

## **CHAPTER 5**

### **Paediatric Renal Replacement Therapy**

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**SECTION A: RRT PROVISION FOR PAEDIATRIC PATIENTS**

This chapter presents data on patients less than 20 years of age receiving renal replacement therapy (RRT) for the past 10 years (2006-2015).

The dialysis acceptance rate for the paediatric population in 2015 was 11 per million age related population (pmarp) and generally had plateaued to around 10 - 11 pmarp for the past decade. The number of new transplants remained low and in 2015 there was only 17 transplants done.

The number of prevalent paediatric patients on dialysis continued to rise. At the end of 2015, 1051 paediatric patients were receiving RRT in Malaysia. Of this cohort of 1051 patients, 841 (80%) were on dialysis while only 210 (20%) were transplanted. The equivalent dialysis prevalence rate almost doubled from 46 pmarp in 2006 to 80 pmarp in 2015. The prevalent HD population continued to expand at a higher rate than the PD population; 51 pmarp versus 29 pmarp. As noted previously although the dialysis acceptance rate for new PD patients was higher than HD, the prevalent HD patients was consistently higher than PD. This was probably due to higher technique failure among PD patients.

Table 5.1: Stock and Flow of Paediatric Renal Replacement Therapy (RRT), 2006-2015

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
New HD patients	54	37	46	40	51	43	54	46	64	45
New PD patients	45	53	49	72	56	60	55	74	42	72
New Transplants	23	20	21	19	9	22	15	18	19	17
HD deaths	7	11	11	14	15	20	17	19	22	27
PD deaths	17	8	11	11	15	14	11	27	19	24
Transplant deaths	1	3	4	2	2	4	7	2	4	4
On HD at 31 <sup>st</sup> December	287	315	353	372	411	430	462	485	536	538
On PD at 31 <sup>st</sup> December	189	203	208	238	249	258	275	290	277	303
Functioning transplant at 31 <sup>st</sup> December	155	164	172	179	180	194	191	200	207	210

Figure 5.1(a): Incidence cases of RRT by modality in children under 20 years old, 2006-2015

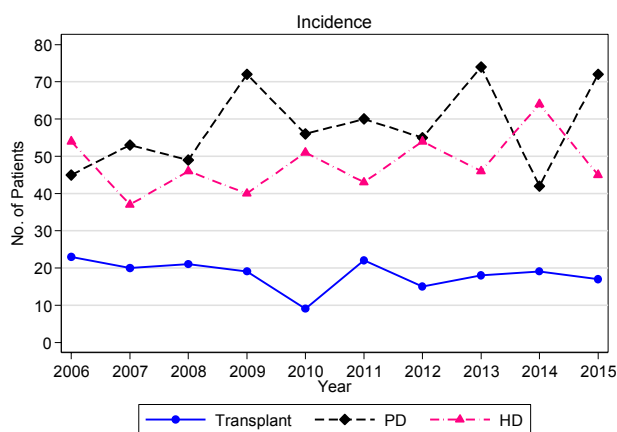


Figure 5.1(b): Prevalence cases of RRT by modality in children under 20 years old, 2006-2015

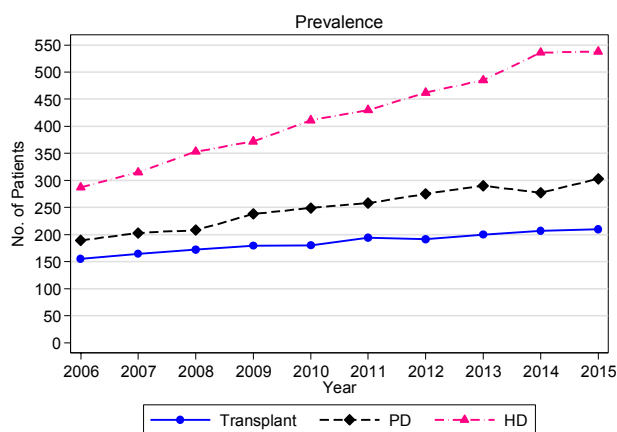
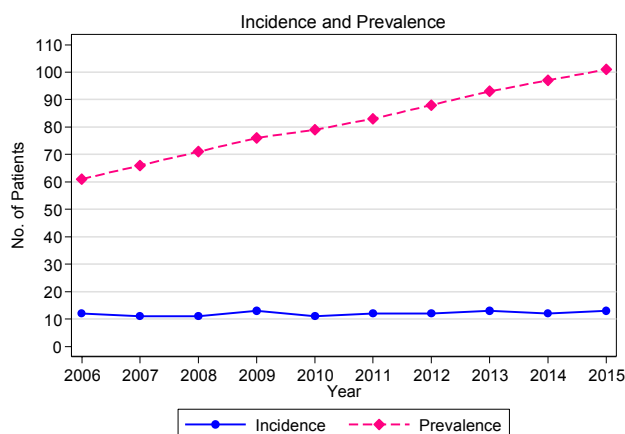


Table 5.2: Paediatric dialysis and transplant rates per million age related population, 2006-2015

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Incidence Rate										
New HD	5	4	4	4	5	4	5	4	6	4
New PD	4	5	5	7	5	6	5	7	4	7
New Transplant	2	2	2	2	1	2	1	2	2	2
All RRT	10	9	9	11	10	10	11	12	10	11
Prevalence Rate at 31 <sup>st</sup> December										
On HD	28	30	34	36	39	41	44	46	51	51
On PD	18	20	20	23	23	24	26	28	26	29
Functioning Graft	15	16	17	17	17	18	18	19	20	20
All RRT	60	65	70	76	78	83	87	92	95	98

Figure 5.2: Incidence and prevalence rate per million age related population, 2006-2015



## SECTION B: DISTRIBUTION OF PAEDIATRIC DIALYSIS PATIENTS

There were no consistent treatment gap noted between West Malaysia and East Malaysia nor between states.

Table 5.3(a): Dialysis treatment rate by state, per million state age related population, 2006-2015

State	2006-2010	2011-2015
Pulau Pinang	15	8
Melaka	9	12
Johor	11	11
Perak	10	12
Selangor & Putrajaya	10	9
Kuala Lumpur	14	12
Negeri Sembilan	6	15
Kedah	7	14
Perlis	8	7
Terengganu	12	17
Pahang	11	11
Kelantan	8	11
Sarawak	8	7
Sabah & WP Labuan	7	8

Table 5.3(b): New dialysis patients by state, 2006-2015

State	2006-2010	2011-2015
Pulau Pinang	37	19
Melaka	14	18
Johor	66	69
Perak	43	50
Selangor & Putrajaya	90	81
Kuala Lumpur	36	29
Negeri Sembilan	12	29
Kedah	27	55
Perlis	4	3
Terengganu	28	39
Pahang	33	34
Kelantan	28	40
Sarawak	37	33
Sabah & WP Labuan	48	55

There had been consistently more males compared to females among the population of children on dialysis and transplant. This trend had persisted and appeared more marked over the last 5 years. Among the transplanted population the male predominance was 62% versus 38% females. This perhaps reflected the higher incidence of ESRD among the males.

Table 5.4: Number of new dialysis and transplant patients by gender, 2006-2015

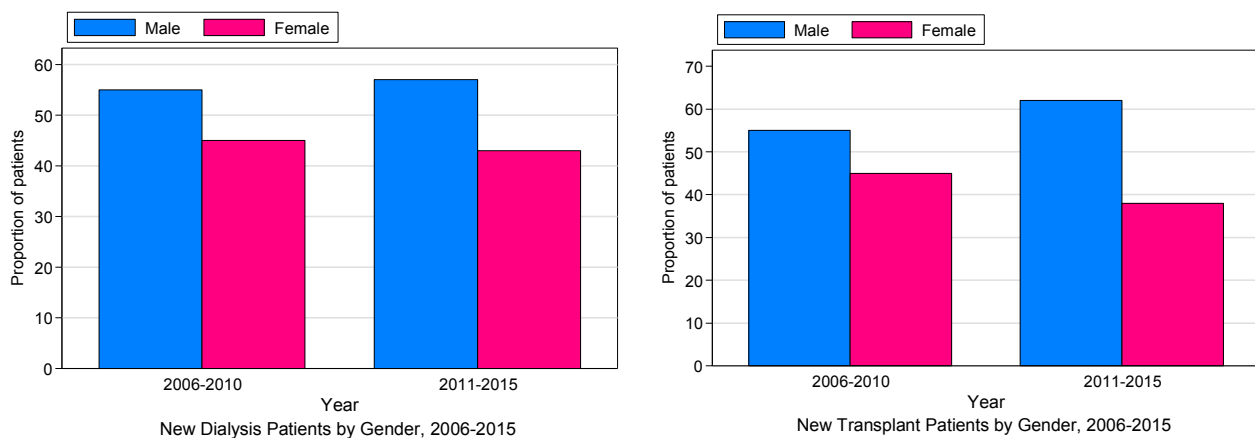
a) New Dialysis

Year	Male		Female	
	n	%	n	%
2006-2010	323	55	264	45
2011-2015	319	57	236	43

b) New Transplant

Year	Male		Female	
	n	%	n	%
2006-2010	51	55	41	45
2011-2015	56	62	35	38

Figure 5.4: Number of new dialysis and transplant patients by gender, 2006-2015

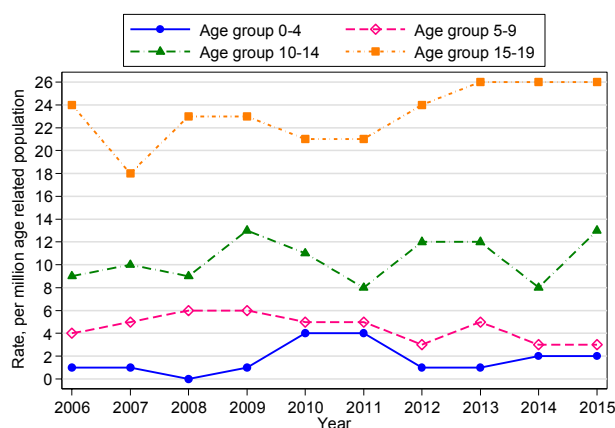


The dialysis treatment rate had levelled off over the last 10 years across all paediatric age groups. The treatment rate had remained consistently higher among the older age groups and very low for children under 5.

Table 5.5: New RRT rate, per million age related population by age group, 2006-2015

Year	New RRT rate, pmp Age group (years)			
	0-4	5-9	10-14	15-19
2006	1	4	9	24
2007	1	5	10	18
2008	0	6	9	23
2009	1	6	13	23
2010	4	5	11	21
2011	4	5	8	21
2012	1	3	12	24
2013	1	5	12	26
2014	2	3	8	26
2015	2	3	13	26

Figure 5.5: New RRT rate by age group, 2006-2015

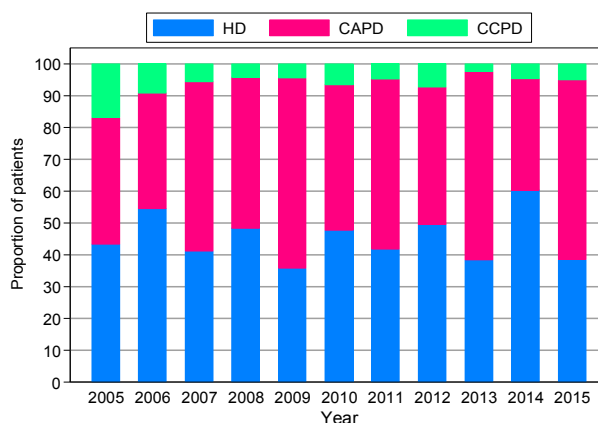


PD was the first modality of dialysis in about two thirds (61%) of patients in 2015. Majority of them were on CAPD; only about 5% was started on automated PD (CCPD).

Table 5.6: New dialysis by treatment modality, 2006-2015

Year	HD		CAPD		CCPD	
	n	%	n	%	n	%
2006	54	55	36	36	9	9
2007	37	41	48	53	5	6
2008	46	48	45	47	4	4
2009	40	36	67	60	5	4
2010	51	48	49	46	7	7
2011	43	42	55	53	5	5
2012	54	50	47	43	8	7
2013	46	38	71	59	3	3
2014	64	60	37	35	5	5
2015	45	38	66	56	6	5

Figure 5.6: New dialysis by treatment modality, 2006-2015

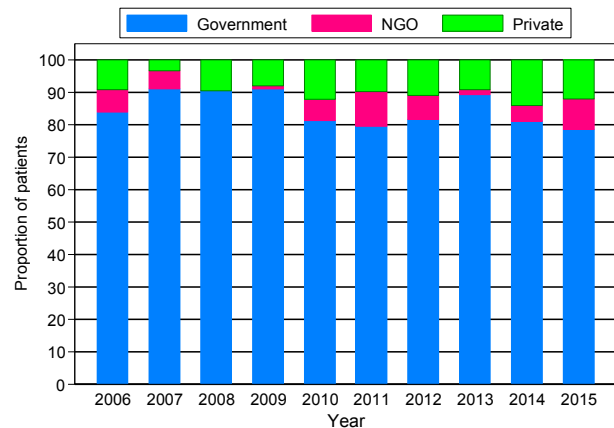


Most of the children (85%) received their dialysis treatment from government centres and hence were government funded.

Table 5.7: New dialysis by sector, 2006-2015

Year	Government		NGO		Private	
	n	%	n	%	n	%
2006	83	84	7	7	9	9
2007	82	91	5	6	3	3
2008	86	91	0	0	9	9
2009	102	91	1	1	9	8
2010	87	81	7	7	13	12
2011	82	80	11	11	10	10
2012	89	82	8	7	12	11
2013	107	89	2	2	11	9
2014	86	81	5	5	15	14
2015	92	79	11	9	14	12

Figure 5.7: New dialysis by sector, 2006-2015



### SECTION C: PRIMARY RENAL DISEASE

The most common primary renal disease identified was glomerulonephritis, which accounted for about 20% of the patients. FSGS on its own accounted for about 8% of the ESRD population. SLE was the second most common cause of ESRD among girls (8%). Unfortunately, in a significant proportion (48%) of children the primary renal disease is unknown.

Table 5.8: Primary renal disease by sex among new dialysis patients, 2006-2015

Primary Renal Disease	Male		Female		All	
	n	%	n	%	n	%
Glomerulonephritis	141	19	130	21	271	20
FSGS	70	9	44	7	114	8
Refux nephropathy	36	5	27	4	63	5
SLE	7	1	49	8	56	4
Obstructive uropathy	44	6	40	7	84	6
Renal dysplasia	26	4	25	4	51	4
Hereditary nephritis	10	1	2	0	12	1
Cystic kidney disease	4	1	7	1	11	1
Metabolic	4	1	8	1	12	1
Others	11	1	11	2	22	2
Unknown	387	52	264	43	651	48

### SECTION D: TYPES OF RENAL TRANSPLANTATION

Living related renal transplant used to be the commonest type of transplantation done among children in Malaysia. However, the trend had changed; now cadaveric renal transplant is the most common transplantation done accounting for about 62% of all transplant done compared to 37% for living related renal transplant. The number of transplant from overseas commercial program had virtually been abolished.

Table 5.9: Types of renal transplantation, 2006-2015

Year	2006-2010		2011-2015	
	n	%	n	%
Commercial cadaver donor	15	16	0	0
Commercial live donor	2	2	1	1
Live donor (genetically related)	24	26	33	37
Live donor (emotionally related)	1	1	0	0
Cadaver donor	50	54	55	62
Total	92	99	89	100

### SECTION E: SURVIVAL ANALYSIS

Renal transplantation had the best patient survival with 90% survival at 5 years and 87% at 10 years. HD patients generally showed better survival compared to PD patients and this disparity becomes more marked when censored for change of dialysis modality. The separation of the survival curve became more obvious after about 3 to 4 years of dialysis with PD patients showing a poorer outcome compared to HD (Figure 5.10b)

Table 5.10(a): Patient survival by dialysis modality analysis (not censored with change of modality), 2006-2015

Modality Interval (months)	Transplant			PD			HD		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	53	100		899	100		757	100	
6	52	96	3	823	96	1	693	96	1
12	51	94	3	761	93	1	642	92	1
24	48	94	3	650	86	1	529	85	1
36	44	92	4	547	82	1	465	82	1
48	40	90	4	444	77	2	398	79	2
60	38	90	4	371	72	2	350	78	2
72	37	90	4	305	67	2	299	75	2
84	36	87	5	249	63	2	257	72	2
96	34	87	5	199	59	2	225	69	2
108	33	87	5	171	56	2	190	66	2
120	33	87	5	142	52	2	157	63	2

Figure 5.10(a): Patient survival by dialysis modality analysis (not censored with change of modality), 2006-2015

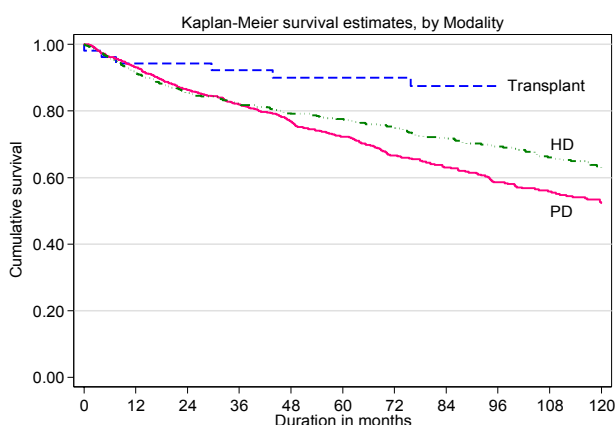


Figure 5.10(b): Patient survival by dialysis modality analysis (censored with change of modality), 2006-2015

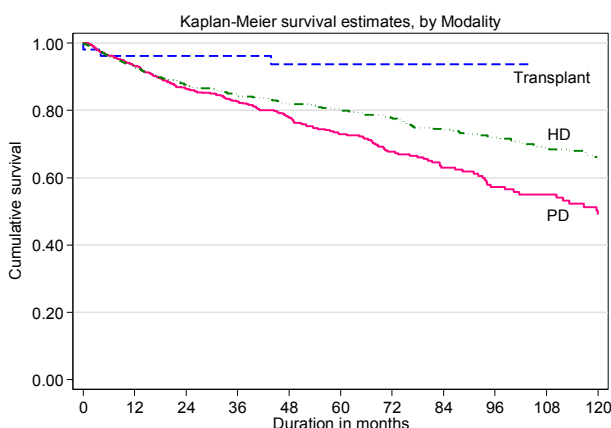


Table 5.10(b): Patient survival by dialysis modality analysis (censored with change of modality), 2006-2015

Modality Interval (months)	Transplant			PD			HD		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	53	100		899	100		757	100	
6	50	96	3	800	96	1	670	96	1
12	47	96	3	705	93	1	610	93	1
24	45	96	3	550	87	1	498	88	1
36	43	96	3	417	83	1	431	84	1
48	39	94	4	309	78	2	362	82	2
60	37	94	4	232	73	2	320	80	2
72	36	94	4	174	68	2	272	78	2
84	35	94	4	117	63	3	236	74	2
96	33	94	4	84	57	3	201	72	2
108	31	94	4	64	55	3	170	69	2
120	31	94	4	49	49	4	139	66	2

The commonest known causes of death among dialysis patients were sepsis and cardiovascular disease.

Table 5.11: Causes of death in dialysis patients, 2006-2015

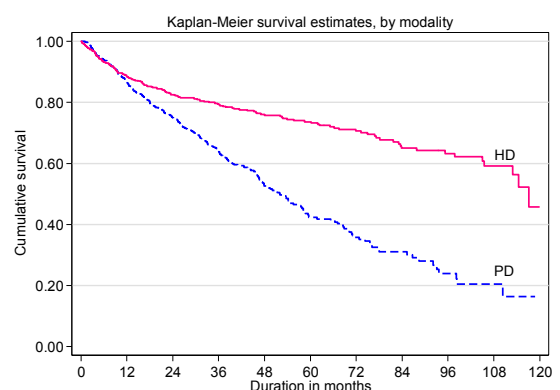
Year Causes of Death	2006-2010		2011-2015	
	n	%	n	%
Cardiovascular	18	31	27	26
Died at home	10	17	10	10
Sepsis	13	22	38	36
PD peritonitis	0	0	0	0
GIT bleed	2	3	4	4
Cancer	0	0	0	0
Liver disease	0	0	0	0
Withdrawal	2	3	2	2
Others	7	12	9	9
Unknown	6	10	15	14
Total	58	100	105	100

After the first year on dialysis, technique failure rate was much higher amongst PD compared to HD patients with progressive widening of the technique survival curve with increasing years on dialysis. Technique survival at 5 years was only 42% for PD compared to 74% for HD.

Table 5.12: Dialysis technique survival by modality, 2006-2015

Modality Interval, months	PD			HD		
	n	% survival	SE	n	% survival	SE
0	621	100		642	100	
6	540	94	1	564	93	1
12	463	87	1	502	89	1
24	348	75	2	381	83	2
36	238	64	2	309	79	2
48	153	53	2	239	76	2
60	96	42	3	190	74	2
72	61	36	3	136	71	2
84	32	31	3	94	65	3
96	16	24	3	61	63	3
108	6	20	4	32	59	4
120	1			1		

Figure 5.12: Dialysis technique survival by modality, 2006-2015





The most common causes of drop out from PD program were death (40%), peritonitis (25%) and membrane failure (11%).

Table 5.13: Reasons for drop-out from PD program, 2006-2015

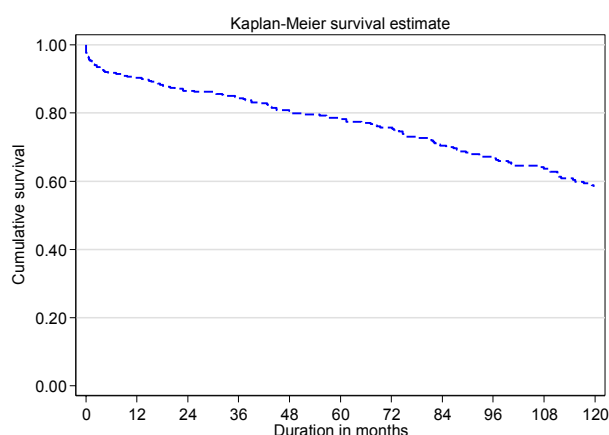
Year	2006-2010		2011-2015	
	n	%	n	%
Death	72	35	39	40
Transplant	48	23	8	8
Peritonitis	35	17	24	25
Catheter related infection	4	2	5	5
Membrane failure	24	12	11	11
Technical problem	10	5	7	7
Patient preference	9	4	1	1
Others	4	2	2	2
Unknown	1	0	0	0

The graft survival for paediatric transplants was 92% at 1 year and 78% at 5 years.

Table 5.14: Transplant graft survival, 2006-2015

Interval (month)	n	% survival	SE
0	353	100	
6	322	92	1
12	314	90	2
24	292	87	2
36	273	84	2
48	251	81	2
60	225	78	2
72	210	76	2
84	182	70	3
96	161	67	3
108	139	64	3
120	114	58	3

Figure 5.14: Transplant graft survival, 2006-2015



The commonest known cause for graft loss among pediatric transplants was rejection (51%). Unfortunately graft loss due to unknown cause accounted for almost a quarter (23%) of cases, not because the causes of graft loss are unknown but notification of outcome of graft loss was indirect and hence no cause was entered Chronic allograft nephropathy accounted for 9% of graft loss and was the third most common cause noted.

Table 5.15: Causes of graft loss, 2006-2015

Causes of graft loss	2006-2010		2011-2015	
	n	%	n	%
Rejection	22	63	18	51
Calcineurin toxicity	2	6	2	6
Other drug toxicity	0	0	0	0
Ureteric obstruction	0	0	1	3
Infection	1	3	0	0
Vascular causes	5	14	2	6
Recurrent/ de novo renal disease	0	0	1	3
Chronic allograft nephropathy/IFTA	0	0	3	9
Technical problem	0	0	0	0
Others	1	3	3	9
Unknown	6	17	8	23
Total	35	100	31	89

## SECTION F: HAEMODIALYSIS PRACTICE

Majority (about 84%) of the paediatric haemodialysis patients had native vascular access. However, the percentage of children with cuffed or non-cuffed central venous catheter increased from 10.5% to about 15.1 over the 2 5-year periods of 2006-2010 and 2011-2015.

Table 5.16: Vascular access on haemodialysis, 2006-2015

Access types	2006-2010		2011-2015	
	n	%	n	%
Wrist AVF	776	57.1	1211	51.4
BCF*	436	32.1	775	32.9
Venous graft	1	0.1	4	0.2
Artificial graft	2	0.1	11	0.5
cuffed catheter	78	5.7	265	11.2
non-cuffed catheter	67	4.9	92	3.9
Total	1360	100	2358	100

The median prescribed Kt/V was 2.1 in 2015. Up to 85% of patients achieved the target Kt/V of  $\geq 1.3$  while 92% achieved an average URR of  $\geq 65\%$ .

Table 5.17(a): Distribution of prescribed Kt/V, HD patients 2011-2015

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 1.3$	% patients $\geq 1.8$	% patients $\geq 2$
2011	368	2.2	0.6	2.2	1.8	2.6	94	75	66
2012	405	2.3	0.6	2.2	1.8	2.7	95	76	65
2013	444	2.3	0.6	2.3	1.9	2.7	95	77	67
2014	464	2.1	0.6	2.1	1.7	2.4	93	71	58
2015	508	2.1	0.5	2.1	1.7	2.4	93	70	56

Table 5.17(b): Distribution of delivered Kt/V, HD patients 2011-2015

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 1.3$	% patients $\geq 1.8$	% patients $\geq 2$
2011	323	2.3	0.6	2.2	1.9	2.7	87	35	24
2012	365	2.3	0.6	2.3	1.9	2.7	88	40	26
2013	396	2.1	0.6	2.1	1.7	2.5	89	37	23
2014	427	2.1	0.5	2.1	1.8	2.4	87	31	18
2015	459	2.1	0.6	2.1	1.7	2.5	85	31	18

Table 5.17(c): Distribution of URR, HD patients 2011-2015

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 65\%$
2010	369	76.1	7	76.7	72.1	81.3	92
2011	396	75.8	8.1	77.1	71.2	81.5	91
2012	420	76.4	7.4	77.2	71.6	81.8	94
2013	463	75.7	7.7	76.3	71.4	80.6	92
2014	496	75.5	7.7	76.2	70.8	80.4	92

## SECTION G: ANAEMIA TREATMENT

The percentage of children treated with erythropoietin had reached a plateau of about 92% to 94% for the last 9 years. Similarly, the proportion of children receiving parenteral iron showed an encouraging upward trend up to 46% in 2015 while the percentage of children on oral iron had reduced slightly to about 48%. The percentage of children who received blood transfusion continue to decline to about 13% in 2015.

Table 5.18: Treatment for anaemia, HD patients 2006-2015

Year	Number of patients	% on Erythropoietin	% received blood transfusion	% on oral iron	% received parenteral iron
2006	272	89	18	71	27
2007	294	93	14	73	25
2008	340	92	17	59	36
2009	373	92	16	57	39
2010	379	92	13	57	37
2011	421	93	14	56	36
2012	460	92	14	57	38
2013	485	94	12	55	42
2014	524	92	17	54	45
2015	559	93	13	48	46

The median transferrin saturation had consistently been above 30% for both the HD and PD patients although in 2015 it was 29.5% in the HD population. About 84% of children on HD and 92% of children on PD had transferrin saturation greater than 20% in 2015.

Table 5.19: Distribution of transferrin saturation on Erythropoietin, HD patients 2006-2015

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients $\geq 20\%$
2006	210	36	15.6	32.7	25	44	88
2007	244	33.7	14.9	31.1	23.4	40	86
2008	286	35	15.7	31.9	24.1	41.9	86
2009	317	35.1	16	31.9	24.9	42.2	86
2010	320	35.2	16.1	31.7	24.3	42.8	85
2011	365	33.2	14.5	30.8	23.5	38	85
2012	385	33	13.4	30.2	24.4	40	88
2013	404	32.7	13.4	30.5	23.9	38.6	87
2014	434	33.4	13.8	30.5	25.1	39	88
2015	468	31.7	12.5	29.5	23.2	39.1	84

Table 5.20: Distribution of transferrin saturation on Erythropoietin, PD patients 2006-2015

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients $\geq 20\%$
2006	176	41.2	16.1	38.8	30.4	49.3	95
2007	182	36.7	16	33.2	26.3	44.3	91
2008	193	38.5	16.6	35.1	28.2	46.7	90
2009	221	38	17.2	34.6	25.5	48.8	88
2010	236	39.1	17.6	35.6	26.1	49.1	92
2011	245	36.3	15.4	34	24.6	47.2	87
2012	253	36	15.3	34.7	25.5	44.4	87
2013	229	37.2	15.2	33.8	26.8	44.6	91
2014	234	35.9	14	33.6	26.2	43.1	91
2015	222	36.3	14.7	33.3	26.2	44	92

The median weekly dose of ESA had increased to about 6000 units per week in 2015.

Table 5.21: Distribution of ESA dose (u/wk), 2006-2015

Year	Number of patients	Mean	SD	Median	LQ	UQ
2006	364	4984.9	2862.9	4000	4000	6000
2007	403	5605.5	4522.5	4000	4000	6000
2008	437	5208.2	3992.7	4000	3000	6000
2009	481	4960.1	2766.7	4000	2000	6000
2010	512	5283.6	3062.5	4000	4000	6000
2011	536	5477.6	3370.8	4000	4000	6000
2012	565	5252	3069.1	4000	4000	6000
2013	602	5648.7	3922.6	4000	3000	6000
2014	624	5905.9	3615.3	6000	4000	8000
2015	623	5895	3917.7	6000	4000	8000