

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 (2007-2016).

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 18 transplants done.

The number of prevalent paediatric patients on dialysis continued to rise. At the end of 2015, 1061 paediatric patients were receiving RRT in Malaysia. Of this cohort of 1061 patients, 847 (79.3%) were on dialysis while only 214 (21.7%) 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), 2007-2016

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
New HD patients	37	46	40	51	43	54	46	64	48	49
New PD patients	53	49	72	56	60	55	74	42	72	57
New Transplants	20	21	19	9	22	15	18	19	18	6
HD deaths	11	11	14	15	20	17	19	22	27	27
PD deaths	8	11	11	15	14	11	27	19	24	11
Transplant deaths	3	4	2	2	4	7	2	4	4	2
On HD at 31 st December	315	353	372	411	430	462	485	536	544	576
On PD at 31 st December	203	208	238	248	257	275	290	277	303	313
Functioning transplant at 31 st December	164	172	179	180	194	191	200	207	214	205

Figure 5.1(a): Incidence cases of RRT by modality in children under 20 years old, 2007-2016

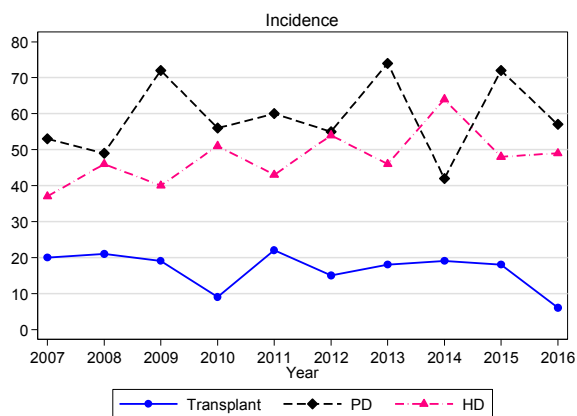


Figure 5.1(b): Prevalence cases of RRT by modality in children under 20 years old, 2007-2016

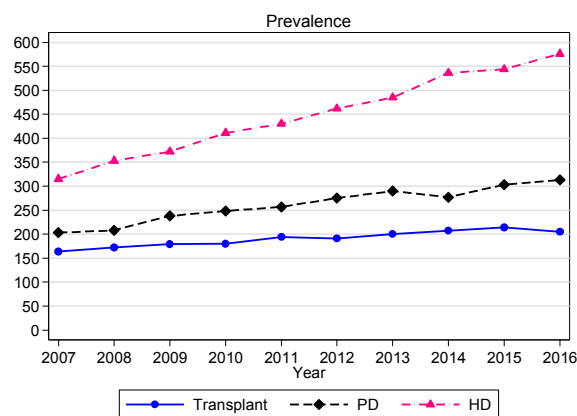
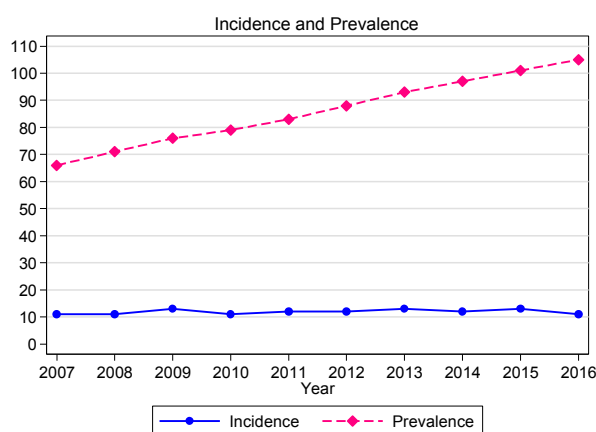


Table 5.2: Paediatric dialysis and transplant rates per million age related population, 2007-2016

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Incidence Rate										
New HD	4	4	4	5	4	5	4	6	5	5
New PD	5	5	7	5	6	5	7	4	7	5
New Transplant	2	2	2	1	2	1	2	2	2	1
All RRT	9	9	11	10	10	11	12	10	11	10
Prevalence Rate at 31 st December										
On HD	30	34	36	39	41	44	46	51	52	55
On PD	20	20	23	23	24	26	28	26	29	30
Functioning Graft	16	17	17	17	18	18	19	20	20	20
All RRT	65	70	76	78	82	87	92	95	99	102

Figure 5.2: Incidence and prevalence rate per million age related population, 2007-2016



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, 2007-2016

State	2007-2011	2012-2016
Pulau Pinang	12	6
Melaka	10	12
Johor	12	11
Perak	10	10
Selangor & Putrajaya	9	10
Kuala Lumpur	12	13
Negeri Sembilan	10	14
Kedah	9	14
Perlis	6	7
Terengganu	11	21
Pahang	12	12
Kelantan	7	14
Sarawak	7	7
Sabah & WP Labuan	7	8

Table 5.3(b): New dialysis patients by state, 2007-2016

State	2007-2011	2012-2016
Pulau Pinang	29	15
Melaka	16	17
Johor	72	63
Perak	45	41
Selangor & Putrajaya	88	89
Kuala Lumpur	31	32
Negeri Sembilan	19	27
Kedah	34	53
Perlis	3	3
Terengganu	27	49
Pahang	35	36
Kelantan	25	49
Sarawak	35	34
Sabah & WP Labuan	47	53

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 61% versus 39% females. This perhaps reflected the higher incidence of ESRD among the males.

Table 5.4: Number of new dialysis and transplant patients by gender, 2007-2016

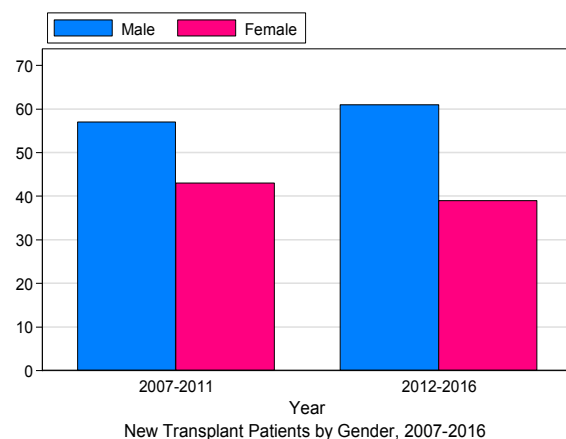
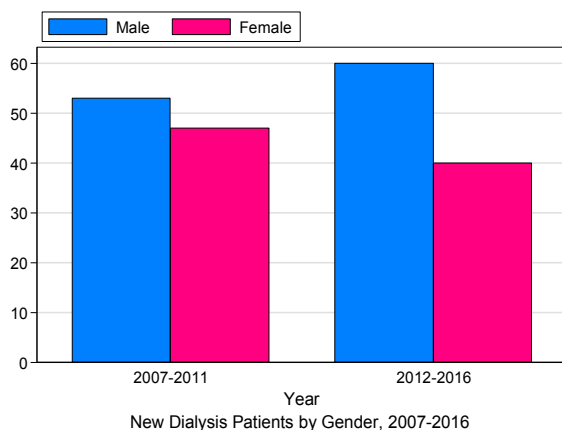
a) New Dialysis

Year	Male		Female	
	n	%	n	%
2007-2011	268	53	239	47
2012-2016	335	60	226	40

b) New Transplant

Year	Male		Female	
	n	%	n	%
2007-2011	52	57	39	43
2012-2016	46	61	30	39

Figure 5.4: Number of new dialysis and transplant patients by gender, 2007-2016

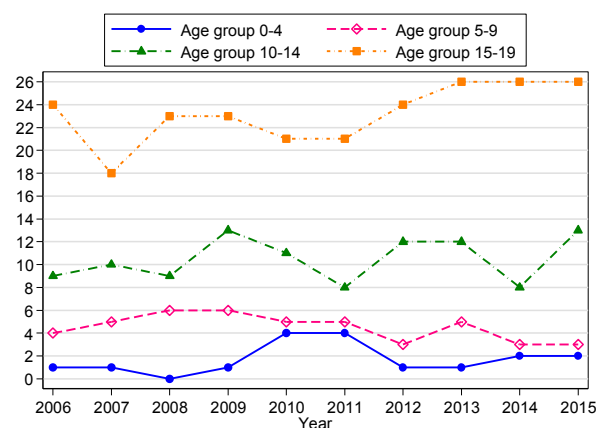


The dialysis treatment rate had levelled off over the last 10 years across all paediatric age groups. The treatment rate had remained consistently higher among the older age groups and very low for children under 5.

Table 5.5: New RRT rate, per million age related population by age group, 2007-2016

Year	New RRT rate, pmp Age group (years)			
	0-4	5-9	10-14	15-19
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	4	13	26
2016	1	5	10	23

Figure 5.5: New RRT rate by age group, 2007-2016

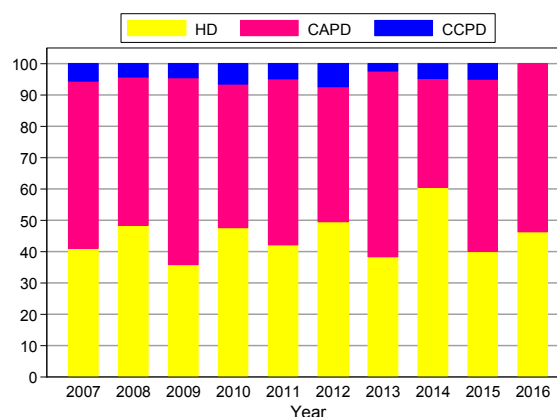


PD was the first modality of dialysis in about two thirds (60%) of patients in 2015. Majority of them were on CAPD; only about 5% was started on automated PD (CCPD).

Table 5.6: New dialysis by treatment modality, 2007-2016

Year	HD		CAPD		CCPD	
	n	%	n	%	n	%
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	54	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	48	40	66	55	6	5
2016	49	46	57	54	0	0

Figure 5.6: New dialysis by treatment modality, 2007-2016

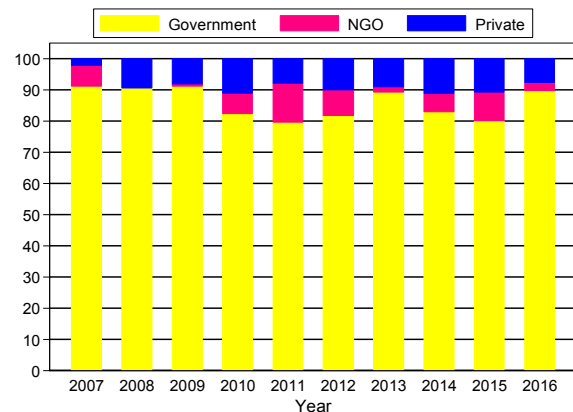


Most of the children (80%) received their dialysis treatment from government centres and hence were government funded.

Table 5.7: New dialysis by sector, 2007-2016

Year	Government		NGO		Private	
	n	%	n	%	n	%
2007	82	91	6	7	2	2
2008	86	91	0	0	9	9
2009	102	91	1	1	9	8
2010	88	82	7	7	12	11
2011	82	80	13	13	8	8
2012	89	82	9	8	11	10
2013	107	89	2	2	11	9
2014	88	83	6	6	12	11
2015	96	80	11	9	13	11
2016	95	90	3	3	8	8

Figure 5.7: New dialysis by sector, 2007-2016



SECTION C: PRIMARY RENAL DISEASE

The most common primary renal disease identified was glomerulonephritis, which accounted for about 39% of the patients. FSGS on its own accounted for about 8% of the ESRD population while obstructive uropathy was also the cause of ESRD for about 8% of the whole cohort. SLE as a cause of ESRD has reduced from 8% about 10 years ago (2006 report) to 3% in this current report. Unfortunately, in a significant proportion (27%) of children the primary renal disease is unknown.

Table 5.8: Primary renal disease by sex among new dialysis patients, 2007-2016

Primary Renal Disease	Male		Female		All	
	n	%	n	%	n	%
Glomerulonephritis	223	30	189	32	412	31
FSGS	66	9	42	7	108	8
Refux nephropathy	29	4	27	5	56	4
SLE	6	1	41	7	47	3
Obstructive uropathy	64	9	43	7	107	8
Renal dysplasia	23	3	21	4	44	3
Hereditary nephritis	12	2	3	1	15	1
Cystic kidney disease	7	1	6	1	13	1
Metabolic	3	0	8	1	11	1
Others	105	14	60	10	165	12
Unknown	211	28	155	26	366	27

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 deceased donor renal transplant is the most common transplantation done accounting for about 57% of all transplant done compared to 40% for living related renal transplant. The number of transplant from overseas commercial program had virtually been abolished.

Table 5.9: Types of renal transplantation, 2007-2016

Year	2007-2011		2012-2016	
	n	%	n	%
Commercial cadaver	8	9	0	0
Commercial living donor	2	2	2	3
Living related donor	27	30	30	40
Deceased donor	53	58	42	57
Living emotionally related	1	1	0	0
Total	91	100	74	100

SECTION E: SURVIVAL ANALYSIS

Renal transplantation had the best patient survival with 90% survival at 5 years and 88% 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), 2007-2016

Modality Interval (months)	Transplant			PD			HD		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	53	100		950	100		803	100	
6	52	96	3	879	96	1	734	96	1
12	51	94	3	824	93	1	677	92	1
24	48	94	3	684	87	1	580	86	1
36	46	92	4	594	82	1	497	82	1
48	42	90	4	493	77	2	441	79	2
60	38	90	4	406	73	2	378	77	2
72	38	90	4	332	68	2	330	75	2
84	36	88	5	276	64	2	279	71	2
96	36	88	5	216	59	2	249	69	2
108	33	88	5	185	56	2	212	66	2
120	33	88	5	154	53	2	179	63	2

Figure 5.10(a): Patient survival by dialysis modality analysis (not censored with change of modality), 2007-2016

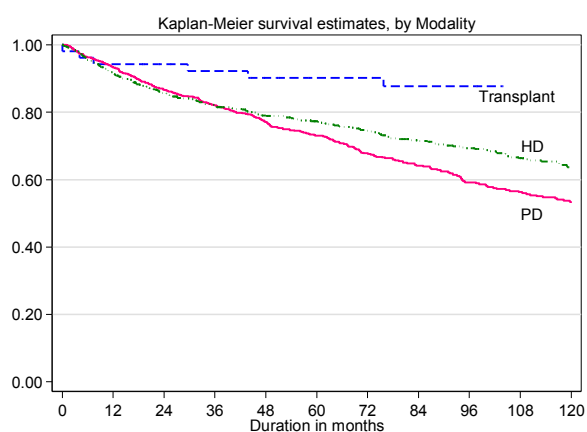


Figure 5.10(b): Patient survival by dialysis modality analysis (censored with change of modality), 2007-2016

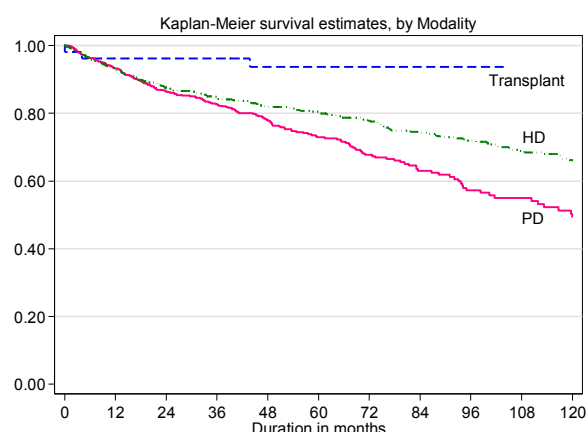


Table 5.10(b): Patient survival by dialysis modality analysis (censored with change of modality), 2007-2016

Modality Interval (months)	Transplant			PD			HD		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	53	100		950	100		803	100	
6	50	96	3	854	96	1	711	96	1
12	47	96	3	765	94	1	642	93	1
24	45	96	3	577	87	1	550	88	1
36	45	96	3	459	83	1	459	84	1
48	41	94	3	342	79	2	401	82	2
60	37	94	3	255	74	2	345	80	2
72	37	94	3	188	69	2	302	77	2
84	35	94	3	136	65	2	256	74	2
96	35	94	3	94	59	3	223	72	2
108	31	94	3	71	56	3	190	69	2
120	31	94	3	53	50	3	161	67	2

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

Table 5.11: Causes of death in dialysis patients, 2007-2016

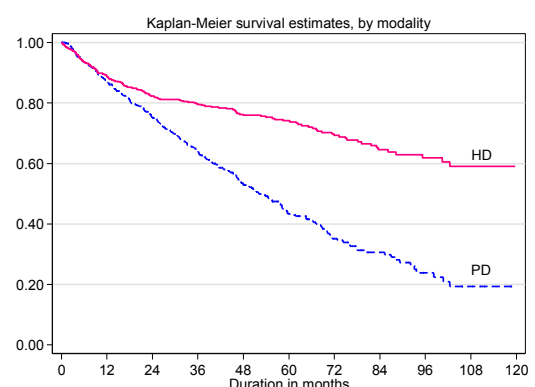
Year Causes of Death	2007-2011		2012-2016	
	n	%	n	%
Cardiovascular	24	34	27	24
Died at home	13	18	9	8
Sepsis	17	24	38	34
PD peritonitis	0	0	0	0
GIT bleed	1	1	4	4
Cancer	0	0	0	0
Liver disease	0	0	0	0
Withdrawal	1	1	7	6
Others	6	8	11	10
Unknown	9	13	16	14
Total	71	100	112	100

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, 2007-2016

Modality Interval, months	PD			HD		
	n	% survival	SE	n	% survival	SE
0	634	100		652	100	
6	557	93	1	568	94	1
12	493	87	1	499	89	1
24	355	75	2	402	82	2
36	264	64	2	305	80	2
48	172	53	2	246	76	2
60	105	43	3	186	74	2
72	61	35	3	141	69	2
84	41	31	3	88	65	3
96	18	24	3	56	62	3
108	8	19	4	27	59	4
120	1			1		

Figure 5.12: Dialysis technique survival by modality, 2007-2016



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, 2007-2016

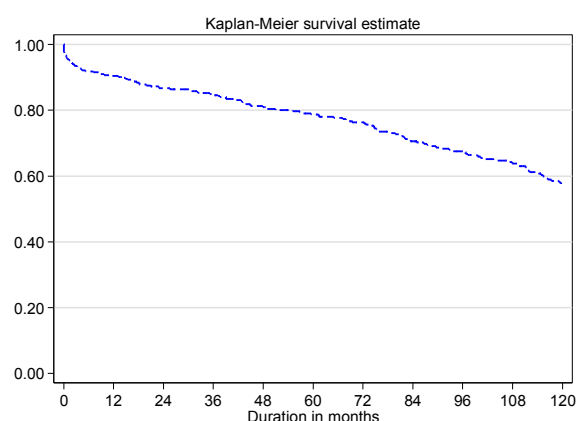
Year	2007-2011		2012-2016	
	n	%	n	%
Death	74	36	33	35
Transplant	39	19	4	4
Peritonitis	38	18	28	29
Catheter related infection	7	3	3	3
Membrane failure	25	12	18	19
Technical problem	10	5	8	8
Patient preference	9	4	0	0
Others	4	2	1	1
Unknown	1	0	0	0

The graft survival for paediatric transplants was 90% at 1 year and 79% at 5 years.

Table 5.14: Transplant graft survival, 2007-2016

Interval (month)	n	% survival	SE
0	355	100	
6	325	92	1
12	320	90	2
24	301	87	2
36	286	85	2
48	261	81	2
60	242	79	2
72	218	76	2
84	194	71	3
96	174	68	3
108	151	64	3
120	125	58	3

Figure 5.14: Transplant graft survival, 2007-2016



The commonest known cause for graft loss among pediatric transplants was rejection (52%). Unfortunately graft loss due to unknown cause accounted for more than almost a quarter (27%) 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 18% of graft loss and was the third most common cause noted.

Table 5.15: Causes of graft loss, 2007-2016

Causes of graft loss	2007-2011		2012-2016	
	n	%	n	%
Rejection	22	67	17	52
Calcineurin toxicity	2	6	2	6
Other drug toxicity	0	0	0	0
Ureteric obstruction	0	0	1	3
Infection	0	0	1	3
Vascular causes	2	6	2	6
Recurrent/ de novo renal disease	0	0	3	9
Chronic allograft nephropathy/IFTA	0	0	6	18
Technical problem	0	0	0	0
Others	1	3	4	12
Unknown	8	24	9	27
Total	33	100	37	112

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 10.8% to about 17% over the two 5-year periods of 2007-2011 and 2012-2016.

Table 5.16: Vascular access on haemodialysis, 2007-2016

Access types	2007-2011		2012-2016	
	n	%	n	%
Wrist AVF	829	56.3	1244	49.6
BCF*	481	32.7	820	32.7
Venous graft	0	0	5	0.2
Artificial graft	4	0.3	11	0.4
cuffed catheter	89	6	332	13.2
non-cuffed catheter	70	4.8	96	3.8
Total	1473	100	2508	100

The median prescribed Kt/V was 2.1 in 2015. Up to 93% of patients achieved the target Kt/V of ≥ 1.3 while 92% achieved an average URR of $\geq 65\%$.

Table 5.17(a): Distribution of prescribed Kt/V, HD patients 2012-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients ≥ 1.3	% patients ≥ 1.8	% patients ≥ 2
2012	444	2.3	0.6	2.3	1.9	2.7	95	77	67
2013	464	2.1	0.6	2.1	1.7	2.4	93	71	58
2014	508	2.1	0.5	2.1	1.7	2.4	93	70	56
2015	549	2.1	0.6	2.1	1.7	2.5	93	71	55
2016	567	2.1	0.6	2.0	1.7	2.4	92	66	51

Table 5.17(b): Distribution of delivered Kt/V, HD patients 2012-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients ≥ 1.3	% patients ≥ 1.8	% patients ≥ 2
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
2016	480	2.1	0.6	2.0	1.7	2.4	84	29	17

Table 5.17(c): Distribution of URR, HD patients 2012-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 65\%$
2012	396	75.8	8.1	77.1	71.2	81.5	91
2013	420	76.4	7.4	77.2	71.6	81.8	94
2014	463	75.7	7.7	76.3	71.4	80.6	92
2015	496	75.5	7.7	76.2	70.8	80.4	92
2016	514	75.2	8.0	75.7	70.9	80.5	91

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 2007-2016

Year	Number of patients	% on Erythropoietin	% received blood transfusion	% on oral iron	% received parenteral iron
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
2016	575	91	13	52	45

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 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients $\geq 20\%$
2007	244	33.7	14.9	31.1	23.4	40.0	86
2008	286	35.0	15.7	31.9	24.1	41.9	86
2009	317	35.1	16.0	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	38.0	85
2012	385	33.0	13.4	30.2	24.4	40.0	88
2013	404	32.7	13.4	30.5	23.9	38.6	87
2014	434	33.4	13.8	30.5	25.1	39.0	88
2015	468	31.7	12.5	29.5	23.2	39.1	84
2016	469	32.3	12.8	30.0	23.6	38.7	86

Table 5.20: Distribution of transferrin saturation on Erythropoietin, PD patients 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients $\geq 20\%$
2007	182	36.7	16.0	33.2	26.3	44.3	91
2008	193	38.5	16.6	35.1	28.2	46.7	90
2009	221	38.0	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	34.0	24.6	47.2	87
2012	253	36.0	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	14.0	33.6	26.2	43.1	91
2015	222	36.3	14.7	33.3	26.2	44.0	92
2016	244	36.1	14.9	34.3	26.1	44.7	88

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), 2007-2016

Year	Number of patients	Mean	SD	Median	LQ	UQ
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	5252.0	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	5895.0	3917.7	6000	4000	8000
2016	637	5764.1	3563.6	6000	4000	8000