

CHAPTER 8

Blood Pressure Control and Dyslipidaemia in Patients on Dialysis

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SECTION 8.1: BLOOD PRESSURE CONTROL ON DIALYSIS

The control of pre-dialysis systolic blood pressure (SBP) in haemodialysis (HD) patients remains a difficult target to achieve with only 25% of HD patients achieving SBP < 140 mmHg (Table 8.1.1) in 2016. The mean and median pre-dialysis SBP in HD patients in 2016 were similar at 152.2 mmHg and 152.3 mmHg respectively. Pre-dialysis diastolic blood pressure (DBP) in HD patients was better controlled than pre-dialysis SBP in 2016, with 85% of such patients achieving pre-dialysis DBP < 90 mmHg (Table 8.1.2). The mean and median pre-dialysis DBP in HD patients was satisfactory at 78.3 mmHg and 77.8 mmHg respectively in 2016. The mean pre-dialysis DBP in HD patients decreased slightly from 80.4 mmHg in 2006 to 78.3 mmHg in 2016.

The ideal pre-dialysis BP targets for hemodialysis patients are still open to debate. Other important parameters such as the change in BP during a hemodialysis session, the amount of fluid removed, the post dialysis BP readings, home BP readings, salt intake and preexisting cardiac dysfunction will have to be taken into consideration in the overall assessment of the appropriate BP control in the individual patient .

Table 8.1.1: Distribution of pre-dialysis systolic blood pressure, HD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percentage of patients				
							<120 mmHg	120-<140 mmHg	140-<160 mmHg	160-<180 mmHg	≥180 mmHg
2007	12829	152.1	19.1	151.9	139.3	164.7	5	21	40	27	7
2008	15317	152.1	19.0	152.0	139.4	164.6	4	21	40	27	7
2009	17877	151.0	19.0	150.6	138.2	163.5	5	23	41	25	6
2010	19507	150.8	18.9	150.4	138.3	163.3	5	23	41	25	6
2011	22229	151.6	18.9	151.5	139.0	164.0	4	22	41	26	6
2012	25595	151.5	19.0	151.3	139.0	164.0	5	22	41	26	7
2013	29032	151.9	18.7	151.9	139.8	164.0	4	21	42	26	7
2014	32322	152.1	18.7	152.0	139.8	164.5	4	21	41	27	7
2015	35168	152.4	18.6	152.4	140.1	164.7	4	21	41	27	7
2016	37909	152.2	18.4	152.3	140.0	164.3	4	21	42	27	7

Figure 8.1.1: Cumulative distribution of pre-dialysis systolic blood pressure, HD patients 2007-2016

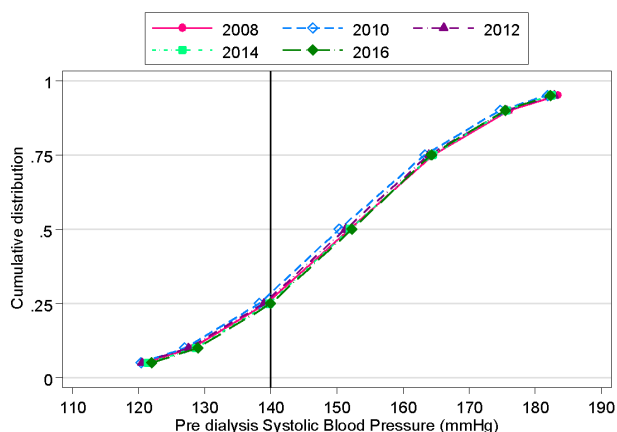
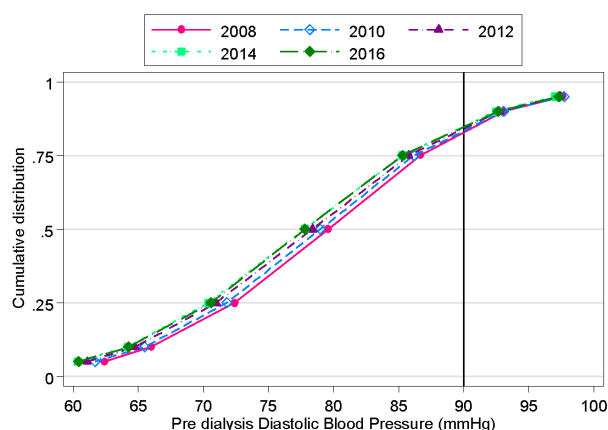


Table 8.1.2: Distribution of pre-dialysis diastolic blood pressure, HD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percentage of patients				
							<70 mmHg	70-<80 mmHg	80-<90 mmHg	90-<100 mmHg	≥100 mmHg
2007	12829	80.4	11.1	80.2	73.1	87.0	16	32	34	14	4
2008	15315	79.8	11.1	79.6	72.4	86.7	18	33	33	13	3
2009	17876	79.7	12.0	79.2	72.0	86.3	19	33	31	12	4
2010	19505	79.4	11.8	79.0	71.8	86.2	20	34	31	12	4
2011	22228	79.2	11.9	78.8	71.6	86.1	20	34	30	12	4
2012	25592	78.8	11.8	78.4	71.0	85.8	22	34	30	11	4
2013	29030	78.8	12.0	78.3	70.9	85.8	22	33	29	11	4
2014	32320	78.2	11.8	77.8	70.4	85.3	23	34	28	11	3
2015	35167	78.3	11.8	77.8	70.5	85.3	23	34	28	11	3
2016	37901	78.3	11.9	77.8	70.6	85.3	23	34	28	11	3

Figure 8.1.2: Cumulative distribution of pre-dialysis diastolic blood pressure, HD patients 2007-2016



In comparison to HD patients, pre-dialysis SBP in PD patients has been better controlled consistently over the last decade. In 2016, 40% of PD patients versus 25% of HD patients had a pre-dialysis SBP < 140 mmHg (Table 8.1.3). The mean and median pre-dialysis SBP in PD patients were lower than HD patients at 144.4 mmHg and 144.6 mmHg respectively in 2016. Pre-dialysis DBP is well controlled with 81% of PD patients in 2016 achieving pre -dialysis DBP < 90 mmHg (Table 8.1.4), together with a mean DBP of 81.1 and median DBP of 80.8 mmHg.

Table 8.1.3: Distribution of pre-dialysis systolic blood pressure, PD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percentage of patients				
							<120 mmHg	120-<140 mmHg	140-<160 mmHg	160-<180 mmHg	≥180 mmHg
2007	1753	139.9	19.2	139.4	127.0	152.8	15	37	33	13	2
2008	2049	139.4	18.7	139.5	126.7	151.4	15	36	35	12	2
2009	2177	140.7	18.7	140.5	128.1	153.4	13	35	35	14	2
2010	2327	140.0	17.8	140.0	128.3	151.4	12	37	38	11	2
2011	2517	140.0	18.0	140.2	128.2	151.8	13	36	38	11	2
2012	2734	141.1	18.3	141.3	128.7	153.1	12	34	38	14	2
2013	2939	142.0	18.3	141.8	130.1	154.4	11	34	39	14	2
2014	3540	143.9	18.3	144.2	131.7	156.8	10	31	40	17	2
2015	4020	143.6	17.7	143.6	132.1	155.7	9	32	42	16	2
2016	4370	144.4	18.6	144.6	132.0	156.7	10	30	40	18	3

Figure 8.1.3: Distribution of pre-dialysis systolic blood pressure, PD patients 2007-2016

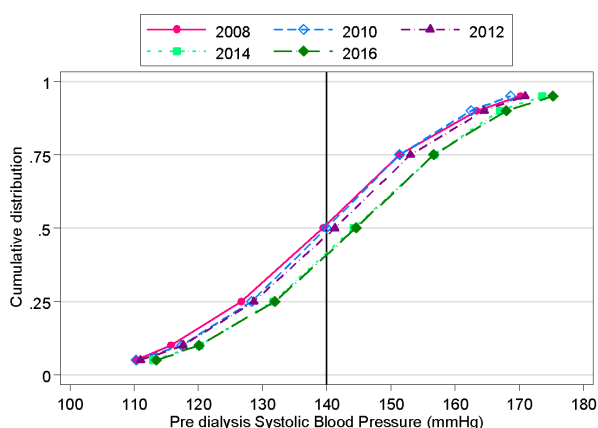
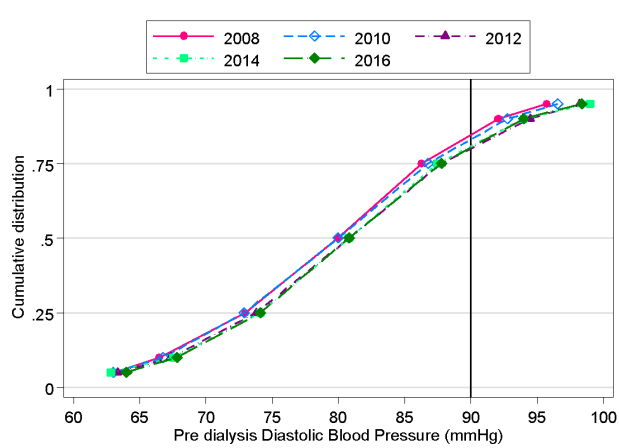


Table 8.1.4: Distribution of pre-dialysis diastolic blood pressure, PD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percentage of patients				
							<70 mmHg	70-<80 mmHg	80-<90 mmHg	90-<100 mmHg	≥100 mmHg
2007	1752	80.6	10.7	80.7	74.0	86.9	14	32	38	12	3
2008	2049	79.7	10.1	80.0	73.0	86.3	16	32	36	13	2
2009	2177	80.2	10.3	80.2	73.5	86.9	15	33	35	14	3
2010	2327	79.9	10.4	80.0	72.9	86.8	17	33	34	13	3
2011	2517	79.9	10.3	80.0	73.3	86.7	16	33	36	13	2
2012	2737	81.2	12.1	80.8	73.8	87.8	15	31	35	15	4
2013	2932	80.6	10.9	80.7	73.6	87.5	15	32	35	15	4
2014	3525	81.1	11.6	80.8	74.1	87.5	14	32	35	14	5
2015	4010	80.9	10.8	80.7	74.0	87.0	14	33	36	13	4
2016	4360	81.1	11.2	80.8	74.1	87.8	14	32	35	14	4

Figure 8.1.4: Cumulative Distribution of pre-dialysis diastolic blood pressure, PD patients 2007-2016

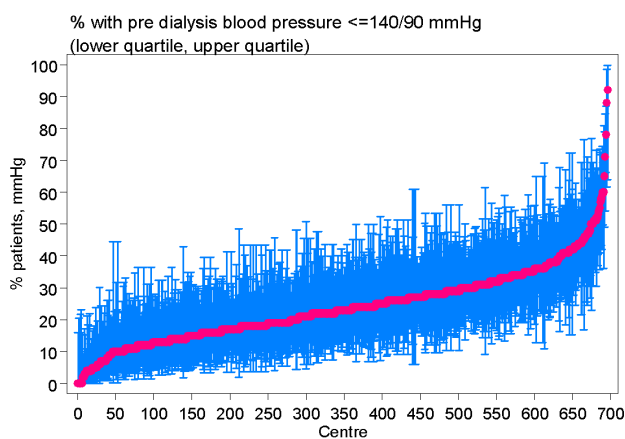


Overall, there is still a wide inter-centre variation amongst haemodialysis centres in 2016 in terms of the proportion of patients achieving pre-dialysis BP < 140/90 (Table & Figure 8.1.5a). This graph is useful for individual dialysis centres to compare their own centre's results with other dialysis centres in Malaysia.

Table 8.1.5(a): Proportion of HD patients with pre-dialysis blood pressure $\leq 140/90$ mmHg, HD centres

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	310	0	7	17	25	34	50	80
2008	358	0	8	17	24.5	33	52	79
2009	402	0	9	19	27	35	50	81
2010	438	0	9	17	26	34	50	87
2011	497	0	7	17	25	33	50	94
2012	558	0	8	17	24.5	33	48	86
2013	610	0	6	16	23	31	46	93
2014	645	0	8	16	23	31	47	93
2015	669	0	8	15	22	31	44	88
2016	696	0	7	16	23	30.5	44	92

Figure 8.1.5(a): Variation in proportion of HD patients with pre-dialysis blood pressure $\leq 140/90$ mmHg, HD centres 2016



There is also significant inter-centre variation in both median SBP and DBP in HD patients in 2016 (Figures 8.1.5 b and c). In 2016, the difference between the HD centres with the second lowest (5th percentile) and second highest median BP (95th percentile) was 21.5 mmHg for SBP (Table 8.1.5b) and 14.8 mmHg for DBP (Table 8.1.5c) respectively.

Table 8.1.5(b): Median systolic blood pressure among HD patients, HD centres

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	310	132.5	139.9	147.5	151.9	157.2	164.4	173.5
2008	358	129.3	140.0	147.6	152.4	156.9	164.5	172.5
2009	402	121.7	139.9	146.5	151.1	155.5	162.3	170.5
2010	438	123.7	140.3	146.5	150.7	155.5	161.8	172.1
2011	497	123.1	139.5	147.3	151.5	156.7	163.9	176.0
2012	558	125.8	140.5	147.8	151.8	156.3	163.3	172.2
2013	610	125.6	141.3	148.3	152.6	157.1	164.6	177.0
2014	645	116.5	140.6	147.7	152.0	157.1	164.1	172.1
2015	669	118.3	142.0	148.5	153.1	157.5	164.3	175.8
2016	697	118.1	141.8	148.6	152.5	157.0	163.3	171.4

Figure 8.1.5(b): Variation in median systolic blood pressure among HD patients, HD centres 2016

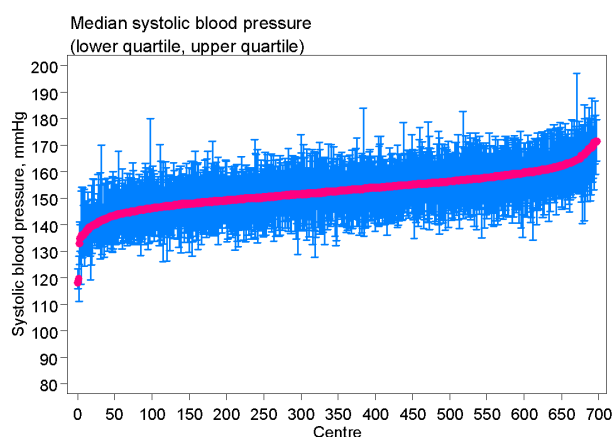
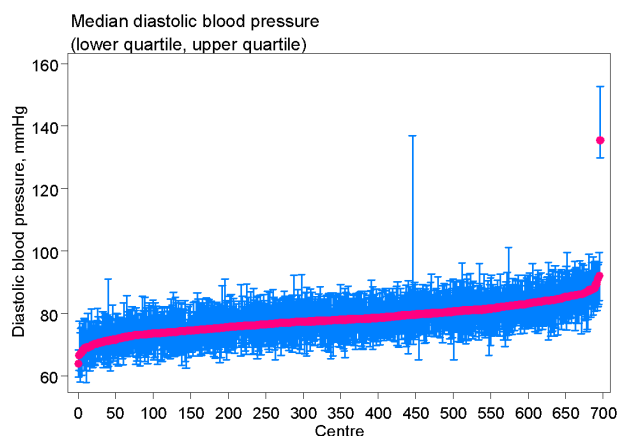


Table 8.1.5(c): Median diastolic blood pressure among HD patients, HD centres

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	310	69.8	73.5	77.7	80.2	82.8	86.7	124.5
2008	358	66.3	73.2	76.9	79.8	82.4	87.1	96.7
2009	402	68.5	73.3	76.8	79.2	82.0	85.9	135.0
2010	438	67.8	72.8	76.4	79.1	81.9	86.4	142.8
2011	497	62.5	72.8	76.2	78.6	81.6	85.8	143.3
2012	558	66.3	71.3	75.7	78.5	81.3	86.8	124.2
2013	610	61.8	70.7	75.4	78.3	81.6	86.3	129.8
2014	645	64.7	70.5	74.7	77.9	80.8	85.4	122.7
2015	669	64.7	70.6	75.1	78.0	81.0	85.9	97.0
2016	696	63.8	71	75	77.9	81	85.8	135.4

Figure 8.1.5(c): Variation in median diastolic blood pressure among HD patients, HD centres 2016

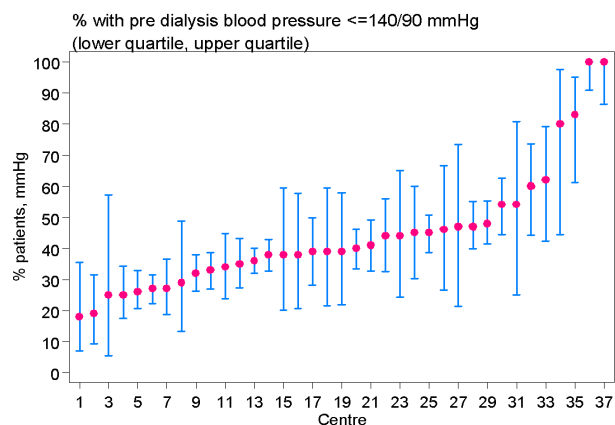


Similar to haemodialysis centres, there was also a wide variation amongst PD centres in the proportion of patients achieving BP < 140/90 in 2016 (Table & Figure 8.1.6a). Figure 8.1.6a shows that there were 2 exemplary peritoneal dialysis centres where more than 90% of their patients were able to achieve target blood pressure of less than 140/90 in 2016.

Table 8.1.6(a): Proportion of PD patients with pre-dialysis blood pressure $\leq 140/90$ mmHg, PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	27	30	44	53	68	92	93
2008	22	28	29	43	52.5	59	88	96
2009	23	10	29	40	51	59	89	93
2010	25	34	34	40	51	64	90	100
2011	26	31	31	43	46.5	71	94	100
2012	27	5	24	39	45	64	90	91
2013	26	17	22	35	39.5	52	93	100
2014	31	8	20	29	37	50	97	100
2015	35	24	27	33	40	45	96	98
2016	37	18	19	33	39	47	100	100

Figure 8.1.6(a): Variation in proportion of PD patients with pre-dialysis blood pressure $\leq 140/90$ mmHg, PD centres 2016



The difference between the PD centres with the second lowest (5th percentile) and the second highest median SBP (95th percentile) was 41.6 mmHg in 2016 (Table 8.1.6b). There was also significant inter-centre variation in median DBP in PD patients in 2016 (Table & Figure 8.1.6c).

Table 8.1.6(b): Median systolic blood pressure among PD patients, PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	115.1	117.3	135.2	138.2	142.8	149.7	153.5
2008	22	115.6	118.1	136.0	137.6	141.9	147.9	149.0
2009	23	113.8	117.0	133.3	138.5	144.9	151.3	161.5
2010	25	115.0	116.9	131.5	138.6	142.6	146.0	146.3
2011	26	113.1	115.6	130.3	140.1	141.6	146.1	147.8
2012	27	114.2	116.0	134.3	140.6	144.5	151.5	156.7
2013	26	112.3	115.1	138.5	142.0	145.4	158.7	161.5
2014	31	114.8	115.3	138.6	145.3	147.5	153.7	158.3
2015	35	114.6	114.7	140.1	142.6	145.6	150.5	153.3
2016	37	112.2	117.0	139.0	143	148.2	153.8	161.0

Figure 8.1.6(b): Variation in median systolic blood pressure among PD patients, PD centres 2016

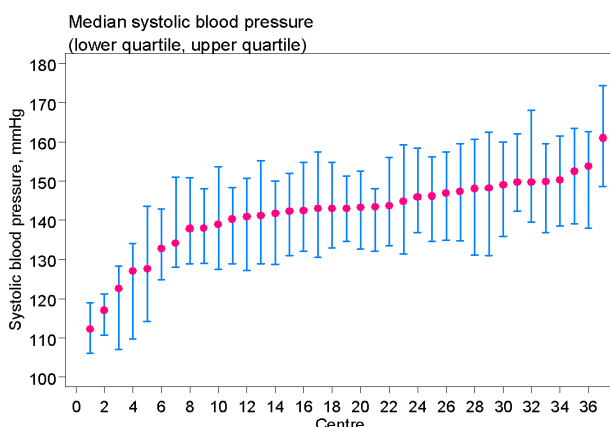
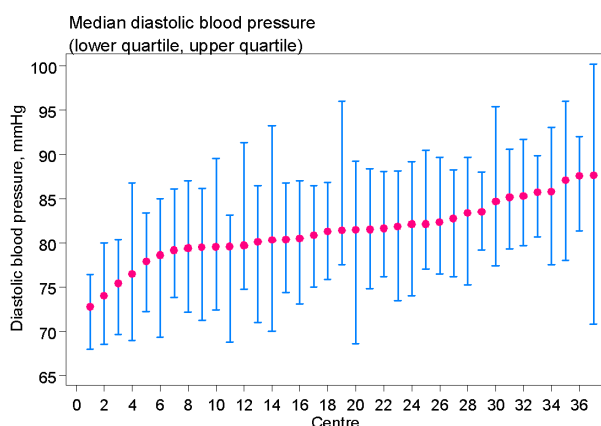


Table 8.1.6(c): Median diastolic blood pressure among PD patients, PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	72.4	72.5	78.8	80.4	82.2	83.2	86.9
2008	22	73.9	76.8	78.1	79.7	82.0	84.5	86.8
2009	23	73.3	73.5	78.3	79.1	82.0	83.3	87.9
2010	25	73.9	74.2	77.5	79.5	81.9	86.0	86.7
2011	26	74.0	74.5	78.4	79.9	81.9	84.3	85.1
2012	27	75.4	75.4	79.2	80.0	83.5	87.2	91.0
2013	26	70.7	75.0	77.6	81.4	82.7	86.8	90.4
2014	31	73.8	75.0	79.6	81.3	83.9	89.7	89.9
2015	35	70.5	71.7	78.7	81.8	85.2	90	94.1
2016	37	72.8	74	79.6	81.4	83.3	87.5	87.6

Figure 8.1.6(c): Variation in median diastolic blood pressure among PD patients, PD centres 2016



In the 2016 analysis of the relationship of BP versus death in dialysis patients, patients with low blood pressure (BP < 120/70) were at the highest risk of death compared to all other blood pressure categories. Dialysis patients with highest blood pressure (BP > 180/100) were the group with the second highest risk of death. This “U” shaped curve in the relationship between BP and death as illustrated in Figure 8.1.7a. Table 8.1.7b. Similarly, looking at hazard ratios (utilising the BP category of < 120/70 as the reference standard), the hazard ratio of all other categories were less than 1 compared to the reference standard emphasising the highest risk of death associated with dialysis patients with low blood pressure.

Table 8.1.7(a): Correlation of blood pressure profile and death, cardiovascular death and ischaemic heart disease, dialysis patients 2007-2016

	SBP<120 and DBP<70 ^(* Ref.) (I)		SBP 120-140 and DBP 70-80 (II)		SBP 140-160 and DBP 80-90 (III)		SBP 160-180 and DBP 90-100 (IV)		SBP>=180 and DBP>=100 (V)	
	n	%	n	%	n	%	n	%	n	%
Men										
n	742	100	2954	100	5150	100	1477	100	227	100
Death	412	56	1176	40	1644	32	475	32	109	48
CVD/IHD	114	15	244	8	232	5	52	4	6	3
Women										
n	693	100	2322	100	3045	100	742	100	126	100
Death	329	47	792	34	852	28	237	32	66	52
CVD/IHD	59	9	127	5	107	4	21	3	4	3

Figure 8.1.7(a): Relationship between blood pressure and death in dialysis patients 2007-2016

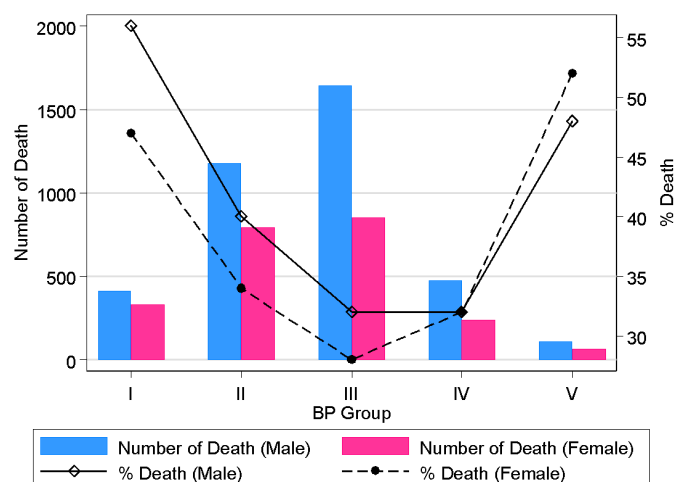


Table 8.1.7(b): Hazard ratio for death in each of the blood pressure categories, 2007-2016

	SBP<120 and DBP<70 (* Ref.)	SBP 120-140 and DBP 70-80	SBP 140-160 and DBP 80-90	SBP 160-180 and DBP 90-100	SBP>=180 and DBP>=100
Men					
n	742	2954	5150	1477	227
Hazard ratio	1.00	0.5008	0.310	0.356	0.889
95% CI		(0.448 ; 0.560)	(0.278 ; 0.345)	(0.312 ; 0.406)	(0.720 ; 1.098)
p value		<0.001	<0.001	<0.001	0.273
Women					
n	693	2322	3045	742	126
Hazard ratio	1.00	0.550	0.392	0.531	1.693
95% CI		(0.484 ; 0.626)	(0.345 ; 0.446)	(0.449 ; 0.627)	(1.130 ; 2.206)
p value		<0.001	<0.001	<0.001	<0.001

SECTION 8.2: DYSLIPIDAEMIA IN DIALYSIS PATIENTS

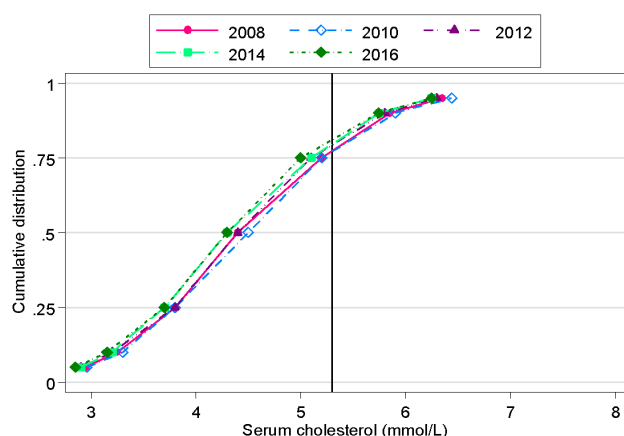
Individuals with end stage renal disease (ESRD) are at high risk for CV morbidity and mortality. CVD is the most common cause of death in dialysis patients. Hence, patients should be screened for the traditional CV risk factors and treated appropriately. However, patients on dialysis have not had similar benefits of lipid lowering therapy as compared to patients with earlier stages of CKD and the general population

In 2016, the majority of haemodialysis patients (81%) had a total serum cholesterol < 5.3 mmol/L. This was an improvement from 10 years ago (76% in 2007) (Table 8.2.1). The mean and median total serum cholesterol levels in HD patients in 2016 were 4.4 mmol/L and 4.3 mmol/L respectively.

Table 8.2.1: Distribution of serum cholesterol, HD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percentage of patients			
							<3.5 mmol/L	3.5-<5.3 mmol/L	5.3-<6.2 mmol/L	≥6.2 mmol/L
2007	11346	4.6	1.1	4.5	3.8	5.2	14	62	18	6
2008	13820	4.5	1.1	4.4	3.8	5.2	15	62	17	6
2009	15910	4.6	1.1	4.5	3.8	5.2	14	62	17	6
2010	17709	4.6	1.1	4.5	3.8	5.2	14	62	18	7
2011	20399	4.5	1.1	4.4	3.8	5.1	16	63	15	6
2012	23347	4.5	1.1	4.4	3.8	5.1	16	63	15	5
2013	26521	4.5	1.1	4.4	3.8	5.1	16	63	15	5
2014	29940	4.4	1.1	4.3	3.7	5.1	17	63	15	5
2015	32579	4.4	1.1	4.3	3.7	5.0	19	62	14	5
2016	35009	4.4	1.1	4.3	3.7	5.0	19	62	14	5

Figure 8.2.1: Cumulative distribution of cholesterol, HD patients 2007-2016

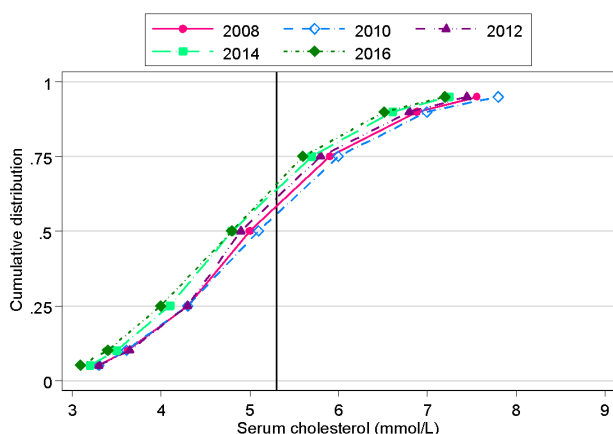


Total cholesterol levels in peritoneal dialysis patients were less optimally controlled in comparison with haemodialysis patients, with only 65% of PD patients achieving total cholesterol < 5.3 mmol/L in 2016 (Table & Figure 8.2.2). The mean and median serum cholesterol levels in PD patients in 2016 were 4.9 mmol/L and 4.8 mmol/L respectively.

Table 8.2.2: Distribution of serum cholesterol, PD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percentage of patients			
							<3.5 mmol/L	3.5-<5.3 mmol/L	5.3-<6.2 mmol/L	≥6.2 mmol/L
2007	1629	5.1	1.3	5.1	4.2	5.9	8	48	26	18
2008	1902	5.2	1.4	5.0	4.3	5.9	7	50	24	18
2009	2016	5.3	1.5	5.1	4.3	6.0	6	48	26	20
2010	2186	5.2	1.4	5.1	4.3	6.0	7	48	25	20
2011	2291	5.1	1.3	5.0	4.2	5.8	8	50	25	17
2012	2628	5.1	1.4	4.9	4.3	5.8	7	52	24	17
2013	2943	5.0	1.4	4.8	4.1	5.7	9	55	22	15
2014	3382	5.0	1.3	4.8	4.1	5.7	10	54	21	15
2015	3969	4.9	1.3	4.8	4.0	5.6	11	55	21	14
2016	4222	4.9	1.3	4.8	4.0	5.6	11	54	21	14

Figure 8.2.2: Cumulative distribution of cholesterol (mmol/L), PD patients 2007-2016

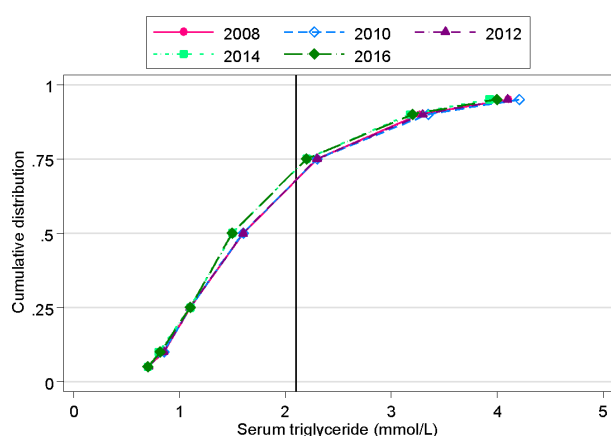


With regards to triglyceride levels, 77% of HD patients had triglyceride levels of <2.3 mmol/L in 2016 (Table 8.2.3). The mean and median serum triglyceride in HD patients in 2016 were 1.8 mmol/L and 1.5 mmol/L which are only slightly better than that of a decade ago (1.9 mmol/l and 1.6 mmol/L respectively in 2007).

Table 8.2.3: Distribution of serum triglyceride, HD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percentage of patients			
							<1.7 mmol/L	1.7-<2.3 mmol/L	2.3-<3.5 mmol/L	≥3.5 mmol/L
2007	10881	1.9	1.2	1.6	1.1	2.3	55	21	16	8
2008	12927	1.9	1.2	1.6	1.1	2.3	56	20	15	8
2009	15189	1.9	1.3	1.6	1.1	2.3	54	21	16	9
2010	17021	1.9	1.3	1.6	1.1	2.3	54	21	16	9
2011	19574	1.9	1.2	1.6	1.1	2.3	55	21	16	8
2012	22811	1.9	1.2	1.6	1.1	2.3	54	21	16	9
2013	25904	1.9	1.2	1.6	1.1	2.3	56	20	16	8
2014	29378	1.8	1.2	1.5	1.1	2.2	58	20	15	7
2015	32031	1.8	1.2	1.5	1.1	2.2	57	20	15	7
2016	34588	1.8	1.2	1.5	1.1	2.2	57	20	15	8

Figure 8.2.3: Cumulative distribution of serum triglyceride, HD patients 2007-2016

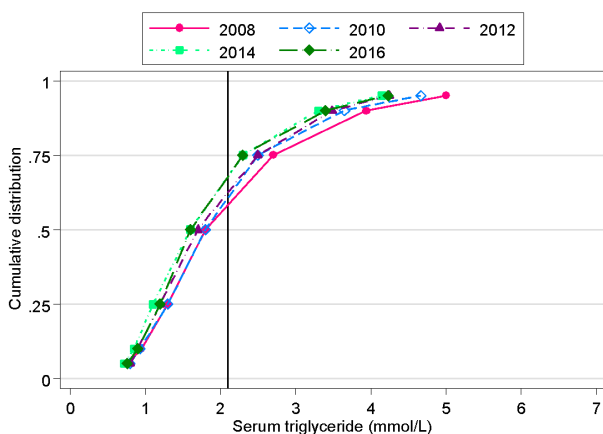


Peritoneal dialysis patients have a similar level of triglyceride control in 2016 (74% have triglyceride levels < 2.3 mmol/L) when compared to HD patients (Table 8.2.4). The mean and median serum triglyceride levels in PD patients have decreased only slightly over the past 10 years from 2.1 mmol/L and 1.8 mmol/L in 2007 to 2.0 mmol/L and 1.6 mmol/L in 2016 respectively.

Table 8.2.4: Distribution of serum triglyceride, PD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	Percentage of patients			
							<1.7 mmol/L	1.7-<2.3 mmol/L	2.3-<3.5 mmol/L	≥3.5 mmol/L
2007	1625	2.1	1.4	1.8	1.3	2.6	45	24	19	12
2008	1907	2.2	1.5	1.8	1.3	2.7	45	21	20	14
2009	2017	2.2	1.6	1.8	1.3	2.7	46	21	20	14
2010	2177	2.1	1.4	1.8	1.3	2.5	47	23	18	11
2011	2309	2.0	1.3	1.7	1.2	2.3	51	23	17	9
2012	2624	2.0	1.3	1.7	1.2	2.5	48	23	19	10
2013	2961	2.0	1.3	1.6	1.2	2.3	52	23	17	9
2014	3398	1.9	1.4	1.6	1.1	2.3	55	21	15	9
2015	3964	1.9	1.2	1.6	1.1	2.2	55	21	16	7
2016	4250	2.0	1.3	1.6	1.2	2.3	52	22	17	9

Figure 8.2.4: Cumulative distribution of serum triglyceride, PD patients 2007-2016



There was slight inter-centre variation in median serum cholesterol levels and the proportion of HD patients with serum cholesterol < 5.3mmol/L varied by 11% between the LQ and UQ in HD centers in 2016 (Table 8.2.5a & b).

Table 8.2.5(a): Median serum cholesterol level among HD patients, HD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	279	3.5	4.0	4.3	4.5	4.8	5.1	5.6
2008	335	3.4	3.9	4.2	4.5	4.7	5.1	5.7
2009	365	3.6	4.0	4.3	4.5	4.8	5.1	5.8
2010	412	3.5	4.0	4.3	4.5	4.7	5.1	5.7
2011	479	3.6	4.0	4.2	4.4	4.6	5.0	5.8
2012	540	3.5	3.9	4.2	4.4	4.6	4.9	5.7
2013	582	3.5	3.9	4.2	4.4	4.6	4.9	5.5
2014	631	3.3	3.9	4.2	4.3	4.6	4.9	5.3
2015	661	3.3	3.8	4.1	4.3	4.5	4.8	5.3
2016	682	3.3	3.9	4.2	4.3	4.5	4.9	5.5

Figure 8.2.5(a): Variation in median serum cholesterol level among HD patients, HD centres 2016

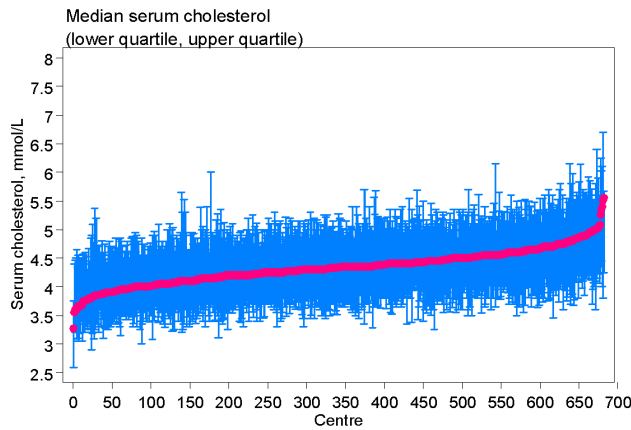
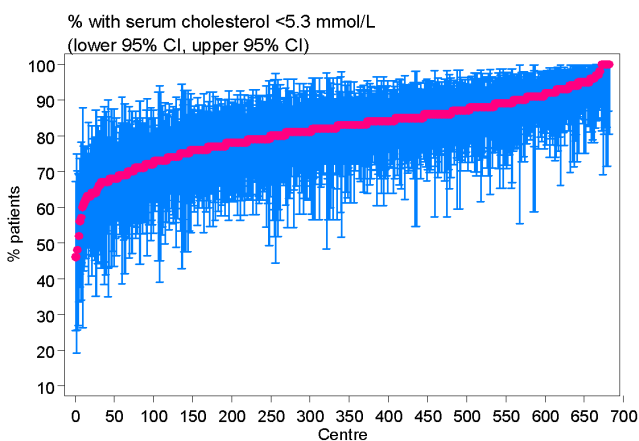


Table 8.2.5(b): Proportion of HD patients with serum cholesterol <5.3mmol/L, HD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	279	31	57	68	76	83	93	100
2008	335	32	56	69	77	85	93	100
2009	365	33	56	69	75	83	92	100
2010	412	27	56	69	76.5	84	93	100
2011	479	27	57	72	79	86	94	100
2012	540	40	62	73	80	86	93	100
2013	582	45	62	73	80	86	94	100
2014	631	42	63	75	81	87	94	100
2015	661	49	66	76	83	88	95	100
2016	682	46	67	77	83	88	95	100

Figure 8.2.5(b): Variation in proportion of patients with serum cholesterol <5.3 mmol/L, HD centres 2016



For median serum triglyceride levels amongst HD centres, the difference between the second lowest (5th percentile) and second highest median triglyceride level (95th percentile) was only 0.8 mmol/L in 2016 (Table & Figure 8.2.5c). There is a 14% difference between the LQ and UQ in terms of the proportion of patients with serum triglyceride < 2.1 mmol/L in HD centres in 2016. This is relatively unchanged from a decade ago (Table & Figure 8.2.5d).

Table 8.2.5(c): Median serum triglyceride level among HD patients, HD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	267	0.8	1.2	1.4	1.6	1.8	2.1	2.6
2008	312	1.0	1.2	1.4	1.6	1.7	2.1	2.3
2009	343	1.0	1.2	1.4	1.6	1.8	2.1	2.6
2010	394	0.9	1.2	1.5	1.6	1.8	2.1	3.6
2011	454	1.1	1.2	1.4	1.6	1.8	2.0	6.3
2012	524	0.8	1.2	1.4	1.6	1.8	2.1	3.0
2013	570	0.9	1.2	1.4	1.6	1.8	2.1	2.8
2014	621	1.0	1.2	1.4	1.5	1.7	2.0	3.1
2015	652	1.0	1.2	1.4	1.5	1.7	2.0	2.4
2016	676	0.8	1.2	1.4	1.5	1.7	2.0	2.6

Figure 8.2.5(c): Variation in median serum triglyceride level among HD patients, HD centers 2016

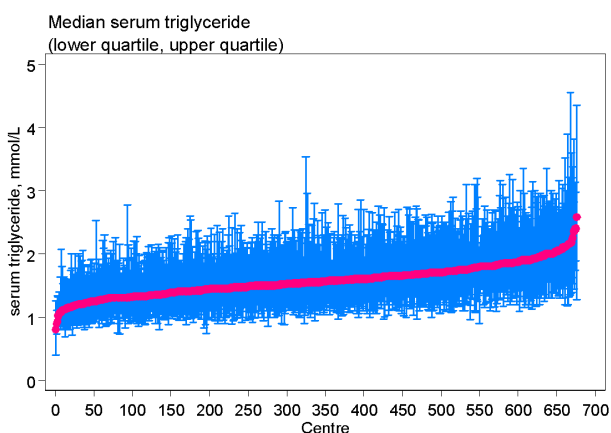
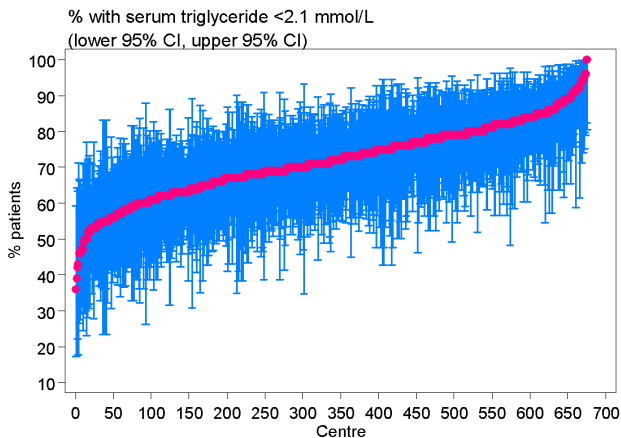


Table 8.2.5(d): Proportion of HD patients with serum triglyceride <2.1 mmol/L, HD centres

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	267	36	50	64	70	78	90	100
2008	312	36	53	64	72	79	87	100
2009	343	35	50	63	70	77	88	100
2010	394	9	50	63	70	77	89	100
2011	454	0	52	64	72	79	89	100
2012	524	28	50	63	70	79	88	100
2013	570	39	52	64	71.5	78	89	100
2014	621	31	53	65	72	80	89	100
2015	652	39	56	66	73	80	89	100
2016	676	36	54	65	72	79	88	100

Figure 8.2.5(d): Variation in proportion of patients with serum triglyceride <2.1mmol/L, HD centers 2016



There was some inter-centre variation in median cholesterol levels among PD patients in 2016 with the difference between the second lowest (5th percentile) and second highest (95th percentile) median cholesterol level being 1.3 mmol/L (Table & Figure 8.2.6a).

Table 8.2.6(a): Median serum cholesterol level among PD patients, PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	4.4	4.4	4.7	5.2	5.4	6.1	6.2
2008	22	4.3	4.5	4.8	5.1	5.4	5.8	6.2
2009	21	4.6	4.7	4.8	5.1	5.3	5.9	6.7
2010	25	4.6	4.6	4.9	5.2	5.5	6.0	7.5
2011	25	4.3	4.4	4.9	5.1	5.3	6.1	7.4
2012	27	4.4	4.4	4.8	5.0	5.3	6.1	7.8
2013	27	4.4	4.4	4.7	4.9	5.2	5.7	7.3
2014	30	4.3	4.3	4.6	5.0	5.3	5.9	6.7
2015	34	4.2	4.3	4.6	4.9	5.2	6.1	6.2
2016	36	4.2	4.2	4.6	4.8	5.1	5.5	5.7

Figure 8.2.6(a): Variation in median serum cholesterol level among PD patients, PD centres 2016

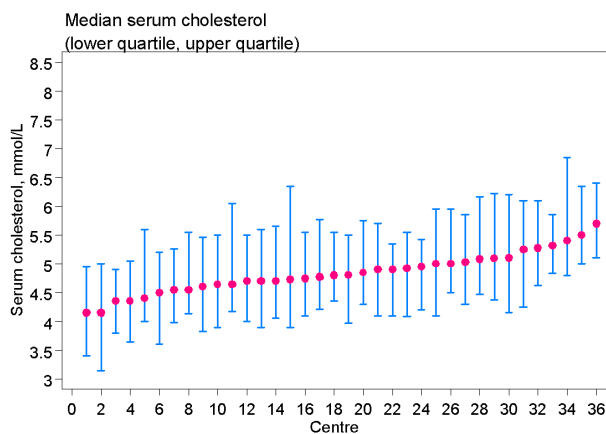
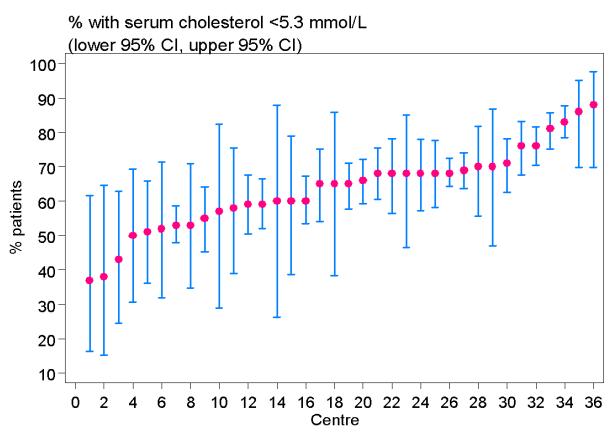


Table 8.2.6(b): Proportion of PD patients with serum cholesterol <5.3 mmol/L, PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	26	30	43	53	65	73	89
2008	22	37	39	45	57	65	74	74
2009	21	15	34	47	52	63	75	76
2010	25	8	22	45	51	60	72	72
2011	25	0	29	45	54	64	74	88
2012	27	11	21	50	57	67	78	81
2013	27	12	36	52	61	69	78	79
2014	30	24	32	45	58	70	79	82
2015	34	27	27	52	62	72	84	88
2016	36	37	38	56	65	69.5	86	88

Figure 8.2.6(b): Variation in proportion of patients with serum cholesterol <5.3 mmol/L, PD centres 2016



As in previous years, there was only a small inter-centre variation in median triglyceride levels among PD centres in 2016 (Figure 8.2.6c). There was some inter centre variation amongst PD centres in the proportion of patients with serum triglyceride levels < 2.1 mmol/L. (Table & Figure 8.2.6d).

Table 8.2.6(c): Median serum triglyceride level among PD patients, PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	1.2	1.5	1.7	1.8	2.0	2.1	2.7
2008	22	1.3	1.5	1.6	1.8	2.0	2.2	2.3
2009	22	1.4	1.5	1.7	1.8	1.9	2.2	2.5
2010	24	1.4	1.5	1.6	1.8	1.9	2.2	2.3
2011	25	1.2	1.4	1.6	1.6	1.8	2.1	2.2
2012	26	1.4	1.4	1.6	1.7	1.9	2.4	2.7
2013	27	1.4	1.4	1.6	1.7	1.8	2.2	2.6
2014	30	1.3	1.4	1.5	1.6	1.7	1.9	2.3
2015	34	1.3	1.3	1.5	1.6	1.6	1.8	2.5
2016	36	1.3	1.4	1.5	1.7	1.8	2.1	2.1

Figure 8.2.6(c): Variation in median serum triglyceride level among PD patients, PD centres 2016

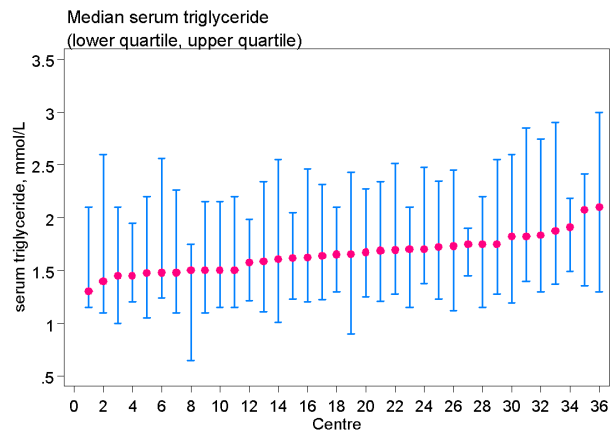
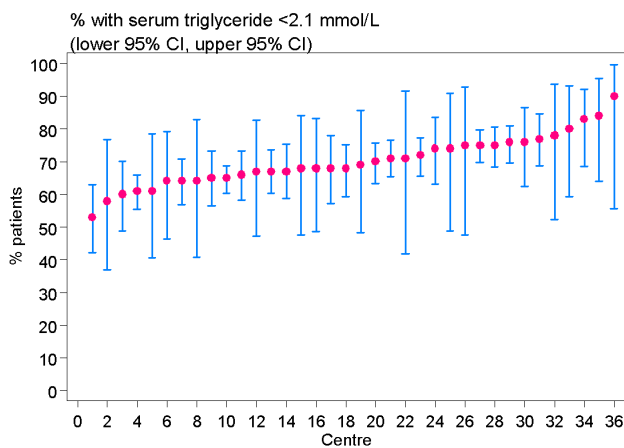


Table 8.2.6(d): Proportion of PD patients with serum triglyceride <2.1 mmol/L, PD centres 2007-2016

Year	Number of centres	Min	5 th Centile	LQ	Median	UQ	95 th Centile	Max
2007	23	40	52	57	63	69	80	81
2008	22	45	48	56	61.5	65	82	85
2009	22	31	47	57	61	67	72	76
2010	24	45	48	58.5	62	69.5	77	82
2011	25	50	50	64	68	73	82	93
2012	26	44	44	61	64.5	71	81	86
2013	27	38	49	63	69	73	86	90
2014	30	45	57	64	73	76	79	81
2015	34	45	56	69	73	77	88	90
2016	36	37	38	56	65	69.5	86	88

Figure 8.2.6(d): Variation in proportion of patients with serum triglyceride <2.1 mmol/L, PD centres 2016



In the analysis of different categories of cholesterol levels with death in dialysis patients in 2016, the highest rate of death occurs in dialysis patients with low total cholesterol levels (< 3.5 mmol/L). This paradoxical observation may be due to the presence of malnutrition and inflammation. The lowest risk of death was seen among dialysis patients with total cholesterol levels between 3.5 mmol/L and 6.2 mmol/L. Figure 8.2.7a illustrates the “U” curve relationship between serum cholesterol categories and death.

Analysing the hazard ratio for death in each of the total cholesterol categories, (utilising the total cholesterol category of < 3.5 mmol/L as the reference standard), it was noted that the hazard ratios of all other categories were less than 1 compared to the reference standard, apart from males with cholesterol levels above 6.2 mmol/L. This emphasizes the observation that for serum cholesterol levels in dialysis patients, the highest risk of death is associated with low cholesterol levels.

Table 8.2.7(a): Relationship of different categories of cholesterol levels with death, dialysis patients 2007 -2016

	<3.5mmol/L (* Ref.)		3.5-<5.3mmol/L		5.3-<6.2mmol/L		≥6.2mmol/L	
	n	%	n	%	n	%	n	%
Men								
n	5806	100	20912	100	3740	100	1179	100
Death	2459	42	7434	36	1362	36	458	39
CVD/IHD	451	8	1200	6	193	5	72	6
Women								
n	2050	100	15516	100	5641	100	2396	100
Death	993	48	5391	35	1900	34	913	38
CVD/IHD	153	7	726	5	235	4	124	5

Figure 8.2.7(a): Relationship between serum cholesterol categories and death, dialysis patients 2007-2016

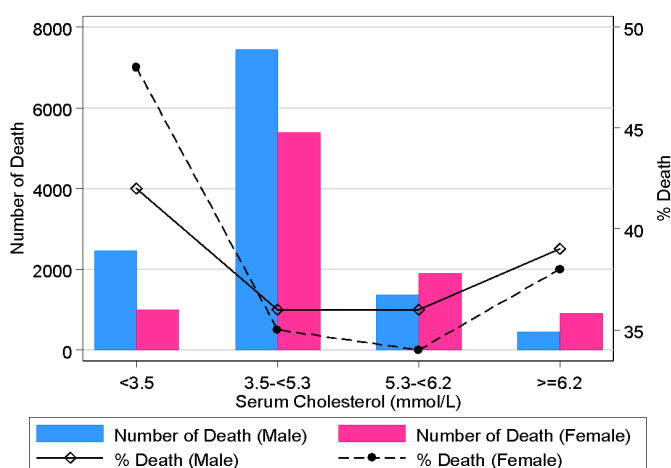


Table 8.2.7(b): Hazard ratio for death in each of the total cholesterol categories, dialysis patients 2007-2016

	<3.5 mmol/L (* Ref.)	3.5-<5.3 mmol/L	5.3-<6.2 mmol/L	>=6.2 mmol/L
Men				
n	5806	20912	3740	1179
Hazard ratio	1.00	0.644	0.753	1.154
95% CI		(0.615 ; 0.674)	(0.705 ; 0.805)	(1.045 ; 1.276)
p-value		<0.001	<0.001	0.005
Women				
n	2050	15516	5641	2396
Hazard ratio	1.00	0.498	0.525	0.804
95% CI		(0.466 ; 0.533)	(0.486 ; 0.567)	(0.735 ; 0.879)
p-value		<0.001	<0.001	<0.001