

## Chapter - 5

# **PAEDIATRIC RENAL REPLACEMENT THERAPY**

Lee Ming Lee

Lim Yam Ngo

Lynster Liaw

Susan Pee

Wan Jazilah Wan Ismail

Yap Yok Chin

## SECTION A: RRT PROVISION FOR PAEDIATRIC PATIENTS

This chapter presents data on paediatric patients less than 20 years of age receiving renal replacement therapy (RRT) for the past 10 years (2004-2013).

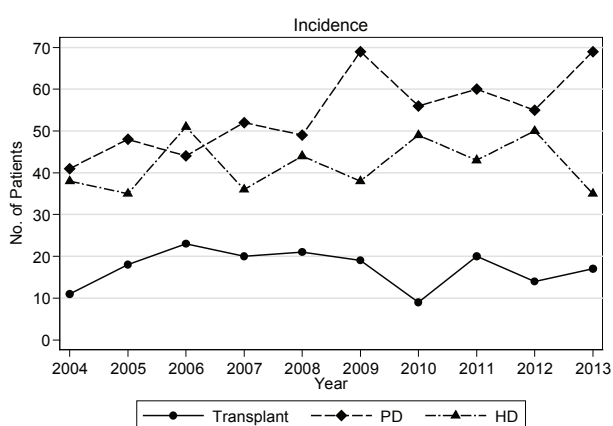
Generally the dialysis acceptance rate for the paediatric population had level off to about 8 to 10 pmarp over the past 10 years. The number of new transplants also had not shown much increase. Only about 20 transplants or so were done annually. The overall incidence rate for all RRT had stabilized to about 10 pmarp since 2009.

As expected, with increasing number of children on dialysis and improved survival; the number of prevalent patients continued to rise. At the end of 2013, 963 paediatric patients were receiving RRT in Malaysia. Of these, 758 (79%) were on dialysis. The equivalent dialysis prevalence rate almost doubled from 49 pmarp in 2004 to 90 pmarp in 2013. The prevalent HD population continued to expand at a higher rate than the PD population. However, the dialysis acceptance rate for new PD patients was higher than HD, although the prevalent HD patients were consistently more than the prevalent PD patients. This was probably due to higher technique failure among PD patients.

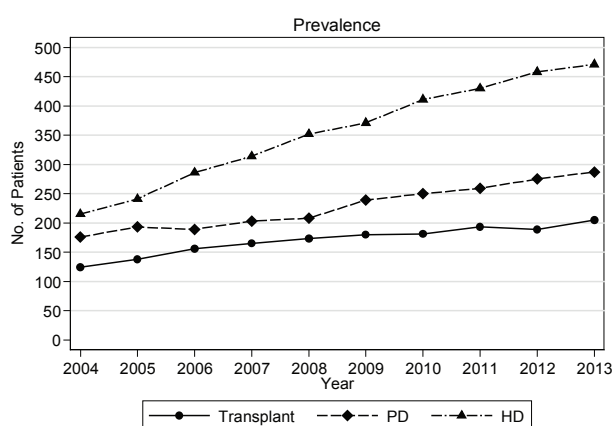
**Table 5.1:** Stock and flow of Paediatric Renal Replacement Therapy (RRT), 2004-2013

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
New HD patients	38	35	51	36	44	38	49	43	50	35
New PD patients	41	48	44	52	49	69	56	60	55	69
New Transplants	11	18	23	20	21	19	9	20	14	17
HD deaths	10	9	7	11	11	14	15	20	17	17
PD deaths	6	9	17	8	11	11	15	14	11	26
Transplant deaths	0	1	1	3	4	2	2	4	7	3
On HD at 31 <sup>st</sup> December	215	241	286	314	352	371	411	430	458	471
On PD at 31 <sup>st</sup> December	176	193	189	203	208	239	250	259	275	287
Functioning transplant at 31 <sup>st</sup> December	124	138	156	165	173	180	181	193	189	205

**Figure 5.1(a):** Incidence cases of RRT by modality in children under 20 years old, 2004-2013

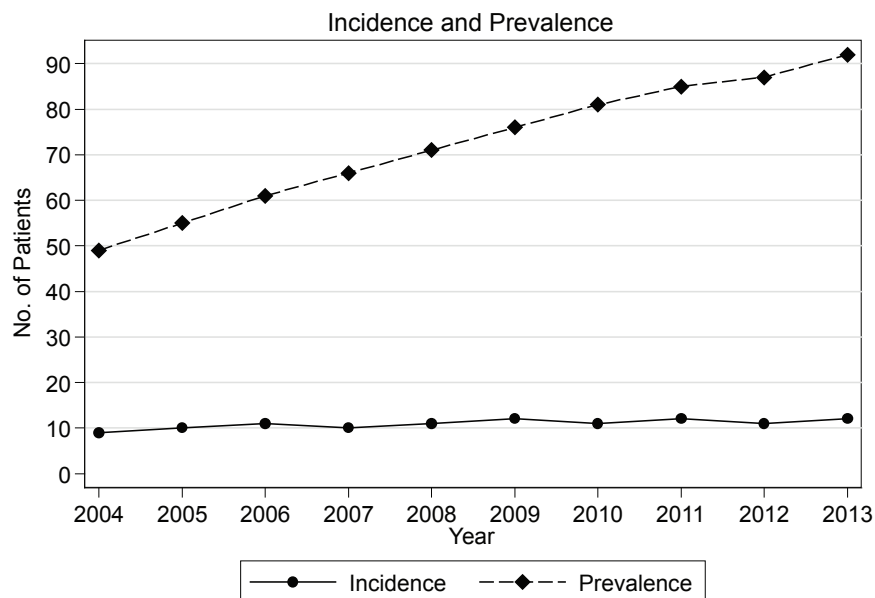


**Figure 5.1(b):** Prevalence cases of RRT by modality in children under 20 years old, 2004-2013



**Table 5.2:** Paediatric dialysis and transplant rates per million age related population, 2004-2013

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Incidence Rate										
New HD	4	3	5	3	4	4	5	4	5	3
New PD	4	5	4	5	5	7	5	6	5	7
New Transplant	1	2	2	2	2	2	1	2	1	2
<b>All RRT</b>	<b>8</b>	<b>8</b>	<b>9</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>10</b>	<b>10</b>	<b>10</b>	<b>10</b>
Prevalence Rate at 31 <sup>st</sup> December										
On HD	21	23	27	30	34	36	40	42	43	45
On PD	17	19	18	20	20	23	24	25	26	27
Functioning Graft	12	13	15	16	17	17	17	19	18	20
<b>All RRT</b>	<b>49</b>	<b>54</b>	<b>60</b>	<b>65</b>	<b>70</b>	<b>76</b>	<b>81</b>	<b>85</b>	<b>87</b>	<b>90</b>

**Figure 5.2:** Incidence and prevalence rate per million age related population, 2004-2013

## SECTION B: DISTRIBUTION OF PAEDIATRIC DIALYSIS PATIENTS

The treatment gap between West Malaysia and East Malaysia had become less obvious over the years with the set up of new paediatric and adult nephrology centres in these regions particularly in the east coast of West Malaysia and East Malaysia.

**Table 5.3(a):** Dialysis treatment rate by state, per million state age related population, 2004-2013

State	2004-2008	2009-2013
Pulau Pinang	14	9
Melaka	14	13
Johor	9	12
Perak	9	11
Selangor & Putrajaya	7	10
Kuala Lumpur	10	12
Negeri Sembilan	8	13
Kedah	6	11
Perlis	11	2
Terengganu	9	14
Pahang	9	11
Kelantan	7	7
Sarawak	8	9
Sabah & WP Labuan	7	10

**Table 5.3(b):** New dialysis patients by state, 2004-2013

State	2004-2008	2009-2013
Pulau Pinang	38	24
Melaka	20	19
Johor	53	73
Perak	41	50
Selangor & Putrajaya	62	86
Kuala Lumpur	28	32
Negeri Sembilan	15	24
Kedah	22	42
Perlis	5	1
Terengganu	21	31
Pahang	27	32
Kelantan	29	25
Sarawak	37	38
Sabah & WP Labuan	39	45

There had been consistently more males compared to females among the population of children on dialysis and transplant. This trend had persisted; probably a reflection of the higher incidence of ESRD among the males. However this gender disparity appears to be less marked in recent years perhaps reflecting a gender bias in the early years.

**Table 5.4:** Number of new dialysis and transplant patients by gender, 2004-2013

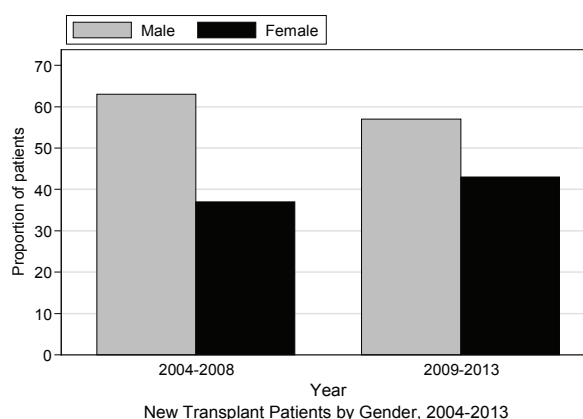
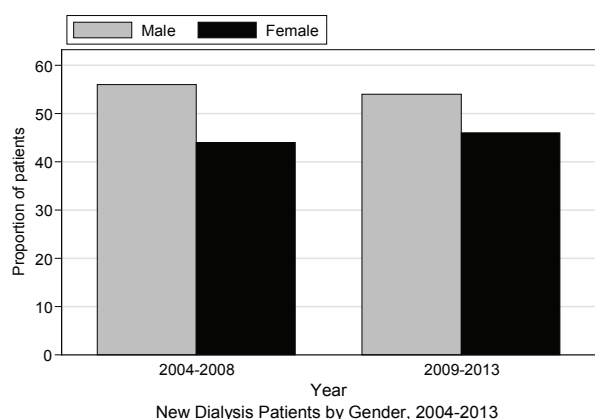
a) New Dialysis

Year	Male		Female	
	n	%	n	%
2004-2008	244	56	194	44
2009-2013	281	54	243	46

b) New Transplant

Year	Male		Female	
	n	%	n	%
2004-2008	59	63	34	37
2009-2013	45	57	34	43

**Figure 5.4:** Number of new dialysis and transplant patients by gender, 2004-2013

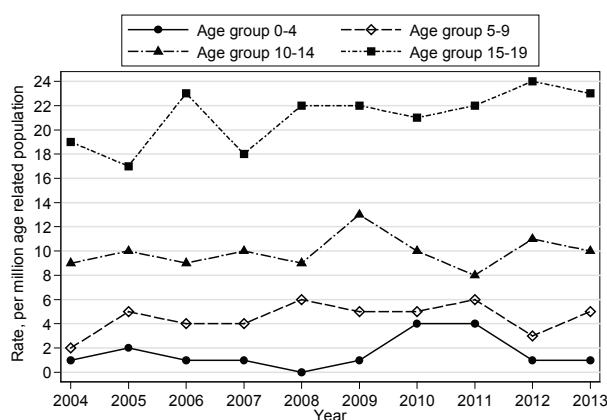


The dialysis treatment rate had levelled off over the last 10 years across all paediatric age groups. The treatment rate had remained consistently higher among the older age groups and very low for children under 5.

**Table 5.5:** New RRT rate, per million age related population by age group, 2004-2013

Year	New RRT rate, pmp Age group (years)			
	0-4	5-9	10-14	15-19
2004	1	2	9	19
2005	2	5	10	17
2006	1	4	9	23
2007	1	4	10	18
2008	0	6	9	22
2009	1	5	13	22
2010	4	5	10	21
2011	4	6	8	22
2012	1	3	11	24
2013	1	5	10	23

**Figure 5.5:** New RRT rate by age group, 2004-2013

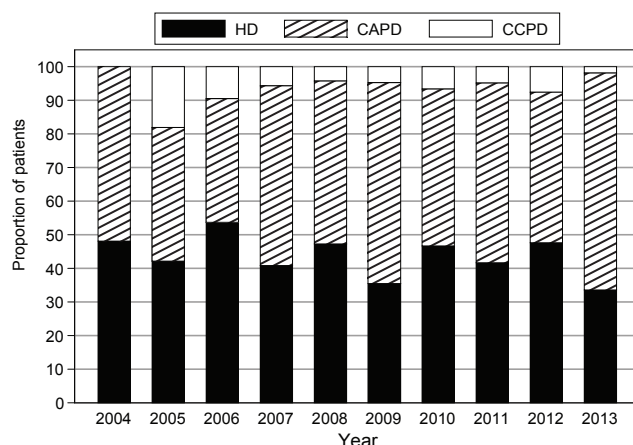


PD was the first modality of dialysis in about two thirds (66%) of patients in 2013. Majority of them were on CAPD; only about 2% were started on automated PD (CCPD).

**Table 5.6:** New dialysis by treatment modality, 2004-2013

Year	HD		CAPD		CCPD	
	n	%	n	%	n	%
2004	38	48	41	52	0	0
2005	35	42	33	40	15	18
2006	51	54	35	37	9	9
2007	36	41	47	53	5	6
2008	44	47	45	48	4	4
2009	38	36	64	60	5	5
2010	49	47	49	47	7	7
2011	43	42	55	53	5	5
2012	50	48	47	45	8	8
2013	35	34	67	64	2	2

**Figure 5.6:** New dialysis by treatment modality, 2004-2013

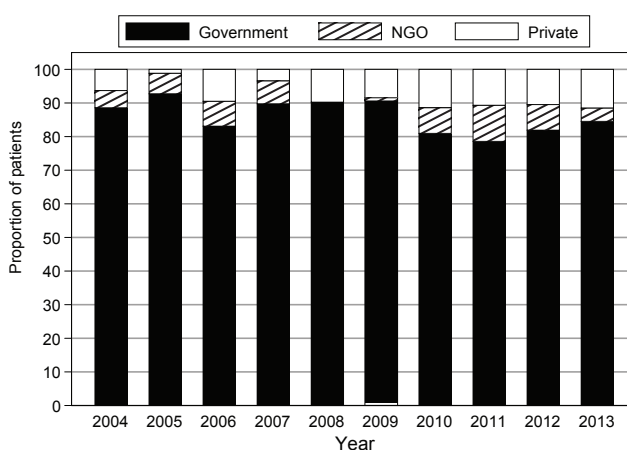


Most of the children (85%) received their dialysis treatment from government centres and hence were government funded.

**Table 5.7:** New dialysis by sector, 2004-2013

Year	Government		NGO		Private	
	n	%	n	%	n	%
2004	70	89	4	5	5	6
2005	77	93	5	6	1	1
2006	79	83	7	7	9	9
2007	79	90	6	7	3	3
2008	84	90	0	0	9	10
2009	97	91	1	1	9	8
2010	85	81	8	8	12	11
2011	81	79	11	11	11	11
2012	86	82	8	8	11	10
2013	88	85	4	4	12	12

**Figure 5.7:** New dialysis by sector, 2004-2013



## SECTION C: PRIMARY RENAL DISEASE

The most common primary renal disease identified was glomerulonephritis, which accounted for about 23% of the patients. FSGS on its own accounted for about 9% of the ESRD population. SLE was the second most common cause of ESRD in girls (11%). Unfortunately in a significant proportion (39%) of children the primary renal disease is unknown.

**Table 5.8:** Primary renal disease by sex among new dialysis patients, 2004-2013

Primary Renal Disease	Male		Female		All	
	n	%	n	%	n	%
Glomerulonephritis	156	23	124	23	280	23
FSGS	65	10	43	8	108	9
Refux nephropathy	50	7	23	4	73	6
SLE	9	1	58	11	67	6
Obstructive uropathy	50	7	38	7	88	7
Renal dysplasia	31	5	19	4	50	4
Hereditary nephritis	15	2	2	0	17	1
Cystic kidney disease	5	1	10	2	15	1
Metabolic	5	1	2	0	7	1
Others	14	2	23	4	37	3
Unknown	274	41	196	36	470	39

## 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 in that cadaveric renal transplant is now the most common transplantation done accounting for about 58% compared to 35% for living related renal transplant. The number of transplant from overseas commercial program had reduced significantly over the last 5 years.

**Table 5.9:** Types of renal transplantation, 2004-2013

Primary Renal Disease	2004-2008		2009-2013	
	n	%	n	%
Commercial cadaver	20	22	3	4
Commercial living donor	2	2	2	3
Living related donor	33	35	27	35
Cadaver	37	40	45	58
Living emotionally related	1	1	1	1
<b>TOTAL</b>	<b>93</b>	<b>100</b>	<b>78</b>	<b>101</b>

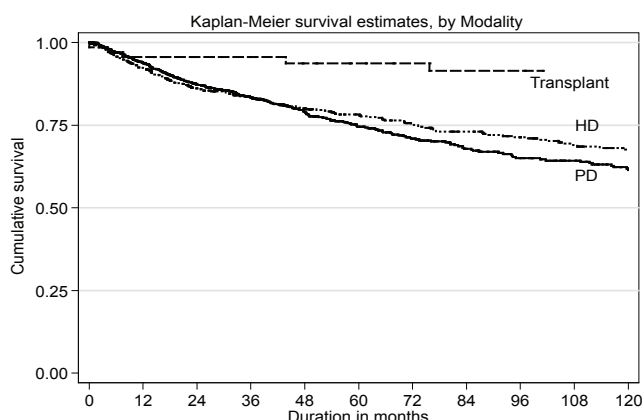
## SECTION E: SURVIVAL ANALYSIS

Renal transplantation had the best patient survival with 94% survival at 5 years and 91% 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 4 to 5 years of dialysis with PD patients showing a poorer outcome compared to HD (Figure 5.10b).

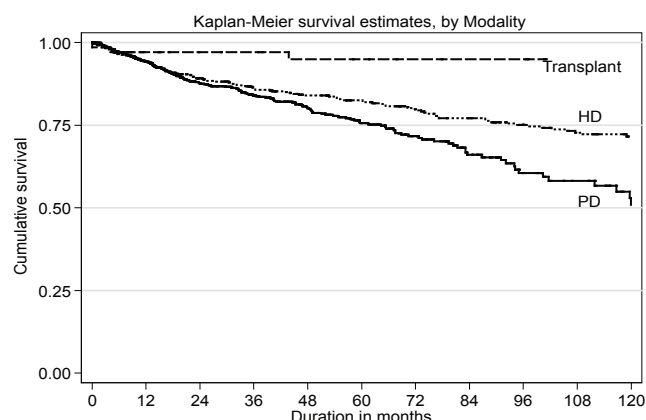
**Table 5.10(a):** Patient survival by dialysis modality analysis (not censored with change of modality), 2004-2013

Modality Interval (months)	Transplant			PD			HD		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	71	100		859	100		698	100	
6	66	97	2	794	97	1	636	96	1
12	63	96	2	725	94	1	584	92	1
24	54	96	2	597	87	1	485	86	1
36	51	96	2	495	83	1	425	83	2
48	48	94	3	415	79	2	364	80	2
60	46	94	3	336	75	2	316	78	2
72	44	94	3	281	71	2	272	75	2
84	43	91	4	234	68	2	232	73	2
96	43	91	4	196	65	2	196	71	2
108	40	91	4	173	64	2	167	69	2
120	40	91	4	139	61	2	141	67	2

**Figure 5.10(a):** Patient survival by dialysis modality analysis (not censored with change of modality), 2004-2013



**Figure 5.10(b):** Patient survival by dialysis modality analysis (censored with change of modality), 2004-2013



**Table 5.10(b):** Patient survival by dialysis modality analysis (censored with change of modality), 2004-2013

Modality Interval (months)	Transplant			PD			HD		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	71	100		859	100		698	100	
6	62	97	2	778	97	1	607	96	1
12	54	97	2	678	94	1	544	94	1
24	50	97	2	502	88	1	443	89	1
36	49	97	2	368	84	1	377	86	1
48	46	95	3	282	80	2	322	84	2
60	44	95	3	197	76	2	280	83	2
72	41	95	3	144	72	2	243	80	2
84	40	95	3	93	66	3	208	77	2
96	40	95	3	60	61	3	174	75	2
108	36	95	3	44	58	4	145	73	2
120	36	95	3	27	51	5	119	72	2

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

**Table 5.11:** Causes of death in dialysis patients, 2004-2013

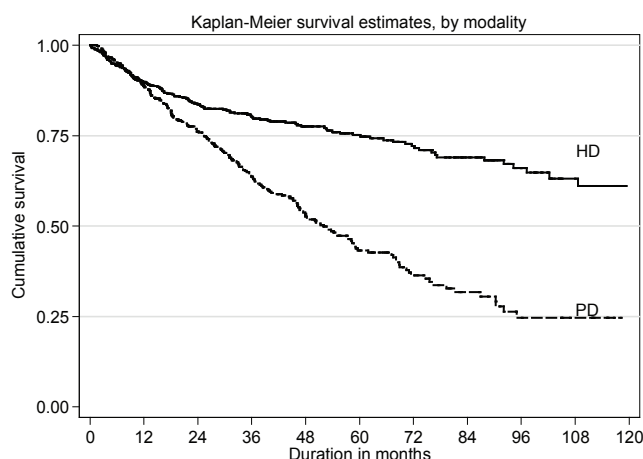
Year Causes of Death	2004-2008		2009-2013	
	n	%	n	%
Cardiovascular	10	19	27	33
Died at home	6	11	11	13
Sepsis	17	31	27	33
PD peritonitis	0	0	0	0
GIT bleed	1	2	1	1
Cancer	0	0	0	0
Liver disease	0	0	0	0
Withdrawal	1	2	2	2
Others	14	26	7	8
Unknown	5	9	8	10
<b>TOTAL</b>	<b>54</b>	<b>100</b>	<b>83</b>	<b>100</b>

After the first year, dialysis technique failure rate was much higher amongst PD patients with progressive widening of the technique survival curve with increasing years on dialysis. Technique survival at 5 years was only 43% for PD compared to 75% for HD.

**Table 5.12:** Dialysis technique survival by modality, 2004-2013

Modality Interval (months)	n	PD		n	HD	
		% survival	SE		% survival	SE
0	580	100		577	100	
6	517	95	1	517	94	1
12	436	89	1	458	90	1
24	306	76	2	357	84	2
36	202	64	2	285	80	2
48	140	53	3	218	78	2
60	82	43	3	169	75	2
72	48	36	3	127	72	2
84	29	32	3	92	69	3
96	16	25	4	53	66	3
108	10	25	4	31	63	4
120	1			1		

**Figure 5.12:** New RRT rate by age group, 2004-2013



The most common causes of drop out from PD program were death (41%), peritonitis (16%) and transplant (13%).

**Table 5.13:** Reasons for drop-out from PD program, 2004-2013

Year Reasons for drop-out	2004-2008		2009-2013	
	n	%	n	%
Death	56	30	38	41
Transplant	54	29	12	13
Peritonitis	38	21	15	16
Catheter related infection	0	0	5	5
Membrane failure	15	8	11	12
Technical problem	7	4	7	8
Patient preference	11	6	1	1
Others	2	1	4	4
Unknown	2	1	0	0

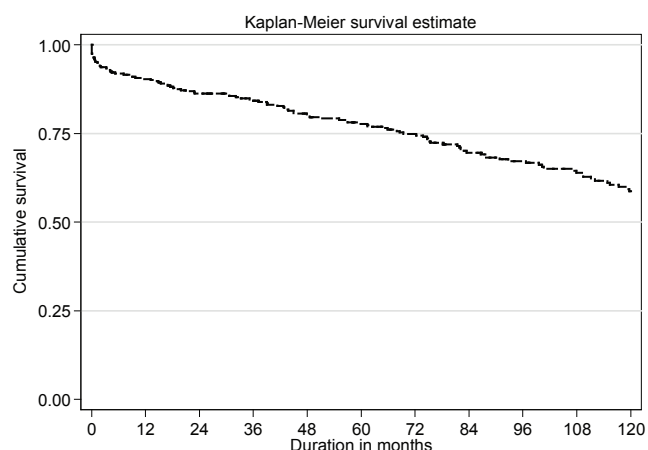


The graft survival for paediatric transplants was 90% at 1 year and 78% at 5 years.

**Table 5.14:** Transplant graft survival, 2004-2013

Interval (month)	n	% survival	SE
0	335	100	
6	303	92	1
12	292	90	2
24	269	86	2
36	245	84	2
48	226	80	2
60	202	78	2
72	180	75	3
84	153	70	3
96	132	67	3
108	114	64	3
120	99	59	3

**Figure 5.14:** Transplant graft survival, 2004-2013



The commonest known cause for graft loss among pediatric transplants was rejection (62%). Unfortunately graft loss due to unknown cause accounted for almost a quarter (24%) 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.

**Table 5.15:** Causes of graft loss, 2004-2013

Year Causes of graft loss	2004-2008		2009-2013	
	n	%	n	%
Rejection	17	65	23	62
Calcineurin toxicity	1	4	1	3
Other drug toxicity	0	0	0	0
Ureteric obstruction	0	0	1	3
Infection	1	4	0	0
Vascular causes	6	23	1	3
Recurrent/ de novo renal disease	0	0	0	0
Others	0	0	2	5
Unknown	1	4	9	24
<b>TOTAL</b>	<b>26</b>	<b>100</b>	<b>37</b>	<b>100</b>

## SECTION F: HAEMODIALYSIS PRACTICE

Majority (about 88%) of the paediatric haemodialysis patients had native vascular access. However the percentage of children with cuffed or non-cuffed central venous catheter appeared to be increasing.

**Table 5.16:** Vascular access on haemodialysis, 2004-2013

Year Access types	2004-2008		2009-2013	
	n	%	n	%
Wrist AVF	797	61.3	1107	54.2
BCF*	376	28.9	682	33.4
Venous graft	2	0.2	3	0.1
Artificial graft	2	0.2	8	0.4
cuffed catheter	65	5	162	7.9
non-cuffed catheter	59	4.5	80	3.9
<b>TOTAL</b>	<b>1301</b>	<b>100</b>	<b>2042</b>	<b>100</b>

The median prescribed Kt/V was 2.1 in 2013. Up to 88% of patients achieved the target Kt/V of  $\geq 1.3$  while 94% achieved an average URR of  $\geq 65\%$ .

**Table 5.17(a):** Distribution of prescribed Kt/V, HD patients 2009-2012

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients		
							$\geq 1.3$	$\geq 1.8$	$\geq 2$
2009	360	2.2	0.6	2.2	1.8	2.6	95	77	63
2010	367	2.2	0.6	2.2	1.8	2.6	94	74	64
2011	404	2.2	0.6	2.2	1.8	2.7	95	76	65
2012	442	2.3	0.6	2.2	1.9	2.7	95	77	65
2013	460	2.1	0.6	2.1	1.7	2.4	93	71	57

**Table 5.17(b):** Distribution of delivered Kt/V, HD patients 2009-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients		
							$\geq 1.3$	$\geq 1.8$	$\geq 2$
2009	286	2.2	0.6	2.2	1.8	2.5	82	36	20
2010	305	2.2	0.6	2.2	1.9	2.6	86	32	21
2011	322	2.3	0.6	2.2	1.9	2.7	87	35	24
2012	363	2.3	0.6	2.3	1.9	2.7	88	39	25
2013	386	2.1	0.6	2	1.7	2.4	88	37	22

**Table 5.17(c):** Distribution of URR, HD patients 2009-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 65$
2009	325	75.3	8.2	76	70.8	80.4	90
2010	326	75.4	7.5	76	70.1	81	92
2011	369	76.1	7	76.7	72.1	81.3	92
2012	394	75.9	7.9	77.1	71.2	81.5	91
2013	417	76.4	7.4	77.1	71.6	81.8	94

## SECTION G: ANAEMIA TREATMENT

The percentage of children treated with erythropoietin had reached a plateau of about 92% to 94% for the last 7 years. Similarly the proportion of children receiving parenteral iron showed an encouraging upward trend up to 42% in 2013 while the percentage of children on oral iron remained around 55-57%. The percentage of children who received blood transfusion had reduced slightly in 2013 to about 12%, the lowest since 2005.

**Table 5.18:** Treatment for anaemia, HD patients 2004-2013

Year	Number of patients	% on Erythropoietin	% received blood transfusion	% on oral iron	% received parenteral iron
2004	192	84	9	88	18
2005	218	88	14	76	18
2006	271	89	18	71	27
2007	293	92	14	73	25
2008	339	92	17	59	36
2009	372	92	16	57	39
2010	378	92	13	57	37
2011	420	93	14	56	36
2012	458	92	14	57	38
2013	481	94	12	55	42

The median transferrin saturation has consistently been above 30%. About 91% of children had transferrin saturation greater than 20%.

**Table 5.19:** Distribution of transferrin saturation on Erythropoietin, HD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 20$ %
2004	125	36.5	14.5	32.6	26.4	41.9	94
2005	165	36.6	16.4	32.6	24.4	44.4	88
2006	209	35.9	15.7	32.6	25	44	88
2007	244	33.7	14.9	31.1	23.4	40	86
2008	285	34.9	15.5	31.8	24.1	41.9	86
2009	317	35.1	16	31.9	24.9	42.2	86
2010	319	35.1	16.1	31.6	24.3	42.8	85
2011	364	33.1	14.4	30.8	23.5	37.9	85
2012	383	33	13.4	30.2	24.4	40	88
2013	400	32.7	13.3	30.5	23.9	38.4	87

**Table 5.20:** Distribution of transferrin saturation on Erythropoietin, PD patients 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 20$ %
2004	148	41.5	16.6	39	30	48.7	97
2005	169	40.5	15.4	38.9	31.2	46.9	94
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

The median weekly dose of ESA has doubled from 2000 units to 4000 units per week since 2006.

**Table 5.21:** Distribution of ESA dose (u/kg/wk), 2004-2013

Year	Number of patients	Mean	SD	Median	LQ	UQ
2004	258	3790.5	2915.3	2000	2000	4000
2005	315	3758.7	2934.3	2000	2000	4000
2006	363	4987.6	2866.4	4000	4000	6000
2007	402	5614.4	4524.6	4000	4000	6000
2008	436	5211	3996.9	4000	3000	6000
2009	480	4953.8	2766.1	4000	2000	6000
2010	511	5290	3062.1	4000	4000	6000
2011	535	5480.4	3373.3	4000	4000	6000
2012	563	5252.9	3073.9	4000	4000	6000
2013	599	5640.2	3923.2	4000	3000	6000

