

# **CHAPTER 3**

## **DEATH AND SURVIVAL ON DIALYSIS**

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### SECTION 3.1: DEATH ON DIALYSIS

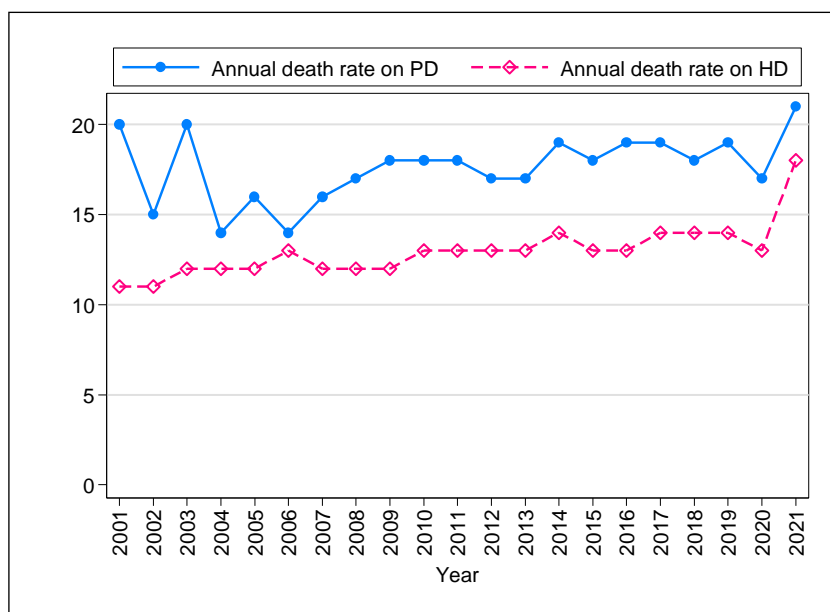
The annual crude death rate on dialysis in 2021 was 18.1% (Table 3.1.1). The annual crude death rate among haemodialysis patients was 17.8% while chronic peritoneal dialysis patients had a rate of 20.6%.

The annual crude death rate among haemodialysis (HD) patients has plateaued since mid 2000s at around 13-14% but that death rate rose to 17.8% in 2021 (Figure 3.1.1). For over the past two decades, the annual crude death rate of patients on PD has consistently been higher than that of patients on HD. This trend is also evident in 2021, where it increased to 20.6% from the usual yearly range of 18-19%. We have attributed the difference in annual death rate between the two modalities 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 2012-2021**

Year	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
Number of dialysis patients at risk	49960	48784	46118	43760	41749	39467	36655	33769	30905	27962
Dialysis deaths	9042	6333	6493	6152	5947	5402	5004	4728	4012	3647
Dialysis death rate %	18	13	14	14	14	14	14	14	13	13
Number of HD patients at risk	44309	43545	41344	39328	37610	35581	33110	30686	28188	25587
HD deaths	7879	5451	5600	5333	5172	4671	4373	4152	3541	3252
HD death rate %	18	13	14	14	14	13	13	14	13	13
Number of PD patients at risk	5652	5240	4774	4432	4139	3886	3545	3083	2717	2375
PD deaths	1163	882	893	819	775	731	631	576	471	395
PD death rate %	21	17	19	18	19	19	18	19	17	17

**Figure 3.1.1: Death rates on dialysis 2001-2021**



Cardiovascular disease has consistently been reported as the primary cause of mortality in our patients throughout the years. Additionally, a significant number of deaths occurring at home is thought to be due to cardiovascular events. However, in 2021, the leading cause of reported mortality in our dialysis population was infection, predominantly driven by Covid-19. Our patients, being the vulnerable segment of society, were severely affected by the pandemic.

**Table 3.1.2: Causes of death on dialysis 2011-2021**

Year Causes of Death	2021		2020		2019		2018		2017		2016	
	n	%	n	%	n	%	n	%	n	%	n	%
Cardiovascular	1974	21.8	1808	28.5	1904	29.3	1656	26.9	1818	30.6	1796	33.2
Died at home	1143	12.6	937	14.8	1016	15.7	1004	16.3	949	16	756	14
Infection	3472**	38.4	1704*	26.9	1554	23.9	1142	18.6	1482	24.9	1521	28.2
PD peritonitis	83	0.9	66	1	73	1.1	61	1	67	1.1	59	1.1
GIT bleed	116	1.3	95	1.5	103	1.6	85	1.4	93	1.6	93	1.7
Cancer	166	1.8	143	2.3	165	2.5	129	2.1	158	2.7	146	2.7
Liver disease	23	0.3	36	0.6	21	0.3	29	0.5	29	0.5	28	0.5
Withdrawal	118	1.3	74	1.2	103	1.6	53	0.9	65	1.1	68	1.3
Accidental Death	69	0.8	48	0.8	64	1	47	0.8	40	0.7	33	0.6
Pulmonary Causes	465	5.1	374	5.9	514	7.9	451	7.3	199	3.3	10	0.2
Dialysis dementia / Aluminium toxicity	15	0	6	0	4	0	5	0	5	0	2	0
Others	829	9	433	7	396	6	890	14	399	7	264	5
Unknown	569	6	609	10	576	9	600	10	643	11	626	12
<b>Total</b>	<b>9042</b>	<b>100</b>	<b>6333</b>	<b>100</b>	<b>6493</b>	<b>100</b>	<b>6152</b>	<b>100</b>	<b>5947</b>	<b>100</b>	<b>5402</b>	<b>100</b>

\* Died due to Covid-19, HD 20, and PD 1

\*\*Died due to Covid-19, HD 1324, and PD 153

Year Causes of Death	2015		2014		2013		2012		2011	
	n	%	n	%	n	%	n	%	n	%
Cardiovascular	1689	33.8	1674	35.4	1427	35.6	1289	35.3	1215	36.9
Died at home	704	14.1	664	14	685	17.1	600	16.5	548	16.6
Infection	1314	26.3	1219	25.8	1011	25.2	960	26.3	792	24.1
PD peritonitis	51	1	52	1.1	43	1.1	18	0.5	28	0.9
GIT bleed	85	1.7	81	1.7	70	1.7	64	1.8	57	1.7
Cancer	114	2.3	122	2.6	91	2.3	89	2.4	92	2.8
Liver disease	21	0.4	43	0.9	24	0.6	15	0.4	21	0.6
Withdrawal	58	1.2	50	1.1	42	1	29	0.8	22	0.7
Accidental Death	33	0.7	28	0.6	30	0.7	25	0.7	29	0.9
Pulmonary Causes	3	0.1	2	0	1	0	0	0	0	0
Dialysis dementia / Aluminium toxicity	4	0	3	0	2	0	4	0	5	0
Others	237	5	161	3	57	1	29	1	33	1
Unknown	691	14	629	13	529	13	525	14	450	14
<b>Total</b>	<b>5004</b>	<b>100</b>	<b>4728</b>	<b>100</b>	<b>4012</b>	<b>100</b>	<b>3647</b>	<b>100</b>	<b>3292</b>	<b>100</b>

## SECTION 3.2: Patient Survival on Dialysis

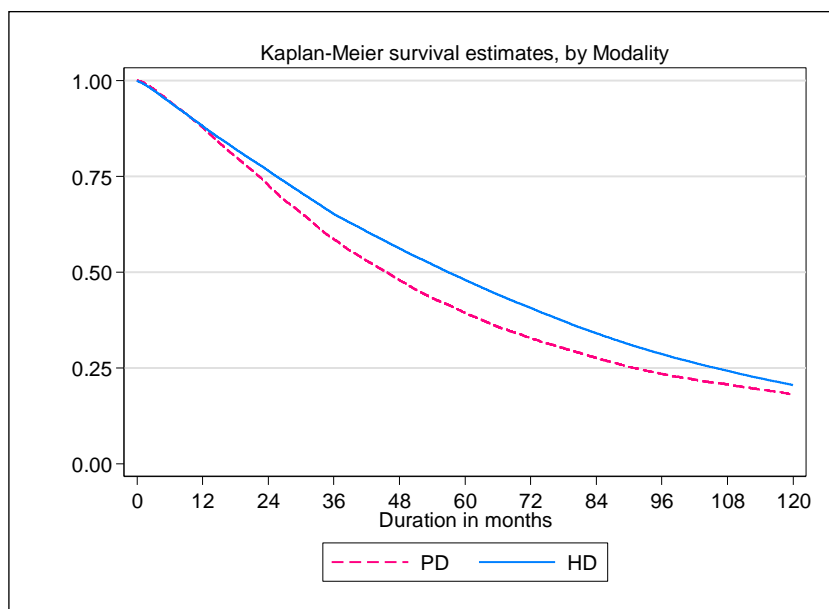
### 3.2.1: Patient survival by type of dialysis modality

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 20% 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 began to widen at second year with maximum difference at 4th-5th year. The difference in survival began to narrow after that.

**Table 3.2.1: Patient survival by dialysis modality [ITT analysis (not censored for change of modality)]**

Dialysis modality Interval (month)	PD			HD			All		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	16437	100		107364	100		123801	100	
6	14760	95	0	97588	94	0	112348	94	0
12	13005	88	0	87748	88	0	100753	88	0
24	9787	73	0	70834	76	0	80621	76	0
36	7326	59	0	56926	65	0	64252	64	0
48	5484	48	0	45386	56	0	50870	55	0
60	4154	39	0	35874	48	0	40024	47	0
72	3199	33	0	28074	41	0	31273	40	0
84	2428	28	0	21556	34	0	23984	33	0
96	1866	23	0	16477	29	0	18343	28	0
108	1494	21	0	12663	24	0	14157	24	0
120	1184	18	0	9704	21	0	10888	20	0

**Figure 3.2.1: Patient survival by dialysis modality analysis (not censored for change of modality)**



### 3.2.2: Patient survival by age at starting dialysis

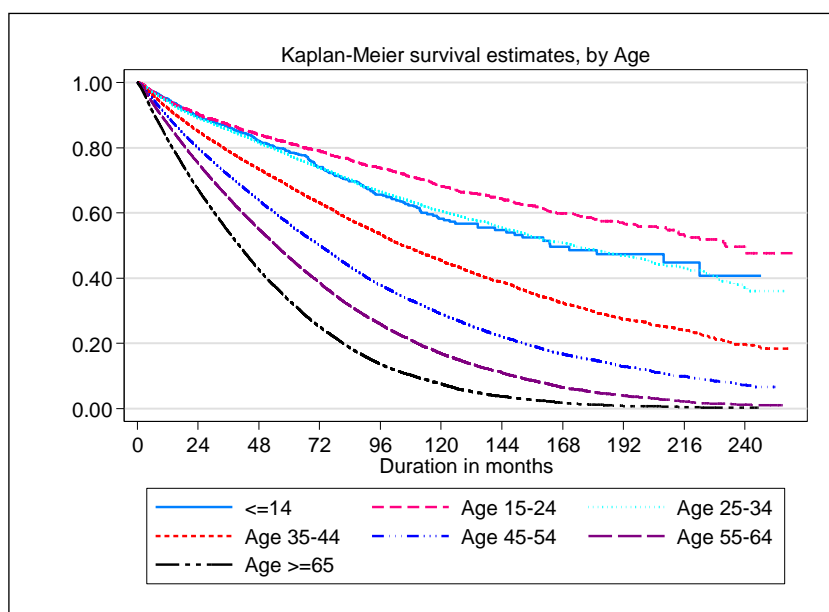
Age at starting dialysis has a major impact on survival with patients in the age group of 15 to 24 having the best outcome (Table 3.2.2 and Figure 3.2.2). Unadjusted 10 years survival of patients in this age group (15-24) was 10-fold better than those who were 65 years old and above.

**Table 3.2.2: Unadjusted patient survival by age**

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	1167	100		4231	100		9179	100		15668	100	
6	1076	97	0	3882	97	0	8341	97	0	14243	96	0
12	979	95	1	3524	94	0	7629	94	0	12820	92	0
24	796	90	1	2968	90	0	6310	89	0	10499	85	0
36	631	87	1	2534	87	1	5343	86	0	8604	79	0
48	513	82	1	2177	84	1	4524	81	0	7147	73	0
60	413	79	1	1871	81	1	3875	78	1	5976	68	0
72	325	74	2	1637	79	1	3261	74	1	4959	63	0
84	251	70	2	1410	76	1	2754	70	1	4052	58	1
96	196	66	2	1176	74	1	2294	67	1	3340	53	1
108	164	62	2	1007	71	1	1912	64	1	2714	49	1
120	128	58	2	857	68	1	1600	61	1	2211	45	1

Age group (years) Interval (month)	45-54			55-64			>=65		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	31025	100		40666	100		34215	100	
6	28213	95	0	36413	94	0	29675	91	0
12	25341	90	0	32103	87	0	25421	82	0
24	20501	80	0	24926	75	0	18618	67	0
36	16652	72	0	19134	65	0	13411	54	0
48	13483	64	0	14633	55	0	9369	42	0
60	10826	57	0	10979	46	0	6490	33	0
72	8627	50	0	8128	39	0	4380	25	0
84	6671	43	0	5833	32	0	2855	19	0
96	5108	38	0	4178	26	0	1823	14	0
108	3959	33	0	2961	21	0	1197	10	0
120	3037	29	0	2036	17	0	752	8	0

Figure 3.2.2: Unadjusted patient survival by age



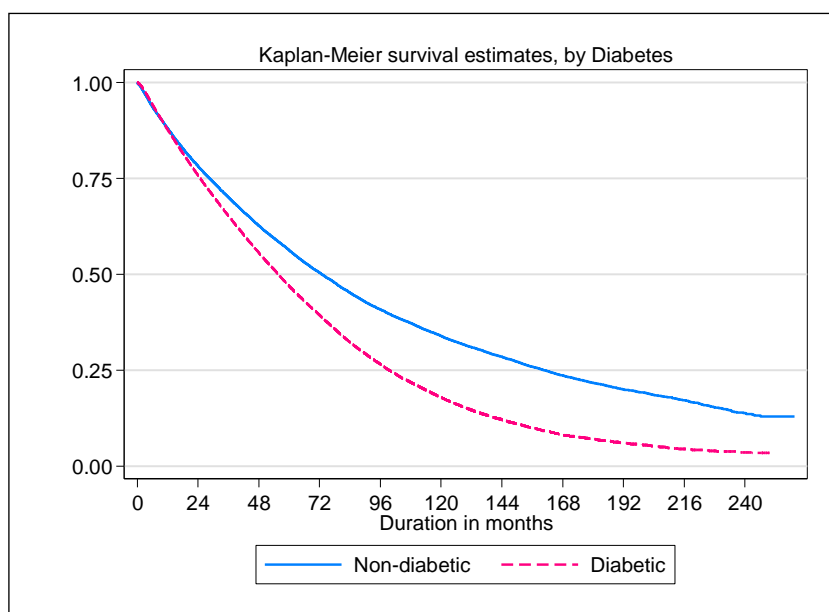
### 3.2.3: Patient survival by diabetic status

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 24 months after initiation of dialysis and 55% diabetic patients died within 5 years of initiating dialysis. The 10 years unadjusted patient survival among diabetics and non-diabetics were 34% and 18% respectively, a two-fold difference.

Table 3.2.3: Unadjusted patient survival by diabetes mellitus status

Diabetes status Interval (month)	Non-diabetic			Diabetic		
	n	% survival	SE	n	% survival	SE
0	65369	100		70782	100	
6	57375	94	0	64467	94	0
12	50020	88	0	57797	88	0
24	39345	78	0	45271	76	0
36	31284	70	0	35025	65	0
48	24883	63	0	26955	55	0
60	20055	56	0	20373	47	0
72	16209	50	0	15108	39	0
84	12957	45	0	10869	32	0
96	10366	41	0	7749	26	0
108	8437	37	0	5476	22	0
120	6785	34	0	3835	18	0

**Figure 3.2.3: Unadjusted patient survival by diabetes mellitus status**



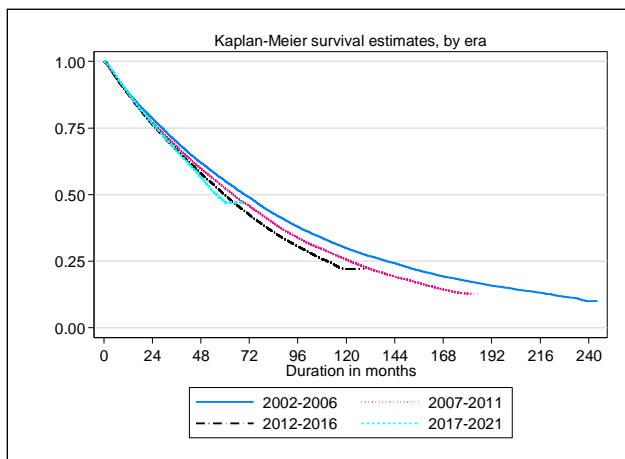
**3.2.4: Patient survival by 5 years era of starting dialysis**

Even though there was no difference in unadjusted patient survival by year 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 2002-2006 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)

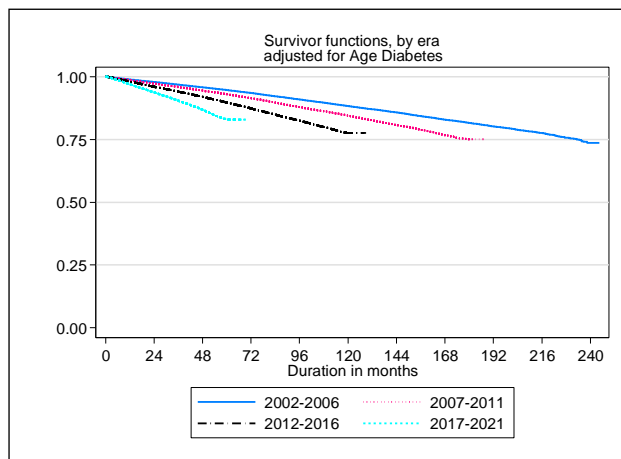
**Table 3.2.4: Unadjusted patient survival by 4 Era, 2002-2021**

Year Interval (month)	2002-2006			2007-2011			2012-2016			2017-2021		
	n	% survival	SE	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	16448	100		27154	100		41105	100		49041	100	
6	15219	94	0	25037	94	0	37812	94	0	41548	94	0
12	14065	88	0	23158	88	0	34866	88	0	33686	88	0
24	12177	79	0	19905	77	0	29569	76	0	21222	77	0
36	10584	70	0	17247	68	0	25307	67	0	11653	66	0
48	9262	62	0	14857	60	0	21496	58	0	4901	56	0
60	8100	55	0	12841	52	0	18129	50	0	213	47	1
72	7103	49	0	11028	46	0	12178	42	0	1		
84	6112	43	0	9339	39	0	7487	36	0	1		
96	5336	38	0	7909	34	0	4088	30	0	1		
108	4684	34	0	6815	29	0	1728	26	0	1		
120	4086	30	0	5827	26	0	109	22	0	1		

**Figure 3.2.4(a): Unadjusted patient survival by 4 Era, 2002-2021**



**Figure 3.2.4(b): Adjusted for Age and Diabetes patient survival by 4 Era, 2002-2021**





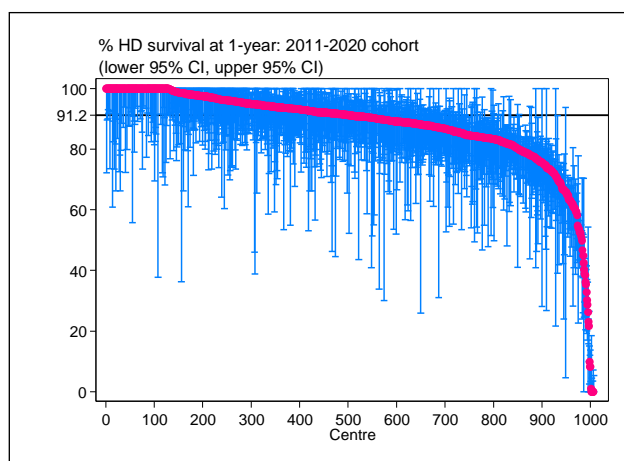
### SECTION 3.3: SURVIVAL OF INCIDENT PATIENTS BY CENTRE

#### 3.3.1: Survival of incident haemodialysis patients 2012-2020 by centre

The mean patient survival at 1 year (adjusted for age and diabetes) among haemodialysis centres for the 2012-2020 cohort was 91.2% [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 290 haemodialysis centres (28.5%) and 441 haemodialysis centres (43.4%) lie within the 2SD and 3SD of the mean respectively.

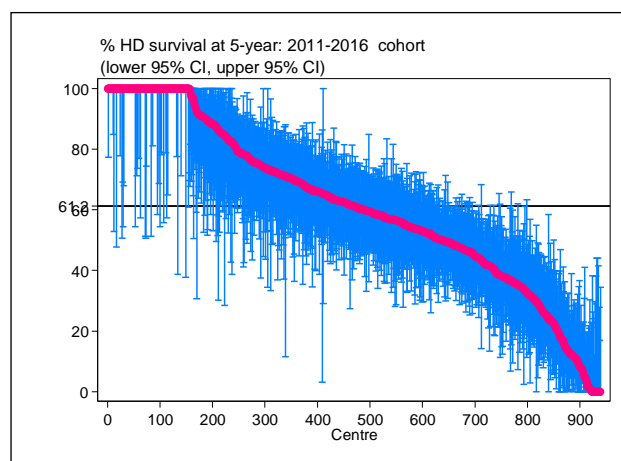
The 5 years mean patient survival (adjusted for age and diabetes) among haemodialysis centres for the 2011-2016 cohort was 61.2% [Figure 3.3.1(c)]. Similar to the 1-year patient survival, there was marked centre variation with only 35.5% and 48.7% of haemodialysis centres lie within 2SD and 3SD of the 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, 2011-2020**



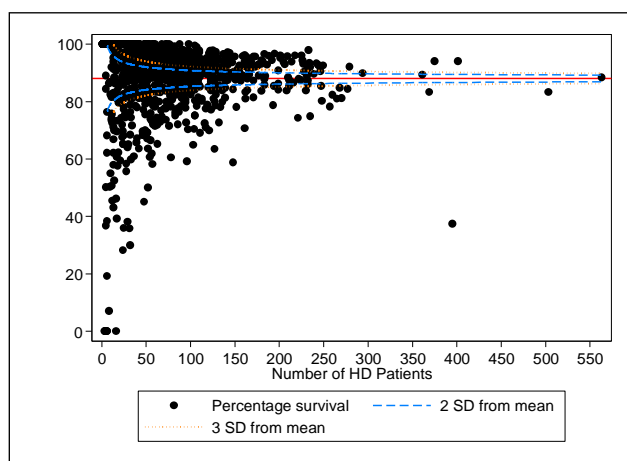
\*Horizontal line represents the mean % survival among HD centres

**Figure 3.3.1(c): Variation in patient survival at 5-years among HD centres adjusted for age and diabetes mellitus status, 2011-2016**



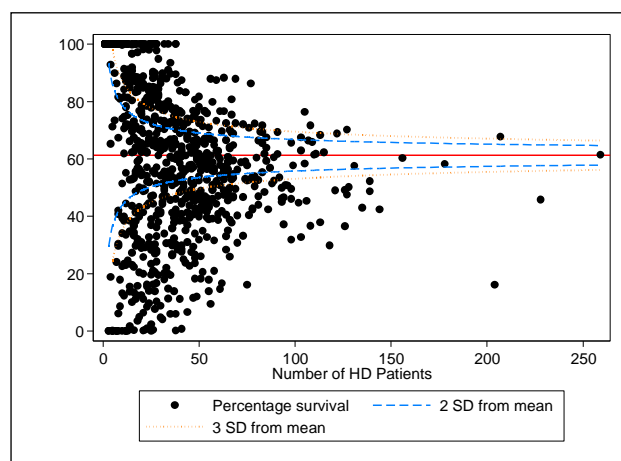
\*Horizontal line represents the mean % survival among HD centres

**Figure 3.3.1(b): Funnel plot at 1-year among HD centres adjusted for age and diabetes mellitus status, 2011-2020 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, 2011-2016 cohort**



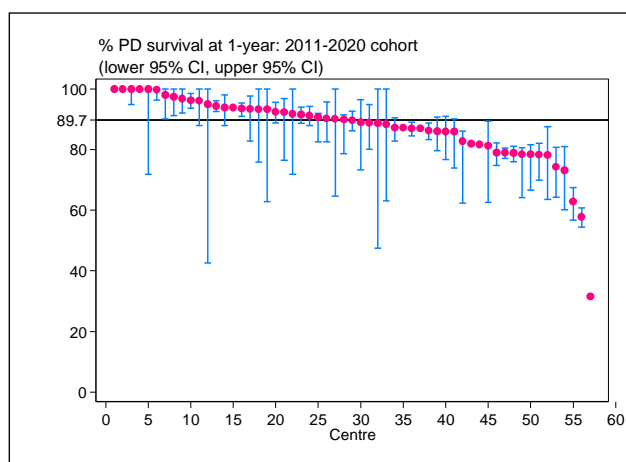
\*Horizontal line represents the mean % survival among HD centres

### 3.3.2: Survival of incident PD patients by centre

The mean patient survival at 1 year (adjusted for age and diabetes mellitus) among PD centres for the 2011-2020 cohort was 89.7% [Figure 3.3.2(a)]. Similar to haemodialysis centres, there was marked centre variation of 1-year patient survival among PD centres with only 43.6% and 54.5% of the centres within the 2SD and 3SD of the mean respectively [Figure 3.3.2(b)].

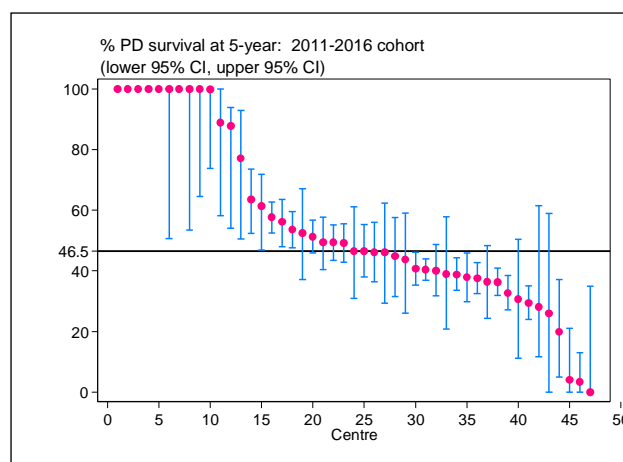
The 5 years mean patient survival (adjusted for age and diabetes mellitus) among PD centres for the 2011-2016 cohort was 46.5% [Figure 3.3.2(c)]. Similar to the 1-year survival, there was a wide variation in the 5-year survival among PD centres with only 43.1% and 51.0% of the centres within 2SD and 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, 2011-2020**



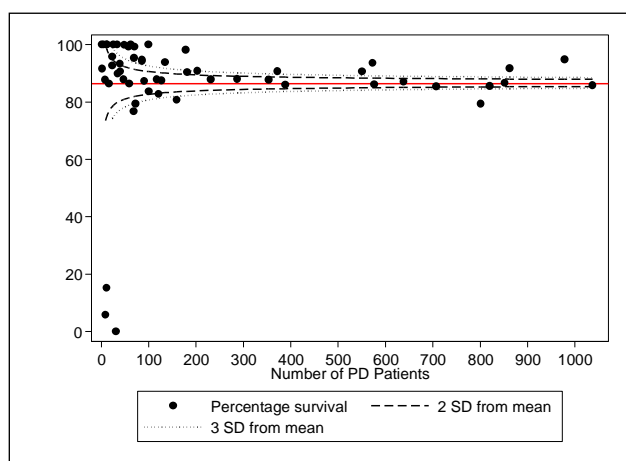
\*Horizontal line represents the mean % survival among PD centres

**Figure 3.3.2(c): Variation in patient survival at 5-years among PD centres adjusted for age and diabetes mellitus, 2011-2016**



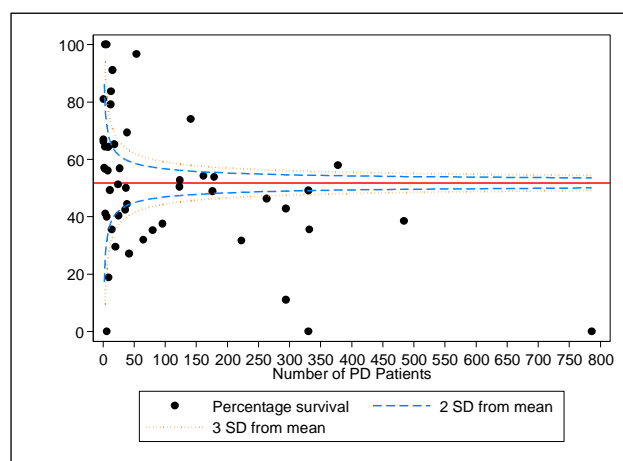
\*Horizontal line represents the mean % survival among PD centres

**Figure 3.3.2(b): Funnel plot at 1-year among PD centres adjusted for age and diabetes mellitus status, 2011-2020 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, 2011-2016 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 2011-2021 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.

There was positive correlation between mortality and age of patient and diastolic blood pressure [Figure 3.4.1(a)], while serum phosphate [Figure 3.4.1(c)] were negatively correlated with mortality. An out-of-range haemoglobin showed an increased mortality risk [Figure 3.1.1(b)].

Female patients have 8.5% lower risk of mortality compared to their male counterpart while patients with diabetic nephropathy 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 (2017-2021) has a 91.2% higher risk of mortality compared to those who started dialysis in the earlier years (2002-2006).

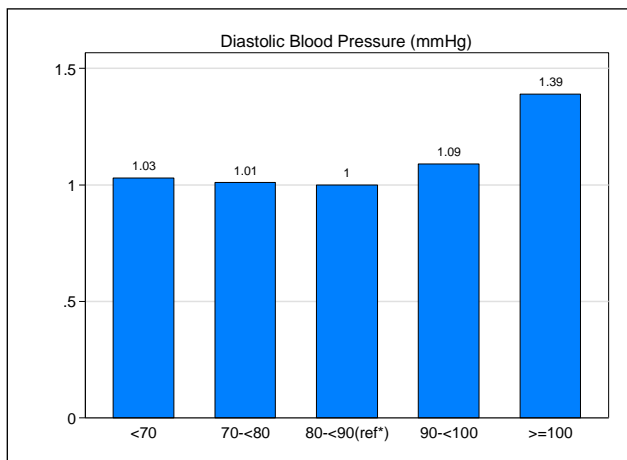
PD patients have a 13.7% higher mortality risk compared to HD patients.

**Table 3.4.1: Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality (2011-2021)**

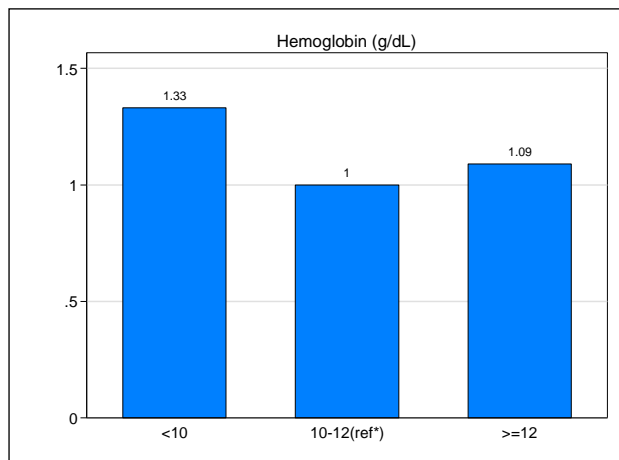
Factors	n	Hazard ratio	95% CI	P-value
<b>Age (years)</b>				
Age 1-14	886	0.749	(0.615, 0.914)	0.004
Age 15-24	3261	0.856	(0.762, 0.962)	0.009
Age 25-34 <sup>(ref*)</sup>	7519	1		
Age 35-44	13576	1.322	(1.223, 1.428)	<0.001
Age 45-54	28367	1.641	(1.524, 1.766)	<0.001
Age 55-64	37871	2.025	(1.878, 2.183)	<0.001
Age >=65	32321	2.468	(2.278, 2.673)	<0.001
<b>Gender</b>				
Male <sup>(ref*)</sup>	68170	1		
Female	55631	0.915	(0.885, 0.946)	<0.001
<b>Primary diagnosis</b>				
Unknown primary	15581	1.011	(0.911, 1.121)	0.837
Diabetes mellitus	75127	1.465	(1.336, 1.608)	<0.001
GN/SLE <sup>(ref*)</sup>	4844	1		
Polycystic kidney	890	0.885	(0.719, 1.091)	0.253
Obstructive nephropathy	1890	1.122	(0.956, 1.316)	0.158
Toxic nephropathy	699	1.142	(0.925, 1.41)	0.218
Hypertension	22169	1.39	(1.266, 1.526)	<0.001
Others	2601	1.572	(1.388, 1.782)	<0.001
<b>Year start dialysis</b>				
2002-2006 <sup>(ref*)</sup>	14674	1		
2007-2011	24917	1.178	(1.152, 1.205)	<0.001
2012-2016	37453	1.386	(1.356, 1.418)	<0.001
2017-2021	44669	1.912	(1.864, 1.962)	<0.001

Factors	n	Hazard ratio	95% CI	P-value
<b>Modality</b>				
HD (ref*)	107364	1		
PD	16437	1.137	(1.077, 1.199)	<0.001
<b>BMI</b>				
BMI<18.5	4632	1.206	(1.108, 1.313)	<0.001
BMI 18.5-25 (ref*)	52582	1		
25-30	50172	1.014	(0.979, 1.05)	0.436
>=30	16415	1.06	(1.013, 1.109)	0.011
<b>Serum albumin (g/L)</b>				
<30	10870	2.031	(1.88, 2.193)	<0.001
30-<35	22143	1.549	(1.474, 1.628)	<0.001
35-<40	57465	1.221	(1.177, 1.267)	<0.001
>=40 (ref*)	33323	1		
<b>Serum cholesterol (mmol/L)</b>				
<3.5	18522	1.119	(1.072, 1.168)	<0.001
3.5-<5.2 (ref*)	84741	1		
5.2-<6.2	14384	1.016	(0.966, 1.069)	0.539
>=6.2	6154	1.091	(1.01, 1.178)	0.027
<b>Diastolic BP (mmHg)</b>				
<70	22251	1.034	(0.984, 1.087)	0.187
70-<80	49394	1.012	(0.973, 1.051)	0.556
80-<90 (ref*)	38845	1		
90-<100	11134	1.085	(1.022, 1.151)	0.007
>=100	2177	1.39	(1.229, 1.572)	<0.001
<b>Haemoglobin (g/dL)</b>				
<10	52118	1.334	(1.29, 1.379)	<0.001
10-<12 (ref*)	62950	1		
>=12	8733	1.094	(1.032, 1.158)	0.002
<b>Serum calcium (mmol/L)</b>				
<2.1	32829	1.122	(1.08, 1.166)	<0.001
2.1-<=2.37 (ref*)	73742	1		
>2.37	17230	0.958	(0.913, 1.006)	0.084
<b>Calcium Phosphate product (mmol<sup>2</sup>/L<sup>2</sup>)</b>				
<3.5	47709	0.962	(0.918, 1.008)	0.106
3.5-<4.5 (ref*)	49184	1		
4.5-<5.5	19841	1.028	(0.97, 1.089)	0.358
>=5.5	7067	1.231	(1.114, 1.359)	<0.001
<b>Serum Phosphate (mmol/L)</b>				
<0.8	740	1.388	(0.997, 1.932)	0.052
0.8-<1.3 (ref*)	16142	1		
1.3-<1.8	56841	0.9	(0.851, 0.951)	<0.001
1.8-<2.2	33860	0.912	(0.847, 0.983)	0.016
>=2.2	16218	0.9	(0.813, 0.997)	0.044
<b>HBsAg</b>				
Negative (ref*)	54729	1		
Positive	1023	0.936	(0.835, 1.049)	0.257
<b>Anti-HCV</b>				
Negative (ref*)	54907	1		
Positive	588	0.874	(0.748, 1.02)	0.087
<b>Cardiovascular disease (CVD)</b>				
No CVD (ref*)	116635	1		
CVD	7166	1.156	(1.083, 1.233)	<0.001

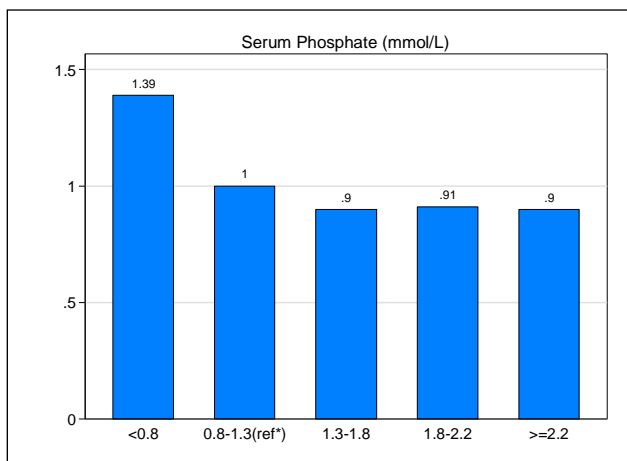
**Figure 3.4.1(a): Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality by diastolic blood pressure (2001-2021 cohort)**



**Figure 3.4.1(b): Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality by haemoglobin (2001-2021 cohort)**



**Figure 3.4.1(c): Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality by serum phosphate (2001-2021 cohort)**



### 3.4.2: Adjusted hazard ratio for mortality of haemodialysis patients

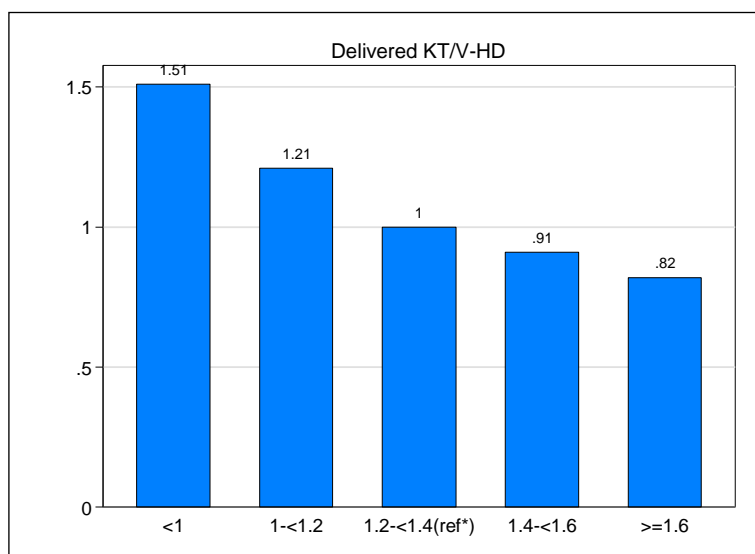
The adjusted hazard ratio for mortality of haemodialysis patients [Table 3.4.2] demonstrated identical pattern with the whole cohort of 2001-2021 dialysis patients since 90% of the dialysis population consisted of haemodialysis patients. The dose of dialysis treatment (Kt/V) and patient mortality appeared to be inversely proportionate [Figure 3.4.2].

**Table 3.4.2: Adjusted hazard ratio for mortality of HD patients [ITT analysis] (2001-2021 cohort)**

Factors	n	Hazard ratio	95% CI	P-value
<b>Age (years)</b>				
Age 1-14	200	1.307	(0.897, 1.905)	0.164
Age 15-24	2131	0.889	(0.767, 1.03)	0.117
Age 25-34 <sup>(ref*)</sup>	5993	1		
Age 35-44	11565	1.342	(1.229, 1.466)	<0.001
Age 45-54	24985	1.75	(1.61, 1.902)	<0.001
Age 55-64	33498	2.176	(1.998, 2.369)	<0.001
Age >=65	28992	2.722	(2.488, 2.978)	<0.001
<b>Gender</b>				
Male <sup>(ref*)</sup>	59594	1		
Female	47770	0.989	(0.95, 1.03)	0.604
<b>Primary diagnosis</b>				
Unknown primary	13856	0.98	(0.867, 1.106)	0.739
Diabetes mellitus	66115	1.461	(1.309, 1.631)	<0.001
GN/SLE <sup>(ref*)</sup>	3462	1		
Polycystic kidney	790	0.868	(0.693, 1.088)	0.22
Obstructive nephropathy	1535	1.059	(0.878, 1.276)	0.55
Toxic nephropathy	575	1.148	(0.908, 1.451)	0.249
Hypertension	19049	1.393	(1.246, 1.557)	<0.001
Others	1982	1.514	(1.305, 1.756)	<0.001
<b>Year start dialysis</b>				
2002-2006 <sup>(ref*)</sup>	12992	1		
2007-2011	22131	1.177	(1.149, 1.205)	<0.001
2012-2016	32772	1.382	(1.349, 1.416)	<0.001
2017-2021	37668	1.899	(1.847, 1.952)	<0.001
<b>BMI</b>				
BMI<18.5	3729	1.248	(1.135, 1.372)	<0.001
BMI 18.5-25 <sup>(ref*)</sup>	45736	1		
BMI 25-30	42995	0.969	(0.932, 1.007)	0.108
>=30	14904	0.96	(0.913, 1.01)	0.114
<b>Serum albumin (g/L)</b>				
<30	5570	2.664	(2.402, 2.955)	<0.001
30-<35	16219	1.57	(1.488, 1.657)	<0.001
35-<40	53435	1.223	(1.178, 1.271)	<0.001
>=40 <sup>(ref*)</sup>	32140	1		
<b>Serum cholesterol (mmol/L)</b>				
<3.5	17319	1.09	(1.042, 1.139)	<0.001
3.5-<5.2	75177	1		
5.2-<6.2	11072	1.074	(1.015, 1.137)	0.014
>=6.2 <sup>(ref*)</sup>	3796	1.118	(1.009, 1.239)	0.033
<b>Kt/V</b>				
<1	3062	1.51	(1.36, 1.676)	<0.001
1-<1.2	8986	1.214	(1.141, 1.292)	<0.001
1.2-<1.4 <sup>(ref*)</sup>	20399	1		
1.4-<1.6	34747	0.909	(0.869, 0.952)	<0.001
>=1.6	40170	0.816	(0.775, 0.859)	<0.001

Factors	n	Hazard ratio	95% CI	P-value
<b>Diastolic BP (mmHg)</b>				
<70	20599	1.022	(0.969, 1.077)	0.43
70-<80	43586	1.009	(0.968, 1.053)	0.661
80-<90 (ref*)	32005	1		
90-<100	9292	1.114	(1.043, 1.19)	0.001
>=100	1882	1.483	(1.3, 1.692)	<0.001
<b>Hemoglobin (g/dL)</b>				
<10	45832	1.384	(1.335, 1.435)	<0.001
10-<12 (ref*)	54458	1		
>=12	7074	1.007	(0.944, 1.074)	0.828
<b>Serum calcium (mmol/L)</b>				
<2.1	27518	1.084	(1.04, 1.131)	<0.001
2.1-<=2.37 (ref*)	65128	1		
>2.37	14718	0.951	(0.902, 1.002)	0.061
<b>Calcium Phosphate product (mmol<sup>2</sup>/L<sup>2</sup>)</b>				
<3.5	38974	0.951	(0.903, 1)	0.051
3.5-<4.5 (ref*)	44130	1		
4.5-<5.5	17911	1.021	(0.959, 1.087)	0.508
>=5.5	6349	1.257	(1.13, 1.399)	<0.001
<b>Serum Phosphate (mmol/L)</b>				
<0.8	551	1.283	(0.88, 1.868)	0.195
0.8-<1.3 (ref*)	12427	1		
1.3-<1.8	49333	0.901	(0.846, 0.96)	0.001
1.8-<2.2	30552	0.91	(0.838, 0.988)	0.025
>=2.2	14501	0.89	(0.796, 0.995)	0.041
<b>HBsAg</b>				
Negative (ref*)	47217	1		
Positive	886	0.896	(0.792, 1.015)	0.084
<b>Anti-HCV</b>				
Negative (ref*)	47419	1		
Positive	498	0.817	(0.69, 0.967)	0.019
<b>Cardiovascular disease (CVD)</b>				
No CVD (ref*)	101380	1		
CVD	5984	1.145	(1.067, 1.228)	<0.001

Figure 3.4.2: Adjusted hazard ratio for mortality of HD patients uncensored for change of modality by Kt/V (2001-2021 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 2011-2021 dialysis patients. However, there were no significant correlations between gender, body mass index, calcium phosphate product, and dialysis dose (Kt/V) with mortality in peritoneal dialysis patients. A low serum cholesterol, albumin, calcium, and a high haemoglobin were associated with higher mortality risk. These differences were partly contributed by the relatively smaller number of PD patients in this cohort.

**Table 3.4.3: Adjusted hazard ratio for mortality of PD patients [ITT analysis] (2001-2021 cohort)**

Factors	n	Hazard ratio	95% CI	P-value
<b>Age (years)</b>				
Age 1-14	686	0.614	(0.454, 0.831)	0.002
Age 15-24	1130	0.821	(0.67, 1.005)	0.056
Age 25-34 <sup>(ref*)</sup>	1526	1		
Age 35-44	2011	1.143	(0.958, 1.364)	0.138
Age 45-54	3382	1.282	(1.077, 1.526)	0.005
Age 55-64	4373	1.588	(1.339, 1.884)	<0.001
Age >=65	3329	1.64	(1.359, 1.98)	<0.001
<b>Gender</b>				
Male <sup>(ref*)</sup>	8576	1		
Female	7861	1.047	(0.924, 1.188)	0.469
<b>Primary diagnosis</b>				
Unknown primary	1725	1.145	(0.927, 1.415)	0.209
Diabetes mellitus	9012	1.33	(1.104, 1.602)	0.003
GN/SLE <sup>(ref*)</sup>	1382	1		
Polycystic kidney	100	0.636	(0.324, 1.25)	0.19
Obstructive nephropathy	355	1.122	(0.816, 1.541)	0.479
Toxic nephropathy	124	0.928	(0.559, 1.542)	0.774
Hypertension	3120	1.238	(1.03, 1.487)	0.023
Others	619	1.47	(1.15, 1.878)	0.002
<b>Year start dialysis</b>				
2002-2006 <sup>(ref*)</sup>	1682	1		
2007-2011	2786	1.187	(1.11, 1.27)	<0.001
2012-2016	4681	1.396	(1.307, 1.49)	<0.001
2017-2021	7001	1.916	(1.785, 2.056)	<0.001
<b>BMI</b>				
BMI<18.5	903	1.096	(0.9, 1.337)	0.362
BMI 18.5-25 <sup>(ref*)</sup>	6846	1		
BMI 25-30	7177	1.092	(0.993, 1.202)	0.071
BMI >=30	1511	1.08	(0.944, 1.237)	0.262
<b>Serum albumin (g/L)</b>				
<30	5300	1.246	(1.052, 1.476)	0.011
30-<35	5924	1.076	(0.918, 1.261)	0.364
35-<40	4030	0.945	(0.805, 1.109)	0.486
>=40 <sup>(ref*)</sup>	1183	1		
<b>Serum cholesterol (mmol/L)</b>				
<3.5	1203	1.256	(1.084, 1.454)	0.002
3.5-<5.2 <sup>(ref*)</sup>	9564	1		
5.2-<6.2	3312	0.865	(0.773, 0.968)	0.012
>=6.2	2358	1.044	(0.924, 1.18)	0.487
<b>Kt/V</b>				
<1.7	10747	1.044	(0.902, 1.209)	0.56
1.7-<2.0 <sup>(ref*)</sup>	5690	1		
>=2.0	0	NA	NA	NA



Factors	n	Hazard ratio	95% CI	P-value
<b>Diastolic BP (mmHg)</b>				
<70	1652	1.241	(1.047, 1.472)	0.013
70-<80	5808	1.004	(0.911, 1.107)	0.931
80-<90 (ref*)	6840	1		
90-<100	1842	0.981	(0.852, 1.13)	0.789
>=100	295	1.01	(0.711, 1.436)	0.955
<b>Hemoglobin (g/dL)</b>				
<10	6286	1.036	(0.944, 1.138)	0.457
10-<12 (ref*)	8492	1		
>=12	1659	1.538	(1.35, 1.753)	<0.001
<b>Serum calcium (mmol/L)</b>				
<2.1	5311	1.239	(1.124, 1.367)	<0.001
2.1-<=2.37 (ref*)	8614	1		
>2.37	2512	0.985	(0.865, 1.122)	0.82
<b>Calcium Phosphate product (mmol<sup>2</sup>/L<sup>2</sup>)</b>				
<3.5	8735	1.024	(0.905, 1.158)	0.712
3.5-<4.5 (ref*)	5054	1		
4.5-<5.5	1930	0.987	(0.833, 1.17)	0.883
>=5.5	718	0.982	(0.739, 1.304)	0.898
<b>Serum Phosphate (mmol/L)</b>				
<0.8	189	1.665	(0.824, 3.364)	0.156
0.8-<1.3 (ref*)	3715	1		
1.3-<1.8	7508	0.902	(0.801, 1.016)	0.089
1.8-<2.2	3308	0.897	(0.748, 1.076)	0.241
>=2.2	1717	0.997	(0.764, 1.302)	0.983
<b>HBsAg</b>				
Negative (ref*)	7525	1		
Positive	128	1.246	(0.925, 1.678)	0.148
<b>Anti-HCV</b>				
Negative (ref*)	7488	1		
Positive	86	1.14	(0.765, 1.699)	0.52
<b>Cardiovascular disease (CVD)</b>				
No CVD (ref*)	15266	1		
CVD	1171	1.119	(0.943, 1.328)	0.198

### 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 17.8 [Figure 3.4.4(a)]. When adjusted for the size of haemodialysis centres using funnel plot, 743 (91.2%) and 794 (97.4 %) 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, 2021

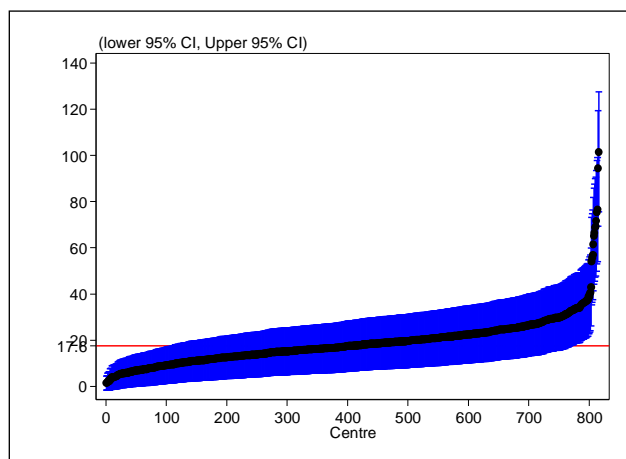
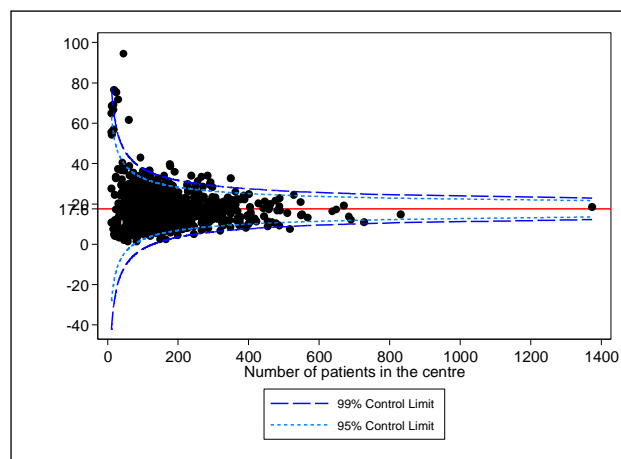


Figure 3.4.4(b): Funnel plot of RAMR by HD centre, 2021



### 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 25.9 [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 63.6% and 70.5% 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, 2021

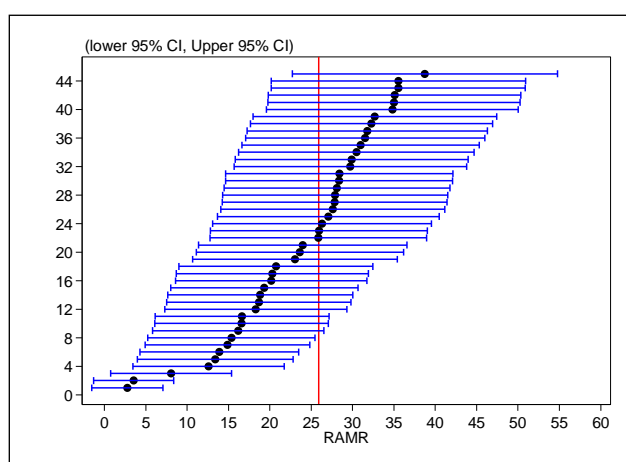


Figure 3.4.5(b): Funnel plot for RAMR by PD centres, 2021

