CHAPTER 3

Death and Survival on Dialysis

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SECTION 3.1: DEATH ON DIALYSIS

The number of death in dialysis patients for 2006 was 1575 (annual death rate of 11.3%). One thousand four hundred and eleven haemodialysis patients died in 2006 (annual rate of 11.1%) while 164 died on continuous ambulatory peritoneal dialysis (annual death rate of 13.3%).

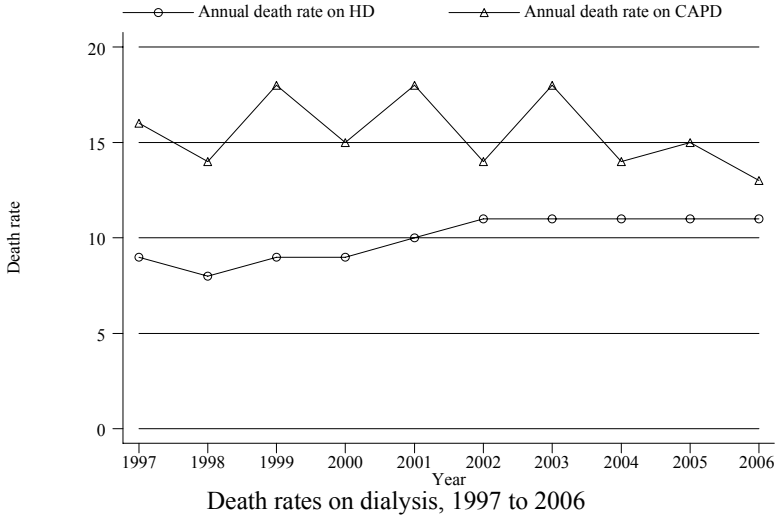
Table 3.1.1: Deaths on Dialysis 1997 – 2006

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
No. of dialysis patients at risk	3309	4119	5039	6115	7265	8477	9772	11142	12596	13992
Dialysis deaths	316	376	492	594	816	925	1153	1265	1403	1575
Dialysis death rate %	10	9	10	10	11	11	12	11	11	11
No. of HD patients at risk	2838	3599	4471	5487	6552	7635	8784	10056	11460	12762
HD deaths	242	302	392	502	686	810	975	1113	1232	1411
HD death rate %	9	8	9	9	10	11	11	11	11	11
No. of CAPD patients at risk	471	520	568	628	713	842	988	1086	1137	1230
CAPD deaths	74	74	100	92	130	115	178	152	171	164
CAPD death rate %	16	14	18	15	18	14	18	14	15	13

Figure 3.1.1 shows the annual death rate on dialysis from 1997 till 2006. Despite a higher percentage of diabetics (27% in 1997 to 45% in 2006) and elderly patients (in 1997, 41% were aged more than 55 years compared with 53% in 2006) on dialysis in recent years, the overall annual death rate of patients on dialysis remained remarkable unchanged over the last 10 years.

The annual death rate for those on CAPD showed a downward trend in recent years while the annual death rate for those on haemodialysis remained unchanged over the last 5 years. The annual death rate for those on CAPD has decreased by 15% over the last 10 years (from 15.7% in 1997 to 13.3% in 2006) and this has narrowed the difference in the annual death rate between the two modalities of dialysis (from 7.2% in 1997 to 2.3% in 2006).

Figure 3.1.1: Death Rates on Dialysis 1997 – 2006



Death rates on dialysis, 1997 to 2006

The causes of death on dialysis are showed in Table 3.1.2. Cardiovascular disease remained the main cause of death in 2006; accounting for 28%. This has remained unchanged over the last 10 years. Death at home accounted for another 21% and a majority of these deaths were probably secondary to cardiovascular events. Death due to sepsis has decreased by 23% over the last 10 years and now accounting for only 13%.

Table 3.1.2: Causes of Death on Dialysis 1997 – 2006

Year	1997		1998		1999		2000		2001	
	No.	%	No.	%	No.	%	No.	%	No.	%
Cardiovascular	85	27	110	29	129	26	177	30	210	26
Died at home	52	16	72	19	107	22	135	23	228	28
Sepsis	53	17	66	18	84	17	85	14	128	16
CAPD peritonitis	5	2	2	1	11	2	21	4	29	4
GIT bleed	4	1	7	2	18	4	18	3	18	2
Cancer	9	3	8	2	6	1	8	1	18	2
Liver disease	3	1	5	1	7	1	14	2	11	1
Others	32	10	55	15	75	15	91	15	108	13
Unknown	73	23	51	14	55	11	45	8	66	8
TOTAL	316	100	376	100	492	100	594	100	816	100

Year	2002		2003		2004		2005		2006	
	No.	%	No.	%	No.	%	No.	%	No.	%
Cardiovascular	307	33	323	28	332	26	350	25	434	28
Died at home	212	23	290	25	304	24	313	22	327	21
Sepsis	141	15	183	16	154	12	159	11	199	13
CAPD peritonitis	16	2	11	1	13	1	18	1	21	1
GIT bleed	24	3	28	2	24	2	28	2	24	2
Cancer	18	2	27	2	19	2	28	2	34	2
Liver disease	16	2	23	2	29	2	25	2	31	2
Others	122	13	186	16	326	26	406	29	385	24
Unknown	69	7	82	7	64	5	76	5	120	8
TOTAL	925	100	1153	100	1265	100	1403	100	1575	100

3.2: PATIENT SURVIVAL ON DIALYSIS

3.2.1 Patient survival by type of dialysis modality

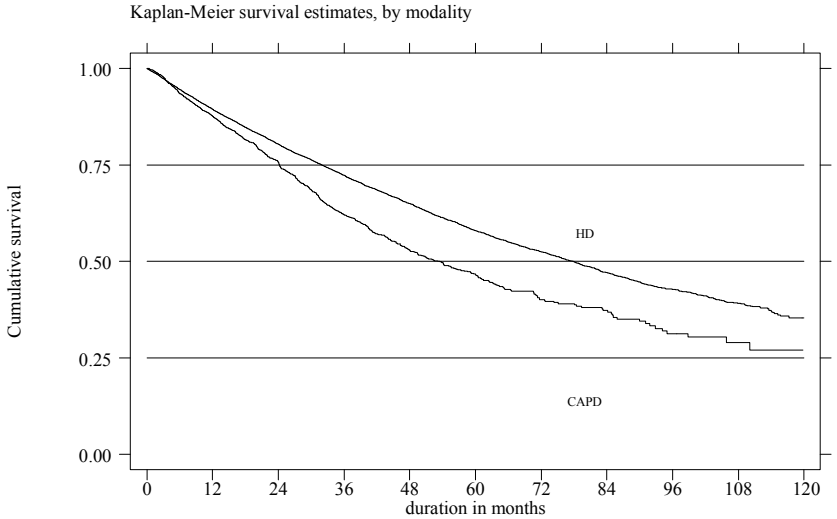
Patient survival by dialysis modalities is showed in Table 3.2.1(a) and Figure 3.2.1(a). The overall unadjusted 5 years and 10 years patient survival on dialysis were 57% and 35% respectively. The unadjusted patient survival was better for those on haemodialysis compared to those on CAPD and this survival difference progressively widened up to 3 years. At 3 years the unadjusted patient survival on haemodialysis was 72% compared 62% in those on CAPD. Beyond 3 years the difference in survival remained at about 10%. Despite adjustment for age and diabetes mellitus [Table 3.2.1(b) and Figure 3.2.1 (b)], patient survival among haemodialysis patients remained superior over CAPD patients. These data contrast with those from the USRDS, Canadian, Australian and the UK registries where patients on PD appeared to have a better survival compared to haemodialysis.

Table 3.2.1(a): Unadjusted patient survival by Dialysis modality, 1997-2006

Dialysis modality	CAPD			HD			All Dialysis		
Interval (months)	No.	% Survival	SE	No.	% Survival	SE	No.	% Survival	SE
6	2537	93	0	17560	95	0	20097	94	0
12	2087	88	1	14950	89	0	17037	89	0
24	1376	76	1	10955	80	0	12331	80	0
36	847	62	1	7895	72	0	8742	71	0
48	497	53	1	5592	65	0	6089	64	0
60	293	47	1	3809	58	0	4102	57	0
72	160	40	2	2536	52	1	2695	51	1
84	88	37	2	1578	47	1	1666	46	1
96	44	31	2	884	43	1	927	42	1
108	19	29	3	372	39	1	390	38	1
120	3	27	3	27	35	1	29	35	1

* No. = Number at risk SE=standard error

Figure 3.2.1(a): Unadjusted patient survival by Dialysis modality, 1997-2006



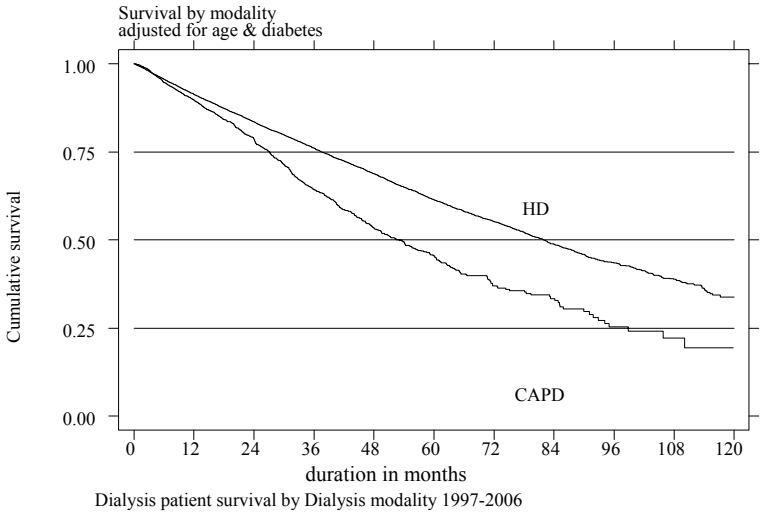
Dialysis patient survival by Dialysis modality 1997-2006

Table 3.2.1(b): Adjusted patient survival with age and diabetes by Dialysis modality, 1997-2006

Dialysis modality	CAPD			HD			All Dialysis		
Interval (months)	No.	% Survival	SE	No.	% Survival	SE	No.	% Survival	SE
6	2537	95	0	17560	96	0	20097	95	0
12	2087	90	1	14950	91	0	17037	91	0
24	1376	79	1	10955	84	0	12331	83	0
36	847	64	1	7895	76	0	8742	75	0
48	497	53	1	5592	69	0	6089	67	0
60	293	46	1	3809	61	0	4102	60	0
72	160	37	2	2536	55	1	2695	54	1
84	88	33	2	1578	49	1	1666	48	1
96	44	25	2	884	44	1	927	43	1
108	19	22	3	372	39	1	390	38	1
120	3	19	3	27	34	1	29	33	1

* No. = Number at risk SE=standard error

Figure 3.2.1(b): Adjusted patient survival for age and diabetes by Dialysis modality, 1997-2006



Dialysis patient survival by Dialysis modality 1997-2006

3.2.2 Patient survival by year of starting dialysis

Table 3.2.2 and Fig 3.2.2 show the unadjusted patient survival by year of entry. The unadjusted 6 months survival of those starting dialysis in 2006 was 94%. Despite a progressive increase in the number of diabetic patients and older people starting dialysis in recent years, the unadjusted patient survival remained constant over the last 10 years with a 1-year and 5-year survival of 88-90% and 56-61% respectively.

Table 3.2.2: Unadjusted patient survival by year of entry, 1997-2006

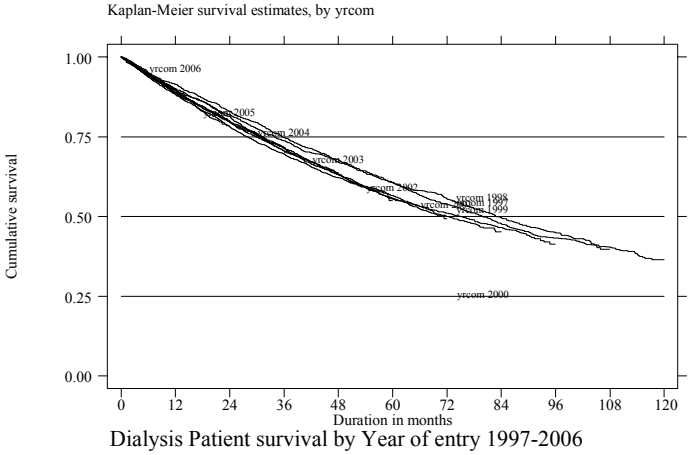
Year	1997			1998			1999			2000		
Interval (months)	No.	% Survival	SE	No.	% Survival	SE	No.	% Survival	SE	No.	% Survival	SE
6	1133	94	1	1244	95	1	1510	95	1	1807	95	1
12	1060	90	1	1178	91	1	1410	90	1	1666	90	1
24	950	82	1	1037	83	1	1213	81	1	1414	80	1
36	835	74	1	913	75	1	1038	72	1	1224	71	1
48	735	67	1	802	68	1	895	63	1	1059	63	1
60	643	61	1	708	61	1	791	57	1	919	56	1
72	555	54	2	637	56	1	706	51	1	802	50	1
84	481	48	2	558	50	1	628	46	1	-	-	-
96	429	43	2	499	45	1	-	-	-	-	-	-
108	390	40	2	-	-	-	-	-	-	-	-	-
120	29	36	2	-	-	-	-	-	-	-	-	-

Year	2001			2002			2003			2004		
Interval (months)	No.	% Survival	SE	No.	% Survival	SE	No.	% Survival	SE	No.	% Survival	SE
6	2068	94	1	2350	95	0	2526	94	0	2835	95	0
12	1884	89	1	2175	90	1	2330	89	1	2606	89	1
24	1601	78	1	1842	80	1	2016	80	1	2263	80	1
36	1385	70	1	1598	71	1	1747	70	1	-	-	-
48	1204	62	1	1398	63	1	-	-	-	-	-	-
60	1044	56	1	-	-	-	-	-	-	-	-	-

Year	2005			2006		
Interval (months)	No.	% Survival	SE	No.	% Survival	SE
6	2968	94	0	1665	94	0
12	2732	88	1	-	-	-

* No. = Number at risk SE=standard error

Figure 3.2.2: Unadjusted patient survival by year of entry, 1997-2006



Dialysis Patient survival by Year of entry 1997-2006

3.2.3 Patient survival by Age at starting dialysis

The unadjusted survival for age groups ≤14 years, 15-24 years and 25-34 years at the start of dialysis were similar, with a 5-year survival of more than 80% as shown in Table 3.2.3.. Beyond the age of 34 years old the unadjusted survival progressively worsened with increasing age. The 9-year unadjusted survival for those who started dialysis at the age of less than 15 years was 72 % compared with 15% in those more than 64 years of age at the time of initiation of dialysis.

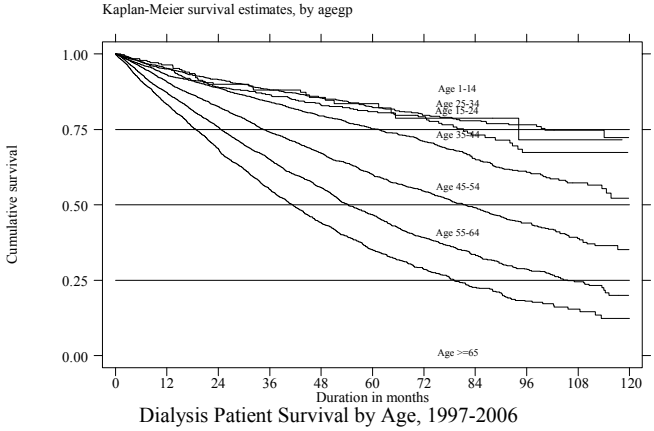
Table 3.2.3: Unadjusted patient survival by age, 1997-2006

Age group (years)	<=14			15-24			25-34			35-44		
Interval (months)	No.	% Survival	SE	No.	% Survival	SE	No.	% Survival	SE	No.	% Survival	SE
6	294	98	1	928	97	1	1649	97	0	2832	96	0
12	258	96	1	793	95	1	1444	95	1	2467	93	0
24	182	90	2	568	89	1	1111	92	1	1934	89	1
36	133	88	2	428	86	1	881	88	1	1502	84	1
48	94	86	3	305	83	1	677	85	1	1146	79	1
60	58	84	3	219	81	2	493	82	1	850	75	1
72	39	79	4	157	79	2	373	80	1	601	71	1
84	23	79	4	103	73	3	253	78	1	381	65	1
96	11	72	8	59	67	3	155	76	2	233	61	2
108	6	72	8	32	67	3	69	75	2	101	57	2
120	-	-	-	4	67	3	4	72	3	6	52	3

Age group (years)	45-54			55-64			>=65		
Interval (months)	No.	% Survival	SE	No.	% Survival	SE	No.	% Survival	SE
6	5083	96	0	5431	93	0	3881	91	0
12	4329	91	0	4582	87	0	3166	83	1
24	3218	83	1	3231	76	1	2092	69	1
36	2303	74	1	2222	65	1	1279	55	1
48	1643	67	1	1475	56	1	750	44	1
60	1125	60	1	928	47	1	431	35	1
72	750	54	1	554	39	1	230	29	1
84	464	49	1	333	33	1	116	23	1
96	247	44	1	171	29	1	57	18	1
108	99	39	2	70	24	1	19	15	2
120	9	35	2	6	20	2	3	12	2

* No. = Number at risk SE=standard error

Figure 3.2.3: Unadjusted patient survival by age, 1997-2006



Dialysis Patient Survival by Age, 1997-2006

3.2.4 Patient survival by Diabetic status

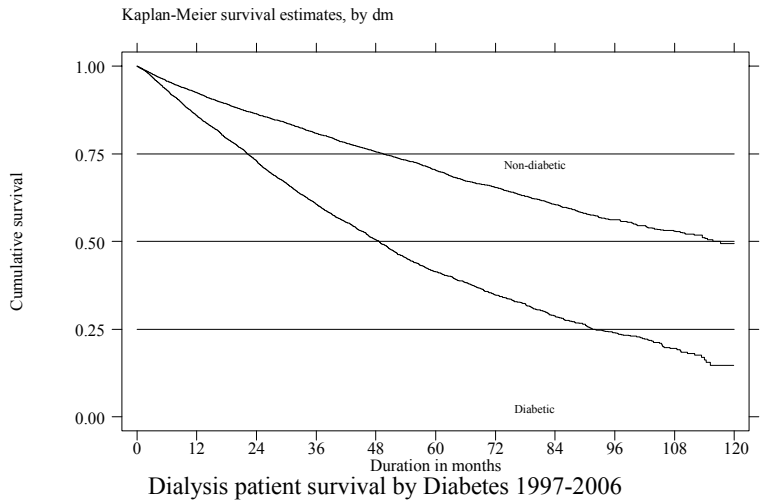
The unadjusted patient survival among diabetic and non-diabetic patients is shown in Table 3.2.4 and Figure 3.2.4. The presence of diabetes mellitus has major impact on patient survival. The difference in the unadjusted patient survival appeared as early as 6 months after initiation of dialysis and increased with the time on dialysis. The 10 years unadjusted patient survival among diabetics and non-diabetics were 49% and 15% respectively, a three fold difference.

Table 3.2.4: Unadjusted patient survival by Diabetes status, 1997-2006

Diabetes status	Non-Diabetic			Diabetic		
Interval (months)	No.	% Survival	SE	No.	% Survival	SE
6	10287	96	0	9810	93	0
12	8967	92	0	8070	86	0
24	6887	86	0	5444	73	0
36	5258	81	0	3484	61	1
48	3908	76	0	2181	51	1
60	2805	70	1	1297	41	1
72	1938	65	1	759	35	1
84	1256	61	1	410	29	1
96	718	56	1	210	24	1
108	328	53	1	63	20	1
120	25	49	1	5	15	2

* No. = Number at risk SE=standard error

Figure 3.2.4: Unadjusted patient survival by Diabetes status, 1997-2006



Dialysis patient survival by Diabetes 1997-2006

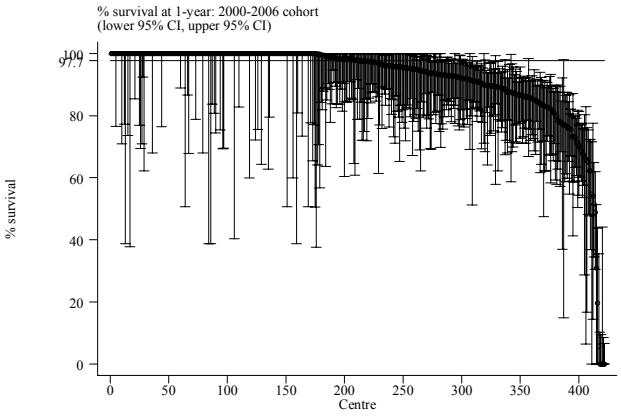
3.3 SURVIVAL OF INCIDENT PATIENTS 2000 – 2006 BY CENTRE

3.3.1. Survival of incident haemodialysis patients 2000 – 2006 by centre

Figure 3.3.1(a) and Figure 3.3.1(b) show the patient survival (adjusted to age and diabetes) by haemodialysis centres at 1year and at 5 years respectively. The median adjusted patient survival among haemodialysis centres at 1 year and 5 years for the 2000-2006 cohort were 97.7% and 71.9% respectively. There was wide centre variation with regards to patient survival at one year and this became more apparent at 5 years (more than 10 fold different)..

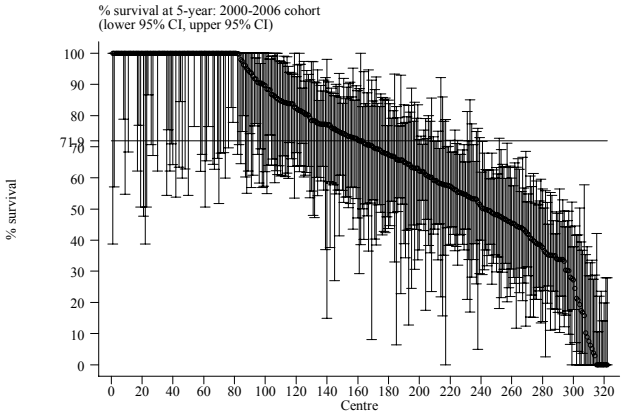
As smaller centres and newer centres tend to have wider confidence interval, data on survival at 1 year and 5 years adjusted for age and diabetes are also shown in funnel plots (Figure 3.3.1(c) and Figure 3.3.1 (d) respectively) to identify outliers. For 1 year survival, 39 (25%) centres lie below 3SD while for 5 years survival 69 (33%) centres are below the 3SD.

Figure 3.3.1(a): Variation in % Survival at 1-year adjusted to age and diabetes, 2000-2006



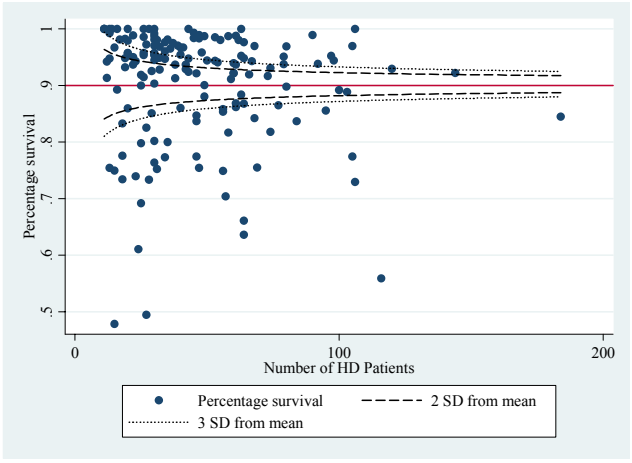
* Horizontal line represents the median % survival among HD centres

Figure 3.3.1(b): Variation in % Survival at 5-years adjusted to age and diabetes, 2000-2006



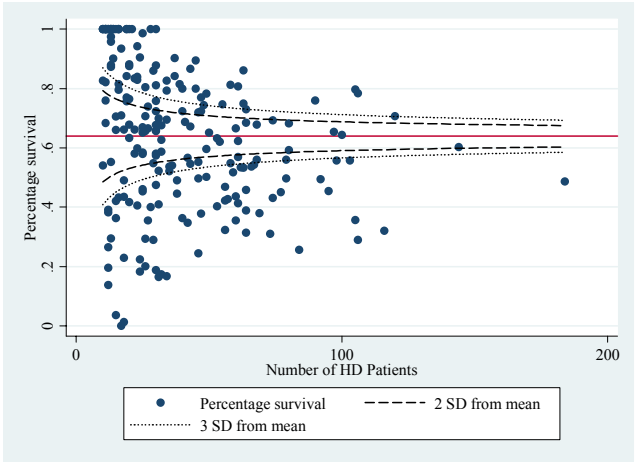
* Horizontal line represents the median % survival among HD centres

Figure 3.3.1(c): Funnel plot for adjusted age at 60 and diabetes at 1 year after 90 days survival; 1997-2002 cohorts (HD centres)



*Centres with new patients <10 were excluded from this analysis.

Figure 3.3.1(d): Funnel plot for adjusted age at 60 and diabetes at 5 years after 90 days survival; 1997-2002 cohorts (HD centres)



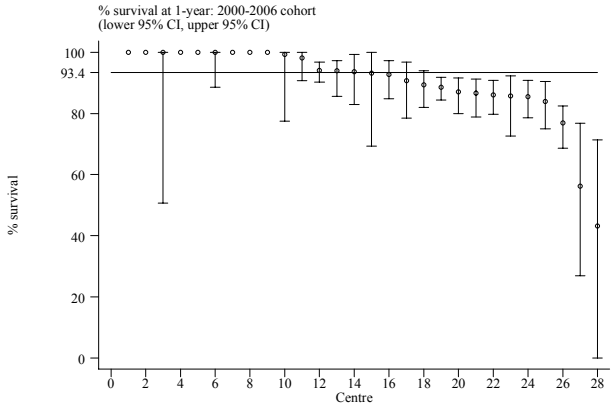
*Centres with new patients <10 were excluded from this analysis.

3.3.2. Survival of incidence CAPD patients 2000 – 2006 by centre

The adjusted patient survival (adjusted to age and diabetes) at 1 year and at 5 years according to CAPD centres are shown in Figure 3.3.2(a) and Figure 3.3.2.(b). The median adjusted patient survival among CAPD centres at one year and 5 years for the 2000-2006 cohort were 93.4% and 51.9% respectively. There was no overt centre variation with regards to patient survival at one year. However the adjusted CAPD patient survival at 5 years demonstrated marked centre variation with a 5 fold difference.

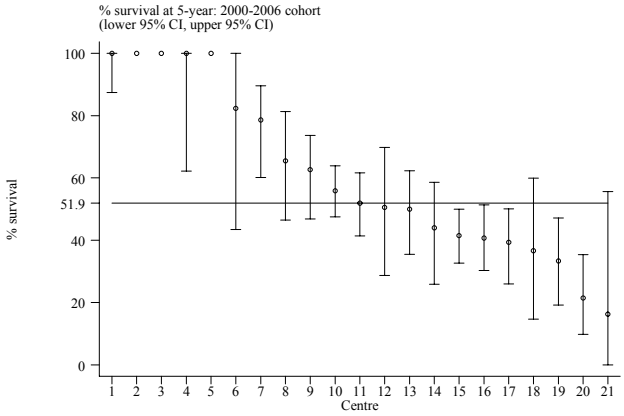
Figure 3.3.2(c) and Figure 3.3.2(d) show the funnel plot for 1 year and 5 years adjusted patient survival among CAPD centres respectively. In both the 1 year and 5 years survival funnel plots, there are 5 centres which lie below the 3SD.

Figure 3.3.2(a): Variation in % Survival at 1-year adjusted to age and diabetes, 2000-2006



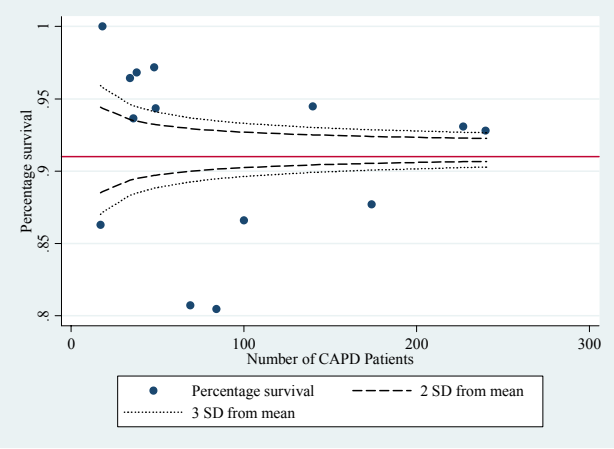
* Horizontal line represents the median % survival among CAPD centres

Figure 3.3.2(b): Variation in % Survival at 5-years adjusted to age and diabetes, 2000-2006



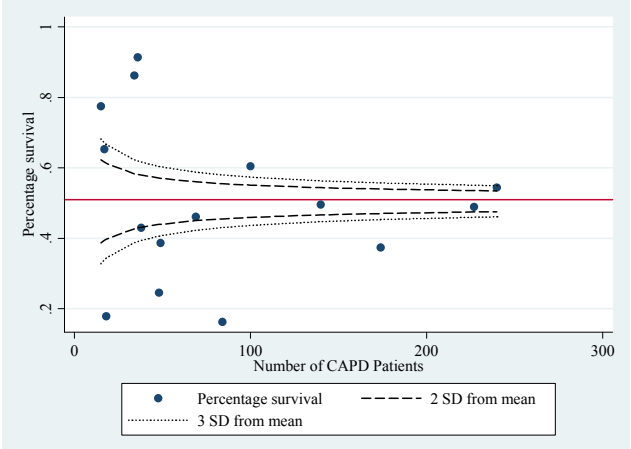
* Horizontal line represents the median % survival among CAPD centres

Figure 3.3.2(c): Funnel plot for adjusted age at 60 and diabetes at 1 year after 90 days survival; 1997-2002 cohorts (CAPD centres)



*Centres with new patients <10 were excluded from this analysis.

Figure 3.3.2(d): Funnel plot for adjusted age at 60 and diabetes at 5 years after 90 days survival; 1997-2002 cohorts (CAPD centres)



*Centres with new patients <10 were excluded from this analysis.

3.4 Adjusted Mortality of dialysis patient

Table 3.4.1 shows the adjusted hazard ratio for mortality of dialysis patients (1997-2006). The 1997-2006 cohort was adjusted for age, gender, primary diagnosis, year commencing dialysis, dialysis modality, body mass index (BMI), serum albumin, serum cholesterol, adequacy of dialysis (KT/V), diastolic blood pressure, haemoglobin, serum calcium, calcium phosphate product, serum phosphate, viral hepatitis status and presence of cardiovascular disease.

Patient characteristics that had significant impact on mortality were age, gender, year commencing dialysis, dialysis modality, BMI, KT/V, diastolic blood pressure and the presence of diabetes or cardiovascular disease. The significant biochemical risk factors for mortality were serum albumin, serum cholesterol, haemoglobin, calcium, calcium phosphate product, phosphate and hepatitis C status.

There were positive correlation between age of patient, diastolic blood pressure (Figure 3.4.1a), serum calcium and serum phosphate (Figure 3.4.1b) with mortality while negative correlation was noted between serum albumin, KT/V (Figure 3.4.1c), haemoglobin concentration (Figure 3.4.1d) and calcium phosphate product with mortality.

Table 3.4.1: Adjusted hazard ratio for mortality of dialysis patients (1997-2006 cohort)

Factors	N	Hazard ratio	95% CI	P value
Age (years):				
0-14(ref.*)	331	1.00		
15-24	1045	1.63	(1.13, 2.34)	0.01
25-34	1856	1.47	(1.03, 2.09)	0.03
35-44	3172	2.06	(1.46, 2.90)	0.00
45-54	5797	2.81	(2.00, 3.95)	0.00
55-64	6301	3.73	(2.66, 5.24)	0.00
≥65	4709	5.06	(3.60, 7.12)	0.00
Gender:				
Male (ref.*)	12897	1.00		
Female	10314	0.89	(0.84, 0.94)	0.00
Primary diagnosis:				
Unknown/ Uncertain (ref.*)	6622	1.00		
Diabetes mellitus	11285	1.60	(1.50, 1.70)	0.00
GN/ SLE	1952	0.92	(0.81, 1.03)	0.16
Polycystic kidney	315	1.14	(0.91, 1.45)	0.26
Obstructive Nephropathy	763	1.09	(0.94, 1.25)	0.26
Others	2274	1.06	(0.96, 1.17)	0.24
Year start dialysis:				
1997-8 (ref.*)	2546	1.00		
1999-2000	3563	1.06	(0.98, 1.14)	0.14
2001-2002	4752	1.10	(1.02, 1.19)	0.01
2003-2006	12350	1.10	(1.01, 1.18)	0.02
Modality:				
CAPD	3069	1.35	(1.24, 1.48)	0.00
HD (ref*)	20142	1.00		
BMI:				
<18.5	2257	1.52	(1.37, 1.70)	0.00
18.5-<25	15615	1.34	(1.26, 1.43)	0.00
≥25(ref.*)	5339	1.00		

Table 3.4.1: Adjusted hazard ratio for mortality of dialysis patients (1997-2006 cohort) - cont'd

Factors	N	Hazard ratio	95% CI	P value
Serum albumin (g/L):				
<30	1347	4.21	(3.77, 4.69)	0.00
30-<35	2952	2.33	(2.14, 2.54)	0.00
35-<40	11046	1.70	(1.59, 1.82)	0.00
≥40(ref.*)	7866	1.00		
Serum cholesterol (mmol/L):				
<3.2	749	1.11	(0.96, 1.28)	0.17
3.2-<5.2	16703	1.16	(1.10, 1.24)	0.00
≥5.2(ref.*)	5759	1.00		
KT/V				
<1.0	358	1.55	(1.30, 1.85)	0.00
1.0-<1.2	1486	1.04	(0.94, 1.16)	0.44
1.2-<1.4(ref.*)	4783	1.00		
1.4-<1.6	6126	0.89	(0.83, 0.95)	0.00
>=1.6	10458	0.80	(0.74, 0.86)	0.00
Diastolic BP (mmHg):				
<70	2548	0.89	(0.01, 0.82)	0.96
70-<80	8465	0.95	(0.90, 1.00)	0.07
80-<90(ref.*)	9358	1.00		
90-<100	2353	1.10	(1.00, 1.21)	0.04
≥100	487	1.96	(1.67, 2.31)	0.00
Hemoglobin (g/dL):				
<8	2378	3.07	(2.74, 3.45)	0.00
8-<9	3567	1.96	(1.75, 2.19)	0.00
9-<10	10019	2.13	(1.92, 2.36)	0.00
10-<11	4084	1.09	(0.97, 1.22)	0.14
11-<12 (ref.*)	2058	1.00		
≥12	1105	0.92	(0.78, 1.09)	0.32
Serum Calcium (mmol/L):				
<2.2	6325	0.85	(0.80, 0.90)	0.00
2.2-<2.6(ref.*)	16240	1.00		
≥2.6	646	1.63	(1.43, 1.85)	0.00
Calcium Phosphate product ($mmol^2/L^2$):				
<3.5	7163	1.00	(0.91, 1.10)	0.98
3.5-<4.5(ref.*)	10759	1.00		
4.5-<5.5	3668	0.69	(0.62, 0.77)	0.00
≥5.5	1621	0.57	(0.47, 0.69)	0.00
Serum Phosphate (mmol/L):				
<1.6	7879	0.90	(0.82, 0.98)	0.02
1.6-<2.0(ref.*)	10244	1.00		
2.0-<2.2	2190	0.98	(0.87, 1.10)	0.76
2.2-<2.4	1303	1.19	(1.03, 1.38)	0.02
2.4-<2.6	794	1.23	(1.00, 1.52)	0.05
≥2.6	801	2.05	(1.64, 2.56)	0.00
HBsAg:				
Negative(ref.*)	22259	1.00		
Positive	952	1.09	(0.98, 1.22)	0.12
Anti-HCV:				
Negative(ref.*)	22121	1.00		
Positive	1090	0.85	(0.77, 0.94)	0.00
Cardiovascular disease (CVD):				
No CVD(ref.*)	18599	1.00		
CVD	4612	1.28	(1.22, 1.35)	0.00

ref: Reference group

Figure 3.4.1(a): Adjusted hazard ratio for mortality of dialysis patients by diastolic blood pressure (1997-2006 cohort)

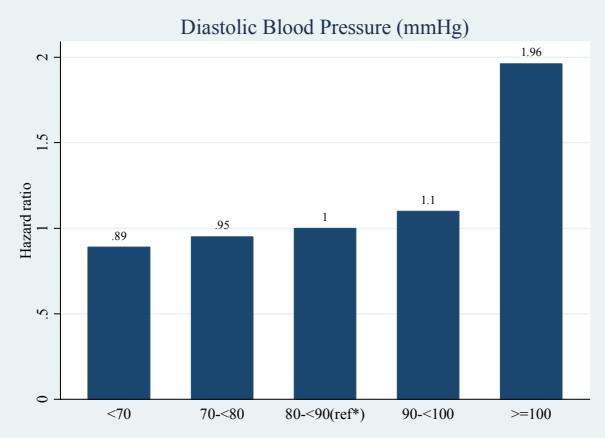


Figure 3.4.1(b): Adjusted hazard ratio for mortality of dialysis patients by serum phosphate (1997-2006 cohort)

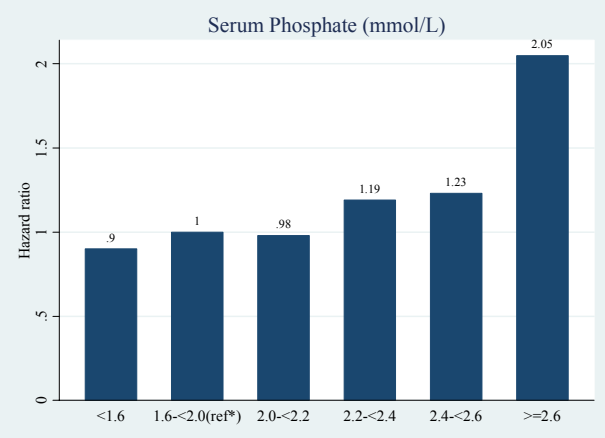


Figure 3.4.1(c): Adjusted hazard ratio for mortality of dialysis patients by KT/V (1997-2006 cohort)

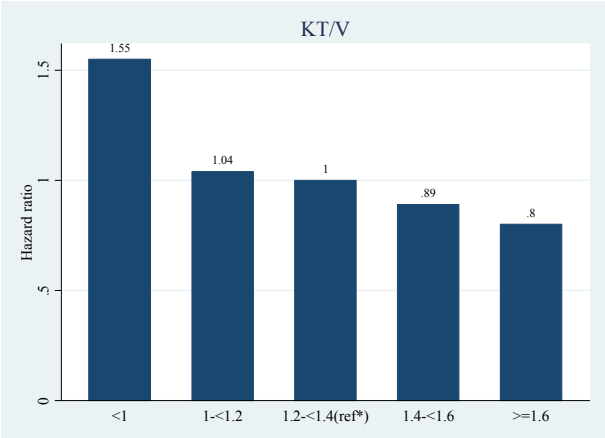


Figure 3.4.1(d): Adjusted hazard ratio for mortality of dialysis patients by haemoglobin (1997-2006 cohort)