CHAPTER 12

Paediatric Patients with Kidney Failure Requiring Replacement Therapy

As well as a summary of current trends in the frequency and causes of Kidney Failure in paediatrics, this report focuses specifically on current trends in the epidemiology and outcomes of paediatric transplantation.

Contents

Summary and Highlights

The incidence of treated Kidney Failure in patients under 18 years in both Australia and New Zealand continues to fluctuate considerably from year to year. The most common treatment modality for incident patients in 2021 was peritoneal dialysis (PD) when under 10 years of age, and haemodialysis (HD) when 10 years of age or more. Rates of pre-emptive transplantation have not substantially changed over the past 5 years.

The paediatric survey for 2021 continues to identify higher incidence of overweight and obese transplant recipients compared to the dialysis treated group.

This year, as well as providing a summary of current trends in the frequency and causes of Kidney Failure, the paediatric report for 2021 data focuses on current trends in the epidemiology and outcomes of paediatric transplantation.

Suggested Citation

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Incidence and Prevalence

The definition of paediatric used throughout this chapter is any patient below 18 years of age (at the time of commencing kidney replacement therapy (KRT) for incident data, or at the time of the annual survey (31 December 2021) for prevalent data). It is acknowledged that some of these patients may have been receiving their care in adult renal units, and some patients treated in paediatric units who are aged 18 years or older will not be included.

Population estimates for Australia and New Zealand used throughout this chapter for the calculation of incidence per million population were sourced from the Australian Bureau of Statistics (2021)[1] and Stats NZ (2021)[2], respectively.

Figure 12.1 shows the annual incidence of KRT per million age matched population. There is no change in the incidence of KRT in children and adolescents in either Australia or New Zealand. The small absolute numbers of incident patients produce large year to year fluctuations.

Figure 12.1.1 - Incidence of KRT - Age 0-17 Years - Australia

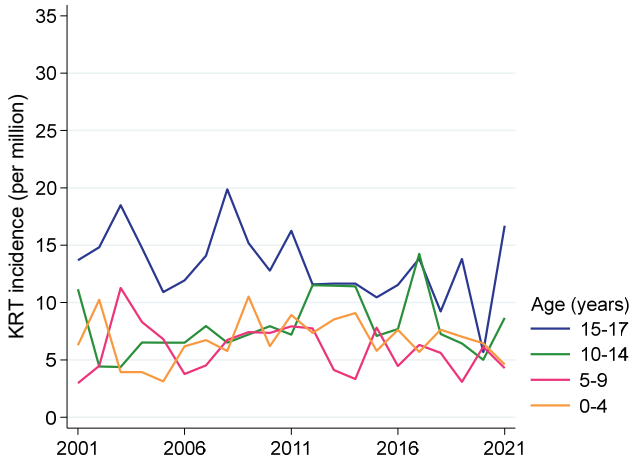
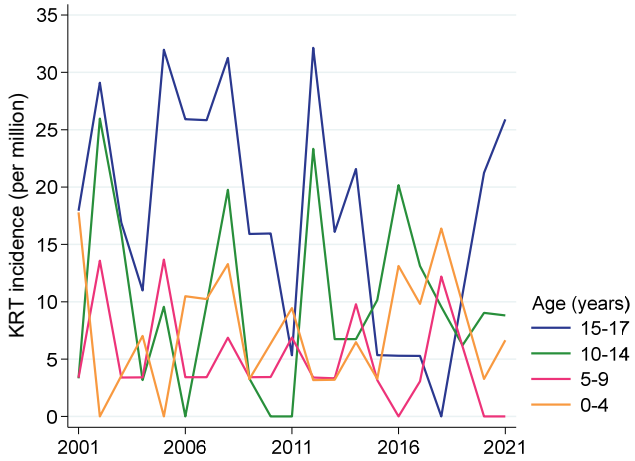


Figure 12.1.2 - Incidence of KRT - Age 0-17 Years - New Zealand



In Australia the prevalent numbers of treated kidney failure have gradually increased in older age groups (figure 12.2.1); the trends are less clear in New Zealand (12.2.2);.

Figure 12.2.1 - Prevalence of KRT - Age 0-17 Years - Australia

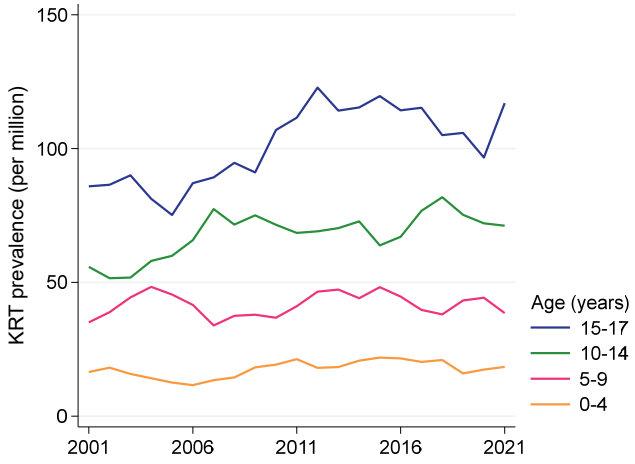
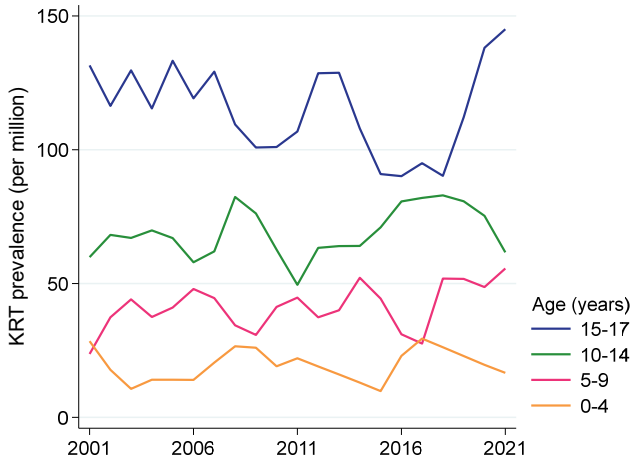


Figure 12.2.2 - Prevalence of KRT - Age 0-17 Years - New Zealand



Primary Kidney Disease

Collectively, congenital abnormalities of the kidney and urinary tract (CAKUT) are the predominant cause of kidney failure in younger children, with glomerular disease being the most common cause in adolescents.

Please note that primary kidney disease coding in ANZDATA is currently based on a legacy classification system derived from historical European Renal Association/European Dialysis and Transplantation Association classifications. The Registry recognises that in some cases, these diagnoses have failed to keep up to date with an evolving understanding of kidney pathology, particularly in the categorisation of glomerular disease and inherited conditions. New categories of primary kidney disease are being introduced for the 2022 survey.

Table 12.1 Primary Kidney Disease, Incident Patients Australia and New Zealand 2016-2021

Primary kidney disease	0-4	5-10	10-14	15-17	Total
Glomerular Disease (GN)	3 (4%)	12 (19%)	22 (21%)	20 (24%)	**57 (17%)**
- FSGS	1 (1%)	9 (14%)	10 (9%)	7 (9%)	**27 (8%)**
Familial GN	2 (3%)	1 (2%)	1 (1%)	2 (2%)	**6 (2%)**
Reflux Nephropathy	-	2 (3%)	8 (8%)	3 (4%)	**13 (4%)**
Polycystic Kidney Disease	5 (6%)	3 (5%)	4 (4%)	1 (1%)	**13 (4%)**
Medullary Cystic Disease	4 (5%)	6 (9%)	4 (4%)	3 (4%)	**17 (5%)**
Posterior Urethral Valve	11 (14%)	5 (8%)	6 (6%)	4 (5%)	**26 (8%)**
Haemolytic Uraemic Syndrome	1 (1%)	-	3 (3%)	-	**4 (1%)**
Hypoplasia/Dysplasia	16 (20%)	10 (16%)	20 (19%)	9 (11%)	**55 (17%)**
Diabetes	-	-	-	1 (1%)	**1 (0%)**
Cortical Necrosis	-	1 (2%)	2 (2%)	-	**3 (1%)**
Interstitial Nephritis	-	1 (2%)	-	2 (2%)	**3 (1%)**
Cystinosis	-	-	3 (3%)	2 (2%)	**5 (2%)**
Uncertain	3 (4%)	-	4 (4%)	6 (7%)	**13 (4%)**
Misc/Other	33 (41%)	13 (20%)	18 (17%)	20 (24%)	**84 (25%)**
Not reported	1 (1%)	1 (2%)	1 (1%)	2 (2%)	**5 (2%)**
Total	**80**	**64**	**106**	**82**	**305**

Modality of Treatment

The modality of the first kidney replacement treatment is shown in table 12.2. Although numbers are small and therefore fluctuate from year to year, around 15-20% of children and adolescents receive pre-emptive kidney transplants. Of the remainder, PD is more common in younger patients (<10 years), and for older patients' similar numbers start on HD and PD.

Table 12.2 Modality of Initial Kidney Replacement Therapy by Year of First Treatment, Australia and New Zealand

Age group	2016	2017	2018	2019	2020	2021	Total
0-9 Years	**23**	**23**	**30**	**21**	**21**	**16**	**134**
HD	5 (22%)	9 (39%)	7 (23%)	3 (14%)	4 (19%)	5 (31%)	**33 (25%)**
PD	15 (65%)	11 (48%)	14 (47%)	14 (67%)	14 (67%)	8 (50%)	**76 (57%)**
Transplant	3 (13%)	3 (13%)	9 (30%)	4 (19%)	3 (14%)	3 (19%)	**25 (19%)**
10-17 Years	**28**	**38**	**22**	**26**	**20**	**37**	**171**
HD	14 (50%)	15 (39%)	6 (27%)	10 (38%)	5 (25%)	15 (41%)	**65 (38%)**
PD	11 (39%)	16 (42%)	10 (45%)	12 (46%)	10 (50%)	14 (38%)	**73 (43%)**
Transplant	3 (11%)	7 (18%)	6 (27%)	4 (15%)	5 (25%)	8 (22%)	**33 (19%)**
Total	**51**	**61**	**52**	**47**	**41**	**53**	**305**

For prevalent patients (table 12.3), a very different pattern is seen, with the great majority (81% in 2021) of children and adolescents with a functioning transplant. This reflects the relatively high rate of transplantation among children.

Table 12.3 Modality of Prevalent Patients by Year of Treatment, Australia and New Zealand

Current treatment	2016	2017	2018	2019	2020	2021
HD	27 (8%)	22 (6%)	21 (6%)	16 (4%)	17 (5%)	20 (5%)
PD	53 (15%)	54 (15%)	46 (12%)	46 (12%)	50 (13%)	53 (14%)
Transplant	277 (78%)	293 (79%)	310 (82%)	313 (83%)	305 (82%)	310 (81%)
Total	**357**	**369**	**377**	**375**	**372**	**383**

Paediatric Assessment

The paediatric survey is collected on all children commencing kidney replacement therapy before the age of 15 and collection continues until they reach 18 years of age (children aged 15 years and older at time of starting KRT are excluded from the data presented below). This survey records data on height, weight and an assessment of educational participation.

Amongst those 12 years or older, modified schooling (within an additional needs class, school, requirement for a teacher's aid or home schooling) was undertaken for a substantial percentage of dialysis recipients. (figure 12.3). Note that multiple categories of paediatric assessment have been collapsed into single groups for reporting purposes (see the survey form for details: (https://www.anzdata.org.au/wp-content/uploads/2020/11/PaediatricForm.pdf)

Figure 12.3.1 - Educational Participation by Age Group and Treatment Modality - Australia 2021

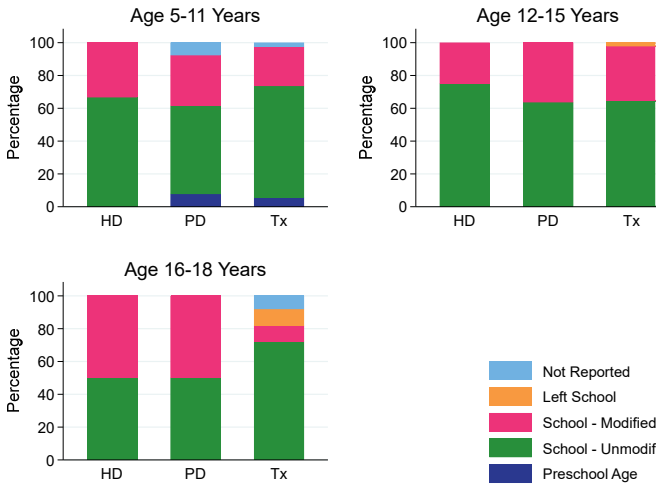
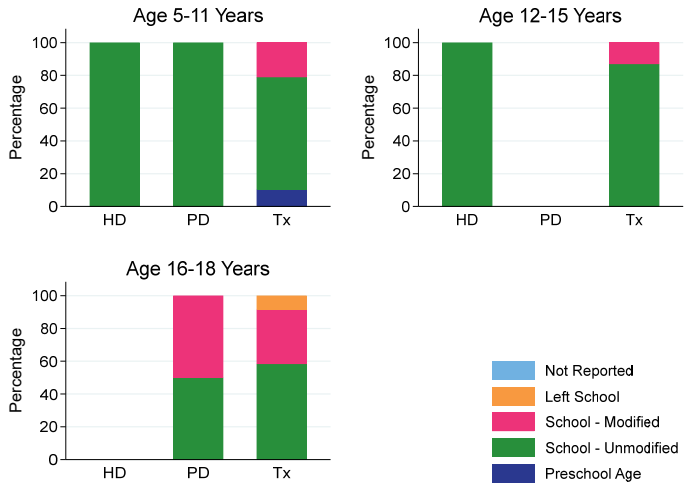


Figure 12.3.2 - Educational Participation by Age Group and Treatment Modality - New Zealand 2021



Paediatric BMI categories are determined using age adjusted z-scores. In Australia, a higher proportion of transplant recipients and haemodialysis patients were overweight or obese, compared with children and adolescents treated with peritoneal dialysis (figure 12.5). New Zealand data should be interpreted with caution due to low numbers of patients.

Figure 12.4.1 - Body Mass Index of Prevalent Paediatric Patients by Treatment Modality - Australia 2021

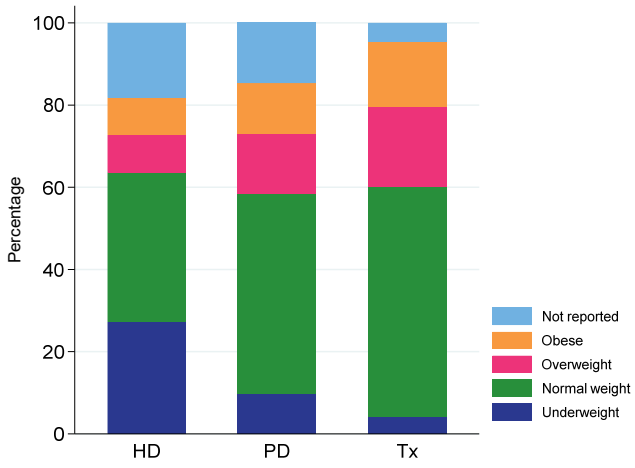
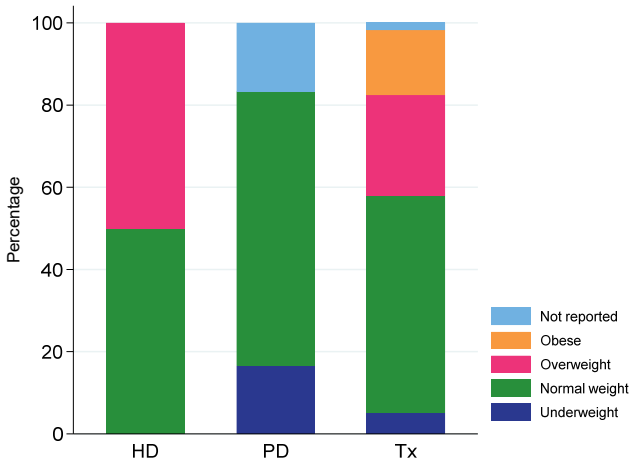


Figure 12.4.2 - Body Mass Index of Prevalent Paediatric Patients by Treatment Modality - New Zealand 2021



Transplantation

Donor and Transplant Characteristics

Figures 12.5-12.8 and tables 12.4-12.5 show the trends in paediatric transplantation over the 12 year period from 2010-2021, including donor source, donor and recipient age by donor type, overall HLA matching, time to transplantation and graft numbers.

Table 12.4 Donor Source by Year, Paediatric Kidney Transplants 2012-2021, Number (% of Transplants). Living Donor (LD), Donation after brain death (DBD), donation after cardiac death (DCD).

Donor type	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
LD pre-emptive	12 (21%)	8 (17%)	9 (18%)	13 (27%)	6 (17%)	9 (15%)	15 (29%)	7 (16%)	8 (24%)	11 (29%)
LD not pre-emptive	26 (46%)	20 (42%)	18 (36%)	22 (45%)	10 (28%)	20 (34%)	12 (23%)	13 (29%)	7 (21%)	8 (21%)
DBD	17 (30%)	18 (38%)	19 (38%)	12 (24%)	18 (50%)	27 (46%)	17 (33%)	19 (42%)	11 (33%)	14 (37%)
DCD	1 (2%)	2 (4%)	4 (8%)	2 (4%)	2 (6%)	3 (5%)	8 (15%)	6 (13%)	7 (21%)	5 (13%)
Total	**56**	**48**	**50**	**49**	**36**	**59**	**52**	**45**	**33**	**38**

Table 12.5 Graft Numbers, Paediatric Kidney Transplants 2012-2021 Australia and New Zealand

Graft number	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	55	43	46	48	33	51	49	43	31	35
2	1	5	3	1	3	8	3	2	2	3
3	0	0	1	0	0	0	0	0	0	0

Figure 12.5 - Donor Age by Donor Source - Paediatric Kidney Transplants 2010-2021

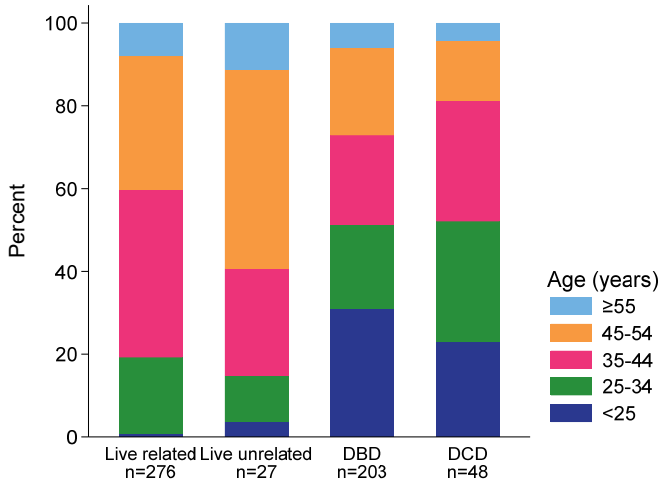


Figure 12.6 - Recipient Age by Donor Source - Paediatric Kidney Transplants 2010-2021

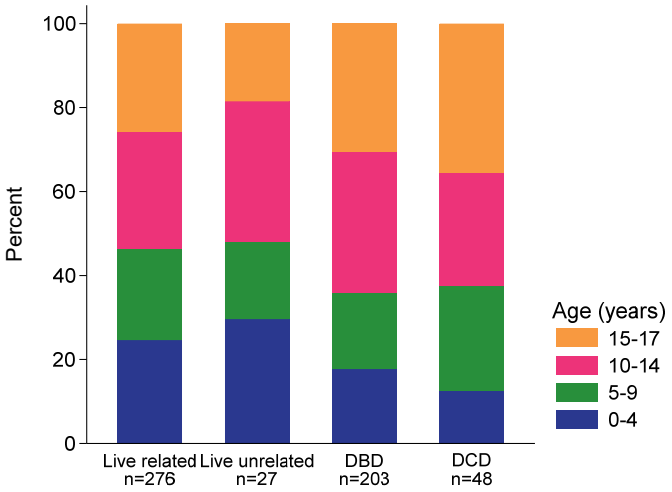


Figure 12.7 - Time to First Kidney Transplant - Paediatric Kidney Transplants 2010-2021

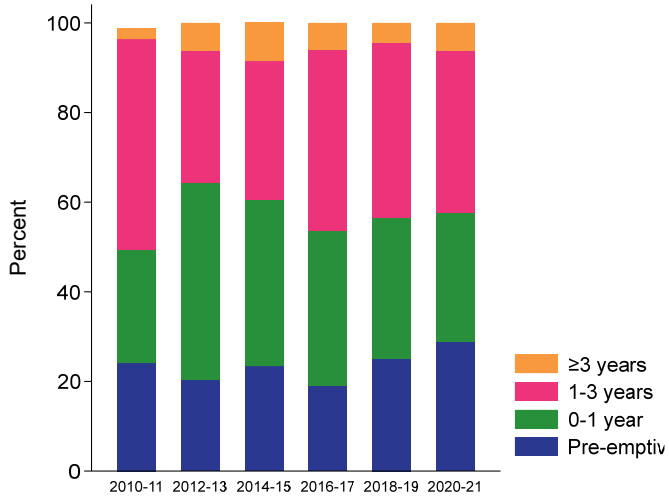
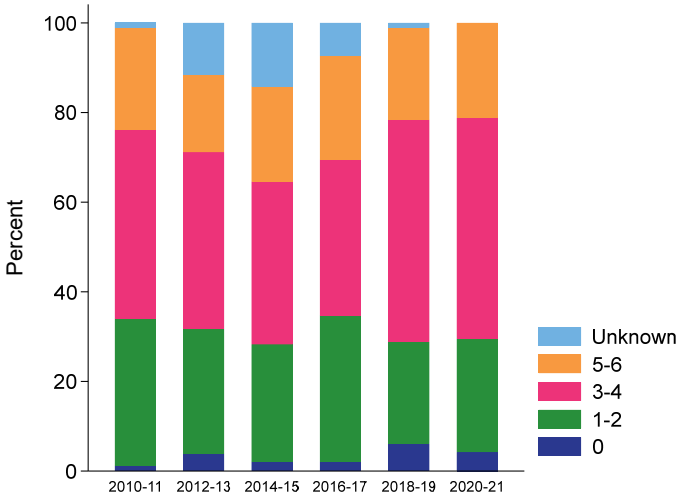


Figure 12.8 - Number of HLA Mismatches - Paediatric Kidney Transplants 2010-2021



Immunosuppression

Most patients in both countries receive induction antibody therapy with anti-CD25 agents (table 12.6).

Table 12.6 Antibody Use for Induction Immunosuppression in Paediatric Kidney Transplants, Number Receiving (%)

Country	Type of agent	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Australia	Intravenous immunoglobulin	0 (0.0%)	2 (4.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Anti-CD25	42 (91.3%)	40 (93.0%)	44 (95.7%)	33 (80.5%)	25 (83.3%)	52 (96.3%)	44 (97.8%)	29 (87.9%)	25 (96.2%)	27 (93.1%)
	Rituximab	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (3.0%)	0 (0.0%)	0 (0.0%)
	T cell depleting polyclonal Ab	1 (2.2%)	1 (2.3%)	1 (2.2%)	3 (7.3%)	1 (3.3%)	1 (1.9%)	0 (0.0%)	1 (3.0%)	1 (3.8%)	1 (3.4%)
	Other	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Not reported	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (2.4%)	3 (10.0%)	1 (1.9%)	0 (0.0%)	2 (6.1%)	1 (3.8%)	1 (3.4%)
	Total new transplants	**46**	**43**	**46**	**41**	**30**	**54**	**45**	**33**	**26**	**29**
New Zealand	Intravenous immunoglobulin	1 (10.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Anti-CD25	10 (100.0%)	5 (100.0%)	4 (100.0%)	8 (100.0%)	6 (100.0%)	5 (100.0%)	7 (100.0%)	11 (91.7%)	7 (100.0%)	9 (100.0%)
	Rituximab	0 (0.0%)	1 (20.0%)	0 (0.0%)	1 (12.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (11.1%)
	T cell depleting polyclonal Ab	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Other	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Not reported	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (8.3%)	0 (0.0%)	0 (0.0%)
	Total new transplants	**10**	**5**	**4**	**8**	**6**	**5**	**7**	**12**	**7**	**9**

Tacrolimus is the most commonly used calcineurin inhibitor (CNI) at induction and at 1, 5 and 10 years post-transplant (figures 12.9-12.12).

Figure 12.9 - Cyclosporin A (CsA), Tacrolimus (Tac) and mammalian target of rapamycin inhibitors (mTOR) at Induction - Paediatric Kidney Transplant Cohorts 2010-2021 (By Year of Transplant)

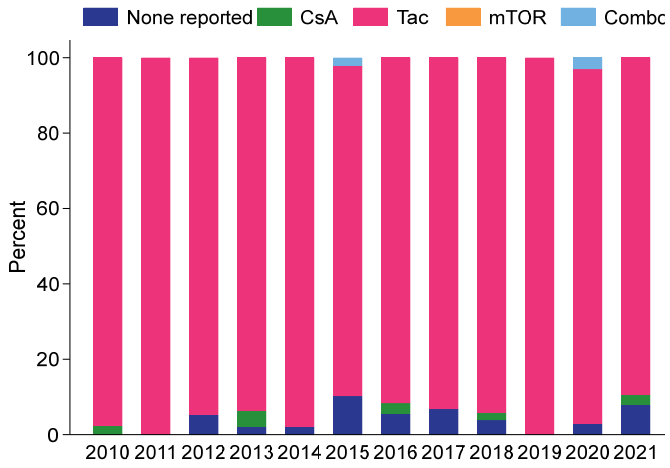


Figure 12.10 - Cyclosporin A (CsA), Tacrolimus (Tac) and mammalian target of rapamycin inhibitors (mTOR) at One Year - Paediatric Kidney Transplant Cohorts 2010-2020 (By Year of Transplant)

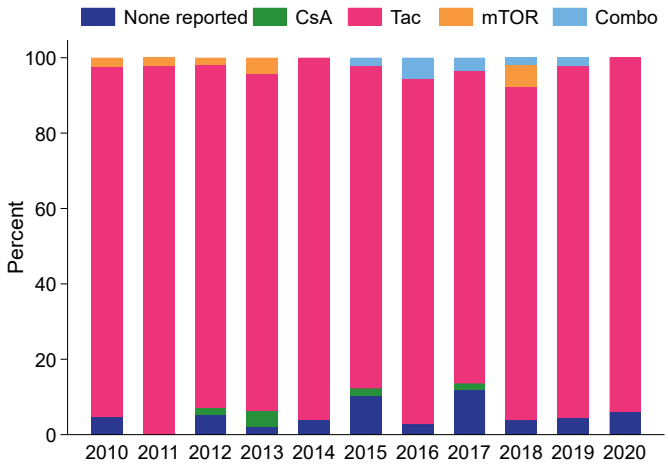


Figure 12.11 - Cyclosporin A (CsA), Tacrolimus (Tac) and mammalian target of rapamycin inhibitors (mTOR) at Five Years - Paediatric Kidney Transplant Cohorts 2010-2016 (By Year of Transplant)

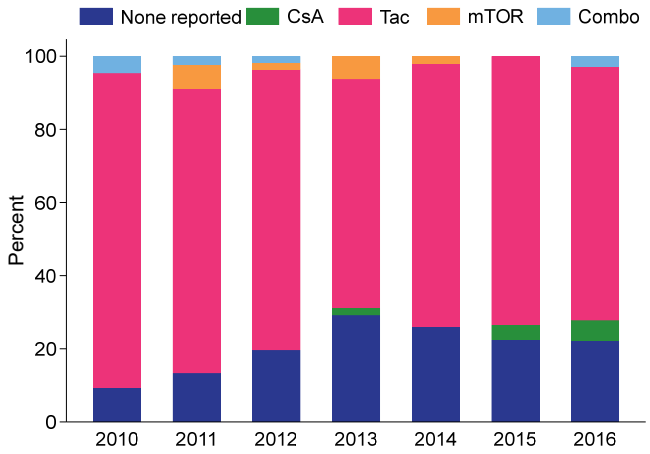
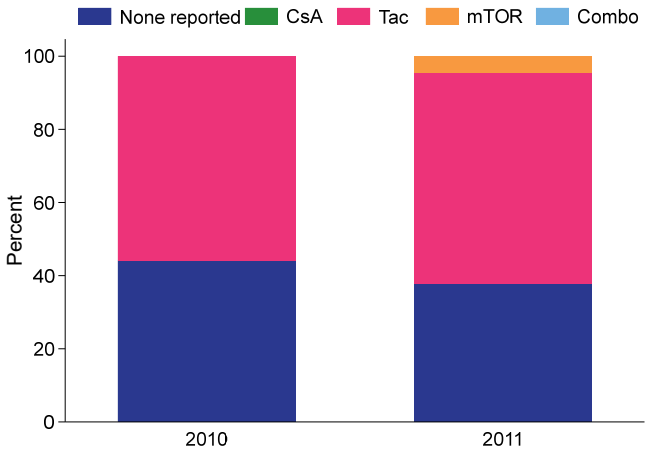


Figure 12.12 - Cyclosporin A (CsA), Tacrolimus (Tac) and mammalian target of rapamycin inhibitors (mTOR) at Ten Years - Paediatric Kidney Transplant Cohorts 2010-2011 (By Year of Transplant)



Mycophenolate (MMF/MPA) is the most used antimetabolite at induction and long-term use has increased over time, with only a small proportion of patients treated with azathioprine (Aza) (figures 12.13-12.16).

Figure 12.13 - Antimetabolites at Induction - Paediatric Kidney Transplant Cohorts 2010-2021 (By Year of Transplant)

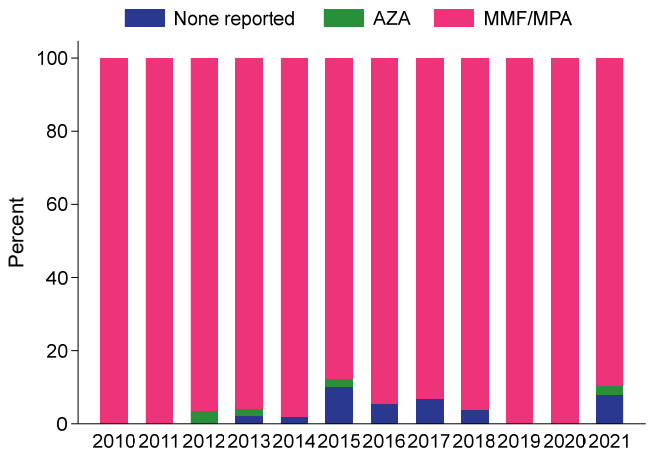


Figure 12.14 - Antimetabolites at One Year - Paediatric Kidney Transplant Cohorts 2010-2020 (By Year of Transplant)

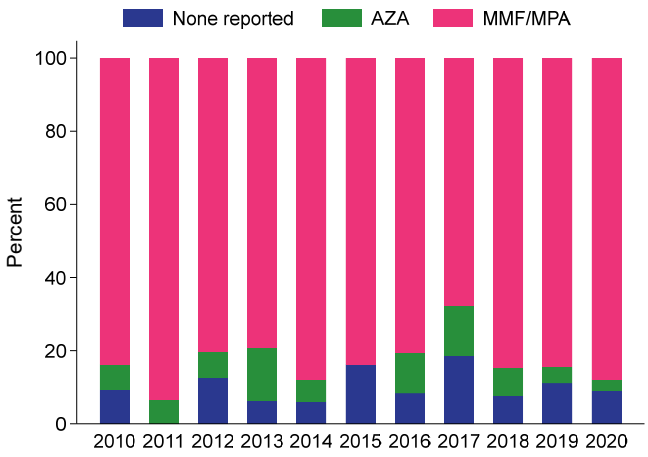


Figure 12.15 - Antimetabolites at Five Years - Paediatric Kidney Transplant Cohorts 2010-2016 (By Year of Transplant)

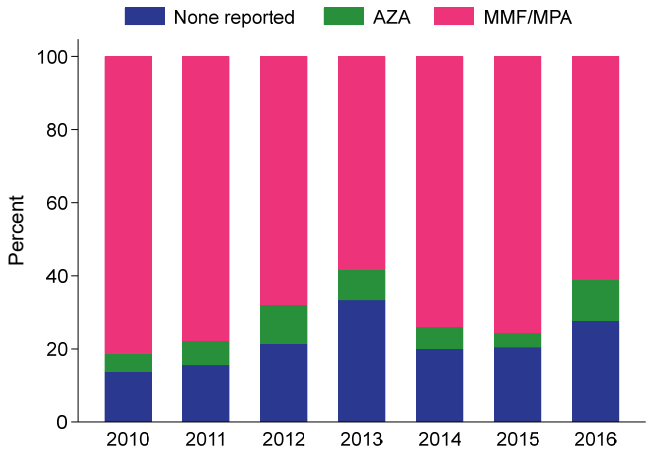


Figure 12.16 - Antimetabolites at Ten Years - Paediatric Kidney Transplant Cohorts 2010-2011 (By Year of Transplant)

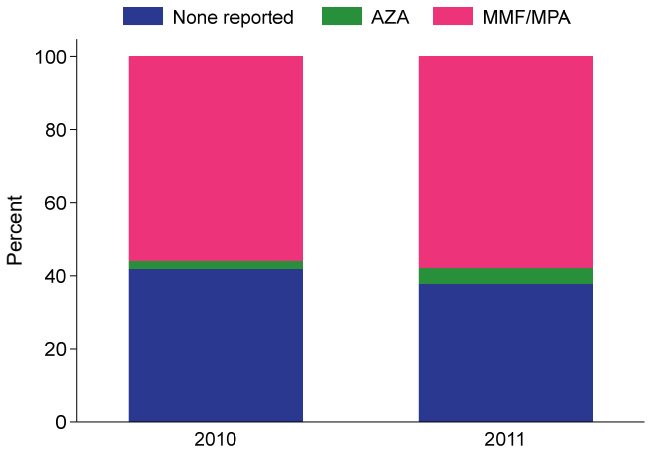
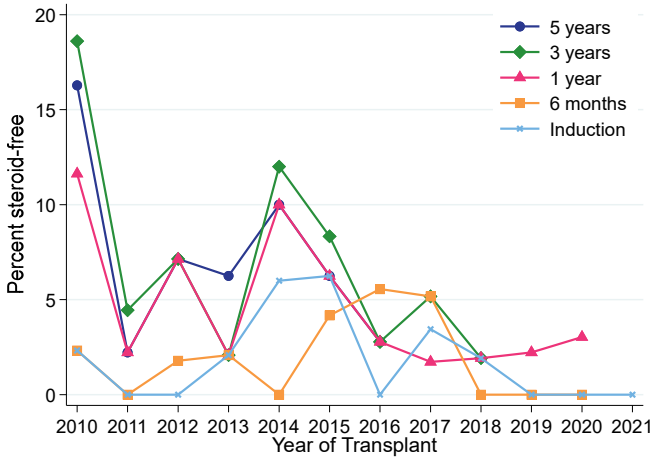


Figure 12.17 shows the percentage of paediatric transplant recipients not receiving steroid immunosuppression (Prednisolone) by transplant year and time since transplant.

Figure 12.17 - Steroid-Free Fraction - Paediatric Kidney Transplant Cohorts 2010-2021



Transplant Outcomes

Graft and patient survival for transplants performed in Australia and New Zealand on recipients aged <18 years, calculated by the Kaplan-Meier method, are shown in table 12.7. Unadjusted one, three and five year patient survival have remained relatively stable over the past ten years, with graft survival improving after the 2008-09 cohort.

Table 12.7 Patient and Graft Survival (95% CI), Paediatric Kidney Transplant Recipients 2012-2021

Outcome	Transplant year (N)	6 months	1 year	3 years	5 years
Patient Survival	**2012-13 (n=104)**	99 (93-100)	99 (93-100)	98 (93-100)	98 (93-100)
	2014-15 (n=99)	100	100	100	100
	2016-17 (n=95)	99 (93-100)	99 (93-100)	99 (93-100)	99 (93-100)
	2018-19 (n=97)	100	100	100	-
	2020-21 (n=71)	99 (90-100)	99 (90-100)	-	-
Graft Survival	**2012-13 (n=104)**	99 (93-100)	98 (93-100)	93 (86-97)	87 (79-92)
	2014-15 (n=99)	97 (91-99)	97 (91-99)	93 (86-97)	88 (80-93)
	2016-17 (n=95)	97 (90-99)	97 (90-99)	97 (90-99)	92 (84-96)
	2018-19 (n=97)	99 (93-100)	99 (93-100)	95 (88-98)	-
	2020-21 (n=71)	97 (89-99)	97 (89-99)	-	-

The causes of graft loss by age at transplant and age at graft loss are shown in tables 12.8 and 12.9 respectively. New categories have been in use for reporting chronic allograft rejection since 2020 (see the Kidney Transplantation chapter for further details).

Table 12.8 Cause of Graft Loss, Paediatric Kidney Transplants Performed 2012-2021 by Age at Transplant

Cause of graft loss	0-4	5-9	10-14	15-17	Total
Death with function	1	2	0	1	**4**
Acute rejection	0	3	1	3	**7**
Chronic allograft nephropathy	0	1	4	2	**7**
Chronic antibody mediated rejection	0	0	0	5	**5**
Gradual graft failure - biopsy not performed	0	3	2	1	**6**
Vascular	1	0	2	2	**5**
Glomerular Disease	0	0	2	4	**6**
Non-compliance	0	0	2	7	**9**
Other	0	0	1	3	**4**
Not reported	0	0	1	2	**3**
Total	**2**	**9**	**15**	**30**	**56**

Table 12.9 Cause of Graft Loss, Paediatric Kidney Transplants Performed 2012-2021 by Age at Graft Loss

Cause of graft loss	0-4	5-9	10-14	15-17	Total
Death with function	1	1	1	1	**4**
Acute rejection	0	0	2	4	**6**
Chronic allograft nephropathy	0	0	1	5	**6**
Gradual graft failure - biopsy not performed	0	0	2	3	**5**
Vascular	1	0	2	2	**5**
Glomerular Disease	0	0	0	3	**3**
Non-compliance	0	0	0	6	**6**
Other	0	0	1	0	**1**
Not reported	0	0	0	2	**2**
Total	**2**	**1**	**9**	**26**	**38**

Rejection

The proportion of patients experiencing at least one episode of acute rejection (biopsy proven or clinically diagnosed) in the first six months post-transplant has remained low (figure 12.18). The proportion experiencing rejection between 6-24 months post-transplant has remained largely unchanged for cohorts since 2010 (figure 12.19). The majority of rejection episodes reported to the registry are cellular rejection (table 12.10).

Figure 12.18 - Rejection <6 Months Post-Transplant - Paediatric Kidney Transplant Cohorts 2012-2020

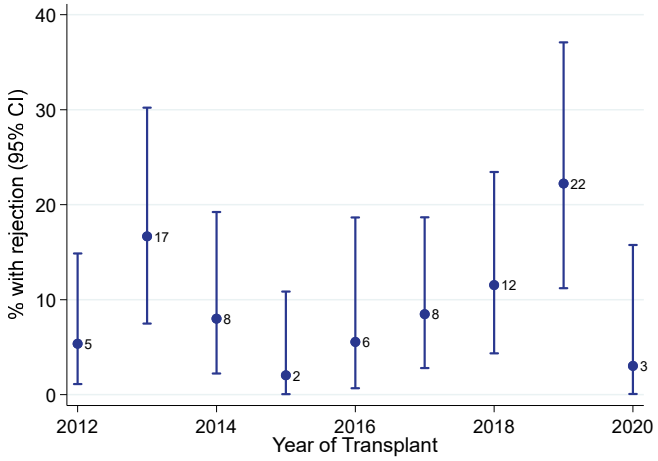


Figure 12.19 - Rejection 6-24 Months Post-Transplant - Paediatric Kidney Transplant Cohorts 2012-2018

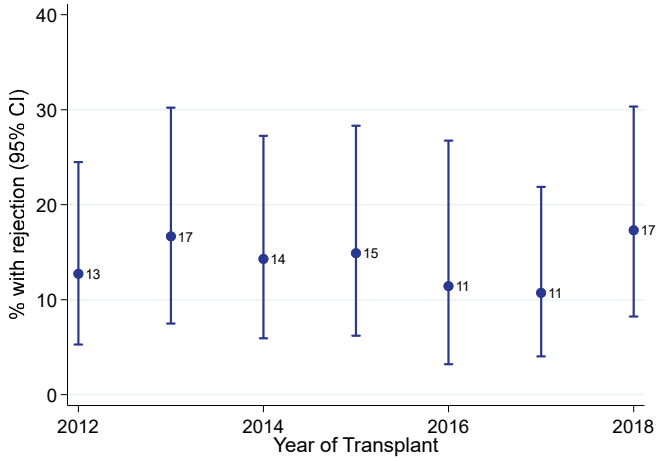


Table 12.10 Type of Rejection, Paediatric Kidney Transplants 2012-2020

Timing of rejection	Type of rejection	2012	2013	2014	2015	2016	2017	2018	2019	2020
<6 months	**No biopsy**	0	1	0	0	0	1	0	0	0
	Cellular	2	7	4	1	4	3	5	7	0
	ABMR	0	1	0	0	0	0	1	1	0
	Cellular + ABMR	0	0	0	0	0	3	1	1	0
6-24 months	**No biopsy**	0	1	0	0	0	0	0	-	-
	Cellular	9	11	8	8	5	6	14	-	-
	ABMR	0	1	0	0	0	0	1	-	-
	Cellular + ABMR	3	1	1	2	0	1	0	-	-

Excludes rejection episodes where a biopsy was performed, and rejection reported as neither antibody mediated, nor T-cell mediated.
ABMR - antibody-mediated rejection

References

[1] Australian Bureau of Statistics, 2021, Quarterly Population Estimates (ERP), by State/Territory, Sex and Age, Jun 2021, viewed 22 Dec 2021, https://www.abs.gov.au/statistics/people/population/national-state-and-territory-population/jun-2021

[2] This work is based on/includes Stats NZ's data which are licensed by Stats NZ for re-use under the Creative Commons Attribution 4.0 International licence. Stats NZ, 2021, Estimated Resident Population by Age and Sex (1991+) (Annual-Jun), NZ Infoshare, viewed 5 Jan 2022, http://infoshare.stats.govt.nz/