

CHAPTER 3

DEATH AND SURVIVAL ON DIALYSIS

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SECTION 3.1: DEATH ON DIALYSIS

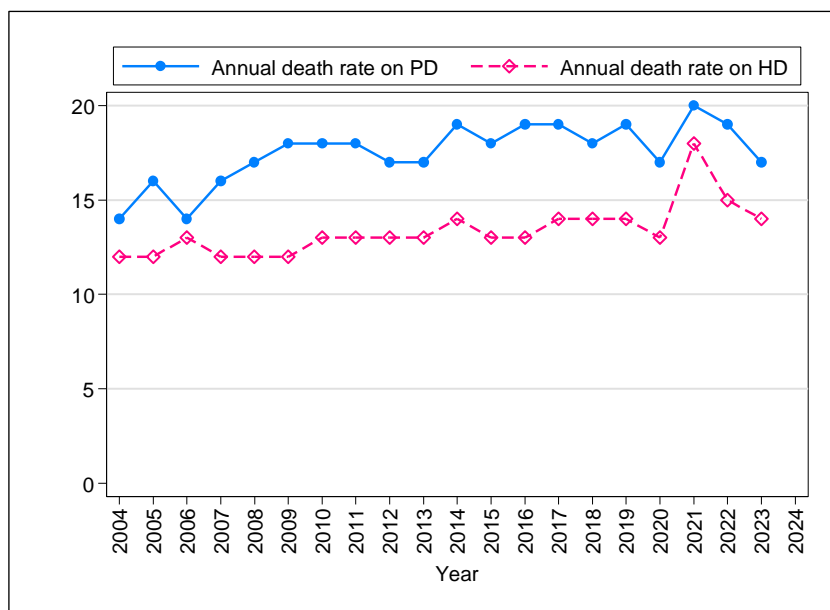
The annual crude death rate on dialysis in 2023 was 14% (Table 3.1.1). The annual crude death rate among haemodialysis patients was 14% while chronic peritoneal dialysis patients had a rate of 17%.

Over the past two decades, the annual crude death rate of patients on PD has consistently been higher than that of patients on HD. (Figure 3.1.1). This constitutes a major reason for PD drop out. It has been postulated that the difference in annual death rate between the two modalities are due to the negative selection of patients for peritoneal dialysis and the changing of modality from HD to PD due to severe cardiovascular disease.

Table 3.1.1: Deaths on dialysis 2014-2023

Year	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014
Number of dialysis patients at risk	52346	50738	49994	48602	45919	43573	41578	39319	36536	33671
Dialysis deaths	7527	8034	9091	6359	6495	6153	5949	5402	5003	4728
Dialysis death rate %	14	16	18	13	14	14	14	14	14	14
Number of HD patients at risk	45903	44611	44266	43338	41132	39132	37432	35429	32988	30585
HD deaths	6419	6850	7922	5477	5602	5334	5174	4671	4372	4152
HD death rate %	14	15	18	13	14	14	14	13	13	14
Number of PD patients at risk	6443	6128	5728	5264	4787	4441	4146	3890	3548	3086
PD deaths	1108	1184	1169	882	893	819	775	731	631	576
PD death rate %	17	19	20	17	19	18	19	19	18	19

Figure 3.1.1: Death rates on dialysis 2004-2023



Traditionally, cardiovascular disease has been the primary contributor to mortality among our patients, with a notable portion of at-home deaths often attributed to cardiac events. However, over the past three years, infections have emerged as the leading reported cause of death, even as the impact of the COVID-19 pandemic has waned. In 2023, 36.2% of reported deaths were due to infections, surpassing the 33.9% attributed to cardiovascular causes.

Over the past 10 years, cause of death from CRBSI has increased in an alarming manner. This is not surprising as 23.5% of our HD patients are either on cuffed or non-cuffed catheter for their dialysis treatment-

Prior to 2023, peritonitis-related deaths in PD patients were defined based on the cause of death as documented by the attending doctor. However, starting in December 2022, the definition was broadened to include any PD patient who died within one month of the onset of a peritonitis episode, regardless of the stated cause of death. This change, reflected in the ISPD guidelines on peritonitis and supported by published studies on PD, has led to a significant increase in the reported rates of peritonitis-related deaths.

Table 3.1.2: Causes of death on dialysis 2014-2023

Year	2023		2022		2021		2020		2019	
	n	%	n	%	n	%	n	%	n	%
Causes of Death (Dialysis)										
Cardiovascular	1770	23.5	1969	24.6	2041	22.4	1875	29.5	1994	30.7
Died at home	784	10.4	918	11.5	1046	11.5	873	13.7	994	15.3
Infection	2350	31.2	2948	36.8	3370	37.1	1591	25	1412	21.7
CRBSI	176	2.3	180	2.2	124	1.4	105	1.7	102	1.6
PD peritonitis	202	2.7	97	1.2	80	0.9	56	0.9	67	1
GIT bleed	105	1.4	118	1.5	113	1.2	88	1.4	93	1.4
Cancer	182	2.4	182	2.3	161	1.8	138	2.2	162	2.5
Liver disease	19	0.3	17	0.2	23	0.3	34	0.5	19	0.3
Withdrawal	185	2.5	64	0.8	96	1.1	66	1	95	1.5
Accidental Death	54	0.7	65	0.8	54	0.6	48	0.8	59	0.9
Pulmonary Causes	194	2.6	218	3	462	5	376	6	517	8
Others	636	8.4	878	11	943	10	493	8	404	6
Unknown	871	11.6	361	5	580	6	615	10	577	9
Total	7528	100	8015	100	9093	100	6358	100	6495	100
Causes of Death (HD)										
Cardiovascular	1556	24.2	1718	25.1	1842	23.2	1647	30.1	1780	31.8
Died at home	608	9.5	699	10.2	745	9.4	638	11.7	723	12.9
Infection	2046	31.9	2547	37.3	2946	37.2	1356	24.8	1226	21.9
CRBSI	176	2.7	180	2.6	124	1.6	105	1.9	102	1.8
GIT bleed	96	1.5	101	1.5	99	1.2	79	1.4	78	1.4
Cancer	171	2.7	169	2.5	151	1.9	133	2.4	153	2.7
Liver disease	19	0.3	17	0.2	23	0.3	31	0.6	19	0.3
Withdrawal	172	2.7	53	0.8	93	1.2	65	1.2	84	1.5
Accidental Death	52	0.8	55	0.8	48	0.6	45	0.8	54	1
Pulmonary Causes	167	2.6	192	3	419	5	356	7	490	9
Others	592	9.2	821	12	909	11	464	8	365	7
Unknown	764	11.9	282	4	526	7	557	10	528	9
Total	6419	100	6834	100	7925	100	5476	100	5602	100

**DEATH AND SURVIVAL
ON DIALYSIS**

Year	2023		2022		2021		2020		2019	
	n	%	n	%	n	%	n	%	n	%
Causes of Death (PD)										
Cardiovascular	214	19.3	251	21.3	199	17	228	25.9	214	24
Died at home	176	15.9	219	18.5	301	25.8	235	26.6	271	30.3
Infection	304	27.4	401	34	424	36.3	235	26.6	186	20.8
PD peritonitis	202	18.2	97	8.2	80	6.8	56	6.3	67	7.5
GIT bleed	9	0.8	17	1.4	14	1.2	9	1	15	1.7
Cancer	11	1.0	13	1.1	10	0.9	5	0.6	9	1
Liver disease	0	0.0	0	0	0	0	3	0.3	0	0
Withdrawal	13	1.2	11	0.9	3	0.3	1	0.1	11	1.2
Accidental Death	2	0.2	10	0.8	6	0.5	3	0.3	5	0.6
Pulmonary Causes	27	2.4	26	2	43	4	20	2	27	3
Others	44	4.0	57	5	34	3	29	3	39	4
Unknown	106	9.6	79	7	54	5	58	7	49	5
Total	1108	100	1181	100	1168	100	882	100	893	100

* Died due to COVID-19, 2023: HD 56, and PD 12, 2022: HD 512, and PD 75, 2021: HD 1436, and PD 175, 2020: HD 36, and PD 3

Year	2018		2017		2016		2015		2014	
	n	%	n	%	n	%	n	%	n	%
Causes of Death (Dialysis)										
Cardiovascular	1841	29.9	1888	31.7	1831	33.9	1749	35	1742	36.8
Died at home	999	16.2	954	16	771	14.3	721	14.4	676	14.3
Infection	1518	24.7	1453	24.4	1471	27.2	1246	24.9	1136	24
CRBSI	94	1.5	87	1.5	55	1	58	1.2	52	1.1
PD peritonitis	66	1.1	75	1.3	55	1	49	1	51	1.1
GIT bleed	105	1.7	91	1.5	88	1.6	79	1.6	78	1.6
Cancer	148	2.4	166	2.8	150	2.8	120	2.4	125	2.6
Liver disease	23	0.4	24	0.4	25	0.5	23	0.5	34	0.7
Withdrawal	51	0.8	72	1.2	65	1.2	58	1.2	51	1.1
Accidental Death	51	0.8	55	0.9	50	0.9	40	0.8	36	0.8
Pulmonary Causes	398	6	201	3	42	1	33	1	15	0
Others	402	7	336	6	212	4	189	4	155	3
Unknown	457	7	547	9	587	11	638	13	577	12
Total	6153	100	5949	100	5402	100	5003	100	4728	100
Causes of Death (HD)										
Cardiovascular	1642	30.8	1697	32.8	1655	35.4	1588	36.3	1593	38.4
Died at home	771	14.5	718	13.9	557	11.9	537	12.3	525	12.6
Infection	1309	24.5	1280	24.7	1259	27	1099	25.1	985	23.7
CRBSI	94	1.8	87	1.7	55	1.2	58	1.3	52	1.3
GIT bleed	94	1.8	79	1.5	80	1.7	69	1.6	71	1.7
Cancer	142	2.7	159	3.1	145	3.1	114	2.6	121	2.9
Liver disease	23	0.4	23	0.4	25	0.5	23	0.5	34	0.8
Withdrawal	47	0.9	54	1	55	1.2	52	1.2	49	1.2
Accidental Death	49	0.9	53	1	47	1	39	0.9	36	0.9
Pulmonary Causes	373	7	197	4	41	1	30	1	14	0
Others	374	7	317	6	201	4	177	4	150	4
Unknown	416	8	510	10	551	12	586	13	522	13
Total	5334	100	5174	100	4671	100	4372	100	4152	100

**DEATH AND SURVIVAL
ON DIALYSIS**

31st Report of the
Malaysian Dialysis and Transplant Registry 2023

Year	2018		2017		2016		2015		2014	
	n	%	n	%	n	%	n	%	n	%
Causes of Death (PD)										
Cardiovascular	199	24.3	191	24.6	176	24.1	161	25.5	149	25.9
Died at home	228	27.8	236	30.5	214	29.3	184	29.2	151	26.2
Infection	209	25.5	173	22.3	212	29	147	23.3	151	26.2
PD peritonitis	66	8.1	75	9.7	55	7.5	49	7.8	51	8.9
GIT bleed	11	1.3	12	1.5	8	1.1	10	1.6	7	1.2
Cancer	6	0.7	7	0.9	5	0.7	6	1	4	0.7
Liver disease	0	0	1	0.1	0	0	0	0	0	0
Withdrawal	4	0.5	18	2.3	10	1.4	6	1	2	0.3
Accidental Death	2	0.2	2	0.3	3	0.4	1	0.2	0	0
Pulmonary Causes	25	3	4	1	1	0	3	0	1	0
Others	28	3	19	2	11	2	12	2	5	1
Unknown	41	5	37	5	36	5	52	8	55	10
Total	819	100	775	100	731	100	631	100	576	100

SECTION 3.2: PATIENT SURVIVAL ON DIALYSIS

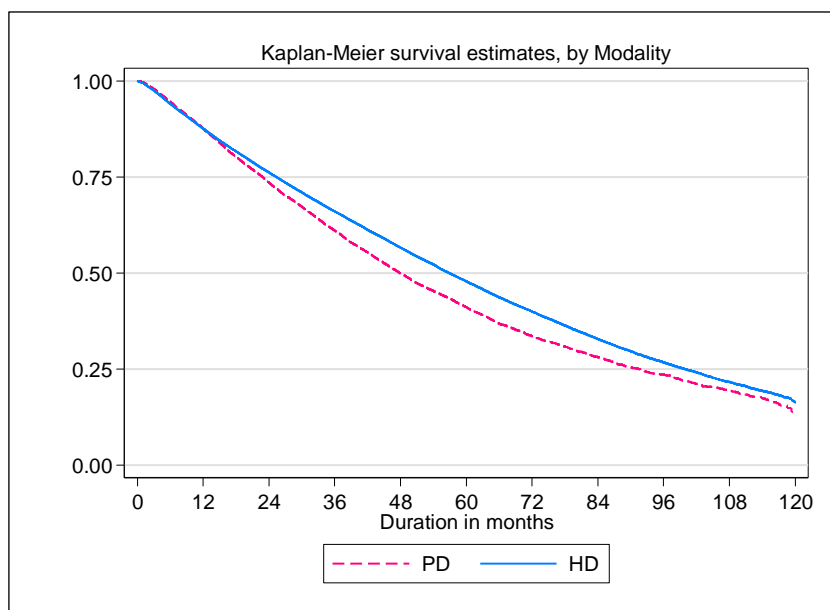
3.2.1: Patient survival by type of dialysis modality

The overall unadjusted 5 years and 10 years patient survival on dialysis; analysed as per ITT (patient not censored for change in dialysis modality) were 47% and 16% respectively (Table 3.2.1). The unadjusted patient survival for those on haemodialysis appeared to be superior compared to those on PD and this survival difference begins from 2nd year onwards.

Table 3.2.1: Patient survival by dialysis modality [ITT analysis (not censored for change of modality)], 2014-2023

Dialysis modality Interval (month)	PD			HD			All		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	13971	100		74456	100		88456	100	
6	12359	95	0	66266	94	0	78625	94	0
12	10573	88	0	57911	88	0	68484	88	0
24	7472	74	0	44156	76	0	51624	76	0
36	5173	61	0	33326	66	0	38499	65	0
48	3459	50	1	24317	57	0	27776	56	0
60	2241	41	1	16909	48	0	19150	47	0
72	1429	34	1	11317	40	0	12746	39	0
84	915	28	1	7060	33	0	7972	32	0
96	546	24	1	3869	27	0	4415	26	0
108	220	19	1	1639	22	0	1857	21	0
120	15	14	1	118	16	0	132	16	0

Figure 3.2.1: Patient survival by dialysis modality analysis (not censored for change of modality), 2014-2023



3.2.2: Patient survival by age at starting dialysis

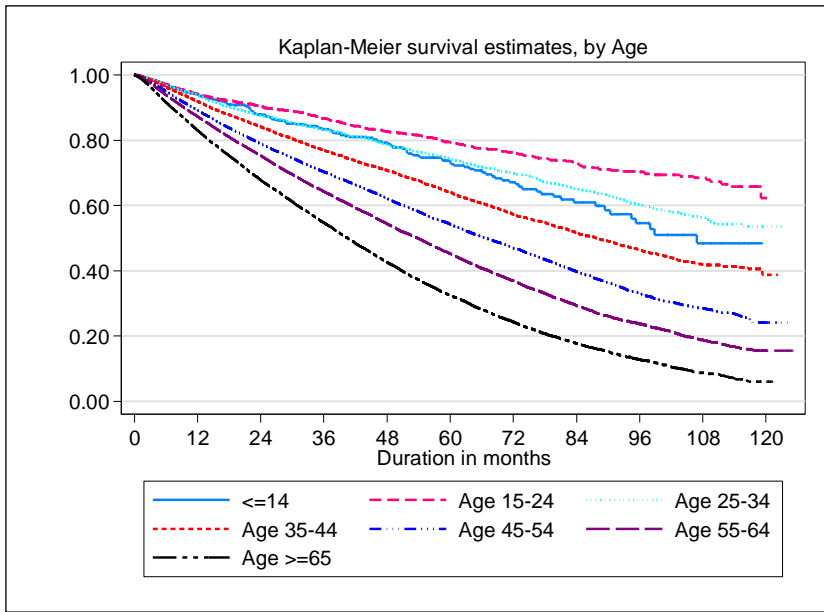
Age at starting dialysis has a major impact on survival with patients in the age group of 15 to 24 having the best outcome (Table 3.2.2 and Figure 3.2.2). Unadjusted 10 years survival of patients in this age group (15-24) was 10-fold better than those who were 65 years old and above. Unadjusted 5 years survival of patients who started dialysis after 65 years old is 32%.

Table 3.2.2: Unadjusted patient survival by age, 2014-2023

Age group (years) Interval (month)	<=14			15-24			25-34			35-44		
	n	% survival	SE	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	604	100		2482	100		6515	100		11637	100	
6	532	97	1	2209	97	0	5746	97	0	10236	96	0
12	468	94	1	1932	94	0	5029	94	0	8848	92	0
24	355	88	1	1538	90	1	3817	88	0	6656	84	0
36	282	83	2	1223	87	1	3014	83	1	5055	77	0
48	222	79	2	958	83	1	2294	79	1	3770	71	1
60	153	73	2	726	79	1	1692	74	1	2630	64	1
72	102	67	3	541	76	1	1202	70	1	1820	57	1
84	64	61	3	374	73	1	840	65	1	1222	52	1
96	37	55	4	245	70	1	477	60	1	728	46	1
108	15	48	5	124	68	2	214	57	1	292	42	1
120	1			10	62	4	10	54	2	10	39	2

Age group (years) Interval (month)	45-54			55-64			>=65		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	21015	100		29600	100		26188	100	
6	18576	95	0	25940	94	0	22396	92	0
12	16063	89	0	22288	87	0	18718	83	0
24	12091	79	0	16488	75	0	12931	68	0
36	9241	70	0	11902	64	0	8808	55	0
48	6822	62	0	8357	54	0	5694	43	0
60	4839	54	0	5646	45	0	3435	32	0
72	3287	47	0	3633	37	0	1995	24	0
84	2086	40	1	2109	29	0	1070	18	0
96	1141	33	1	1095	24	0	507	13	0
108	472	29	1	413	19	0	158	9	0
120	19	24	1	6	16	1	9	6	1

Figure 3.2.2: Unadjusted patient survival by age, 2014-2023



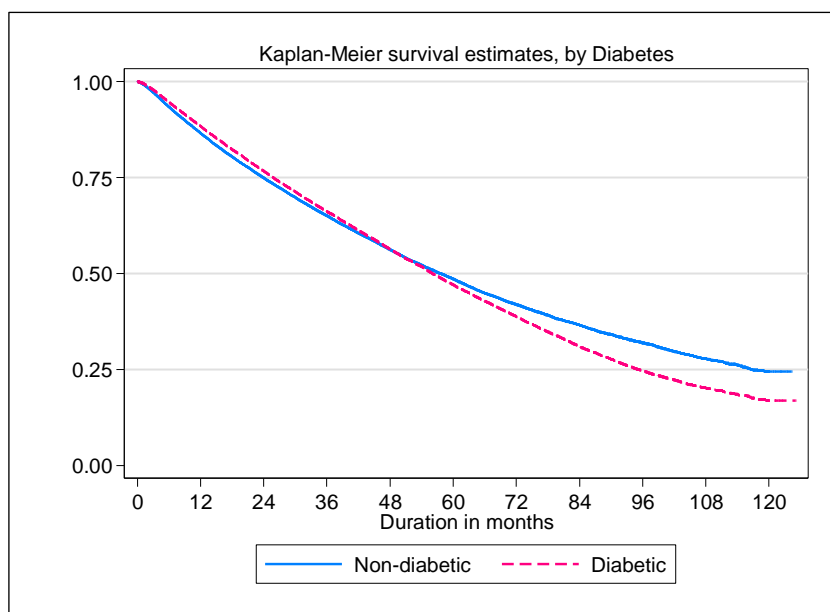
3.2.3: Patient survival by diabetic status

Similar to age at starting dialysis, the presence of diabetes mellitus has major impact on patient survival (Table 3.2.3 and Figure 3.2.3). The unadjusted patient survival began to diverge by 60 months after initiation of dialysis and 53% diabetic patients died within 5 years of initiating dialysis. The 10 years unadjusted patient survival among diabetics and non-diabetics were 17% and 24% respectively.

Table 3.2.3: Unadjusted patient survival by diabetes mellitus status, 2014-2023

Diabetes status Interval (month)	Non-diabetic			Diabetic		
	n	% survival	SE	n	% survival	SE
0	49797	100		41563	100	
6	42589	93	0	37595	95	0
12	35517	86	0	33413	88	0
24	24826	75	0	26035	77	0
36	17308	65	0	20105	66	0
48	12217	56	0	14475	56	0
60	8378	49	0	9821	47	0
72	5559	42	0	6463	39	0
84	3558	37	0	3877	31	0
96	2037	32	0	1982	25	0
108	851	28	0	788	20	0
120	7	24	1	35	17	1

Figure 3.2.3: Unadjusted patient survival by diabetes mellitus status, 2014-2023



3.2.4: Patient survival by 5 years era of starting dialysis

When unadjusted patient survival was analysed by 5 years era of starting dialysis, it appeared that patient survival has deteriorated over the last 20 years; with patients starting dialysis in the 2004-2008 era having the best outcome (Table 3.2.4 and Figure 3.2.4a). Despite adjusting for age and DM (major change in patient demography over the last 2 decades), the difference in patient survival persisted (Figure 3.2.4b). The overall mean age of patients starting dialysis remained almost same in the past 10 years (refer Table 2.1.4(a)).

Table 3.2.4: Unadjusted patient survival by 4 Era, 2004-2023

Year Interval (month)	2004-2008			2009-2013			2014-2018			2019-2023		
	n	% survival	SE	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	19455	100		31914	100		43796	100		42830	100	
6	18016	94	0	29325	93	0	40502	94	0	43921	94	0
12	16622	88	0	27080	87	0	37244	88	0	35064	87	0
24	14292	77	0	23135	76	0	31510	76	0	21559	76	0
36	12337	68	0	19858	67	0	26837	67	0	11981	65	0
48	10658	60	0	16948	58	0	22477	57	0	5100	56	0
60	9202	52	0	14460	50	0	18676	48	0	62	49	1
72	7959	46	0	12212	43	0	12283	41	0	1		
84	6764	40	0	10267	37	0	7568	34	0	1		
96	5768	34	0	8588	31	0	4070	28	0	1		
108	4998	30	0	7186	27	0	1630	24	0	1		
120	4311	26	0	5946	22	0	21	20	0	1		

Figure 3.2.4(a): Unadjusted patient survival by 4 Era, 2004-2023

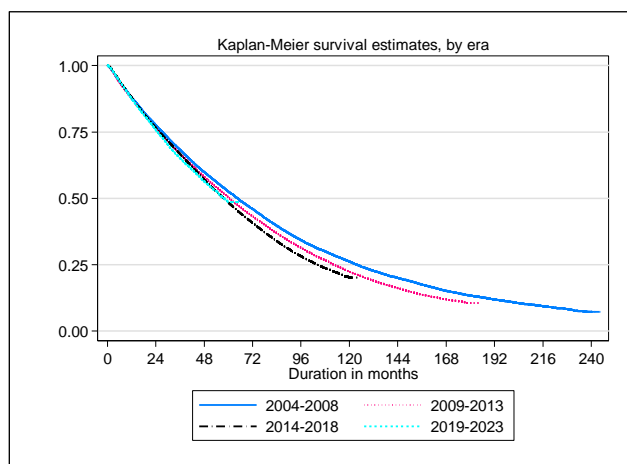


Figure 3.2.4(b): Adjusted for Age and Diabetes patient survival by 4 Era, 2004-2023

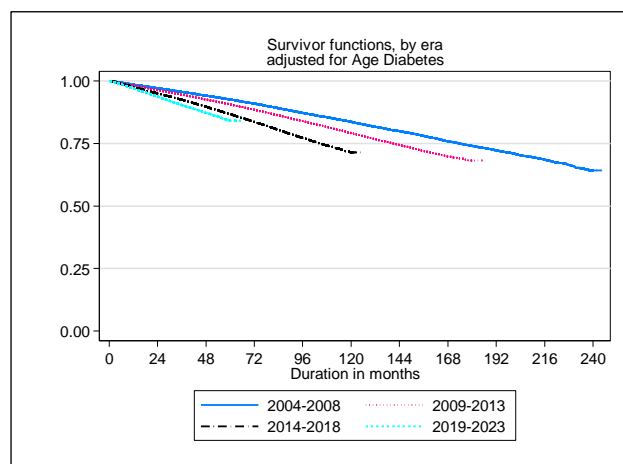


Table 3.2.5: Unadjusted HD patient survival by 4 Era, 2004-2023

Year Interval (month)	2004-2008			2009-2013			2014-2018			2019-2023		
	n	% survival	SE	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	17042	100		27828	100		36842	100		42621	100	
6	15849	94	0	25682	93	0	34218	94	0	35648	94	0
12	14736	88	0	23860	87	0	31685	88	0	28794	88	0
24	12857	78	0	20686	77	0	27341	77	0	18233	76	0
36	11268	69	0	18022	68	0	23717	68	0	10409	66	0
48	9861	61	0	15602	59	0	20219	59	0	4518	58	0
60	8614	54	0	13463	52	0	17048	50	0	58	50	1
72	7518	47	0	11498	44	0	11382	42	0	1		
84	6435	41	0	9735	38	0	7069	35	0	1		
96	5545	35	0	8199	32	0	3826	30	0	1		
108	4825	31	0	6871	27	0	1549	25	0	1		
120	4178	27	0	5714	23	0	19	21	0	1		

Figure 3.2.5(a): Unadjusted HD patient survival by 4 Era, 2004-2023

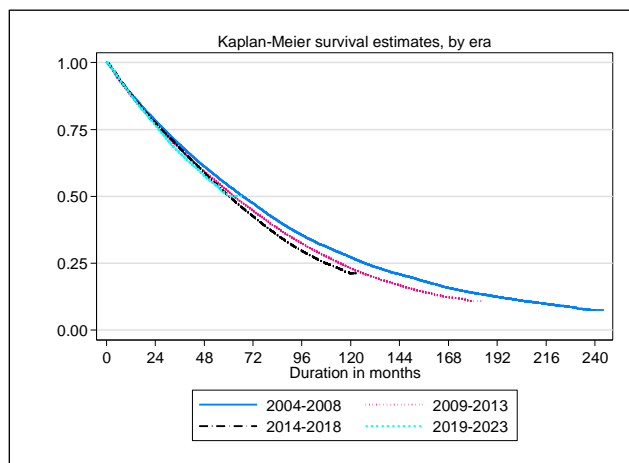


Figure 3.2.5(b): Adjusted for Age and Diabetes HD patient survival by 4 Era, 2004-2023

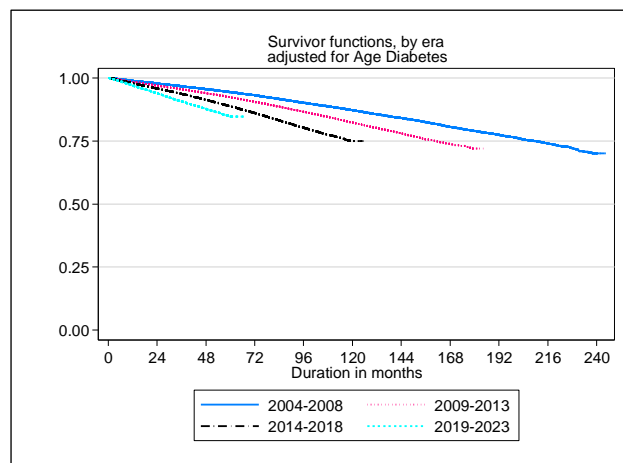


Table 3.2.6: Unadjusted PD patient survival by 4 Era, 2004-2023

Year Interval (month)	2004-2008			2009-2013			2014-2018			2019-2023		
	n	% survival	SE	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	2413	100		4086	100		6954	100		10209	100	
6	2167	93	1	3643	93	0	6284	93	0	8273	94	0
12	1886	85	1	3220	86	1	5559	86	0	6270	86	0
24	1435	71	1	2449	72	1	4169	71	1	3326	72	1
36	1069	60	1	1836	59	1	3120	58	1	1581	59	1
48	799	49	1	1348	48	1	2258	46	1	593	49	1
60	589	40	1	999	39	1	1628	37	1	6	39	2
72	442	33	1	714	31	1	901	29	1	1		
84	330	27	1	534	26	1	501	23	1	1		
96	224	21	1	389	21	1	244	19	1	1		
108	174	18	1	316	19	1	83	15	1	1		
120	134	15	1	234	15	1	3	14	1	1		

Figure 3.2.6(a): Unadjusted PD patient survival by 4 Era, 2004-2023

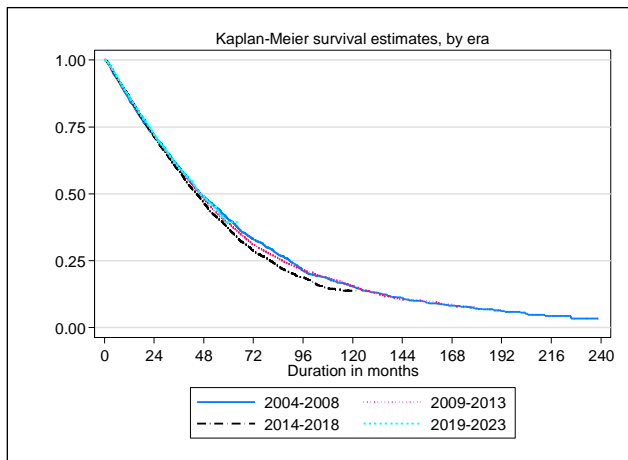
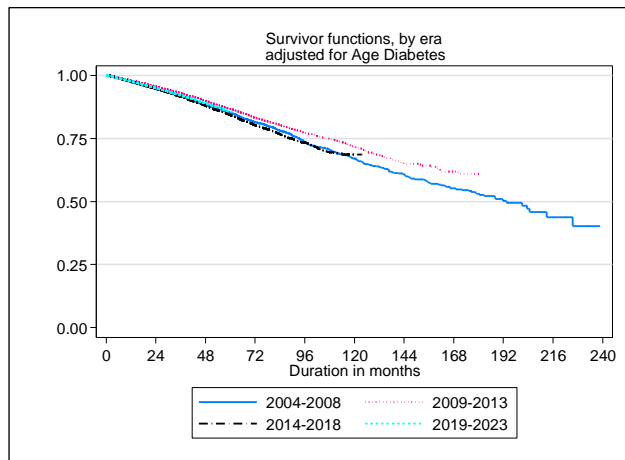


Figure 3.2.6(b): Adjusted for Age and Diabetes PD patient survival by 4 Era, 2004-2023



SECTION 3.3: SURVIVAL OF INCIDENT PATIENTS BY CENTRE

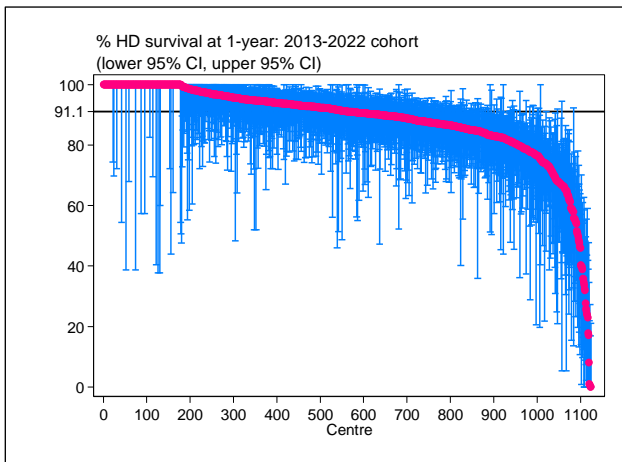
3.3.1: Survival of incident haemodialysis patients (2013-2022) by centre

The mean patient survival at 1 year (adjusted for age and diabetes) among haemodialysis centres for the 2013-2022 cohort was 91.1% [Figure 3.3.1(a)]. There was marked centre variation and when the 1-year patient survival of the individual haemodialysis centres were illustrated in the funnel plots [Figure 3.3.1(b)], only 374 haemodialysis centres (33.3%) and 565 haemodialysis centres (50.3%) lie within the 2SD and 3SD of the mean respectively.

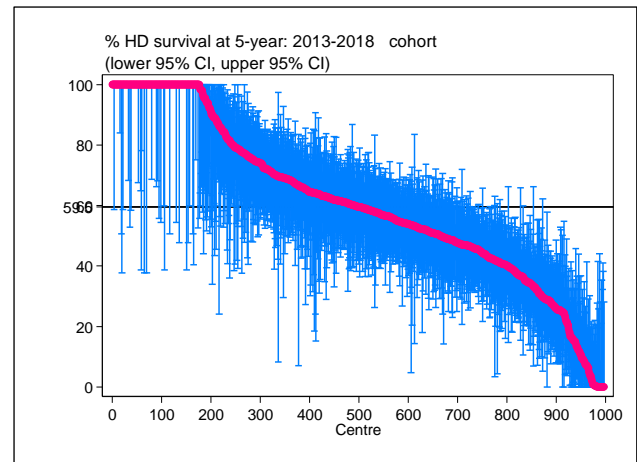
The 5 years mean patient survival (adjusted for age and diabetes) among haemodialysis centres for the 2013-2018 cohort was 59.5% [Figure 3.3.1(c)]. Similar to the 1-year patient survival, there was marked centre variation with only 36% and 52.8% of haemodialysis centres lie within 2SD and 3SD of the mean respectively [Figure 3.3.1(d)].

Figure 3.3.1(a): Variation in patient survival at 1-year among HD centres adjusted for age and diabetes mellitus status, 2013-2022

Figure 3.3.1(c): Variation in patient survival at 5-years among HD centres adjusted for age and diabetes mellitus status, 2013-2018

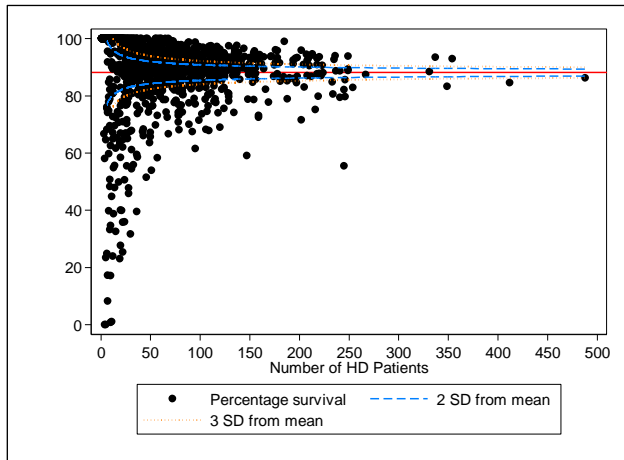


*Horizontal line represents the median % survival among HD centres



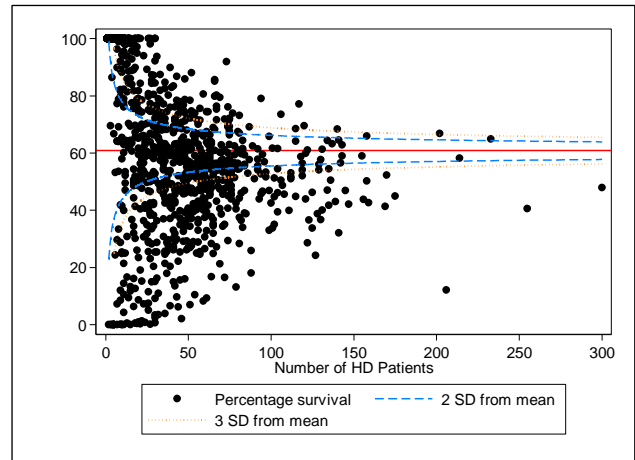
*Horizontal line represents the median % survival among HD centres

Figure 3.3.1(b): Funnel plot at 1-year among HD centres adjusted for age and diabetes mellitus status, 2013-2022 cohort



*Horizontal line represents the mean % survival among HD centres

Figure 3.3.1(d): Funnel plot for patient survival at 5-years among HD centres adjusted age and diabetes mellitus, 2013-2018 cohort



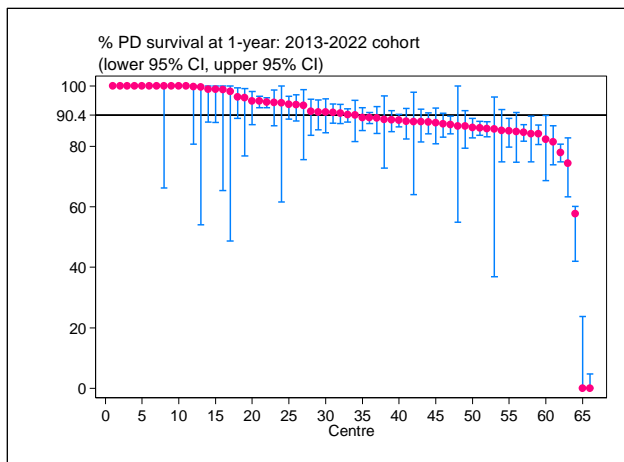
*Horizontal line represents the mean % survival among HD centres

3.3.2: Survival of incident peritoneal dialysis patients (2013-2022) by centre

The mean patient survival at 1 year (adjusted for age and diabetes mellitus) among PD centres for the 2013-2022 cohort was 90.4% [Figure 3.3.2(a)]. Similar to haemodialysis centres, there was marked centre variation of 1-year patient survival among PD centres with only 39.1% and 60.9% of the centres within the 2SD and 3SD of the mean respectively [Figure 3.3.2(b)].

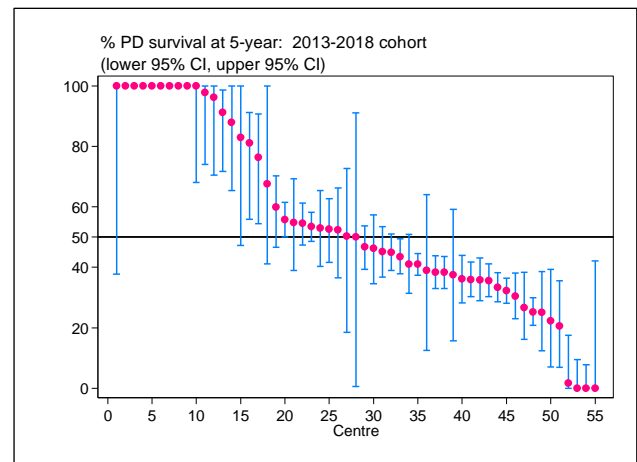
The 5 years mean patient survival (adjusted for age and diabetes mellitus) among PD centres for the 2013-2018 cohort was 50% [Figure 3.3.2(c)]. Similar to the 1-year survival, there was a wide variation in the 5-year survival among PD centres with only 31% and 39.7% of the centres within 2SD and 3SD of the mean respectively [Figure 3.3.2(d)].

Figure 3.3.2(a): Variation in patient survival at 1-year among PD centres adjusted for age and diabetes mellitus, 2013-2022



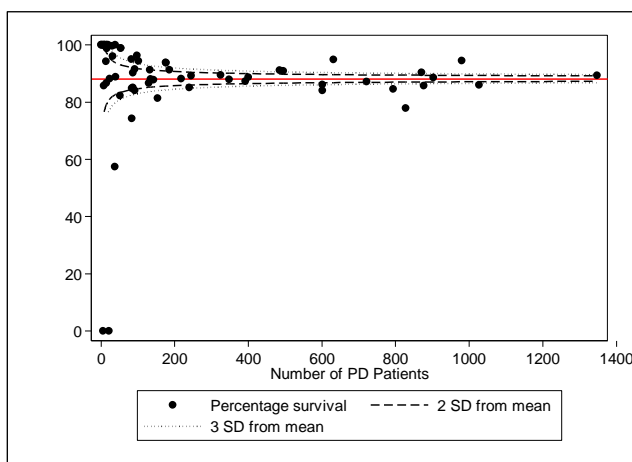
*Horizontal line represents the median % survival among PD centres

Figure 3.3.2(c): Variation in patient survival at 5-years among PD centres adjusted for age and diabetes mellitus, 2013-2018



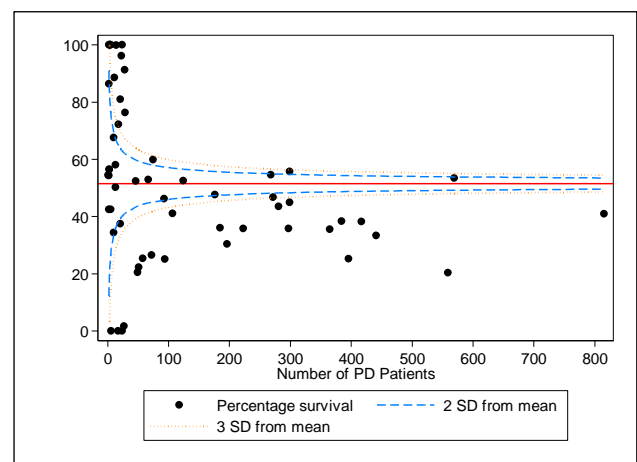
*Horizontal line represents the median % survival among PD centres

Figure 3.3.2(b): Funnel plot at 1-year among PD centres adjusted for age and diabetes mellitus status, 2013-2022 cohort



*Horizontal line represents the mean % survival among PD centres

Figure 3.3.2(d): Funnel plot for patient survival at 5-years among PD centres adjusted age and diabetes mellitus, 2013-2018 cohort



*Horizontal line represents the mean % survival among PD centres

3.4.1: Adjusted hazard ratio for mortality of dialysis patients

The mortality and hazard ratio of the 2004-2023 cohort, adjusted for age, gender, primary diagnosis, year commencing dialysis, dialysis modality, body mass index (BMI), serum albumin, serum cholesterol, diastolic blood pressure, haemoglobin, serum calcium, calcium phosphate product, serum phosphate, viral hepatitis status, and presence of cardiovascular disease were showed in Table 3.4.1.

Patient variables that had significant impact on mortality were age, gender, primary kidney disease, year starting dialysis, dialysis modality, BMI, diastolic blood pressure and the presence cardiovascular disease. The biochemical variables associated with a significant risk factor for mortality were serum albumin, serum cholesterol, haemoglobin, calcium, calcium phosphate product, and phosphate.

Diastolic blood pressure [Figure 3.4.1(a)], low haemoglobin [Figure 3.1.1(b)], low serum phosphate [Figure 3.4.1(c)] was of higher risk for mortality.

Female patients have 20% lower risk of mortality compared to their male counterpart while patients with diabetes mellitus as the primary aetiology of kidney failure has the highest mortality risk when compared to other causes of end stage kidney failure. Patients initiating dialysis in this era (2019-2023) has the highest risk of mortality compared to those who started dialysis in the earlier years (2004-2008).

PD patients have a 5% higher mortality risk compared to HD patients.

Table 3.4.1: Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality (2004-2023)

Factors	n	Hazard ratio	95% CI	P-value
Age (years)				
Age 1-14	892	0.85	(0.71, 1.019)	0.08
Age 15-24	3,359	0.80	(0.722, 0.881)	<0.001
Age 25-34 (ref*)	8,199	1.00		
Age 35-44	15,176	1.50	(1.419, 1.595)	<0.001
Age 45-54	30,753	2.17	(2.053, 2.291)	<0.001
Age 55-64	41,660	2.97	(2.813, 3.142)	<0.001
Age >=65	36,589	4.14	(3.912, 4.385)	<0.001
Gender				
Male (ref*)	75,058	1.00		
Female	61,570	0.80	(0.78, 0.811)	<0.001
Primary diagnosis				
Unknown primary	14,749	1.23	(1.143, 1.321)	<0.001
Diabetes mellitus	82,283	1.74	(1.626, 1.859)	<0.001
GN/SLE (ref*)	4,647	1.00		
Polycystic kidney	906	0.94	(0.812, 1.092)	0.429
Obstructive nephropathy	1,855	1.25	(1.122, 1.389)	<0.001
Toxic nephropathy	739	1.25	(1.093, 1.436)	0.001
Hypertension	28,010	1.21	(1.126, 1.292)	<0.001
Others	3,448	1.37	(1.251, 1.506)	<0.001
Year start dialysis				
2004-2008 (ref*)	13,775	1.00		
2009-2013	27,460	2.05	(1.937, 2.173)	<0.001
2014-2018	38,668	3.33	(3.138, 3.527)	<0.001
2019-2023	46,701	4.37	(4.108, 4.641)	<0.001

Factors	n	Hazard ratio	95% CI	P-value
Modality				
HD (ref*)	117,324	1.00		
PD	19,304	0.79	(0.764, 0.818)	<0.001
BMI				
BMI <18.5	5,148	1.34	(1.278, 1.41)	<0.001
BMI 18.5-25 (ref*)	55,620	1.00		
BMI 25-30	56,544	1.07	(1.053, 1.097)	<0.001
BMI ≥30	19,316	0.94	(0.917, 0.971)	<0.001
Albumin (g/L)				
<25	4,010	7.04	(6.639, 7.463)	<0.001
25-<30	8,960	4.12	(3.943, 4.301)	<0.001
30-<35	25,580	2.42	(2.353, 2.499)	<0.001
35-<40	62,590	1.55	(1.514, 1.59)	<0.001
≥40 (ref*)	35,488	1.00		
Serum cholesterol (mmol/L)				
<3.5	22,429	1.00	(0.974, 1.023)	0.893
3.5-<5.2 (ref*)	92,642	1.00		
5.2-<6.2	14,992	1.11	(1.079, 1.148)	<0.001
≥6.2	6,565	1.35	(1.285, 1.409)	<0.001
Diastolic BP (mmHg)				
<70	25,470	1.01	(0.977, 1.035)	0.718
70-<80	53,296	0.96	(0.938, 0.983)	0.001
80-<90 (ref*)	42,759	1.00		
90-<100	12,500	1.19	(1.145, 1.236)	<0.001
≥100	2,603	1.69	(1.565, 1.827)	<0.001
Haemoglobin (g/dL)				
<10	57,736	1.58	(1.547, 1.61)	<0.001
10-<12 (ref*)	69,572	1.00		
≥12	9,320	0.92	(0.889, 0.962)	<0.001
Serum calcium (mmol/L)				
<2.1	37950	1.05	(1.028, 1.075)	<0.001
2.1-<=2.37 (ref*)	81512	1.00		
>2.37	17166	0.92	(0.892, 0.95)	<0.001
Calcium Phosphate product (mmol²/L²)				
<3.5	51,485	0.90	(0.871, 0.92)	<0.001
3.5-<4.5 (ref*)	51,703	1.00		
4.5-<5.5	21,238	0.94	(0.906, 0.976)	0.001
≥5.5	7,159	1.09	(1.02, 1.162)	0.01
Serum Phosphate (mmol/L)				
<0.8	858	1.96	(1.741, 2.201)	<0.001
0.8-<1.3 (ref*)	17,997	1.00		
1.3-<1.8	62,543	0.89	(0.867, 0.921)	<0.001
1.8-<2.2	37,037	0.86	(0.827, 0.901)	<0.001
≥2.2	18,193	0.93	(0.876, 0.992)	0.027
HBsAg				
Negative (ref*)	94,256	1.00		
Positive	1,975	1.08	(1.015, 1.146)	0.015
Anti-HCV				
Negative (ref*)	94,608	1.00		
Positive	1,050	1.16	(1.072, 1.256)	<0.001
Cardiovascular disease (CVD)				
No CVD (ref*)	128,576	1.00		
CVD	8,052	1.05	(1.016, 1.093)	0.005

Figure 3.4.1(a): Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality by diastolic blood pressure (2004-2023 cohort)

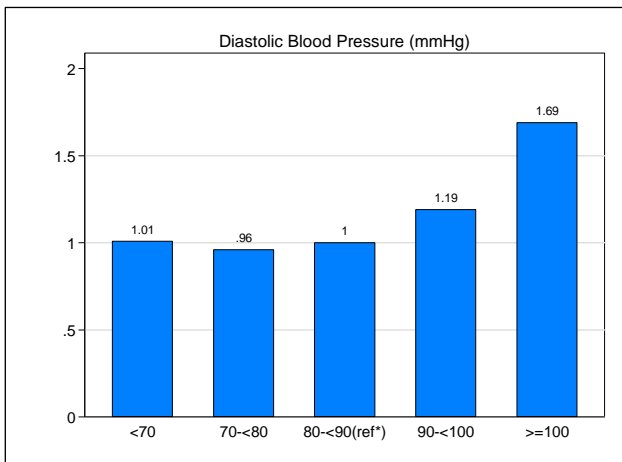


Figure 3.4.1(b): Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality by haemoglobin (2004-2023 cohort)

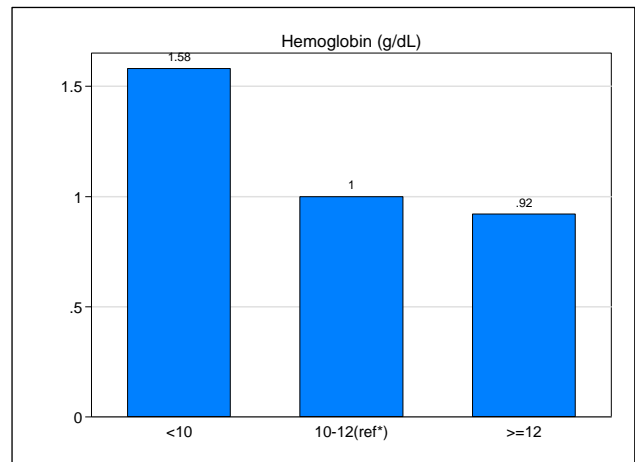


Figure 3.4.1(c): Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality by serum phosphate (2004-2023 cohort)

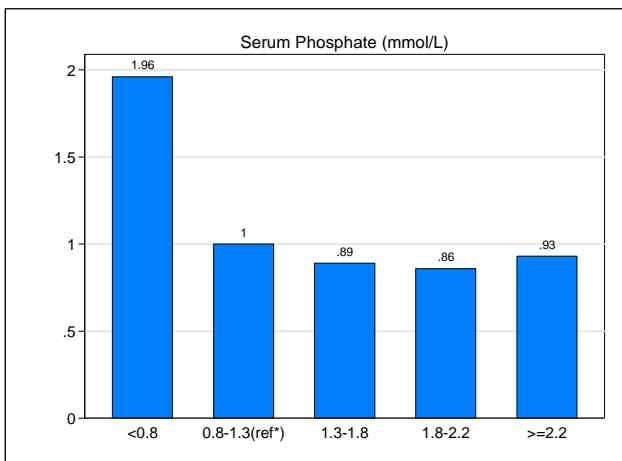
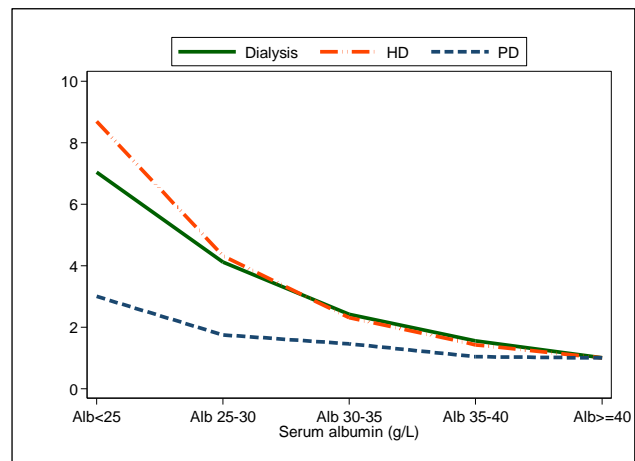


Figure 3.4.1(d): Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality by serum albumin (2004-2023 cohort)



3.4.2: Adjusted hazard ratio for mortality of haemodialysis patients

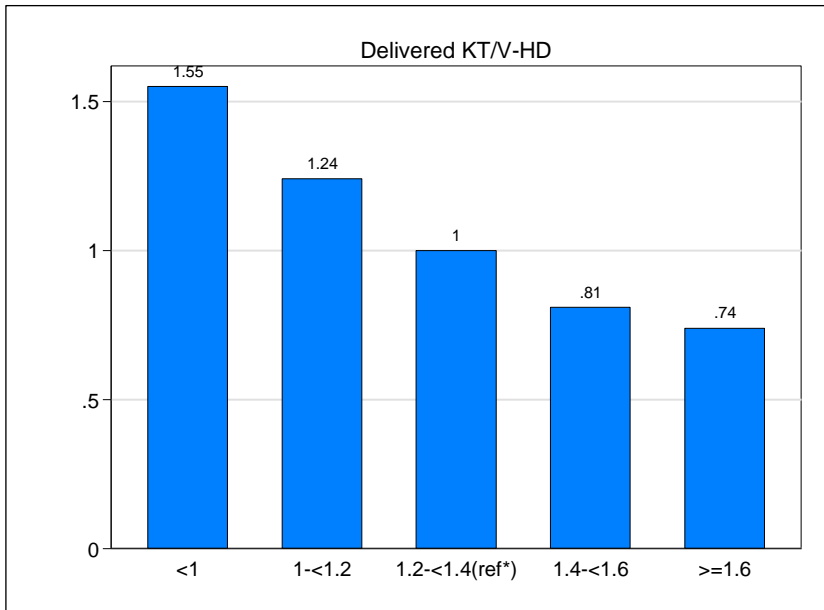
The adjusted hazard ratio for mortality of haemodialysis patients [Table 3.4.2] demonstrated identical pattern with the whole cohort of 2004-2023 dialysis patients since about 90% of the dialysis population consisted of haemodialysis patients. The dose of dialysis treatment (Kt/V) and patient mortality appeared to be inversely proportionate [Figure 3.4.2].

Table 3.4.2: Adjusted hazard ratio for mortality of HD patients [ITT analysis] (2004-2023 cohort)

Factors	n	Hazard ratio	95% CI	P-value
Age (years)				
Age 1-14	204	1.03	(0.723, 1.459)	0.882
Age 15-24	2,143	0.79	(0.689, 0.913)	0.001
Age 25-34 (ref*)	6,364	1.00		
Age 35-44	12,687	1.53	(1.419, 1.66)	<0.001
Age 45-54	26,781	2.23	(2.076, 2.406)	<0.001
Age 55-64	36,514	3.12	(2.901, 3.366)	<0.001
Age >=65	32,631	4.39	(4.066, 4.741)	<0.001
Gender				
Male (ref*)	64,908	1.00		
Female	52,416	0.88	(0.856, 0.905)	<0.001
Primary diagnosis				
Unknown primary	12,856	1.20	(1.087, 1.324)	<0.001
Diabetes mellitus	71,636	1.74	(1.584, 1.903)	<0.001
GN/SLE (ref*)	3,267	1.00		
Polycystic kidney	798	1.00	(0.831, 1.192)	0.957
Obstructive nephropathy	1,491	1.23	(1.064, 1.419)	0.005
Toxic nephropathy	605	1.26	(1.047, 1.523)	0.015
Hypertension	24,037	1.22	(1.113, 1.343)	<0.001
Others	2,634	1.36	(1.202, 1.546)	<0.001
Year start dialysis				
2004-2008 (ref*)	12,256	1.00		
2009-2013	24,430	2.10	(1.947, 2.261)	<0.001
2014-2018	33,612	3.64	(3.368, 3.924)	<0.001
2019-2023	38,878	5.48	(5.06, 5.941)	<0.001
BMI				
BMI <18.5	4,106	1.46	(1.369, 1.556)	<0.001
BMI 18.5-25 (ref*)	47,498	1.00		
BMI 25-30	17,427	0.93	(0.905, 0.957)	<0.001
BMI >=30	48,293	0.84	(0.805, 0.867)	<0.001
Serum albumin (g/L)				
<25	1,658	8.69	(7.848, 9.612)	<0.001
25-<30	4,752	4.32	(4.067, 4.597)	<0.001
30-<35	18,545	2.31	(2.22, 2.396)	<0.001
35-<40	58,180	1.43	(1.385, 1.472)	<0.001
>=40 (ref*)	34,189	1.00		
Serum cholesterol (mmol/L)				
<3.5	20,819	1.04	(1.012, 1.077)	0.007
3.5-<5.2 (ref*)	81,129	1.00		
5.2-<6.2	11,394	1.23	(1.176, 1.279)	<0.001
>=6.2	3,982	1.51	(1.408, 1.611)	<0.001

Factors	n	Hazard ratio	95% CI	P-value
Kt/V				
<1	4,465	1.55	(1.468, 1.629)	<0.001
1-<1.2	10,445	1.24	(1.19, 1.285)	<0.001
1.2-<1.4 (ref*)	21488	1.00		
1.4-<1.6	15,654	0.81	(0.785, 0.842)	<0.001
Diastolic BP (mmHg)				
<70	23,655	0.99	(0.951, 1.025)	0.489
70-<80	46,407	0.94	(0.911, 0.969)	<0.001
80-<90 (ref*)	34663	1.00		
90-<100	10,339	1.17	(1.114, 1.234)	<0.001
>=100	2,260	1.69	(1.53, 1.872)	<0.001
Haemoglobin (g/dL)				
<10	50308	1.74	(1.692, 1.783)	<0.001
10-<12 (ref*)	59513	1.00		
>=12	7503	0.93	(0.884, 0.982)	0.008
Serum calcium (mmol/L)				
<2.1	31329	1.09	(1.056, 1.121)	<0.001
2.1-<=2.37 (ref*)	71,224	1.00		
>2.37	14,771	0.98	(0.941, 1.02)	0.319
Calcium Phosphate product (mmol²/L²)				
<3.5	43,642	0.97	(0.939, 1.011)	0.168
3.5-<4.5 (ref*)	47252	1.00		
4.5-<5.5	19552	0.98	(0.937, 1.032)	0.486
>=5.5	6,878	1.15	(1.06, 1.255)	0.001
Serum Phosphate (mmol/L)				
<0.8	644	1.64	(1.374, 1.964)	<0.001
0.8-<1.3 (ref*)	13,845	1.00		
1.3-<1.8	53644	0.85	(0.818, 0.888)	<0.001
1.8-<2.2	33,122	0.86	(0.81, 0.909)	<0.001
>=2.2	16,069	0.87	(0.804, 0.947)	0.001
HBsAg				
Negative (ref*)	81,645	1.00		
Positive	1,713	1.08	(0.996, 1.161)	0.063
Anti-HCV				
Negative (ref*)	82,037	1.00		
Positive	878	1.18	(1.062, 1.306)	0.002
Cardiovascular disease (CVD)				
No CVD (ref*)	110,618	1.00		
CVD	6,706	1.05	(1.002, 1.104)	0.043

Figure 3.4.2: Adjusted hazard ratio for mortality of HD patients uncensored for change of modality by Kt/V (2004-2023 cohort)



3.4.3: Adjusted hazard ratio for mortality of peritoneal dialysis patients

The adjusted hazard ratio for peritoneal dialysis patients [Table 3.4.3] showed some similarity to the whole cohort of 2014-2023 dialysis patients. Patients with diabetes mellitus as their primary kidney disease fare worst compared to others. A 'U curve' phenomenon is seen for diastolic blood pressure and haemoglobin levels.

Table 3.4.3: Adjusted hazard ratio for mortality of PD patients [ITT analysis] (2004-2023 cohort)

Factors	n	Hazard ratio	95% CI	P-value
Age (years)				
Age 1-14	688	0.73	(0.569, 0.947)	0.018
Age 15-24	1,216	0.82	(0.68, 0.991)	0.04
Age 25-34 (ref*)	1,835	1.00		
Age 35-44	2,489	1.42	(1.24, 1.634)	<0.001
Age 45-54	3,972	1.95	(1.711, 2.217)	<0.001
Age 55-64	5,146	2.53	(2.217, 2.883)	<0.001
Age >=65	3,958	3.40	(2.966, 3.903)	<0.001
Gender				
Male (ref*)	10,150	1.00		
Female	9,154	0.85	(0.807, 0.903)	<0.001
Primary diagnosis				
Unknown primary	1,893	1.40	(1.177, 1.665)	<0.001
Diabetes mellitus	10,647	2.18	(1.868, 2.544)	<0.001
GN/SLE (ref*)	1,380	1.00		
Polycystic kidney	99	0.64	(0.355, 1.144)	0.132
Obstructive nephropathy	364	1.51	(1.175, 1.952)	0.001
Toxic nephropathy	134	1.19	(0.859, 1.661)	0.291
Hypertension	3,973	1.39	(1.191, 1.631)	<0.001
Others	814	1.30	(1.048, 1.605)	0.017
Year start dialysis				
2004-2008 (ref*)	1,519	1.00		
2009-2013	3,030	1.58	(1.232, 2.016)	<0.001
2014-2018	5,056	1.96	(1.547, 2.494)	<0.001
2019-2023	7,823	2.32	(1.819, 2.949)	<0.001
BMI				
BMI <18.5	1,042	1.35	(1.175, 1.552)	<0.001
BMI 18.5-25 (ref*)	8,122	1.00		
BMI 25-30	1,889	1.05	(0.985, 1.11)	0.14
BMI >=30	8,251	0.96	(0.875, 1.043)	0.311
Serum albumin (g/L)				
<25	2,352	3.00	(2.581, 3.492)	<0.001
25-<30	4,208	1.75	(1.515, 2.015)	<0.001
30-<35	7,035	1.46	(1.276, 1.679)	<0.001
35-<40	4,410	1.04	(0.902, 1.199)	0.594
>=40 (ref*)	1,299	1.00		
Serum cholesterol (mmol/L)				
<3.5	1,610	1.03	(0.941, 1.127)	0.518
3.5-<5.2 (ref*)	11,513	1.00		
5.2-<6.2	3,598	1.01	(0.944, 1.088)	0.715
>=6.2	2,583	1.23	(1.137, 1.341)	<0.001

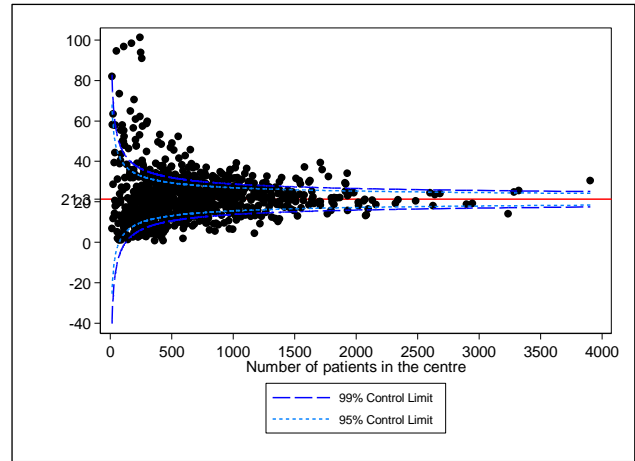
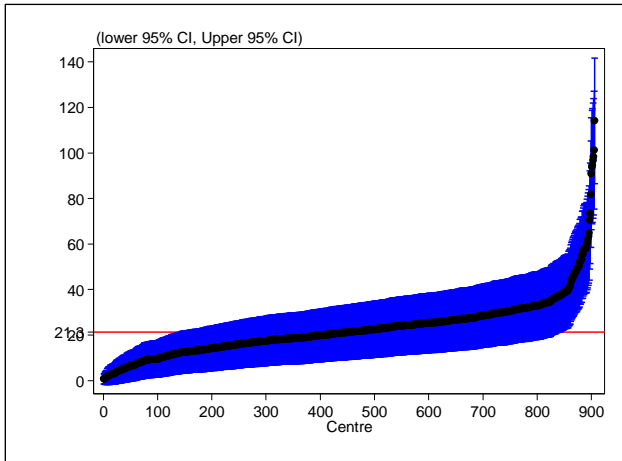
Factors	n	Hazard ratio	95% CI	P-value
Diastolic BP (mmHg)				
<70	1,815	1.54	(1.396, 1.689)	<0.001
70-<80	6,889	1.04	(0.978, 1.107)	0.211
80-<90 (ref*)	8,096	1.00		
90-<100	2,161	1.15	(1.036, 1.268)	0.008
>=100	343	1.27	(0.991, 1.626)	0.058
Haemoglobin (g/dL)				
<10	7,428	1.29	(1.212, 1.365)	<0.001
10-<12 (ref*)	10,059	1.00		
>=12	1,817	1.13	(1.029, 1.247)	0.011
Serum calcium (mmol/L)				
<2.1	6,621	1.15	(1.082, 1.225)	<0.001
2.1-<=2.37 (ref*)	10,288	1.00		
>2.37	2,395	1.03	(0.941, 1.136)	0.488
Calcium Phosphate product (mmol²/L²)				
<3.5	10,173	1.00	(0.919, 1.084)	0.964
3.5-<4.5 (ref*)	6,020	1.00		
4.5-<5.5	2,318	0.97	(0.862, 1.096)	0.647
>=5.5	793	1.00	(0.813, 1.22)	0.97
Serum Phosphate (mmol/L)				
<0.8	214	2.67	(2.124, 3.347)	<0.001
0.8-<1.3 (ref*)	4,152	1.00		
1.3-<1.8	8,899	0.90	(0.834, 0.964)	0.003
1.8-<2.2	3,915	0.91	(0.807, 1.021)	0.108
>=2.2	2,124	1.09	(0.915, 1.306)	0.326
HBsAg				
Negative (ref*)	12,587	0.00	(0, 0)	<0.001
Positive	275	0.97	(0.811, 1.163)	0.75
Anti-HCV				
Negative (ref*)	12,552	0.00	(0, 0)	<0.001
Positive	154	1.51	(1.226, 1.866)	<0.001
Cardiovascular disease (CVD)				
No CVD (ref*)	17,972	1.00		
CVD	1,332	1.11	(1.007, 1.219)	0.035

3.4.4: Risk Adjusted Mortality Rate by haemodialysis centres

There appeared to be a wide centre variation in risk adjusted mortality rate (RAMR) and the median RAMR for haemodialysis patients by HD centre was 21.3 [Figure 3.4.4(a)]. When adjusted for the size of haemodialysis centres using funnel plot, 554 (61.2%) and 675 (74.6%) of haemodialysis centres were within the 95% CI and 99% CI of the median RAMR respectively [Figure 3.4.4(b)].

Figure 3.4.4(a): Variations in RAMR by HD centre, 2023

Figure 3.4.4(b): Funnel plot of RAMR by HD centre, 2023



3.4.5: Risk Adjusted Mortality Rate by PD centres

There was a wide variation in RAMR among PD centres with a median risk adjusted mortality rate (RAMR) of 26.5 [Figure 3.4.5(a)]. The variation of the RAMR rate among the various PD centres in this country were rather similar to haemodialysis centres where 34% and 42% of PD centres were within the 95% CI and 99% CI of the median RAMR respectively [Figure 3.4.5(b)].

Figure 3.4.5(a): Variations in RAMR by PD centres, 2023

Figure 3.4.5(b): Funnel plot for RAMR by PD centres, 2023

