

Chapter - 12

**PERITONEAL DIALYSIS**

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**SECTION 12.1: MODALITIES AND PRESCRIPTION OF PD (Tables 12.1.1 -12.1.4)**

In 2013, there were a total of 2815 patients on peritoneal dialysis (PD) in Malaysia. The overall number of PD patients had been increasing over the last decade. The annual PD growth rate was fluctuating over the last decade. It had reached its peak in 2007 (17.6%) and dropped to 5.5% in 2010. In 2012, it had risen to 17.1% however it was not sustainable to 2013 (Table 2.1.1b)

In 2013, 79.8% of PD patients were on CAPD and 14.6% on APD. APD penetration was increasing although at a very slow rate. DAPD was prescribed to only a very small proportion of patients accounting for about 5.7% (Table 12.1.1).

**Table 12.1.1:** Peritoneal dialysis regimes, 2004-2013

PD regime	2004		2005		2006		2007		2008	
	n	%	n	%	n	%	n	%	n	%
Standard CAPD	1266	96.1	1303	93.2	1397	90	1547	85.7	1717	82.4
DAPD	39	3	45	3.2	67	4.3	115	6.4	121	5.8
Automated PD/ CCPD	12	0.9	50	3.6	88	5.7	144	8	245	11.8
<b>Total</b>	<b>1317</b>	<b>100</b>	<b>1398</b>	<b>100</b>	<b>1552</b>	<b>100</b>	<b>1806</b>	<b>100</b>	<b>2083</b>	<b>100</b>
PD regime	2009		2010		2011		2012		2013	
	n	%	n	%	n	%	n	%	n	%
Standard CAPD	1847	83.5	1973	83.6	2061	80.9	2309	81.1	2572	79.8
DAPD	119	5.4	91	3.9	117	4.6	140	4.9	183	5.7
Automated PD/ CCPD	246	11.1	296	12.5	371	14.6	397	13.9	470	14.6
<b>Total</b>	<b>2212</b>	<b>100</b>	<b>2360</b>	<b>100</b>	<b>2549</b>	<b>100</b>	<b>2846</b>	<b>100</b>	<b>3225</b>	<b>100</b>

In 2013, 77.4% of patients were on the Baxter disconnect system (Table 12.1.2). 92.5% were performing 4 exchanges a day. Only 1.9% of patients require 5 exchanges a day reflecting that patients that require better clearances were converted to haemodialysis rather than increasing the number of exchanges (Table 12.1.3a). About 80% of patients on APD use dwell volumes of 10litres or less (Table 12.1.3b).

**Table 12.1.2:** CAPD connectology, 2004-2013

CAPD connectology	2004		2005		2006		2007		2008	
	n	%	n	%	n	%	n	%	n	%
Baxter disconnect	1147	88.8	1286	92.1	1425	92	1675	93.5	1955	93.9
Fresenius disconnect	145	11.2	111	7.9	119	7.7	116	6.5	124	6
Others	0	0	0	0	5	0.3	0	0	4	0.2
<b>Total</b>	<b>1292</b>	<b>100</b>	<b>1397</b>	<b>100</b>	<b>1549</b>	<b>100</b>	<b>1791</b>	<b>100</b>	<b>2083</b>	<b>100</b>
CAPD connectology	2009		2010		2011		2012		2013	
	n	%	n	%	n	%	n	%	n	%
Baxter disconnect	2013	92.1	2126	90.7	2169	85.5	2270	79.6	2503	77.4
Fresenius disconnect	173	7.9	218	9.3	366	14.4	579	20.3	731	22.6
Others	0	0	1	0	1	0	1	0	1	0
<b>Total</b>	<b>2186</b>	<b>100</b>	<b>2345</b>	<b>100</b>	<b>2536</b>	<b>100</b>	<b>2850</b>	<b>100</b>	<b>3235</b>	<b>100</b>

**Table 12.1.3(a):** CAPD Number of Exchanges per day, 2004-2013

Number of exchanges/ day	2004		2005		2006		2007		2008	
	n	%	n	%	n	%	n	%	n	%
2	6	0.5	3	0.2	3	0.2	2	0.1	3	0.2
3	12	1	20	1.5	52	3.7	29	1.9	47	2.8
4	1185	94.8	1234	95.1	1296	93.2	1456	95.8	1611	94.4
5	47	3.8	40	3.1	39	2.8	33	2.2	46	2.7
<b>Total</b>	<b>1250</b>	<b>100</b>	<b>1297</b>	<b>100</b>	<b>1390</b>	<b>100</b>	<b>1520</b>	<b>100</b>	<b>1707</b>	<b>100</b>

Number of exchanges/ day	2009		2010		2011		2012		2013	
	n	%	n	%	n	%	n	%	n	%
2	2	0.1	7	0.4	1	0	10	0.4	18	0.7
3	79	4.4	125	6.4	112	5.5	136	6	124	4.9
4	1676	92.3	1778	91.1	1857	91.3	2057	90.3	2338	92.5
5	59	3.2	42	2.2	65	3.2	74	3.2	47	1.9
<b>Total</b>	<b>1816</b>	<b>100</b>	<b>1952</b>	<b>100</b>	<b>2035</b>	<b>100</b>	<b>2277</b>	<b>100</b>	<b>2527</b>	<b>100</b>

**Table 12.1.3(b):** APD dwell volumes per day, 2004-2013

Dwell volumes/ day	2004		2005		2006		2007		2008	
	n	%	n	%	n	%	n	%	n	%
8	0	0	9	47.4	6	12.5	11	10.5	4	2.2
10	4	100	7	36.8	32	66.7	83	79	164	92.1
12	0	0	3	15.8	10	20.8	10	9.5	10	5.6
14	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	1	1	0	0
<b>Total</b>	<b>4</b>	<b>100</b>	<b>19</b>	<b>100</b>	<b>48</b>	<b>100</b>	<b>105</b>	<b>100</b>	<b>178</b>	<b>100</b>

Dwell volumes/ day	2009		2010		2011		2012		2013	
	n	%	n	%	n	%	n	%	n	%
8	7	5.1	11	14.5	2	1	11	10.7	5	17.9
10	119	87.5	56	73.7	200	98	89	86.4	20	71.4
12	8	5.9	8	10.5	1	0.5	1	1	2	7.1
14	0	0	0	0	0	0	0	0	0	0
16	2	1.5	1	1.3	1	0.5	2	1.9	1	3.6
<b>Total</b>	<b>136</b>	<b>100</b>	<b>76</b>	<b>100</b>	<b>204</b>	<b>100</b>	<b>103</b>	<b>100</b>	<b>28</b>	<b>100</b>

In 2013, 64% of patient on CAPD were able to perform their own exchanges, however only 33% of APD patients were self-cared. The figures demonstrated that more patients required assistance when on APD than on CAPD justifying the need of APD in these patients.

**Table 12.1.4:** Assistance to Perform PD, 2004-2013

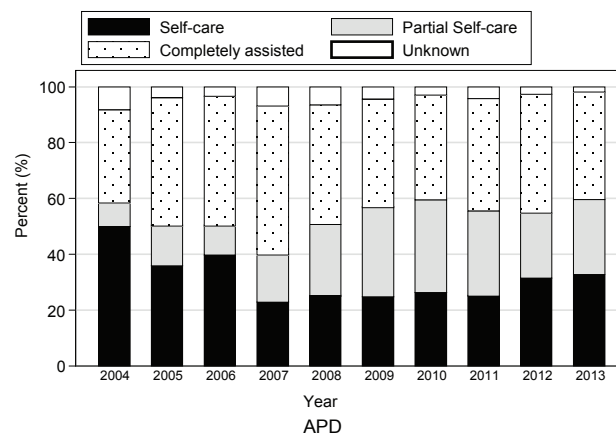
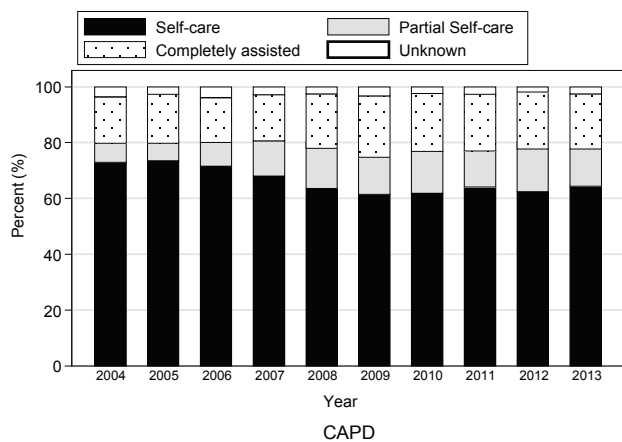
PD regime/Assistance	2004		2005		2006		2007		2008	
	n	%	n	%	n	%	n	%	n	%
<b>CAPD</b>										
Self-care	923	73	958	74	997	71	1051	68	1088	63
Partial self-care	87	7	82	6	121	9	197	13	249	15
Completely assisted	210	17	228	17	224	16	254	16	336	20
Unknown	46	4	35	3	55	4	45	3	44	3
<b>Automated PD</b>										
Self-care	6	50	18	36	35	40	33	23	62	25
Partial self-care	1	8	7	14	9	10	24	17	62	25
Completely assisted	4	33	23	46	41	47	77	53	105	43
Unknown	1	8	2	4	3	3	10	7	16	7

PD regime/Assistance	2009		2010		2011		2012		2013	
	n	%	n	%	n	%	n	%	n	%
<b>CAPD</b>										
Self-care	1133	61	1222	62	1319	64	1441	62	1651	64
Partial self-care	246	13	294	15	267	13	349	15	342	13
Completely assisted	407	22	408	21	420	20	476	21	514	20
Unknown	61	3	49	2	55	3	43	2	65	3
<b>Automated PD</b>										
Self-care	61	25	78	26	94	25	125	31	153	33
Partial self-care	78	32	98	33	112	30	92	23	127	27
Completely assisted	96	39	111	38	149	40	169	43	181	39
Unknown	11	4	9	3	16	4	11	3	9	2

**Figure 12.1.4(a):** Assistance to Perform CAPD, 2004-2013

**Figure 12.1.4(b):** Assistance to Perform APD, 2004-2013



## SECTION 12.2: ACHIEVEMENT OF SOLUTE CLEARANCE AND PERITONEAL TRANSPORT

The percentage of patients achieving target solute clearance of  $\geq 1.7$  per week had been static at 79% in 2010-2012 and declined further in 2013 (Table 12.2.1). The declined rate compared to 2004-2009 was attributed to a change in the recommended target Kt/V on PD adequacy in 2007<sup>1</sup>. This declining pattern stresses the need to target higher Kt/V to achieve the minimum requirement in solute clearance in PD patients.

The proportion of patients achieving the delivered Kt/V in 2013 was 52% in 5<sup>th</sup> percentile and 88% in 95<sup>th</sup> Apercentile. This wide inter-centre variation pattern was observed annually for the past 10 years (Table 12.2.2).

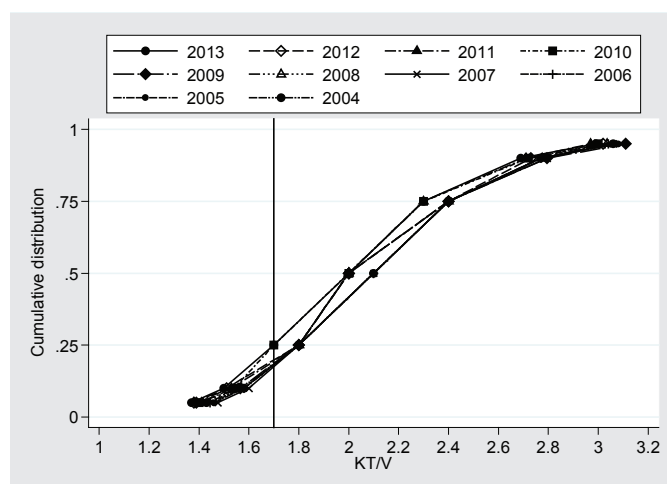
There was no predilection for any type of peritoneal membrane characteristics in incident PD patients (Table 12.2.3). However, there was consistent predominance of high transport compared to low transport status for those with more than 10 years dialysis (Table 12.3.4).

Table and Figure 12.3.5 showed residual renal volume (RRV) steadily declined over time. More than 50% of PD patients tend to lose their RRV (<400 ml/day) after 2 years on PD.

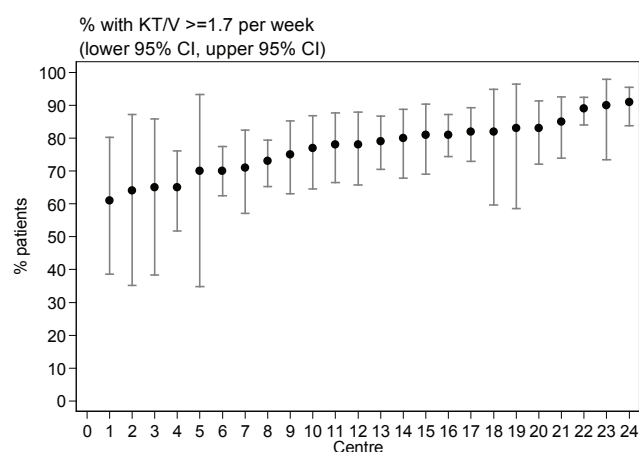
**Table 12.2.1:** Distribution of delivered Kt/V, PD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 1.7$ per week
2004	1038	2.1	0.5	2.1	1.8	2.4	85
2005	1092	2.1	0.5	2.1	1.8	2.4	83
2006	1266	2.1	0.5	2.1	1.8	2.4	84
2007	1412	2.1	0.5	2.1	1.8	2.4	83
2008	1679	2.1	0.5	2	1.8	2.4	82
2009	1837	2.1	0.5	2	1.8	2.4	81
2010	1913	2.1	0.5	2	1.7	2.3	79
2011	1727	2.1	0.5	2	1.8	2.3	79
2012	2278	2.1	0.5	2	1.8	2.4	79
2013	2724	2.1	0.5	2	1.7	2.3	78

**Figure 12.2.1:** Cumulative distribution of delivered Kt/V, PD patients 2004-2013



**Figure 12.2.2:** Variation in proportion of patients with Kt/V  $\geq 1.7$  per week among PD centres 2013



**Table 12.2.2:** Variation in proportion of patients with Kt/V  $\geq$ 1.7 per week among PD centres, 2004-2013

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2004	17	75	75	79	85	88	100	100
2005	18	56	56	75	85	89	96	96
2006	20	66	66	78	82.5	91.5	100	100
2007	21	25	69	78	85	89	93	93
2008	20	33	50.5	76.5	80	89	93.5	96
2009	21	48	63	76	83	89	97	100
2010	22	48	59	73	79	86	90	94
2011	23	61	64	70	79	83	90	91
2012	24	53	59	70	79.5	87.5	95	100
2013	25	48	52	70	80	84	88	91

**Table 12.2.3:** Peritoneal transport status by PET D/P creatinine at 4 hours, new PD patients 2004-2013

Year	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Low	31	15.6	45	11.1	88	12.7	92	10.1	145	13.2	186	13.8	190	13.6	163	10.3	194	10.5	265	12.5
Low average	72	36.2	159	39.3	285	41.2	376	41.3	465	42.2	530	39.2	549	39.2	622	39.3	743	40.4	861	40.6
High average	82	41.2	156	38.5	256	37	355	39	384	34.8	455	33.7	480	34.3	604	38.2	705	38.3	752	35.4
High	14	7	45	11.1	63	9.1	88	9.7	108	9.8	181	13.4	180	12.9	194	12.3	198	10.8	245	11.5
<b>Total</b>	<b>199</b>	<b>100</b>	<b>405</b>	<b>100</b>	<b>692</b>	<b>100</b>	<b>911</b>	<b>100</b>	<b>1102</b>	<b>100</b>	<b>1352</b>	<b>100</b>	<b>1399</b>	<b>100</b>	<b>1583</b>	<b>100</b>	<b>1840</b>	<b>100</b>	<b>2123</b>	<b>100</b>

**Table 12.2.4:** Peritoneal Transport Status (PET) with dialysis vintage

Duration (Years)	<1		1-<2		2-<3		3-<4		4-<5	
	n	%	n	%	n	%	n	%	n	%
Low	60	12	79	14	42	12	23	10	29	17
Low average	162	34	231	41	155	42	101	45	70	41
High average	200	42	189	33	115	32	80	36	60	35
High	59	12	68	12	53	15	21	9	12	7
<b>Total</b>	<b>481</b>	<b>100</b>	<b>567</b>	<b>100</b>	<b>365</b>	<b>100</b>	<b>225</b>	<b>100</b>	<b>171</b>	<b>100</b>

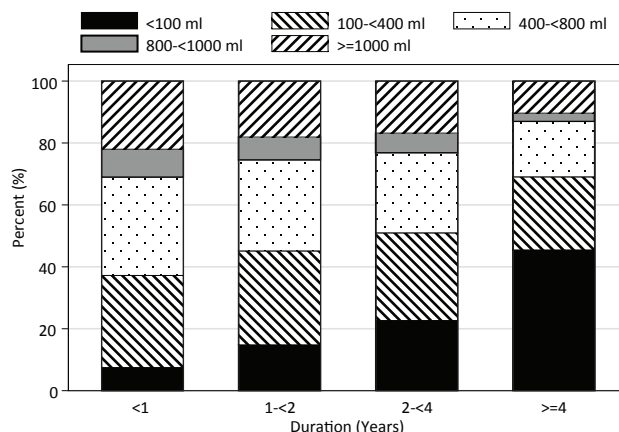
  

Duration (Years)	5-<6		6-<7		7-<8		8-<9		9-<10		10 or more	
	n	%	n	%	n	%	n	%	n	%	n	%
Low	15	14	10	11	3	6	2	6	2	7	4	7
Low average	48	44	47	53	20	38	15	44	12	40	13	23
High average	34	31	28	31	20	38	13	38	13	43	32	56
High	12	11	4	4	9	17	4	12	3	10	8	14
<b>Total</b>	<b>109</b>	<b>100</b>	<b>89</b>	<b>100</b>	<b>52</b>	<b>100</b>	<b>34</b>	<b>100</b>	<b>30</b>	<b>100</b>	<b>57</b>	<b>100</b>

**Table 12.2.5:** Residual Urine Volume

Duration (Years)	<1		1-<2		2-<4		4 or more	
	n	%	n	%	n	%	n	%
<100 ml	22	7	69	15	95	23	139	45
100 - <400 ml	89	30	141	30	119	28	72	24
400 - <800 ml	95	32	138	30	109	26	55	18
800 - <1000 ml	27	9	34	7	27	6	8	3
>=1000 ml	66	22	85	18	71	17	32	10
<b>Total</b>	<b>299</b>	<b>100</b>	<b>467</b>	<b>100</b>	<b>421</b>	<b>100</b>	<b>306</b>	<b>100</b>

**Figure 12.2.5:** Residual Urine Volume in prevalent PD patients (2013)



**SECTION 12.3: TECHNIQUE SURVIVAL ON PD**

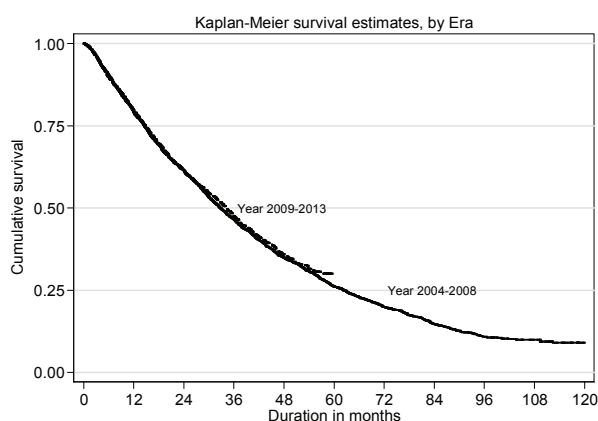
The annual death rate and the adjusted hazard ratio for mortality for PD patients had remained static (refer Chapter 3, Figure 3.1.1 and Table 3.4.3)

There was no difference in technique survival (uncensored and censored for death and transplant) between eras 2004-2008 and 2009-2013 (Table and Figure 12.3.1a & b). In the latter era, technique survival was 93%, 78% and 69% at 1, 3 and 4 years respectively.

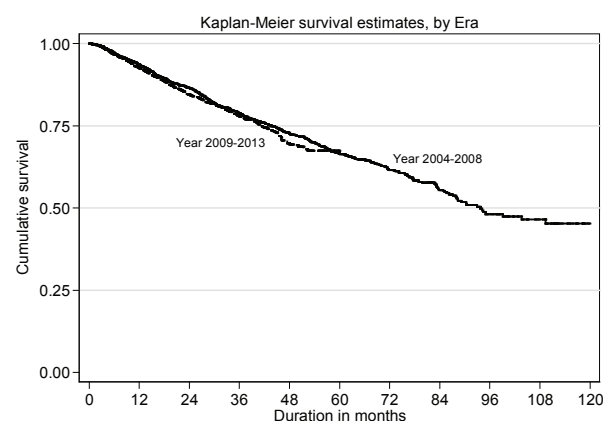
**Table 12.3.1(a):** Unadjusted technique survival by era 2004–2008 and 2009–2013 (uncensored for death and transplant)

Era Interval (month)	2004-2008			2009-2013		
	n	% Survival	SE	n	% Survival	SE
0	2412	100		4000	100	
6	2167	97	0	3205	97	0
12	1885	94	1	2397	93	0
24	1435	87	1	1229	85	1
36	1068	79	1	580	78	1
48	796	72	1	228	69	2
60	588	66	1	-	-	-
72	336	62	1	-	-	-
84	173	55	2	-	-	-
96	82	48	2	-	-	-
108	41	46	2	-	-	-
120	-	-	-	-	-	-

**Figure 12.3.1(a):** Unadjusted technique survival by era 2004–2008 and 2009–2013 (uncensored for death and transplant)



**Figure 12.3.1(b):** Unadjusted technique survival by era 2004–2008 and 2009–2013 (censored for death and transplant)



**Table 12.3.1(b):** Unadjusted technique survival by era 2004–2008 and 2009–2013 (censored for death and transplant)

Era Interval (month)	2004-2008			2009-2013		
	n	% Survival	SE	n	% Survival	SE
0	2412	100		4000	100	
6	2167	97	0	3205	97	0
12	1885	94	1	2397	93	0
24	1435	87	1	1229	85	1
36	1068	79	1	580	78	1
48	796	72	1	228	69	2
60	588	66	1			
72	336	62	1			
84	173	55	2			
96	82	48	2			
108	41	46	2			
120						

Youngest age group (age <14 years) had better technique survival (uncensored for death and transplant) (Table & Figure 12.3.2a). However, after censored for death and transplant, age 15-34 and ≥65 years fared best compared to other age groups after 2 years on PD treatment (Table & Figure 12.3.2b).

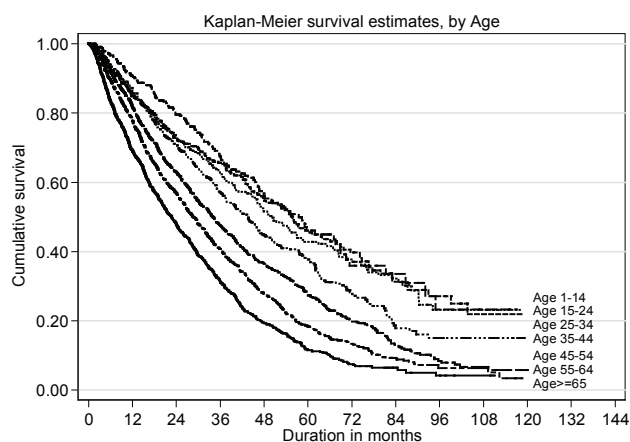
**Table 12.3.2(a):** Unadjusted technique survival by age (uncensored for death and transplant), 2004-2013

Age group (year)	≤ 14			15-24			25-34			35-44		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	342	100		473	100		511	100		705	100	
6	310	97	1	405	93	1	436	93	1	612	94	1
12	270	91	2	329	87	2	363	85	2	502	85	1
24	194	80	2	231	73	2	256	73	2	347	71	2
36	125	68	3	165	63	3	186	66	2	228	57	2
48	83	56	3	120	52	3	117	55	3	154	45	2
60	45	46	4	78	43	3	77	46	3	99	38	2
72	23	36	5	55	38	3	49	40	3	54	28	3
84	15	34	5	32	32	3	28	31	4	24	18	3
96	7	23	6	16	23	4	16	27	4	15	15	3
108	4	23	6	11	23	4	6	22	5	8	15	3
120	1			1			1			1		

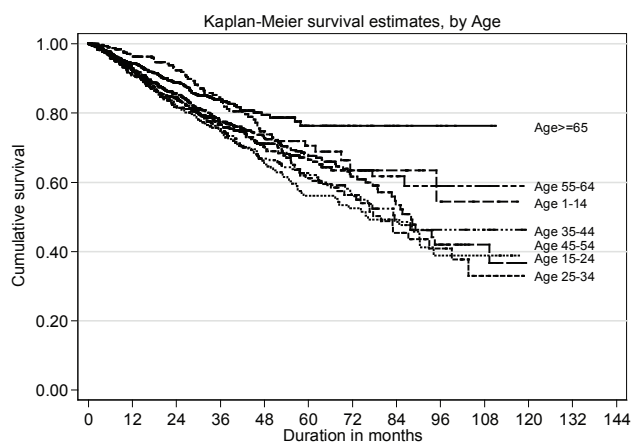
Age group (year)	45-54			55-64			≥65		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	1320	100		1686	100		1375	100	
6	1132	92	1	1410	90	1	1073	83	1
12	915	82	1	1107	78	1	801	69	1
24	565	63	1	641	57	1	433	48	2
36	349	48	2	367	41	1	230	31	2
48	235	36	2	205	28	1	113	19	1
60	138	27	2	108	18	1	49	11	1
72	80	20	2	56	13	1	25	8	1
84	44	13	2	25	9	1	11	6	1
96	19	8	1	8	6	1	6	4	1
108	9	7	1	6	6	1	3	4	1
120	1			1			1		



**Figure 12.3.2(a):** Unadjusted technique survival by age (uncensored for death and transplant), 2004-2013



**Figure 12.3.2(b):** Unadjusted technique survival by age (censored for death and transplant), 2004-2013



**Table 12.3.2(b):** Unadjusted technique survival by age (censored for death and transplant), 2004-2013

Age group (year)	≤ 14			15-24			25-34			35-44		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	342	100		473	100		511	100		705	100	
6	310	99	1	405	96	1	436	96	1	612	98	1
12	270	97	1	329	93	1	363	91	1	502	93	1
24	194	92	2	231	82	2	256	82	2	347	85	2
36	125	84	3	165	75	2	186	77	2	228	75	2
48	83	74	3	120	65	3	117	70	3	154	67	3
60	45	71	4	78	56	3	77	61	3	99	62	3
72	23	63	5	55	52	4	49	56	4	54	56	3
84	15	63	5	32	49	4	28	45	5	24	49	4
96	7	54	10	16	39	5	16	41	5	15	46	5
108	4	54	10	11	39	5	6	33	7	8	46	5
120	1			1			1			1		

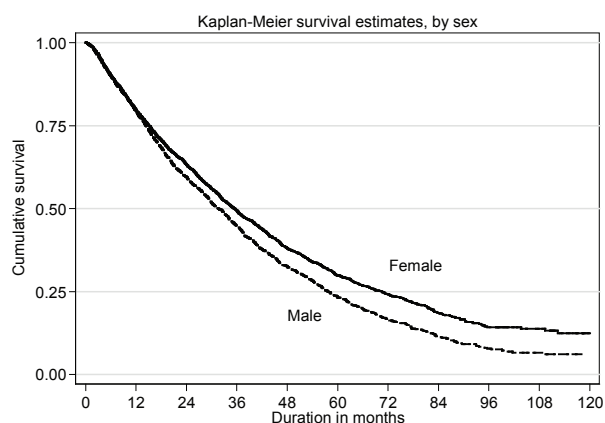
Age group (year)	45-54			55-64			≥65		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	1320	100		1686	100		1375	100	
6	1132	97	1	1410	97	0	1073	97	1
12	915	92	1	1107	93	1	801	94	1
24	565	86	1	641	84	1	433	89	1
36	349	78	2	367	77	1	230	84	2
48	235	73	2	205	71	2	113	79	2
60	138	68	2	108	67	2	49	76	3
72	80	62	3	56	63	3	25	76	3
84	44	53	4	25	62	3	11	76	3
96	19	42	5	8	59	4	6	76	3
108	9	42	5	6	59	4	3	76	3
120	1			1			1		

Females consistently had better technique survival than their male counterparts (Table and Figure 12.3.3a & b).

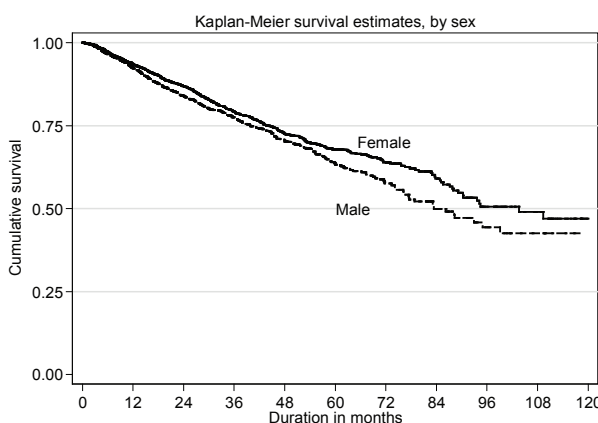
**Table 12.3.3(a):** Unadjusted technique survival by gender (uncensored for death and transplant), 2004-2013

Gender Interval (months)	Male			Female		
	n	% Survival	SE	n	% Survival	SE
0	3236	100		3176	100	
6	2721	97	0	2651	97	0
12	2153	92	1	2129	94	0
24	1286	84	1	1378	87	1
36	775	77	1	873	79	1
48	468	70	1	553	72	1
60	259	63	2	331	68	1
72	133	58	2	204	64	2
84	68	50	3	107	59	2
96	30	44	3	52	51	3
108	15	43	4	27	49	3
120	1			1		

**Figure 12.3.3(a):** Unadjusted technique survival by gender (uncensored for death and transplant), 2004-2013



**Figure 12.3.3(b):** Unadjusted technique survival by gender (censored for death and transplant), 2004-2013



**Table 12.3.3(b):** Unadjusted technique survival by gender (censored for death and transplant), 2004-2013

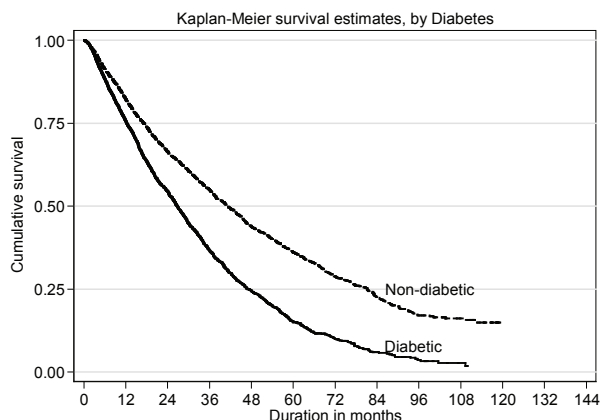
Gender Interval (months)	Male			Female		
	n	% Survival	SE	n	% Survival	SE
0	3236	100		3176	100	
6	2721	97	0	2651	97	0
12	2153	92	1	2129	94	0
24	1286	84	1	1378	87	1
36	775	77	1	873	79	1
48	468	70	1	553	72	1
60	259	63	2	331	68	1
72	133	58	2	204	64	2
84	68	50	3	107	59	2
96	30	44	3	52	51	3
108	15	43	4	27	49	3
120	1			1		

The technique survival (uncensored for death and transplant) was better for non-diabetic patients (Table & Figure 12.3.4a). However, there was no difference after censored for death and transplant (Table & Figure 12.3.4b).

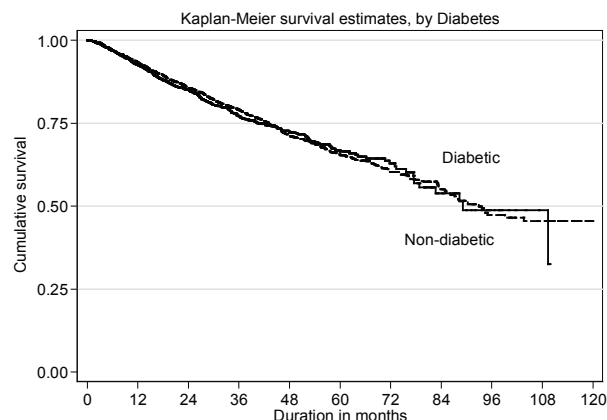
**Table 12.3.4(a):** Unadjusted technique survival by diabetes status (uncensored for death and transplant), 2004-2013

Diabetes status Interval (month)	Non-diabetic			Diabetic		
	n	% Survival	SE	n	% Survival	SE
0	3888	100		2524	100	
6	3242	97	0	2133	97	0
12	2581	93	0	1701	93	1
24	1638	86	1	1026	85	1
36	1060	79	1	588	77	1
48	677	71	1	346	72	1
60	428	65	1	161	66	2
72	258	60	2	79	63	2
84	144	55	2	30	54	4
96	70	47	2	12	49	5
108	38	46	3	4	49	5
120	1			1		

**Figure 12.3.4(a):** Unadjusted technique survival by Diabetes status (uncensored for death and transplant), 2004-2013



**Figure 12.3.4(b):** Unadjusted technique survival by diabetes status (censored for death and transplant), 2004-2013



**Table 12.3.4(b):** Unadjusted technique survival by diabetes status (censored for death and transplant), 2004-2013

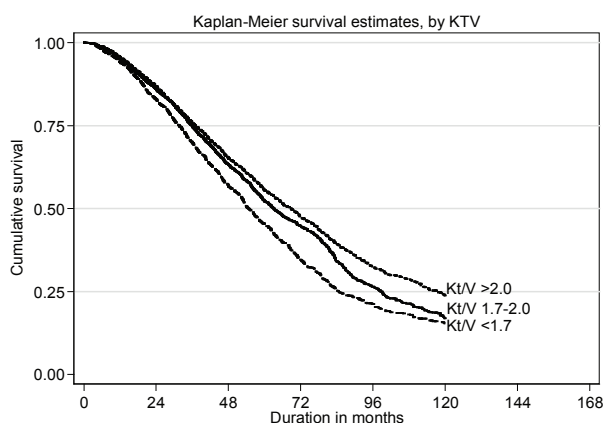
Diabetes status Interval (month)	Non-diabetic			Diabetic		
	n	% Survival	SE	n	% Survival	SE
0	3888	100		2524	100	
6	3242	97	0	2133	97	0
12	2581	93	0	1701	93	1
24	1638	86	1	1026	85	1
36	1060	79	1	588	77	1
48	677	71	1	346	72	1
60	428	65	1	161	66	2
72	258	60	2	79	63	2
84	144	55	2	30	54	4
96	70	47	2	12	49	5
108	38	46	3	4	49	5
120	1			1		

There was a clear association of technique survival with solute clearance. Patients with Kt/V <1.7 had the worst technique survival. There was no initial difference in technique survival between Kt/V 1.7-2.0 and Kt/V >2.0 but the curves started to diverge at 48 months, with better outcome in Kt/V >2.0 (Table & Figure 12.3.5).

**Table 12.3.5:** Unadjusted technique survival by Kt/V, 2004-2013

Kt/V Interval(months)	<1.7			1.7-2.0			>2.0		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	2656	100		3783	100		7697	100	
6	2602	98	0	3723	98	0	7612	99	0
12	2490	94	0	3587	95	0	7345	96	0
24	2121	83	1	3151	86	1	6416	87	0
36	1675	70	1	2623	75	1	5223	76	0
48	1289	57	1	2100	63	1	4148	65	1
60	915	45	1	1589	52	1	3168	55	1
72	630	35	1	1221	45	1	2440	47	1
84	429	25	1	821	34	1	1723	39	1
96	322	21	1	564	26	1	1211	32	1
108	246	18	1	382	21	1	938	29	1
120	159	15	1	253	17	1	606	24	1

**Figure 12.3.5:** Unadjusted technique survival by Kt/V, 2004-2013



Age (15-24 years), peritonitis, female gender, low hemoglobin, low serum albumin, low serum calcium and low serum phosphate were associated with an increased risk of technique failure (Table 12.3.6).

**Table 12.3.6:** Adjusted hazard ratio for change of modality, 2004-2013

Factors	n	Hazard ratio	95% CI	p value
<b>Age (years)</b>				
Age 1-14 (ref*)	342	1.000		
Age 15-24	473	1.489	(1.01 ; 2.196)	0.044
Age 25-34	511	1.263	(0.838 ; 1.905)	0.265
Age 35-44	705	1.275	(0.853 ; 1.906)	0.236
Age 45-54	1320	1.026	(0.693 ; 1.521)	0.897
Age 55-64	1686	1.139	(0.773 ; 1.678)	0.510
Age >=65	1375	1.008	(0.662 ; 1.535)	0.970
<b>Peritonitis</b>				
No (ref*)	6000	1.000		
Yes	412	9.633	(8.35 ; 11.112)	<0.001
<b>Diabetes Mellitus</b>				
Non-diabetic (ref*)	3888	1.000		
Diabetic	2524	1.074	(0.908 ; 1.269)	0.404

Factors	n	Hazard ratio	95% CI	p value
<b>Gender</b>				
Male (ref*)	3236	1.000		
Female	3176	0.754	(0.648 ; 0.878)	<0.001
<b>Cardiovascular Disease</b>				
No CVD (ref*)	5229	1.000		
CVD	1183	0.830	(0.666 ; 1.034)	0.097
<b>BMI</b>				
<18.5	638	0.937	(0.728 ; 1.207)	0.615
18.5-<25 (ref*)	3329	1.000		
>=25	2445	1.252	(1.075 ; 1.458)	0.004
<b>Serum Albumin</b>				
<30	1987	1.299	(1.076 ; 1.568)	0.006
30-<35	2371	1.106	(0.94 ; 1.301)	0.224
35-<45 (ref*)	1985	1.000		
>=45	69	0.805	(0.376 ; 1.726)	0.577
<b>Serum cholesterol (mmol/L)</b>				
<3.5	332	0.955	(0.658 ; 1.385)	0.807
3.5-<5.2	3466	0.823	(0.675 ; 1.003)	0.053
5.2-<6.2	1613	0.938	(0.761 ; 1.155)	0.545
>=6.2 (ref*)	1001	1.000		
<b>Diastolic BP</b>				
<70	887	1.021	(0.777 ; 1.341)	0.882
70-<80	2356	1.032	(0.87 ; 1.223)	0.719
80-<90 (ref*)	2347	1.000		
90-<100	703	1.219	(0.994 ; 1.495)	0.057
>=100	119	2.569	(1.668 ; 3.958)	<0.001
<b>Hemoglobin (g/dL)</b>				
<10	2222	1.323	(1.138 ; 1.539)	<0.001
10-<12 (ref*)	3523	1.000		
>=12	667	1.014	(0.786 ; 1.308)	0.914
<b>Serum calcium (mmol/L)</b>				
<2.1	1842	1.321	(1.119 ; 1.56)	0.001
2.1-<=2.37 (ref*)	3495	1.000		
>2.37	1075	0.952	(0.788 ; 1.151)	0.613
<b>Calcium Phosphate product</b>				
<3.5	3815	1.154	(0.934 ; 1.426)	0.185
3.5-<4.5 (ref*)	1742	1.000		
4.5-<5.5	620	0.668	(0.495 ; 0.902)	0.008
>=5.5	235	0.974	(0.609 ; 1.559)	0.914
<b>Serum Phosphate (mmol/L)</b>				
<0.8	96	3.574	(1.969 ; 6.486)	<0.001
0.8-<1.3 (ref*)	1678	1.000		
1.3-<1.8	3096	0.813	(0.669 ; 0.988)	0.038
1.8-<2.2	1029	0.974	(0.713 ; 1.33)	0.868
>=2.2	513	1.454	(0.907 ; 2.331)	0.120
<b>Kt/V</b>				
<1.7	1096	1.197	(0.984 ; 1.455)	0.072
1.7-2.0 (ref*)	1366	1.000		
<=2	2845	1.024	(0.87 ; 1.206)	0.774
<b>Assisted PD</b>				
Selfcare (ref*)	2859	1.000		
Assisted	2977	0.981	(0.831 ; 1.159)	0.824

The commonest cause of technique failure in year 2013 was peritonitis (13%) followed by membrane failure (6%) as shown in Table and Figure 12.3.7(a). Majority of the technique failure (74%) occurred after 12 months of treatment (Table 12.3.7b).

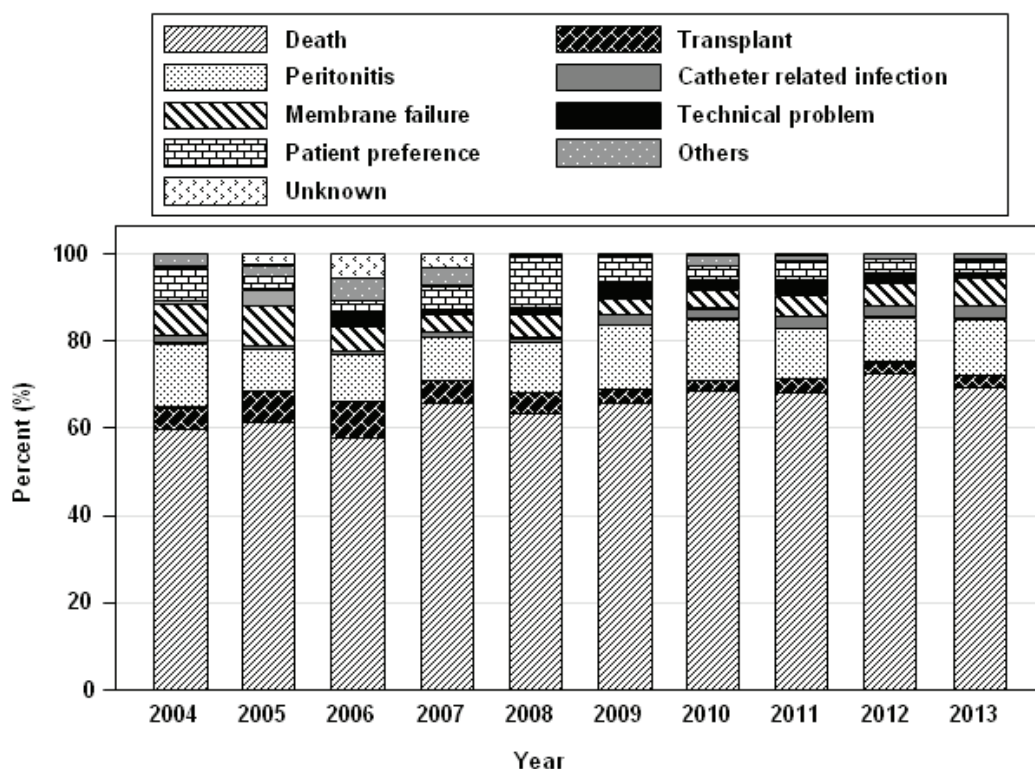
**Table 12.3.7(a):** Reasons for drop-out from PD program, 2004-2013

Year	2004		2005		2006		2007		2008	
	n	%	n	%	n	%	n	%	n	%
Death	156	60	182	61	177	58	231	66	277	63
Transplant	13	5	22	7	25	8	18	5	21	5
Peritonitis	38	15	29	10	33	11	35	10	50	11
Catheter related infection	5	2	2	1	2	1	4	1	4	1
Membrane failure	19	7	27	9	18	6	13	4	24	5
Technical problem	2	1	11	4	9	3	4	1	7	2
Patient preference	20	8	10	3	9	3	20	6	50	11
Others	8	3	7	2	16	5	14	4	2	0
Unknown	0	0	8	3	17	6	12	3	2	0
<b>Total</b>	<b>261</b>	<b>100</b>	<b>298</b>	<b>100</b>	<b>306</b>	<b>100</b>	<b>351</b>	<b>100</b>	<b>437</b>	<b>100</b>

Year	2009		2010		2011		2012		2013	
	n	%	n	%	n	%	n	%	n	%
Death	321	66	353	69	372	68	397	72	423	69
Transplant	15	3	12	2	17	3	14	3	17	3
Peritonitis	72	15	72	14	63	12	57	10	78	13
Catheter related infection	11	2	13	3	15	3	14	3	19	3
Membrane failure	18	4	22	4	27	5	28	5	38	6
Technical problem	19	4	12	2	19	3	14	3	8	1
Patient preference	28	6	16	3	23	4	17	3	18	3
Others	3	1	14	3	9	2	7	1	9	1
Unknown	1	0	1	0	1	0	0	0	0	0
<b>Total</b>	<b>488</b>	<b>100</b>	<b>515</b>	<b>100</b>	<b>546</b>	<b>100</b>	<b>548</b>	<b>100</b>	<b>610</b>	<b>100</b>

**Figure 12.3.7(a):** Reasons for drop-out from PD program, 2004-2013



**Table 12.3.7(b):** Drop-out rate from PD program with time on treatment, 2004-2013

Year	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
< 3 months	8	3	16	5	12	4	19	5	29	7	38	8	20	4	28	5	34	6	36	6
3-<6 months	17	7	24	8	24	8	33	9	31	7	38	8	41	8	48	9	51	9	52	9
6- <12 months	37	14	40	13	39	13	58	17	66	15	76	16	68	13	74	14	76	14	73	12
>=12 months	199	76	218	73	231	75	241	69	311	71	336	69	386	75	395	72	387	71	449	74
<b>Total</b>	<b>261</b>	<b>100</b>	<b>298</b>	<b>100</b>	<b>306</b>	<b>100</b>	<b>351</b>	<b>100</b>	<b>437</b>	<b>100</b>	<b>488</b>	<b>100</b>	<b>515</b>	<b>100</b>	<b>545</b>	<b>100</b>	<b>548</b>	<b>100</b>	<b>610</b>	<b>100</b>

**Table 12.3.8:** Time on PD (2004-2013)

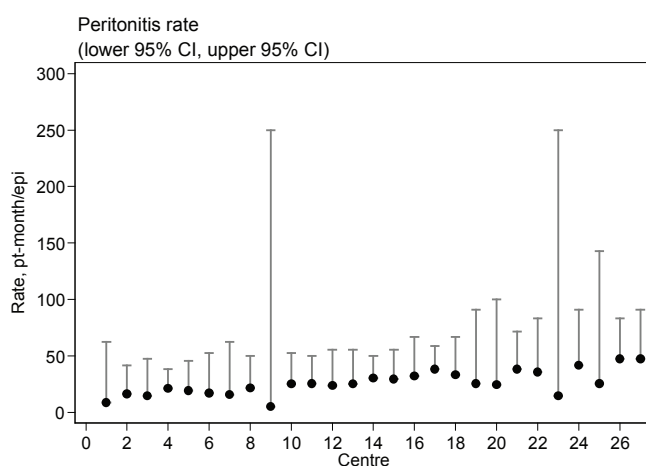
1 <sup>st</sup> Treatment (n=6412)	Months													
	0-<6	6-11	12-17	18-23	24-29	30-35	36-41	42-4	48-59	60-71	72-83	84-95	96-107	≥108
	1042	1088	914	704	548	468	348	279	432	252	164	93	40	40

## SECTION 12.4: PERITONITIS

The median peritonitis rate was 1 in 40.5 patient-months in 2013, compared to 1 in 59.3 patient-months in the preceding year (Table 12.4.1).

**Table 12.4.1:** Variation of peritonitis rate (pt-month/epi) among PD centres, 2004-2013

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2004	15	0	0	23.6	32.6	35.6	41.5	41.5
2005	15	18	18	26.3	35.8	43	57.7	57.7
2006	21	14.8	18.5	26.2	37.7	49.8	65.2	97.7
2007	23	12	12.9	31.2	42.1	55.7	67	106.7
2008	25	12	13	30	39.9	58.7	106	114.6
2009	25	13	17.7	29.1	38.2	55.6	119.7	246.1
2010	26	10.8	15.3	28.1	36.3	52.2	72.5	85.6
2011	28	8.9	12	34.2	47	63.6	113	261.4
2012	27	25.3	25.5	41.6	59.3	90.6	164.5	261.1
2013	27	15.7	25.8	33.1	40.5	52	61.8	63.8

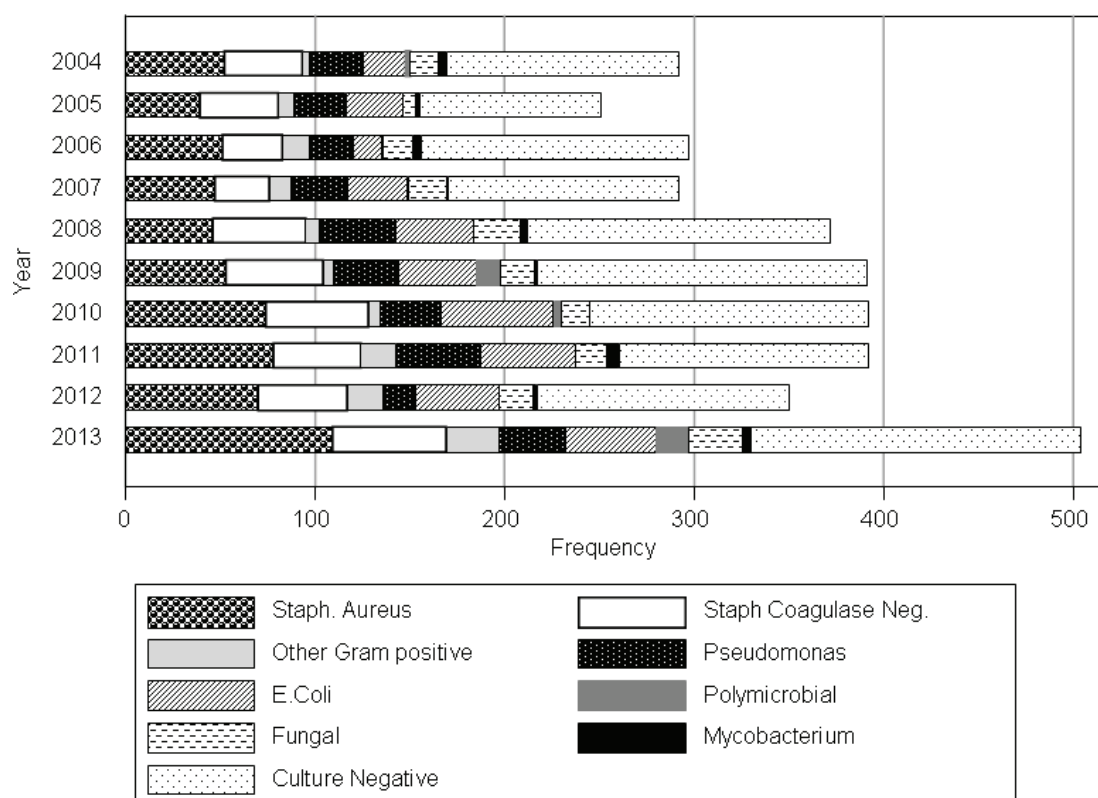
**Figure 12.4.1:** Variation in peritonitis rate among PD centres, 2013

Gram-positive organisms accounted for 37.4% of peritonitis with Staphylococcus aureus as the predominant gram-positive organism (43.6%). E. coli remained the commonest gram-negative pathogen accounted for 30% of gram-negative infections. The fungal peritonitis rate remained about 4% and there was less than 1% of mycobacterial peritonitis. The culture negative rate unfortunately remained high at 26% as compared to the ISPD target of less than 20% (Table & Figure 12.4.2a).

**Table 12.4.2(a):** Causative organism in PD peritonitis, 2004-2013

	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<b>(A) Gram Positives</b>																				
Staph. aureus	52	13.9	39	12.1	51	13.9	47	12.7	46	9.9	53	10.8	74	15	78	14.9	70	14.6	109	16.3
Staph Coagulase Neg.	41	11	42	13.1	32	8.7	29	7.8	49	10.5	51	10.4	54	10.9	46	8.8	47	9.8	60	9
Strep	13	3.5	10	3.1	17	4.6	14	3.8	19	4.1	17	3.5	12	2.4	34	6.5	39	8.1	53	7.9
Others	4	1.1	8	2.5	14	3.8	11	3	7	1.5	6	1.2	6	1.2	19	3.6	19	4	28	4.2
<b>(B) Gram Negatives</b>																				
Pseudomonas	28	7.5	27	8.4	23	6.3	30	8.1	40	8.6	34	6.9	32	6.5	44	8.4	17	3.5	35	5.2
Acinetobacter	25	6.7	21	6.5	8	2.2	21	5.7	20	4.3	17	3.5	9	1.8	22	4.2	13	2.7	19	2.8
Klebsiella	19	5.1	19	5.9	20	5.5	17	4.6	23	4.9	27	5.5	31	6.3	29	5.5	26	5.4	36	5.4
Enterobacter	9	2.4	13	4	7	1.9	8	2.2	3	0.6	13	2.7	8	1.6	9	1.7	7	1.5	11	1.6
E.Coli	23	6.2	30	9.3	15	4.1	32	8.6	42	9	41	8.4	60	12.1	50	9.5	44	9.2	48	7.2
Others	7	1.9	4	1.2	7	1.9	6	1.6	8	1.7	9	1.8	9	1.8	9	1.7	11	2.3	11	1.6
<b>(C) Polymicrobial</b>	2	0.5	0	0	1	0.3	0	0	0	0	13	2.7	4	0.8	0	0	0	0	17	2.5
<b>(D) Others</b>																				
Fungal	15	4	7	2.2	16	4.4	20	5.4	24	5.2	18	3.7	15	3	17	3.2	18	3.8	28	4.2
Mycobacterium	4	1.1	2	0.6	4	1.1	1	0.3	4	0.9	1	0.2	0	0	6	1.1	2	0.4	5	0.7
Others	8	2.1	3	0.9	10	2.7	12	3.2	21	4.5	16	3.3	33	6.7	30	5.7	34	7.1	36	5.4
<b>(E) No growth</b>	123	33	96	29.9	141	38.5	122	33	160	34.3	174	35.5	147	29.8	132	25.1	133	27.7	174	26
<b>Total</b>	<b>373</b>	<b>100</b>	<b>321</b>	<b>100</b>	<b>366</b>	<b>100</b>	<b>370</b>	<b>100</b>	<b>466</b>	<b>100</b>	<b>490</b>	<b>100</b>	<b>494</b>	<b>100</b>	<b>525</b>	<b>100</b>	<b>480</b>	<b>100</b>	<b>670</b>	<b>100</b>

**Figure 12.4.2(b):** Causative organism in PD peritonitis, 2004-2013



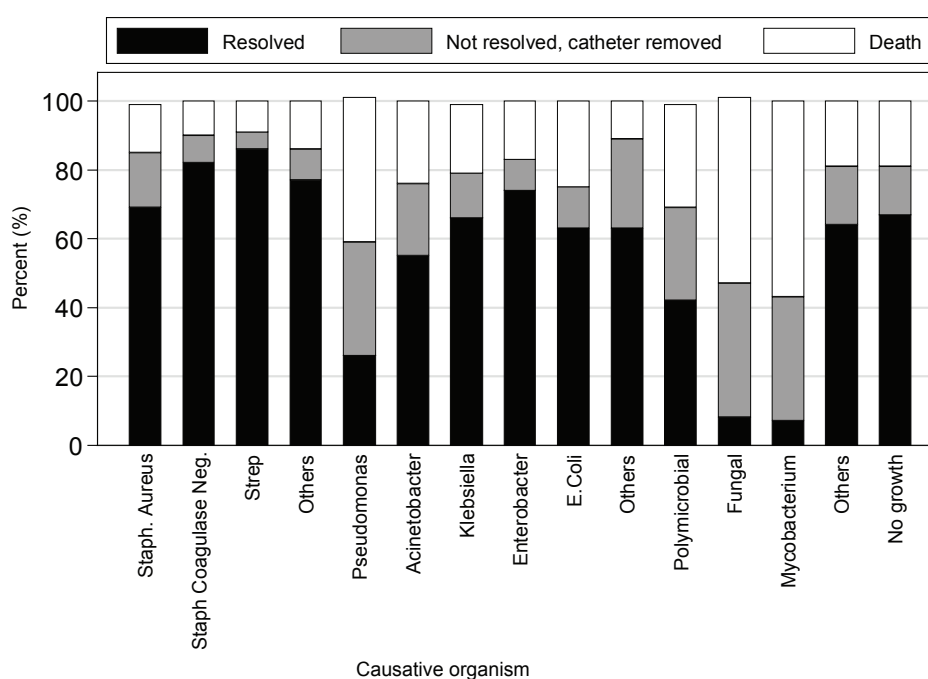


In terms of outcomes of peritonitis, it was clear that gram positive infections had better outcomes (Table and Figure 12.4.3a & b). There was complete resolution in 78.5% cases overall in the era 2009-2013 (Table & Figure 12.4.3b). In contrast, gram negative peritonitis had almost tripled the incidence of requiring catheter removal (29.8% vs 9.5% in gram positive peritonitis) and doubled the incidence of death (23% vs 11.75% in gram positive peritonitis). Among gram negative infections, Pseudomonas had the highest incidence of deaths (42%). Death rates from fungal and mycobacterial peritonitis remained high at 54% and 57% respectively (Table & Figure 12.4.3b).

**Table 12.4.3(b):** Outcome of peritonitis by causative organism, 2009-2013

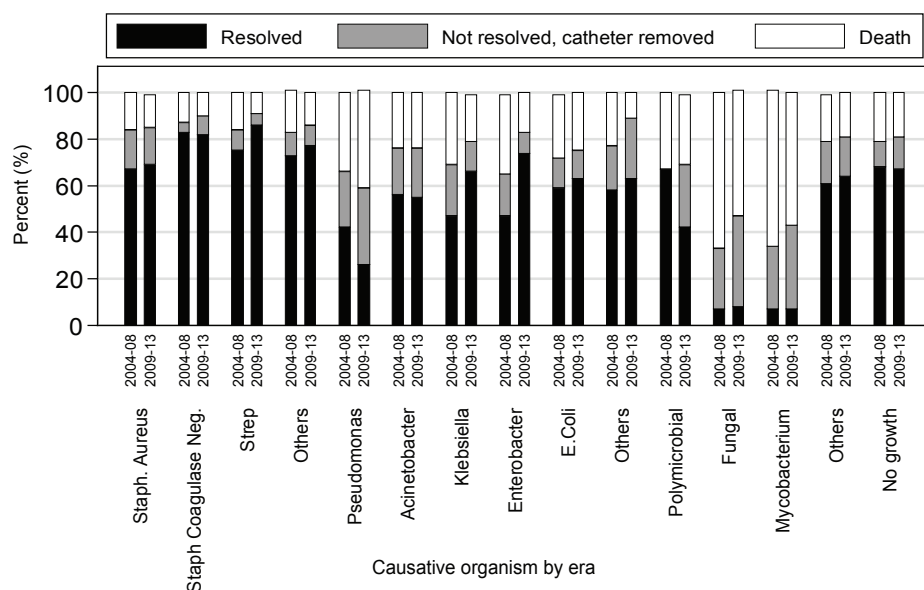
	Outcome							
	Resolved		Not resolved, catheter removed		Death		Total	
	n	%	n	%	n	%	n	%
<b>(A) Gram Positives</b>								
Staph. Aureus	249	69	58	16	52	14	359	100
Staph Coagulase Neg.	201	82	20	8	24	10	245	100
Strep	131	86	8	5	14	9	153	100
Others	57	77	7	9	10	14	74	100
<b>(B) Gram Negatives</b>								
Pseudomonas	38	26	49	33	62	42	149	100
Acinetobacter	41	55	16	21	18	24	75	100
Klebsiella	94	66	19	13	29	20	142	100
Enterobacter	34	74	4	9	8	17	46	100
E.Coli	147	63	28	12	59	25	234	100
Others	29	63	12	26	5	11	46	100
<b>(C) Polymicrobial</b>								
	14	42	9	27	10	30	33	100
<b>(D) Others</b>								
Fungal	7	8	36	39	50	54	93	100
Mycobacterium	1	7	5	36	8	57	14	100
Others	89	64	24	17	27	19	140	100
<b>(E) No growth</b>								
	492	67	100	14	139	19	731	100

**Figure 12.4.3(b):** Outcome of peritonitis by causative organism, 2009-2013



When comparing the last 2 eras of PD i.e. 2004-2008 and 2009-2013, there was not much difference in outcomes, except for pseudomonas infections where rates of catheter removal and death had increased. This may reflect increasing emergence of multi-resistant Pseudomonas organisms (Figure 12.4.3c). Total mortality rates remained almost the same in the two eras (18.7 % versus 20.3%). However, there was a decrease in fungal and mycobacterium peritonitis deaths which may be due to a more aggressive approach to remove catheters when there was a non-resolving peritonitis.

**Figure 12.4.3(c):** Outcome of peritonitis by causative organism by era, 2004-2008 & 2009-2013



In multivariate analysis (Table 12.4.4) two factors appeared to contribute significantly to a reduced peritonitis risk i.e. age less than or equal to 14 years and higher income level of the patient. Diabetes was not associated with an increased risk of peritonitis. Complete assistance with PD therapy was however associated with approximately 10% increased risk. It would be interesting in future to further analyse this finding with respect to the age of the assisted patient - presumably the group with the increased risk was the elderly group with multiple comorbidities. This was because the analysis had shown that those assisted by parents i.e. the youngest age group had lowest peritonitis risk.

**Table 12.4.4:** Risk factors influencing peritonitis rate, 2004-2013

Factors	n	Risk Ratio	95% CI	P value
<b>Age (years)</b>				
<=14	295	0.779	(0.637 ; 0.953)	0.015
15-24	398	0.959	(0.814 ; 1.13)	0.614
25-34 (ref*)	425	1.000		
35-44	579	1.042	(0.897 ; 1.21)	0.589
45-54	1091	1.077	(0.936 ; 1.24)	0.301
55-64	1392	1.141	(0.988 ; 1.319)	0.073
>=65	1070	1.097	(0.934 ; 1.287)	0.258
<b>Gender</b>				
Male (ref*)	2662	1.000		
Female	2588	1.031	(0.961 ; 1.107)	0.397
<b>Diabetes</b>				
No (ref*)	3092	1.000		
Yes	2158	1.067	(0.987 ; 1.154)	0.105
<b>Income</b>				
<RM 1000 (ref*)	1916	1.000		
RM 1000-3000	2603	0.835	(0.776 ; 0.899)	<0.001
RM 3001-5000	712	0.687	(0.604 ; 0.78)	<0.001
RM 5001-10000	17	0.435	(0.14 ; 1.354)	0.151
>=RM 10000	2	2.006	(0.281 ; 14.3)	0.487
<b>Education</b>				
Nil	477	1.090	(0.954 ; 1.245)	0.207
Primary	2563	0.991	(0.913 ; 1.076)	0.837
Secondary (ref*)	1689	1.000		
Tertiary	521	0.926	(0.811 ; 1.058)	0.256
<b>Assistance to perform CAPD</b>				
Self care (ref*)	2578	1.000		
Partially assisted	948	1.080	(0.976 ; 1.196)	0.138
Completely assisted	1724	1.115	(1.018 ; 1.222)	0.019