Hormozgan Medical Journal
doi 10.34172/hmj.8361
Hormozgan Med J. 2024;28(4):214-220

Original Article

Evaluating Kidney Transplant Outcomes and Its Survival Rates in Pediatric Patients

Zeynab Jabrailian[1], Azam Mivefroshan[1*], Saeed Abkhiz[1]

[1]Department of Internal Medicine, School of Medicine, Urmia University of Medical Sciences, Urmia, Iran

***Correspondence to**
Azam Miveforushan,
Email: dr.azam2011@gmail.com

Abstract

Background: The incidence and prevalence of advanced kidney failure among pediatric patients have increased recently. Kidney transplantation is the preferred treatment option for children with advanced kidney failure. This study aimed to investigate kidney transplantation outcomes and survival rates in pediatric patients.

Methods: This cross-sectional descriptive study retrospectively reviewed the medical records of pediatric patients under 18 years of age who underwent transplantation at Imam Khomeini Hospital, Urmia, Iran, between 2001 and 2021 (20 years). Data were collected using a standardized checklist, which included information on patient age, gender, dialysis type, etiology of end-stage renal disease (ESRD), and prescribed medications. Data analysis was conducted using SPSS version 21.

Results: Of the 93 pediatric kidney transplant recipients, 54 (58.1%) were male, and 39 (41.9%) were female, with a mean age of 12.87±4.24 years. Urological complications were the most common cause, affecting 40.9% of patients overall (44.4% of males and 35.9% of females). Glomerulonephritis (28.0%) and hypertension (11.8%) were the next most common etiologies. Living non-relatives (78 patients) served as the predominant source of donor kidneys (83.9%). CellCept (87.0%) was the most frequently prescribed immunosuppressive medication. An analysis of patient outcomes revealed a higher survival rate among males (59.5%) compared to females (40.5%), with a balanced gender distribution among non-survivors (50% male, 50% female). Overall patient survival rates were high throughout the study, with 94.63% surviving the first year, 89.25% surviving three years, and 87.10% surviving five years. Cytomegalovirus infection (10.7%), diabetes (6.4%), BK virus infection (3.2%), and malignancy (1.0%) were observed at lower frequencies. The graft survival rate was 90.33% at one year, 83.88% at three years, and 81.73% at five years.

Conclusion: Kidney transplantation remains the optimal treatment for ESRD, especially in children, leading to improved survival and quality of life. Early detection of rare post-transplant complications, along with strict adherence to treatment regimens, is critical for successful outcomes.

Keywords: Pediatric renal transplant, Patient survival, Graft survival, Post-transplant complications

Received: July 11, 2024, **Revised:** August 20, 2024 ,**Accepted:** August 24, 2024, **ePublished:** October 30, 2024

Background

Kidney transplantation is considered the gold standard for treating end-stage renal disease (ESRD) in children, despite the relatively low prevalence of ESRD in this population (1, 2). This preference is evident in transplant practices, with pediatric cases accounting for a small proportion (approximately 4%) of all kidney transplants performed in Europe (3). In Iran, the incidence of pediatric chronic kidney disease is 16.8 per million, while the rate of pediatric kidney transplantation is substantially lower at 7.2 per million (4). Numerous studies have documented the superiority of renal transplantation over dialysis therapy in children, highlighting benefits in overall survival, psychomotor development, social integration, and quality of life (5).

The main objectives of pediatric kidneys include providing renal replacement therapy, alleviating dialysis-related morbidity, promoting linear growth, improving overall survival, and enhancing quality of life (6). Advances in immunosuppressive medications, refined surgical techniques, and enhanced post-operative care for pediatric patients have yielded excellent clinical outcomes, including physical and mental development comparable to healthy children (7). Despite these successes, pediatric kidney transplantation presents several unique challenges. A combination of factors, including co-morbidities, technical difficulties, immunological complexities, and psychosocial aspects,

distinguishes this patient population from adults undergoing the procedure (8).

While pediatric kidney transplantation offers significant benefits, it also presents unique challenges. Notably, congenital urinary tract abnormalities account for at least 20% of ESRD cases in this population, presenting a distinct hurdle (9). The limited abdominal space in children further complicates surgical procedures, particularly when performing vascular anastomosis with smaller kidneys (10). Maintaining hemodynamic stability, fluid balance, and medication regimens during transplantation and the post-operative period adds further complexity for pediatric patients (11). Despite these advancements, many children will eventually require re-transplantation due to graft loss (12). Furthermore, kidneys from living donors generally exhibit superior long-term survival rates compared to those from deceased donors (13).

An increasing number of individuals under 18 are experiencing irreversible kidney failure, a concerning trend highlighted by the limited research on pediatric kidney transplantation outcomes (14). This study endeavored to address this gap by investigating the clinical results of kidney transplantation in this specific age group.

Methods

This cross-sectional descriptive study, approved by the Ethics Committee of Urmia University of Medical Sciences (No. IR.UMSU.REC.1395.566), investigated pediatric kidney transplantation outcomes. The study retrospectively reviewed medical records of children under 18 who underwent transplantation at Imam Khomeini Hospital, Urmia, Iran, between 2001 and 2021 (18 years). A standardized checklist was used to collect data on patient age, gender, type of dialysis, etiology of ESRD, and prescribed medications (15). The primary outcomes assessed were graft survival, defined as the duration of transplanted kidney function and the absence of the need for renal replacement therapy, and patient survival post-transplantation. Patient confidentiality was strictly maintained throughout the study.

The inclusion criteria consisted of women under 18 years old who had received a kidney transplant, had body mass index (BMI) ≥ 18.5 kg/m^2, had post-transplant survival, and were willing to sign the consent form.

Exclusion criteria included the use of hormones or medications that could potentially influence study outcomes within the past 2 months, acupuncture treatment within the past 2 months, pregnancy within the past 6 weeks, recent abortion, childbirth, or breastfeeding (within the past 6 weeks), inability or unwillingness to provide written consent, bariatric surgery within the past 12 months, or an ongoing period of rapid weight loss.

Statistical Analysis

Data were analyzed using SPSS software. Quantitative data underwent descriptive analysis, with means and standard deviations (SDs) calculated. Qualitative data were presented using frequency tables and graphs. Chi-square tests assessed group differences for qualitative variables, while independent t-tests evaluated quantitative variables between the groups. Kaplan-Meier survival curves were generated to estimate one-year survival rates for both kidneys and patients. Log-rank tests were used to compare survival functions and associated patient outcomes.

Results

Ninety-three pediatric kidney transplant recipients under the age of 18 participated in this study. The sample comprised 54 males (58.1%) and 39 females (41.9%). The mean age of the patient was 12.87 years (SD = 4.24), ranging from 4 to 18 years. Statistical analysis revealed no significant difference ($P = 0.12$) in the mean age between males (12.29 years, SD = 4.54) and females (13.66 years, SD = 3.71). Further stratification identified three distinct age groups: 4-8 years (17 patients, 18.3%), 9-13 years (36 patients, 38.7%), and 14-18 years (40 patients, 43.0%). Table 1 presents the frequency and relative frequency distribution of patient ages.

An analysis of the etiology of ESRD in the study population (Table 2) revealed a diverse range of contributing factors. Urological complications were the most prevalent cause, affecting 40.9% of patients. This was further reflected in the gender breakdown, with 44.4% of males and 35.9% of females experiencing urological issues as the primary cause of ESRD. Glomerulonephritis (28.0%) and hypertension (11.8%) were the next most common etiologies. Diabetes played a minor role (1.1%), with only one female patient identified in this category. Unidentified causes accounted for 18.27% of cases, with a slightly higher prevalence in males (20.4%) than in females (15.4%).

Living non-relatives were the predominant source of kidney donations, accounting for 78 patients (83.9%) of the total cohort, with a similar pattern observed across genders (males: 87.0%, females: 79.5%), as illustrated in Table 2. In contrast, deceased donor kidneys were used less frequently, representing 8.6% of total donations, with a higher proportion in females (15.4%) compared to males (3.7%). Kidneys from living relatives were utilized in a smaller proportion of cases (males: 9.3%, females: 5.1%), with no statistically significant difference detected

Table 1. Frequency and Relative Frequency of Age Groups Among the Subjects

Age	Frequency	Relative Frequency
4-8	17	18.3%
9-13	36	38.7%
14-18	40	43%

Note. $P = 0.12$

Table 2. Relationship Between Gender, Causes of ESRD, and Source of Kidney Donation

	Unknown	Urological	Glomerulonephritis	Hypertension	Diabetes	Total
Male	11 (20.4%)	24 (44.4%)	13 (24.1%)	6 (11.1%)	0 (0.0%)	54 (100%)
Female	6 (15.4%)	14 (35.9%)	13 (33.3%)	5 (12.8%)	1 (2.6%)	39 (100%)
Total	17 (18.27%)	38 (40.9%)	(28%)26	11 (11.8%)	1 (1.1%)	93 (100%)
	Relatives	**Non-relatives**	**Cadaveric Transplants**	**Total**	***P* Value**	-
Male	5 (9.3%)	47 (87%)	2 (3.7%)	54 (100%)	0.11	-
Female	2 (5.1%)	31 (79.5%)	6 (15.4%)	39 (100%)		-
Total	7 (7.5%)	78 (83.9%)	8 (8.6%)	93 (100%)		-

Note. ESRD: End-stage renal disease.

between genders regarding the source of kidney donation ($P = 0.11$), as depicted in Table 2.

Before transplantation, hemodialysis was the most common dialysis modality, employed by 67.7% (63 patients) of the participants. Peritoneal dialysis was utilized in 15.1% (14 patients), while 17.2% (16 patients) did not require dialysis before the transplant (Table 3). CellCept (87.0%) emerged as the most frequently administered immunosuppressive therapy, followed by steroids (77.0%), cyclosporine (76.0%), rapamycin (21.0%), and tacrolimus (8.0%), as illustrated in Table 3.

Post-transplantation complications were documented in 73.11% (68 patients) of the population, with the remaining 26.88% experiencing an uneventful course (Table 3). Urinary tract infections (UTIs) (53.7%) were the most prevalent complication, followed by hypertension (47.31%). As seen in Table 3, less frequently observed complications included cytomegalovirus infection (10.7%), diabetes (6.4%), BK virus infection (3.2%), and malignancy (1.0%).

Acute rejection episodes were identified in 32.2% (29 patients) of the study population, with a significantly higher incidence among females (87.5%). Conversely, 68.8% of patients did not experience rejection. Surgical complications were less common, affecting only a small number of patients: lymphocele (1.1%), collection complications (3.2%), and urine leaks (2.3%). Fortunately, 93.0% of patients were free from surgical complications (Table 3).

An analysis of patient outcomes revealed a higher survival rate among males (59.5%) compared to females (40.5%). However, the gender distribution among non-survivors was balanced (50% male, 50% female). Notably, patient survival remained high throughout the study, with 94.63% surviving the first year, 89.25% surviving three years, and 87.10% surviving five years (Table 4, Figure 1). Similarly, the graft survival rates were impressive, with 90.33% of grafts functioning at one year, 83.88% at three years, and 81.73% at five years (Table 4, Figure 1).

Table 3. Frequency of Dialysis History, Medicine Intake, Type of Complication, and Rejection Frequency in Studied Patients

	Number	Percent
Dialysis history		
Hemodialysis	63	67.7
Peritoneal dialysis	14	15.1
Without dialysis	16	17.2
Total	93	100
Medicine		
Cyclosporine + steroid + cellcept	53	57
Not using medicine	5	4.5
Cyclosporine + cellcept	3	2.3
Tacrolimus + CellCept + steroid	8	6.8
Cyclosporine + steroid + CellCept + Rapamune	12	9.12
Steroids	1	1.1
CellCept + steroid + Rapamune	9	7.9
CellCept + steroid	2	2.2
Type of complication		
Urinary infection	50	53.76
Hypertension	44	47.31
CMV infection	10	10.75
Diabetes	6	6.45
BK Infection	3	3.22
Malignancy	1	1.07
Without complication	25	26.8
Post-operative complications		
Lymphocele	1	1.1
Collection	3	3.2
Urine leakage + collection	2	2.2
Without complications	87	93.5
Acute rejection	29	32.2%
Male	15	27.8%
Female	14	87.5%

Table 4. Graft and Patient Survival Rates

	One Year	Three Years	Five Years
Survival of the Graft	90.33%	83.88%	81.73%
Survival of Patients	94.63%	89.25%	87.10%

Discussion

ESRD signifies an irreversible loss of kidney function, necessitating permanent reliance on alternative therapies,

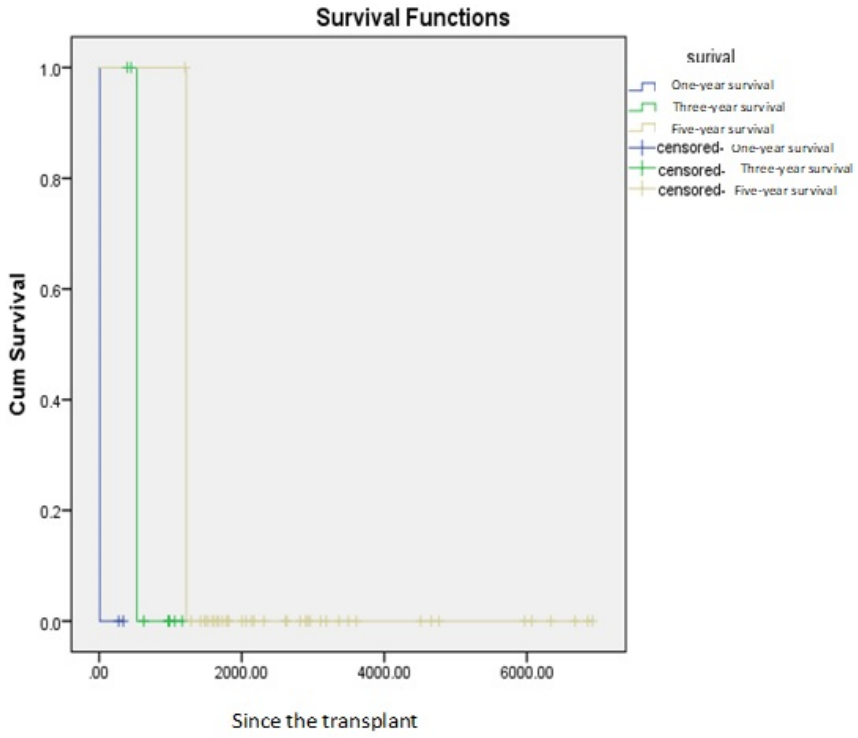

Figure 1. The One, Two, and Three Years Survival of the Studied Patients

particularly in children (16, 17). Kidney transplantation is among the most effective treatments for advanced kidney disease (18). Advances in surgical expertise, pre-operative and post-operative care, and immunosuppressive therapy have all contributed to improved outcomes in pediatric renal transplantation (19,20). While kidney transplantation offers undeniable benefits, its application in children requires specific considerations (1). This study investigated the outcomes of kidney transplantation in a pediatric patient population.

The study population comprised children aged 4 to 18 years, with a mean age of 12.87 years (SD ± 4.24). This age range is consistent with the demographics reported in previous studies, although the mean age observed in the present study was slightly higher than in other investigations: 10.9 ± 3.7 years in the study by Rosati et al (21) and 13.8 ± 3.5 years in the study by Parada et al (22). Shajari et al also documented a similar mean age of 13.71 ± 3.65 years (20). It is well-established that recipient age can influence graft survival, with younger patients generally experiencing better outcomes (23). In the United States, for instance, younger age emerged as a key predictor of transplant success (23). Conversely, studies in Spain suggest that the benefits of younger age might be offset by an increased incidence of complications, including venous thrombosis and higher rejection rates, in patients over five years of age (24).

ESRD can arise from various factors, including urological problems, glomerulonephritis, hypertension, diabetes, and unidentified causes, as confirmed by prior research (25). The findings of this study, which identify urological complications (40.9%) and glomerulonephritis (28.0%) as leading causes of ESRD, are consistent with previous reports. Kazi et al identified kidney agenesis, chronic glomerulonephritis, reflux nephropathy, and unidentified factors as contributors to ESRD, with the latter being the most common (26). Similarly, Parada et al reported glomerulonephritis, tubulointerstitial disease, congenital malformations, metabolic disorders like diabetes, and hypertension as primary causes (22). Jones and Anand's findings further support this notion, highlighting dysplasia, hypoplasia, obstructive uropathy, glomerulonephritis, hereditary nephropathy, and unidentified factors as prevalent etiologies (27).

Living-donor kidney transplantation holds historical significance as the first successful human organ transplant (28). Studies report varying ratios of living-donor versus deceased-donor kidney utilization in pediatric populations. Rosati et al documented 70 living-donor transplants compared to 108 deceased-donor procedures (21). Conversely, Allain-Launay et al reported a breakdown of 14% of living-donor and 86% of deceased-donor transplants (29). In contrast, this study, along with research by Park et al (30), observed a contrasting trend where living-donor kidney transplantation exceeded deceased-donor procedures in pediatric patients.

Studies report variations in the prevalence of pre-transplant dialysis modalities employed for pediatric patients. Allain-Launay et al (29) found hemodialysis to be the most common approach (62.4%), followed by peritoneal dialysis (18.2%), with a distribution similar to our study. This finding aligns with the concept of

"prophylactic transplantation" (15.5%), which involves performing transplantation before the need for dialysis (29). However, Rosati et al (21) reported peritoneal dialysis (48%) as more prevalent than hemodialysis (30%) in their study population.

Kidney transplantation typically involves a multi-drug immunosuppressive regimen targeting various pathways to prevent organ rejection (31, 32). These agents fall into five main categories: calcineurin inhibitors (CNIs), mammalian target of rapamycin (mTOR) inhibitors, anti-proliferatives, glucocorticosteroids, and biological agents (31). Notably, immunosuppressive therapy should be individualized for each patient to optimize outcomes (31, 32). This study found a higher prevalence of CellCept (mycophenolic acid) and Rapamycin (sirolimus) use, compared to steroid and tacrolimus (another CNI), which may differ from other studies. The selection of the optimal immunosuppressive regimen necessitates a patient-centered approach, considering factors such as medication properties, potential side effects, drug interactions, pre-existing conditions, rejection risk, and current medications (33).

This study identified UTIs as the most prevalent complication following kidney transplantation. While advancements have been made in transplantation care, post-transplant infections remain a significant cause of death in transplant recipients (34). Factors contributing to this risk include potent immunosuppression, surgical intervention, and ongoing exposure to hospital-acquired pathogens (35). The study also reported several post-surgical complications such as lymphocele, hematoma, and urinary leaks. Lymphoceles, fluid collections that develop after surgery, typically occur within the first year post-transplant, with incidence rates ranging from 0.6% to 33.9%, depending on surgical technique, underlying medical conditions, and post-transplant imaging practices (36). However, only a subset of these lymphoceles are symptomatic, with reported rates ranging from 0.03% to 26%, with an average of 5.2% (37). Prakash et al reported similar surgical complication rates, with lymphocele observed in 16.3% of patients, hematoma in 19.4%, and urinary leaks in 4.3% (38).

This study reports patient survival rates of 94.6%, 89.27%, and 87.1% at one, three, and five years post-transplant, respectively. Graft survival rates followed a similar trend at 90.33%, 83.88%, and 81.73%. Shajari et al (20) reported graft survival rates of 91%, 88%, and 81% at corresponding time points. Notably, their study demonstrated a 100% one-year patient survival rate and a 99% five-year rate (16). In contrast, Rosati et al (21) reported superior survival outcomes for living-donor recipients, with one-, three-, and five-year survival rates of 98%. Additionally, an extensive study by Lee Jin Koh et al (39) involving 3010 patients observed a five-year graft survival rate of 87.1% for children with focal segmental glomerulosclerosis (FSGS), compared to 74.3% for those with other glomerular diseases ($P=0.033$). However, this study did not find a statistically significant advantage for living donors in the FSGS group (hazard ratio 1.51 for deceased donors, $P=0.12$).

Research Limitations

This study encountered limitations, including incomplete and illegible clinical records, missed clinic referrals for some patients, and the unavailability of patient reference numbers.

Conclusion

This study reinforces kidney transplantation as the preferred treatment for ESRD, especially in children, due to its positive impact on survival and quality of life. Early detection of infrequent post-transplant complications and adherence to treatment regimens are critical for success. The high patient and graft survival rates suggest that our protocols are effective and may serve as benchmarks for other institutions. Furthermore, the dynamic nature of a child's developing immune system necessitates a thorough understanding of transplant rejection risk factors, particularly within the context of pediatric kidney transplantation.

Acknowledgments

The authors would like to express their gratitude to the Clinical Research Development Unit of Imam Khomeini Hospital, Urmia University of Medical Sciences, for their assistance with English editing.

Authors' Contribution

Conceptualization: Zeynab Jabrailian, Azam Mivefroshan .
Formal analysis: Zeynab Jabrailian.
Investigation: Zeynab Jabrailian, Saeed Abkhiz.
Project administration: Azam Mivefroshan.
Supervision: Azam Mivefroshan.
Writing–original draft: Zeynab Jabrailian, Saeed Abkhiz.
Writing–review & editing: Zeynab Jabrailian, Azam Mivefroshan, Saeed Abkhiz.

Competing Interests

The authors have no competing interests to declare with regard to the content of this study.

Consent to Participate

Informed consent was obtained from all individual participants included in the study.

Ethical Approval

This study was performed in accordance with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Urmia University of Medical Sciences (No. IR.UMSU.REC.1395.566).

Funding

The authors did not receive funding from any organization for the submitted work

References

1. Antunes H, Parada B, Tavares-da-Silva E, Carvalho J, Bastos C, Roseiro A, et al. Pediatric renal transplantation: evaluation of long-term outcomes and comparison to adult population. Transplant Proc. 2018;50(5):1264-71. doi: 10.1016/j.transproceed.2018.02.089.
2. Grohs J, Rebling RM, Froede K, Hmeidi K, Pavičić L, Gellermann J, et al. Determinants of growth after kidney transplantation in prepubertal children. Pediatr Nephrol. 2021;36(7):1871-80. doi: 10.1007/s00467-021-04922-2.
3. Harambat J, van Stralen KJ, Schaefer F, Grenda R, Jankauskiene A, Kostic M, et al. Disparities in policies, practices and rates of pediatric kidney transplantation in Europe. Am J Transplant. 2013;13(8):2066-74. doi: 10.1111/ajt.12288.
4. Gheissari A, Hemmatzadeh S, Merrikhi A, Fadaei Tehrani S, Madihi Y. Chronic kidney disease in children: a report from a tertiary care center over 11 years. J Nephropathol. 2012;1(3):177-82. doi: 10.5812/nephropathol.8119.
5. Miller LC, Bock GH, Lum CT, Najarian JS, Mauer SM. Transplantation of adult kidney into the very small child: long-term outcome. J Pediatr. 1982;100(5):675-80. doi: 10.1016/s0022-3476(82)80563-5.
6. Evans-Barns H, Mushtaq I, Michell I, Kausman J, Webb N, Taghavi K. Paediatric kidney transplantation: towards a framework for pretransplant urological evaluation. Pediatr Transplant. 2022;26(7):e14299. doi: 10.1111/petr.14299.
7. Haasova M, Snowsill T, Jones-Hughes T, Crathorne L, Cooper C, Varley-Campbell J, et al. Immunosuppressive therapy for kidney transplantation in children and adolescents: systematic review and economic evaluation. Health Technol Assess. 2016;20(61):1-324. doi: 10.3310/hta20610.
8. Cho MH. Pediatric kidney transplantation is different from adult kidney transplantation. Korean J Pediatr. 2018;61(7):205-9. doi: 10.3345/kjp.2018.61.7.205.
9. Isert S, Müller D, Thumfart J. Factors associated with the development of chronic kidney disease in children with congenital anomalies of the kidney and urinary tract. Front Pediatr. 2020;8:298. doi: 10.3389/fped.2020.00298.
10. Aikawa A, Muramatsu M, Takahashi Y, Hamasaki Y, Hashimoto J, Kubota M, et al. Surgical challenge in pediatric kidney transplant vascular anastomosis. Exp Clin Transplant. 2018;16(Suppl 1):14-9. doi: 10.6002/ect.TOND-TDTD2017.L41.
11. Mathew A, Rai E. Pediatric perioperative fluid management. Saudi J Anaesth. 2021;15(4):435-40. doi: 10.4103/sja.sja_140_21.
12. Gholamrezaie HR, Tabibi A, Nikravesh N, Bagheri-Amiri F, Mohsenirad H. Results of pediatric kidney transplants in an 8-year period: a retrospective study. Transplant Proc. 2020;52(3):793-9. doi: 10.1016/j.transproceed.2019.12.047.
13. Winterberg PD, Garro R. Long-term outcomes of kidney transplantation in children. Pediatr Clin North Am. 2019;66(1):269-80. doi: 10.1016/j.pcl.2018.09.008.
14. McCulloch M, Luyckx VA, Cullis B, Davies SJ, Finkelstein FO, Yap HK, et al. Challenges of access to kidney care for children in low-resource settings. Nat Rev Nephrol. 2021;17(1):33-45. doi: 10.1038/s41581-020-00338-7.
15. Ataei N, Madani A, Esfahani ST, Otoukesh H, Hooman N, Hoseini R, et al. Chronic kidney disease in Iran: first report of the national registry in children and adolescences. Urol J. 2020;18(1):122-30. doi: 10.22037/uj.v16i7.5759.
16. Ghelichi Ghojogh M, Salarilak S, Taghezadeh Afshari A, Khalkhali HR, Mohammadi-Fallah MR, Makhdoomi K. The effect of body mass index on patient and graft survival rate in kidney transplanted patients in Iran. Nephrourol Mon. 2017;9(4):e14386. doi: 10.5812/numonthly.14386.
17. Naderi G, Latif A, Karimi S, Tabassomi F, Esfahani ST. The long-term outcome of pediatric kidney transplantation in Iran: results of a 25-year single-center cohort study. Int J Organ Transplant Med. 2017;8(2):85-96.
18. Tang E, Bansal A, Novak M, Mucsi I. Patient-reported outcomes in patients with chronic kidney disease and kidney transplant-part 1. Front Med (Lausanne). 2017;4:254. doi: 10.3389/fmed.2017.00254.
19. Voet M, Cornelissen EA, van der Jagt MF, Lemson J, Malagon I. Perioperative anesthesia care for the pediatric patient undergoing a kidney transplantation: an educational review. Paediatr Anaesth. 2021;31(11):1150-60. doi: 10.1111/pan.14271.
20. Shajari A, Ashrafi MM, Shajari H, Derakhshan A. Graft and patient survival rate among Iranian pediatric recipients of kidney transplantation: a systematic review and meta-analysis. Iran J Public Health. 2022;51(6):1232-44. doi: 10.18502/ijph.v51i6.9666.
21. Rosati P, Pinto V, Delucchi A, Salas P, Cano F, Zambrano P, et al. Pediatric renal transplantation: 13 years of experience--report from the Chilean Cooperative Multicenter Group. Transplant Proc. 2005;37(3):1569-73. doi: 10.1016/j.transproceed.2004.09.013.
22. Parada B, Figueiredo A, Nunes P, Bastos C, Macário F, Mota A. Pediatric renal transplantation: comparative study with renal transplantation in the adult population. Transplantation. 2004;78(2):322-3.
23. Smith JM, Martz K, Blydt-Hansen TD. Pediatric kidney transplant practice patterns and outcome benchmarks, 1987-2010: a report of the North American Pediatric Renal Trials and Collaborative Studies. Pediatr Transplant. 2013;17(2):149-57. doi: 10.1111/petr.12034.
24. Gander R, Asensio M, Royo GF, Molino JA, Vilalta R, Coma A, et al. Treatment of post-transplant lymphocele in children. Urology. 2017;103:218-23. doi: 10.1016/j.urology.2016.12.039.
25. Rosenstein K, Tannock LR. Dyslipidemia in chronic kidney disease. In: Endotext [Internet]. South Dartmouth, MA: MDText.com Inc; 2000. Available from: https://www.ncbi.nlm.nih.gov/books/NBK305899/. Updated February 10, 2022.
26. Kazi AM, Hashmi MF. Glomerulonephritis. In: StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing; 2024. Available from: https://www.ncbi.nlm.nih.gov/books/NBK560644/. Updated June 26, 2023.
27. Jones W, Saggar A. Global health implications of inherited renal diseases. In: Kumar D. Genomics and Health in the Developing World [Internet]. Oxford University Press; 2012. Available from: https://doi.org/10.1093/med/9780195374759.003.0025.
28. Vella I, di Francesco F, Accardo C, Pagano D, Petri SL, Boggi U, et al. Review of the history of living donor solid organ transplants. Eur J Transplant. 2024(1):3-12. doi: 10.57603/ejt-403.
29. Allain-Launay E, Roussey-Kesler G, Ranchin B, Guest G, Maisin A, Novo R, et al. Mortality in pediatric renal transplantation: a study of the French pediatric kidney database. Pediatr Transplant. 2009;13(6):725-30. doi: 10.1111/j.1399-3046.2009.01036.x.
30. Park C, Jones MM, Kaplan S, Koller FL, Wilder JM, Boulware LE, et al. A scoping review of inequities in access to organ transplant in the United States. Int J Equity Health. 2022;21(1):22. doi: 10.1186/s12939-021-01616-x.
31. Hariharan S, Israni AK, Danovitch G. Long-term survival after kidney transplantation. N Engl J Med. 2021;385(8):729-43. doi: 10.1056/NEJMra2014530.

32. Viklicky O, Slatinska J, Novotny M, Hruba P. Developments in immunosuppression. Curr Opin Organ Transplant. 2021;26(1):91-6. doi: 10.1097/mot.0000000000000844.
33. Szumilas K, Wilk A, Wiśniewski P, Gimpel A, Dziedziejko V, Kipp M, et al. Current status regarding immunosuppressive treatment in patients after renal transplantation. Int J Mol Sci. 2023;24(12):10301. doi: 10.3390/ijms241210301.
34. Pinchera B, Trucillo E, D'Agostino A, Gentile I. Urinary Tract Infections in Kidney Transplant Patients: An Open Challenge-Update on Epidemiology, Risk Factors and Management. Microorganisms 2024;12(11). doi: 10.3390/microorganisms12112217.
35. Agrawal A, Ison MG, Danziger-Isakov L. Long-term infectious complications of kidney transplantation. Clin J Am Soc Nephrol. 2022;17(2):286-95. doi: 10.2215/cjn.15971020.
36. Ranghino A, Segoloni GP, Lasaponara F, Biancone L. Lymphatic disorders after renal transplantation: new insights for an old complication. Clin Kidney J. 2015;8(5):615-22. doi: 10.1093/ckj/sfv064.
37. Lucewicz A, Wong G, Lam VW, Hawthorne WJ, Allen R, Craig JC, et al. Management of primary symptomatic lymphocele after kidney transplantation: a systematic review. Transplantation. 2011;92(6):663-73. doi: 10.1097/TP.0b013e31822a40ef.
38. Prakash J, Ghosh B, Singh S, Soni A, Rathore SS. Causes of death in renal transplant recipients with functioning allograft. Indian J Nephrol. 2012;22(4):264-8. doi: 10.4103/0971-4065.101245.
39. Koh LJ, Martz K, Blydt-Hansen TD. Risk factors associated with allograft failure in pediatric kidney transplant recipients with focal segmental glomerulosclerosis. Pediatr Transplant. 2019;23(5):e13469. doi: 10.1111/petr.13469.