ²	% patients ≥3.5 & <4 mmol ² /L ²	% patients ≥4 & <4.5 mmol ² /L ²	% patients ≥4.5 & <5 mmol ² /L ²	% patients ≥5 & <5.5 mmol ² /L ²	% patients ≥5.5 mmol ² /L ²
1997	468	3.9	1.1	3.7	3.1	4.5	40	20	15	10	6	7
1998	533	4	1.1	3.8	3.2	4.6	38	18	16	10	6	11
1999	580	4	1.2	3.8	3.2	4.8	36	20	13	12	9	10
2000	621	3.8	1.1	3.7	3.1	4.5	44	19	12	10	7	8
2001	723	3.8	1.1	3.6	2.9	4.5	46	18	12	10	8	7
2002	856	3.8	1.2	3.6	2.9	4.5	45	17	12	11	7	8
2003	1164	3.9	1.2	3.7	3	4.6	43	17	13	10	8	10
2004	1275	4	1.2	3.8	3	4.7	41	15	14	10	8	12

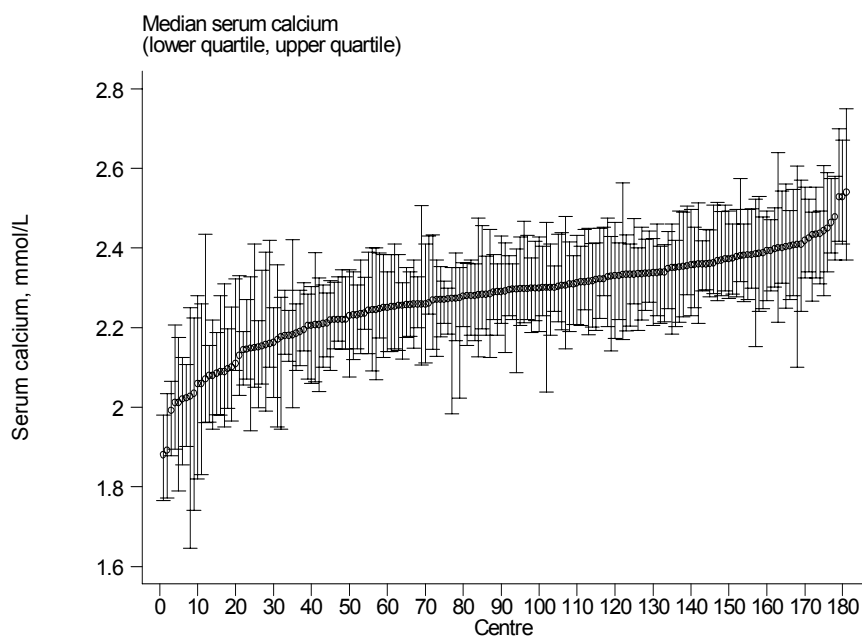
In 2004 the median calcium value among HD centres was 2.3 mmol/l compared to 2.4 mmol/l in CAPD centre (table 9.2.7a and 9.2.8a)

Table 9.2.7: Variation in corrected serum calcium levels among HD centres, 2004

(a) Median serum calcium level among HD patients

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	46	2.1	2.2	2.3	2.3	2.4	2.5	2.5
1998	45	1.9	2.1	2.2	2.3	2.4	2.4	2.5
1999	64	1.7	2	2.2	2.3	2.4	2.5	2.5
2000	91	2	2.2	2.3	2.3	2.4	2.6	3.2
2001	110	1.9	2.1	2.3	2.3	2.4	2.5	2.6
2002	131	1.9	2.1	2.2	2.3	2.4	2.5	2.6
2003	149	2	2.1	2.2	2.3	2.4	2.5	2.5
2004	181	1.9	2.1	2.2	2.3	2.4	2.4	2.5

Figure 9.2.7(a): Variation in median serum calcium level among HD patients, HD centres 2004



We reviewed among centers (both HD and CAPD) the proportion of patients with serum calcium range between 2.2 to 2.6 mmol/l from 1997 to 2004. The median was higher for CAPD centres(71%) compared to HD centres(63%) for the year 2004.

Table 9.2.7(b) Proportion of patients with serum calcium 2.2 to 2.6 mmol/L

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	46	23	36	50	58	63	73	75
1998	45	21	25	53	65	72	80	81
1999	64	8	24	49	61	68	80	100
2000	91	0	25	53	61	70	79	100
2001	110	0	31	56	66	72	86	100
2002	131	5	25	48	60	70	80	91
2003	149	11	30	51	63	70	81	92
2004	181	0	24	48	63	72	82	90

Figure 9.2.7(b): Variation in proportion of patients with serum calcium 2.2 to 2.6 mmol/L, HD centres 2004

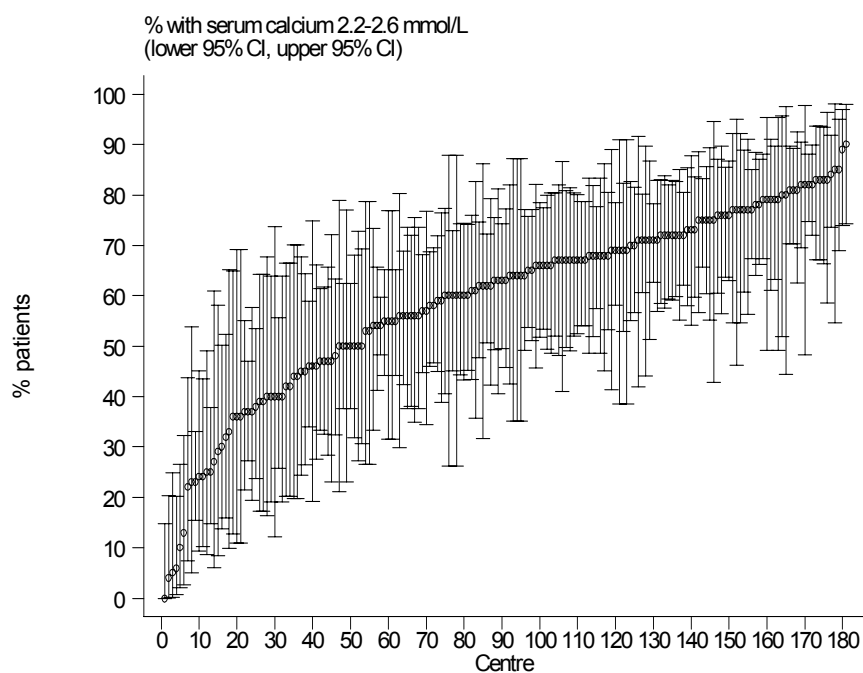


Table 9.2.8: Variation in corrected serum calcium levels among CAPD centres, 2004

(a) Median serum calcium level among CAPD patients

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	7	2.1	2.1	2.4	2.4	2.5	2.6	2.6
1998	9	2.3	2.3	2.4	2.4	2.5	2.6	2.6
1999	9	2.4	2.4	2.4	2.5	2.5	2.6	2.6
2000	11	2.4	2.4	2.4	2.5	2.5	2.6	2.6
2001	12	2.3	2.3	2.4	2.5	2.5	2.6	2.6
2002	14	2.4	2.4	2.4	2.5	2.5	2.6	2.6
2003	17	2.3	2.3	2.4	2.4	2.5	2.6	2.6
2004	17	2.3	2.3	2.4	2.4	2.5	2.5	2.5

Figure 9.2.8(a): Variation in median serum calcium level among CAPD patients, CAPD centres 2004

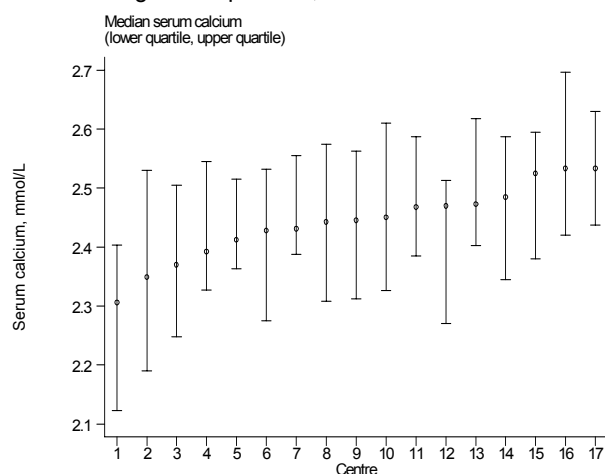


Figure 9.2.8(b): Variation in proportion of patients with serum calcium 2.2 to 2.6 mmol/L, CAPD centres 2004

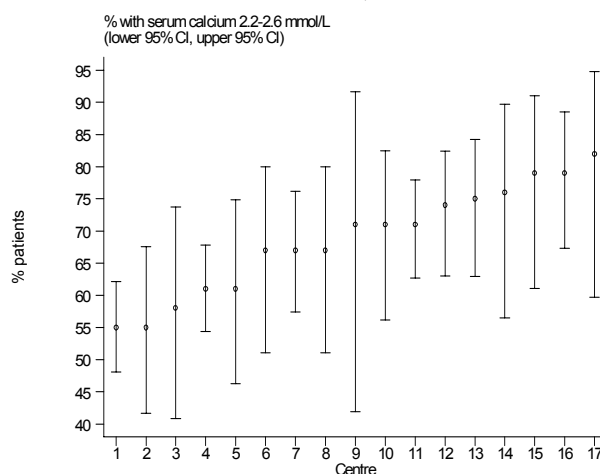


Table 9.2.8(b) Proportion of patients with serum calcium 2.2 to 2.6 mmol/L

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	7	34	34	35	59	67	71	71
1998	9	0	0	43	56	58	79	79
1999	9	43	43	54	58	63	82	82
2000	11	44	44	46	55	69	83	83
2001	12	46	46	53	57	60.5	69	69
2002	14	48	48	55	69.5	73	80	80
2003	17	40	40	61	65	67	76	76
2004	17	55	55	61	71	75	82	82

In reviewing the proportion of patients with a serum phosphate level below 1.6 mmol/l, the CAPD centers have a higher median proportion of patients with serum phosphate level below 1.6 mmol/L compared to HD centres.

Table 9.2.9: Variation in serum phosphate levels among HD centres, 2004

(a) Median serum phosphate level among HD patients

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	46	1.3	1.5	1.8	1.9	2.1	2.3	2.8
1998	45	1.5	1.5	1.8	1.9	2	2.2	2.6
1999	66	1.1	1.6	1.7	1.9	2	2.1	2.3
2000	97	1.4	1.6	1.7	1.9	2	2.2	3.7
2001	109	1.4	1.5	1.7	1.8	2	2.1	2.5
2002	133	1.3	1.6	1.8	1.8	2	2.2	2.4
2003	155	.9	1.5	1.7	1.8	2	2.2	2.5
2004	183	1.3	1.6	1.7	1.8	1.9	2.2	2.5

Figure 9.2.9(a): Variation in median serum phosphate level among HD patients, HD centres 2004

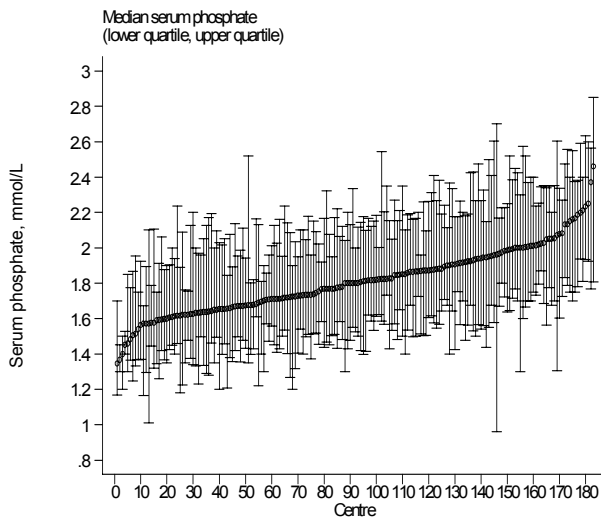


Figure 9.2.9(b): Variation in proportion of patients with serum phosphate ≤ 1.6 mmol/L, HD centres 2004

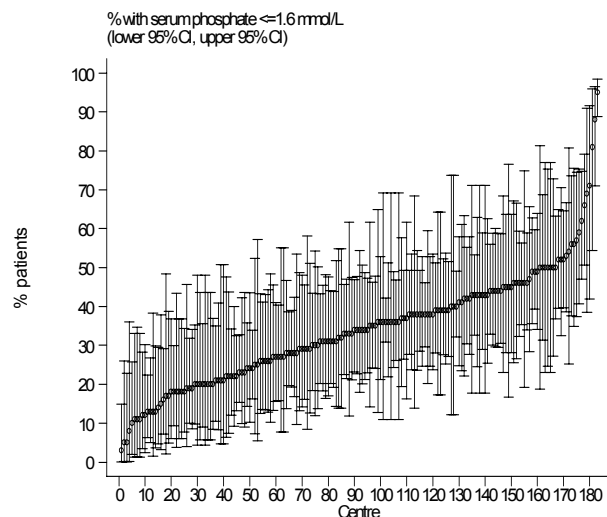


Table 9.2.9(b) Proportion of patients with serum phosphate ≤ 1.6 mmol/L among HD centres

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	46	0	10	17	25.5	36	55	71
1998	45	0	5	17	22	29	54	56
1999	66	0	11	20	29	39	51	87
2000	97	4	10	22	29	38	50	68
2001	109	0	11	22	28	38	58	83
2002	133	0	8	21	29	35	53	74
2003	155	5	12	22	32	39	55	95
2004	183	3	12	23	34	43	56	95

Table 9.2.10: Variation in serum phosphate levels among CAPD centres, 2004

(a) Median serum phosphate level among CAPD patients

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	7	1.4	1.4	1.5	1.5	1.6	1.7	1.7
1998	9	1.1	1.1	1.5	1.6	1.6	1.8	1.8
1999	9	1.5	1.5	1.6	1.6	1.7	2.2	2.2
2000	11	1.3	1.3	1.4	1.5	1.6	1.9	1.9
2001	12	1.3	1.3	1.4	1.5	1.6	2	2
2002	14	1.4	1.4	1.5	1.6	1.6	2	2
2003	17	1.2	1.2	1.4	1.5	1.6	1.7	1.7
2004	17	1.3	1.3	1.5	1.5	1.7	1.8	1.8

Figure 9.2.10(a): Variation in median serum phosphate level among CAPD patients, CAPD centres 2004

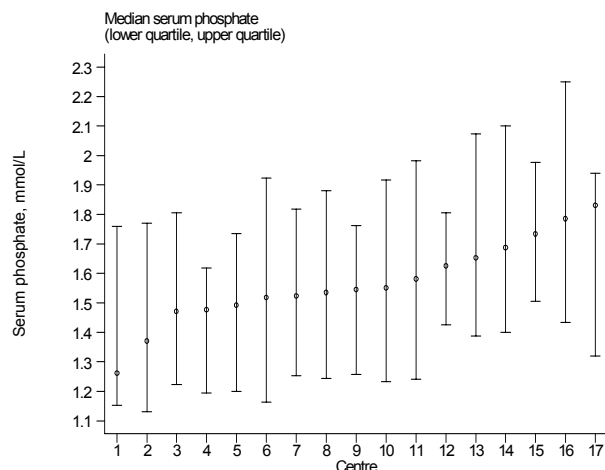


Figure 9.2.10(b): Variation in proportion of patients with serum phosphate ≤ 1.6 mmol/L, CAPD centres

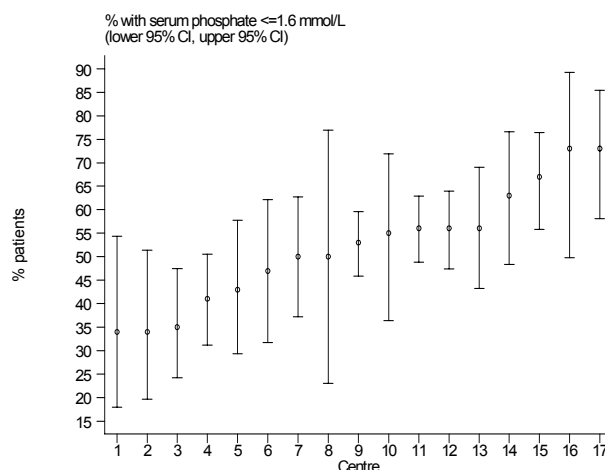


Table 9.2.10(b) Proportion of patients with serum phosphate ≤ 1.6 mmol/L, CAPD centres

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	7	24	24	53	54	63	75	75
1998	9	37	37	45	52	56	100	100
1999	9	0	0	43	51	56	57	57
2000	11	22	22	48	56	66	72	72
2001	12	27	27	50	57.5	66	71	71
2002	14	31	31	49	55.5	61	73	73
2003	17	33	33	48	56	63	75	75
2004	17	34	34	43	53	56	73	73

A higher number of CAPD centers have median serum calcium phosphate product less than 4.5 as compared to HD centers (71-78% versus 51.5 –65%). There is an increasing trend among HD centers achieving a corrected calcium phosphate product less than 4.5 mmol²/L² (table and fig 9.2.11 & 9.2.12)

Table 9.2.11: Variation in corrected calcium x phosphate product among HD centres, 2004

(a) Median corrected calcium x phosphate product among HD patients

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	46	2.9	3.7	4.1	4.4	4.8	5.3	6.2
1998	45	3.2	3.4	4.1	4.5	4.7	5.1	5.3
1999	64	2.4	3.2	4	4.3	4.7	5.2	5.4
2000	89	2.9	3.5	4	4.3	4.7	5.2	6.1
2001	106	3	3.5	4	4.3	4.6	5	6.3
2002	130	2.9	3.6	4	4.3	4.5	5.1	5.9
2003	149	2.2	3.3	3.9	4.2	4.5	4.9	5.7
2004	181	2.9	3.3	3.8	4.1	4.4	5	5.5

Figure 9.2.11(a): Variation in median corrected calcium x phosphate product among HD patients, HD centres 2004

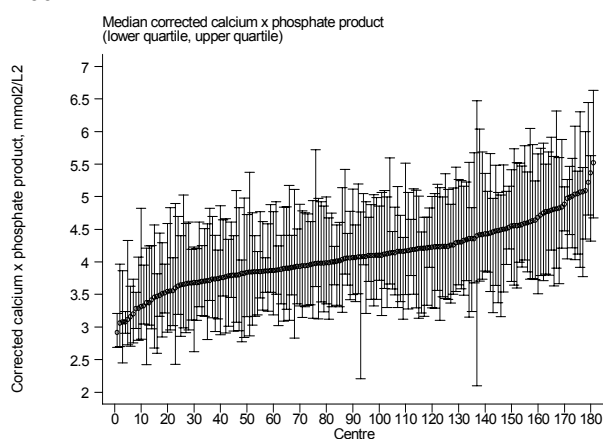


Figure 9.2.11(b): Variation in proportion of patients with corrected calcium x phosphate product < 4.5 mmol²/L², HD centres 2004

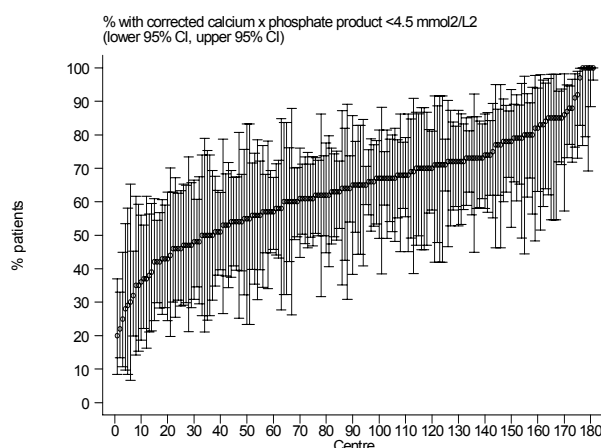


Table 9.2.11(b) Proportion of patients with corrected calcium x phosphate product < 4.5 mmol²/L²

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	46	15	26	39	51.5	65	77	100
1998	45	29	33	43	53	66	80	91
1999	64	18	31	43.5	55.5	66	90	97
2000	89	14	25	46	56	66	80	91
2001	106	9	38	47	57	70	82	87
2002	130	17	31	48	57	68	83	99
2003	149	27	35	50	62	70	85	100
2004	181	20	36	54	65	73	88	100

Table 9.2.12: Variation in corrected calcium x phosphate product among CAPD centres, 2004

(a) Median corrected calcium x phosphate product among CAPD patients

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	7	3.5	3.5	3.6	3.7	3.8	3.9	3.9
1998	9	2.8	2.8	3.7	3.8	3.9	4	4
1999	9	3.1	3.1	3.8	4	4.1	4.2	4.2
2000	11	3.3	3.3	3.5	3.7	4	4.4	4.4
2001	12	3.1	3.1	3.4	3.7	4	4.7	4.7
2002	14	3.3	3.3	3.5	3.7	4.1	4.6	4.6
2003	17	3.1	3.1	3.5	3.7	4	4.1	4.1
2004	17	3.2	3.2	3.6	3.8	4	4.4	4.4

Figure 9.2.12(a): Variation in median corrected calcium x phosphate product among CAPD patients, CAPD centres 2004

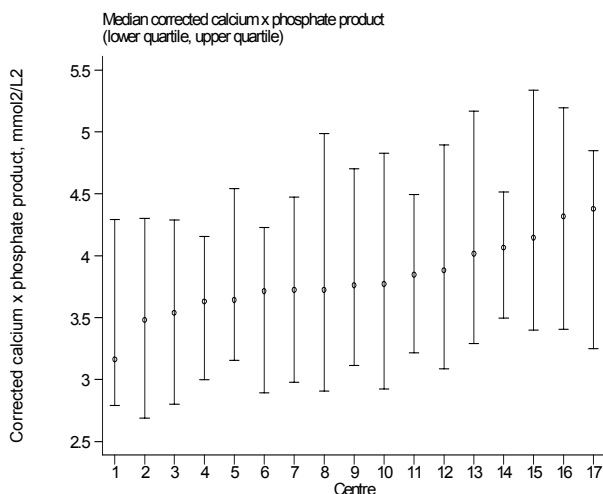


Figure 9.2.12(b): Variation in proportion of patients with corrected calcium x phosphate product < 4.5 mmol²/L², CAPD centres 2004

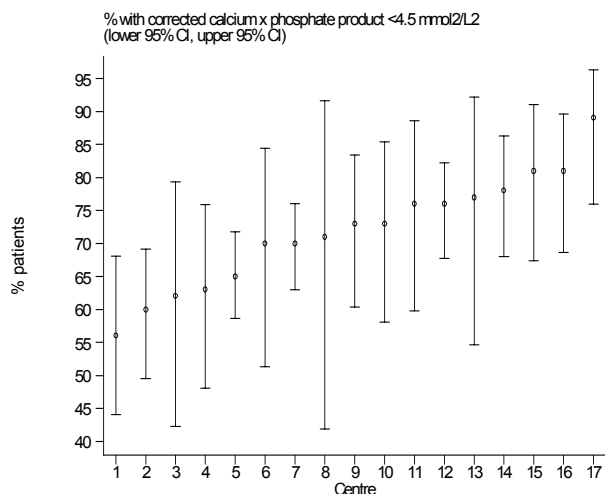


Table 9.2.12(b) Proportion of patients with corrected calcium x phosphate product < 4.5 mmol²/L²

Year	No. of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
1997	7	70	70	74	78	82	94	94
1998	9	64	64	72	72	80	100	100
1999	9	61	61	65	71	75	100	100
2000	11	56	56	71	73	83	91	91
2001	12	45	45	73.5	75	79	83	83
2002	14	44	44	64	71	82	90	90
2003	17	60	60	67	74	79	87	87
2004	17	56	56	65	73	77	89	89

Conclusion

Following realization of the toxicity associated with prolonged use of aluminium based phosphate binders, there was increased use of calcium based binders amongst the dialysis population in Malaysia. This however was not associated with significant hypercalcemia. The control of phosphate retention was better amongst CAPD patients. A higher phosphate level and a higher calcium phosphate product in HD patients predispose towards the development of cardiovascular disease. It would be interesting to study the incidence of cardiovascular disease in relation to these factors. Two important goals for the future in bone disease management are attainment of optimal phosphate control and calcium phosphate product in all centers.