KIDNEY TRANSPLANTATION IN UZBEKISTAN (2022–2025): CLINICAL OUTCOMES AND HEALTHCARE SYSTEM CHALLENGES

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Abstract
Background: Kidney transplantation is recognised as the gold standard for treating end-stage renal disease (ESRD). Compared with dialysis, it restores renal function more effectively and provides better survival and quality of life. In low- and middle-income countries, including Uzbekistan, access to transplantation remains limited and outcome data are scarce.
Objective: This study assessed short-term clinical outcomes of kidney transplantation performed between 2022 and 2025 at the Andijan State Medical Institute and two regional hospitals. It also explored systemic barriers that may affect the long-term expansion of transplant programmes.
Methods: Seventeen transplantation cases were analysed. Data were collected on patient demographics, underlying causes of ESRD, donor types, surgical techniques, and immunosuppressive regimens. All patients were followed prospectively for three months.
Results: The recipients were relatively young (mean age 38 years), and males represented 59%. Hypertension and diabetes accounted for nearly 60% of ESRD cases. Most grafts (82%) were from living-related donors. At three months, patient survival was 100% and graft survival was 94%. Complications included delayed graft function in two cases, acute rejection in three, and infections in four. Notably, two procedures were successfully carried out in district hospitals under specialist supervision.
Conclusion: Kidney transplantation in Uzbekistan is feasible, safe, and effective, even under resource constraints. The early results are encouraging. However, sustainable progress will require expanding donor sources, strengthening infection control, improving referral systems, and establishing a national transplant registry.
Keywords: Kidney Transplantation; End-Stage Renal Disease; Living Donors; Graft Survival; Uzbekistan
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Introduction

End-stage renal disease (ESRD) is the irreversible failure of the kidney and is one of the most acute health problems in the world. ESRD patients rely on renal replacement therapy to stay alive, usually by dialysis or kidney transplantation. Dialysis is life-sustaining, but it does not fully replace the renal functions, creating serious physical, social and financial health challenges [1]. Kidney transplantation, on the other hand, has been found to recover near normal renal physiology, minimise cardiovascular morbidity, and greatly increase life expectancy. It is thus considered to be the treatment of choice for ESRD throughout the world [2].

The burden of chronic kidney disease, often leading to ESRD, remains constantly increasing around the world. According to the Global Observatory on Donation and Transplantation (GODT), it was estimated that more than 100,000 kidney transplants were carried out all over the world in 2022, but the figure is still less than 10 percent of the global demand [3]. Sophisticated deceased donor systems, advanced

immunological matching regimes and powerful immunosuppressive regimens have been developed by high-income countries, with very good results. As per benchmark analysis, patient survival in one year is over 97 percent, and graft survival is over 95 percent [4]. These statistics depict how impressive advances in transplantation medicine can be made in the event that resources and infrastructure are adequate.

But this does not always work out. Financial and accessibility to immunosuppressive drugs and lack of organs, systemic barriers in low- and middle-income countries (LMICs) tend to undermine both short-term and long-term outcomes in these countries (5). Besides, it appears challenging to assess the outcomes in full due to the absence of organised long-term follow-up and national registries. Such differences have been emphasised by the comparative studies of survival in terms of transplantation, which show that although this treatment increases the survival in almost all environments, the level of enhancement differs across healthcare service capacity [6].

In addition to survival, kidney transplantation has an extensive change in quality of life. Studies that are to be done in the future with multiple centres have recorded better performances both physically and psychologically, and also social reintegration of those who receive transplantation over those who are kept on dialysis [7]. These advancements highlight the reality that transplantation is not a life-saving procedure, but also a life-restoring procedure. However, continued exposure to therapy, constant availability of immunosuppressive drugs, and properly structured post-transplant follow-up systems are all necessary to maintain such benefits.

Over the past 10 years, the Republic of Uzbekistan has made significant strides in the development of transplantation services. Professional training has helped in enhancing the capacity of the country, and specialised surgical departments have been created. But still, there are essential issues. Regardless, organ donation, to a large extent, is restricted to living related donors, with deceased donor programmes being in early development stages. The availability of immunosuppressive treatment is not always reliable and poses threats of graft rejection and loss. Also, the lack of a nationwide system of follow-up inhibits the possibility of following the long-term outcomes and responding to complications. These macro-environmental influences resonate with documented problems throughout LMICs, with transplantation programs experiencing issues in balancing both short-term clinical outcomes and long-term outcomes [8].

In this respect, the clinical effectiveness of transplantation must be documented urgently, as well as the healthcare system barriers affecting its outcome. To fill this gap, the current prospective study will be carried out at the Clinic of the Andijan State Medical Institute, 2nd Department of Surgery, in the period starting in January 2024 and continuing until June 2025. This was a study on seventeen patients undergoing kidney transplants as a result of ESRD, but were followed up on to identify early clinical outcomes. In addition to the survival and functional recovery reporting, the analysis of the additional systemic limitations, including donor organ supply, access to immunosuppressive therapy, and post-transplant care provision, which dictate the sustainability of kidney transplantation in Uzbekistan, is also assessed in the study. This piece of work will seek to offer locally-specific evidence and place it in the universal context of transplantation in resource-restricted environments by synthesising clinical findings and healthcare system analysis [9].

Methods

This observational study was planned to start in January 2024 and continue until June 2025, and included seventeen patients with end-stage renal disease undergoing kidney transplantation at the Andijan State Medical Institute. All procedures (15 in total) were done in the institute's own clinic at the 2nd Department of Surgery, which serves as a regional referral centre for patients with a need for renal replacement therapy. Moreover, two transplants were performed at the district hospitals in the Andijan region in Shahrixon and Qo‘rg‘ontepa. These two cases were arranged in a close collaboration with the local surgical teams, but under the guidance of the same transplant specialists of the institute. The inclusion of these district locations is a sign of the progressive growth of transplant services in Uzbekistan, as well as an indicator of the ability to translate national experience to smaller regional hospitals without referring to the loss of surgical and clinical control.

The selection of recipients was based on the generally recognised international recommendations. All the patients were confirmed to have irreversible renal failure after a series of laboratory tests and had been on dialysis for differing lengths of time. The exclusion criteria were active systemic infections, uncontrolled cardiovascular disease, active malignancy or contraindication to long-term immunosuppressive therapy. All candidates were subject to thorough preoperative examination, which consisted of haematology and biochemistry checks, infectious disease testing, chest radiography, and cardiology (echocardiography) and, in some cases, exercise testing. All the donors (living relatives or thoroughly-considered volunteers) underwent medical and psychosocial examination to guarantee safety and voluntariness. The compatibility testing was done according to the standard procedures of ABO blood typing, human leukocyte antigen matching, and complement-dependent cytotoxic crossmatch. The sensitisation was by assessing panel reactive antibody levels, and only those pairs of donor to recipient that had a negative crossmatch went to transplantation. This has been a rigorous immunological screening, which has been thought to be a critical determinant in pre-empting hyperacute rejection, and also in enhancing long-term prognosis [10].

The surgical procedures were conducted according to international standards and performed by experienced transplant surgeons. The kidney was extraperitoneally

implanted in the iliac fossa of the recipient, and arterial and venous anastomoses were made to the external iliac vessels and urinary continuity was provided with a ureteroneocystostomy. Doppler ultrasonography of the intraoperative graft perfusion was regularly used to determine the integrity of the vessels before the healing process. The mean surgery took three to four hours based on differences in the anatomy. These techniques have been tested in large pools of transplantation, and they continue to be a foundation for the successful implantation of the graft [11].

The standardised immunosuppression used on all patients was a triple drug regimen of tacrolimus or cyclosporine, mycophenolate mofetil, and corticosteroids. Induction therapy with basiliximab was administered to patients who can be classified as at higher immunological risk, such as those with high levels of panel reactive antibody before graft reperfusion. Close examination of serum drug concentrations was done to ensure effective therapeutic ranges to reduce the chances of rejection and drug-induced nephrotoxicity. Those in favour of having this approach are validated by the plethora of clinical evidence indicating that combination regimens continue to be central to long-term graft survival [12,13].

Intensive postoperative care was provided during the initial 48 to 72 hours, whereby special consideration was given to urine output, serum creatinine levels, electrolytes and blood counts. Vascular complications were suspected, and Doppler ultrasonography was applied. Universal protocols of antimicrobial prophylaxis were introduced: antidispersive trimethoprim-sulfamethoxazole in preventing Pneumocystis jirovecii pneumonia and valganciclovir in the prevention of cytomegalovirus in seropositive recipients. Whenever possible, episodes of suspected rejection were demonstrated by use of biopsy and treated with intravenous corticosteroid pulses. The importance of infection prevention and early rejection management in transplant medicine has been stressed repeatedly in the modern literature [14].

The clinical data were documented as a prospective study and incorporated the demographic data, aetiology of renal failure, dialysis time, donor type, perioperative data and postoperative complications. Early graft function, incidence of delayed graft function, incidence of acute rejection episode, incidence of infection, graft survival, and patient survival during the follow-up were the outcomes of interest. The visits were arranged every week during the first month, monthly over six months and quarterly. Data analysis was done using SPSS version 27.0 (IBM Corp., Armonk, NY, USA). Means with standard deviations were used to summarise continuous variables, proportions were used to summarise categorical variables, and Kaplan-Meier estimates were used to summarise survival outcomes. A p-value of less than 0.05 was taken to be statistically significant.

The methodology was meant to be such that it would strike a balance between strict compliance with the international procedures and adapting to local realities. The programme, by centralising most processes in the central clinic and spreading two procedures to other hospitals in Shahrixon and Qo’rg'ontepa district, demonstrated the consistency of a high-volume centre, as well as the possibility of extending transplantation to peripheral hospitals. Such a two-fold environment serves as a valuable insight into the ways in which transplant programmes can develop in a resource-constrained setting and continue to be both patient-safe and clinically effective [15].

This paper followed the ethical guidelines of the institutional review board of the Andijan State Medical Institute in all the procedures and complied with the principles of the Declaration of Helsinki. All patients and their donors gave informed consent before surgery, and verbal consent was also confirmed to make sure that participation was fully voluntary. Their confidentiality, autonomy, and dignity were preserved all the time, and the donors were also guaranteed that they were not pressured financially or socially to go ahead.

Results

The study period involved seventeen kidney transplantation procedures under the supervision of the Andijan State Medical Institute, of which fifteen transplantation procedures took place in the central clinic of the institute and two in the district hospitals of Shahrixon and Qo‘rg‘ontepa. The study successfully transplanted all the patients and followed them prospectively in terms of outcome over time. The median recipient age was 38 (22-56) years old, and there was a slight level of dominance of male patients (59%). The most common causes of renal failure were hypertensive nephropathy and diabetic nephropathy, and chronic glomerulonephritis and polycystic kidney disease were also identified.

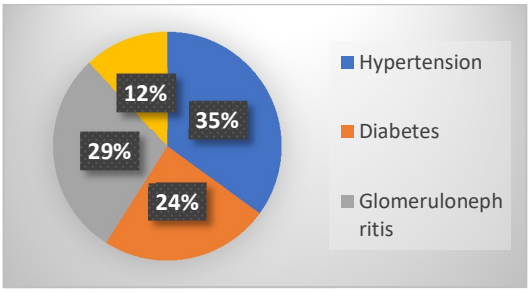
Table 1. Baseline demographic and clinical characteristics of recipients (n = 17)

Variable	Value
Median age (years)	38 (22–56)
Male, n (%)	10 (59%)
Female, n (%)	7 (41%)
Primary renal disease	Hypertension 6 (35%), Diabetes 4 (24%), Glomerulonephritis 5 (29%), Polycystic kidney disease 2 (12%)
Pre-transplant dialysis duration (months)	18 (6–42)
Donor type	Living related 14 (82%), Living unrelated 3 (18%)

Table 1 indicates that the majority of the recipients were middle-aged, and there was a slight difference in the number of men and women. The prevalence of hypertension and diabetes as underlying etiologies is a reflection of the global epidemiological change in renal failure, especially in middle-income countries.

The majority of the patients were on dialysis for more than a year before transplantation, which is a typical situation in resource-limited facilities where transplantation is usually postponed because of logistical issues. This strength of living-related donors is in line with areas where deceased donor programmes are still in their infancy and where they focus on family-based donation.

Diagram 1. Distribution of primary renal disease among recipients



This flow chart shows the etiological distribution of ESRD in transplant candidates. It underscores the alarming increase in the number of lifestyle-related diseases, including diabetes and hypertension, which accounted for almost 60 percent of the cases. Chronic glomerulonephritis remains an important factor, with its indication of the continued presence of infectious and autoimmune trends in the area. Less common but showing the existence of inherited kidney disorders among the population is polycystic kidney disease. These trends are in line with those in the low- and middle-income countries where the coexistence of both noncommunicable and traditional renal pathologies has been observed to be the leading cause of ESRD [16].

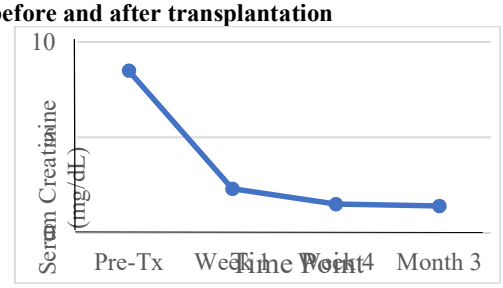
There were generally positive results in the early post-transplant. In only two patients (11.7%), delayed graft functioning was observed, and both of them ultimately regained stable renal function after two weeks. The levels of serum creatinine decreased quickly in the majority of patients, the mean level being 1.4 mg/dl at discharge. Three patients (17.6%), who all responded to high-dose corticosteroid pulses, were suspected of experiencing acute rejection. A single graft loss was a result of vascular thrombosis in the early postoperative period, which means graft survival rates of 94 percent after three months. The survival rate of the patients at the last follow-up was 100%.

Table 2. Postoperative outcomes and complications

Outcome	Value
Delayed graft function	2 (11.7%)
Acute rejection episodes	3 (17.6%)
Graft loss (vascular thrombosis)	1 (5.8%)
Early infection (bacterial/viral)	4 (23.5%)
Patient survival at 3 months	100%
Graft survival at 3 months	94%

Table 2 is a summary of the initial results of the cohort. Despite some delayed graft functioning or acute rejection that was observed in a minority of patients, interventions proved to be useful and overall short-term outcomes were high. The most common complication was infection, which occurred in about a quarter of the recipients, and this is indicative of the fine line between immunosuppression and infection in transplant medicine. Notably, 94% graft survival and universal patient survival represent the technical success of the programme, even with the limitations of an immature health care system. These findings are in line with the initial findings of other LMIC transplant centres [17].

Diagram 2. Trends in mean serum creatinine before and after transplantation



This line graph shows that, after transplantation, there was a dramatic decrease in serum creatinine, which is the closest objective of better renal functioning. The mean creatinine level decreased during the first week to near-normal levels of more than 8mg/dl. Stabilisation was achieved within the first month, with maintenance functioning for three months. This trend indicates the effective engraftment of donor kidneys, and it is similar to the results of other clinical series, in which early biochemical improvement is highly correlated with long-term graft survival [18]. Their sustainability in terms of renal functioning supports the effectiveness of the surgical and immunosuppressive management.

Generally, the research shows that kidney transplantation in Uzbekistan is viable and successful, despite the infrastructural constraints in the health facility. The fact that living related donors are in the majority is indicative of no systematic deceased donor programme, but graft and patient survival is high. The fact that two successful transplantations had been carried out at the district hospitals under the direct supervision of the central hospital further indicates that surgical skills are safely transferable to the peripheral hospitals. These results emphasise the need to continue investing in immunological screening, infection prevention and post-transplant follow-ups in order to solidify the early positive results observed in this series.

Discussion

The outcomes of this series underscore the fact that kidney transplant in Uzbekistan can be effectively undertaken even in an environment where the healthcare infrastructure is at an immature stage. Our results of 100 percent patient survival and more than 90 percent graft survival at three months are consistent with the general experience around the world, where

transplantation is considered the most effective mode of renal replacement therapy. Not only are such results technically encouraging, but they are also socially important, as they prove that patients in Uzbekistan do not have to leave their country to receive life-saving treatment anymore. But these short-term successes are followed by a multifaceted array of problems that are worth scrutiny.

Most of our patients had significantly prolonged their dialysis duration until the time of transplant, and the average time on renal replacement therapy was 18 months. This observation is reflective of the experience of most low and middle-income nations, where access to early transplantation is still constrained. Several studies have confirmed that preemptive transplantation, that is done before dialysis is commenced, enhances survival and minimises complications [19]. As an example, a meta-analysis study by Magar and colleagues revealed that the rates of acute rejection and the long-term performance of preemptive recipients were significantly lower. Within our cohort, the delay is indicative of lapses in the referral system, financial and logistical constraints. In order to achieve better results, it will be essential to define more specific clinical pathways regarding early referral, so that patients can be discussed regarding transplantation before the development of irreversible complications associated with dialysis.

The early postoperative complications were also usually controllable, but infections and acute cases of rejection were reported. One-fourth of people who received them developed infections, and three cases of biopsy-proven rejection were treated effectively using corticosteroid pulses. Such are not new findings. It has always been demonstrated in international literature that infections continue to be one of the most frequent causes of morbidity in transplant patients, particularly in a setting where accessibility to high-level laboratory diagnostics and prophylactic treatment might not be steady [20]. Financial constraints in low- and middle-income countries are reported to be the common barriers to routine monitoring of viral loads, as well as access to broad-spectrum antimicrobials that could increase exposure to infections. Our data support the need to improve infection control measures, maximise prophylaxis and invest in laboratory capacity to detect the infection early.

The profiles of the donors in our series should also be discussed. The situation of preponderance of living related donors reflects cultural and systemic reality. In Uzbekistan, as in most of the Central Asian nations, there is no established deceased donor programme as yet. Although depending on the family members ensures the continuity of the transplant services, it limits its magnitude and could be accused of coercing donors or unfairness. Transplant activity in countries where deceased donor systems have effectively been used has multiplied by a significant factor; this saves time and increases accessibility [21].

Khadjibaev and others have suggested that Uzbekistan possesses the infrastructure and know-how to create such programmes, but that no progress can be made without legislative changes, popular education and the active participation of religious and community leaders. The introduction of a paired kidney exchange system can also be a viable short-term solution until the practice of deceased donor transplantation is further normalised.

In our cohort, immunosuppressive treatment was of the standard regimens and seemed to work in the short run. Nevertheless, the reviews on international practice emphasise individualised dosing, therapeutic monitoring and incorporation of new biologics that produce minimal rejection but reduce toxicity [22]. Cost and drug availability continue to be obstructions in Uzbekistan, as well as in other LMICs. The increased availability of contemporary immunosuppressive agents and expertise in the field of pharmacokinetics and monitoring would improve long-term results. Stability of renal function at three months in our series is hopeful, but the sustainability of this is going to be dependent on how well the health system chains of supply of drugs and how well the system follows up.

One of the encouraging results was the successful performance of two transplantation practices in district hospitals under central supervision. This indicates that kidney transplantation can safely be decentralised, other than in tertiary centres, with proper training, infrastructure, and supervision. This type of decentralisation can be used to increase access and decrease the stress on hospitals in cities. However, this growth should be surrounded with strict measures, regular training and effective referral systems to ensure quality of care. Decentralisation, however, according to evidence in LMICs, can bring more equity and less disparity in the region when well controlled [23].

Last, but not least, the creation of national registries must also be considered a pressing priority. Strong registries cannot be ignored to monitor the outcomes, detect complications, and measure the performance relative to the international standards [24]. It is challenging to assess long-term graft survival, quality of life of patients or the actual burden of post-transplant complications without systematic data collection. Moreover, registries can be used to support research, generate international collaboration, and educate evidence-based policy. In the case of Uzbekistan, establishing a national transplant registry would be a breakthrough move in the consolidation of the gains made and also provide accountability as the programme expands.

To sum up, the immediate results of kidney transplantation in Uzbekistan are quite positive, and the sustainability of the results will be associated with the need to address the systemic issues. Referral to transplantation, bone marrow availability expansion, modernisation of immunosuppressants, decentralisation of services and development of strong registries are all key milestones. These measures will help Uzbekistan develop a robust transplant programme that can not only help more patients

survive but also increase their quality of life with end-stage renal disease.

Conclusion

This research proves that in Uzbekistan, kidney transplantation is possible, safe, and successful. The survival of all the patients was achieved, and graft survival was high with normalisation of creatinine in a short time. Such outcomes are dramatic since they demonstrate that modern transplant medicine can be effectively provided even in a system that has few resources. To the patients, the consequences were tremendous: no longer would their lives be attached to dialysis, and they would have the possibility of being independent again. Nonetheless, there are significant problems. The long wait time incurred by many patients under dialysis before surgery is indicative of referral and financing lapses in the structure. These delays are not tolerated; they have an impact on both survival and long-term graft functioning. Earlier candidate identification and better coordination between the nephrology and transplant teams should be emphasised. The most frequent complication was an infection. The same is echoed worldwide, but the dangers are more prevalent where laboratory surveillance and prophylactic treatment are not as available. To deal with this, it will have to invest in infection control, diagnostic potential, and training.

The profile of the donors also shows one weakness: nearly all the grafts were provided by live relatives. Although this is typical of the area, it cannot serve the increase in demand. It is essential to introduce deceased donor programmes with the help of legislation and community involvement to be sustainable. Lastly, it is encouraging that two transplants were done in the district hospitals. It demonstrates that decentralisation can be realised in cases where protocols and supervision are high. In the future, the establishment of a national registry, better tracking of immunosuppression and embracing best practices in the world will transform these initial successes into a strong, sustainable program.

REFERENCES

1. Tonelli M, Wiebe N, Knoll G, et al. Systematic review: kidney transplantation compared with dialysis in clinically relevant outcomes. *Am J Transplant*. 2011;11(10):2093–2109. doi:10.1111/j.1600-6143.2011.03686.x
2. Wolfe RA, Ashby VB, Milford EL, et al. Comparison of mortality in all patients on dialysis, patients on dialysis awaiting transplantation, and recipients of a first cadaveric transplant. *N Engl J Med*. 1999;341(23):1725–1730. doi:10.1056/NEJM199912023412303
3. Global Observatory on Donation and Transplantation (GODT). International Report on Organ Donation and Transplantation 2022. Available at: https://www.transplant-observatory.org
4. Rompianesi G, Montalti R, Vrakas G, et al. Benchmark outcomes in deceased donor kidney transplantation: a multicenter analysis of 80,996 transplants from 126 centers. *Transplant Direct*. 2024;10(5):e1618. doi:10.1097/TXD.0000000000001618
5. Jha V, Garcia-Garcia G, Iseki K, et al. Chronic kidney disease: global dimension and perspectives. *Lancet*. 2013;382(9888):260–272. doi:10.1016/S0140-6736(13)60687-X
6. Shi B, Ying T, Chadban SJ. Survival after kidney transplantation compared with ongoing dialysis for people over 70 years of age: a matched-pair analysis. *Am J Transplant*. 2023;23(10):1551–1560. doi:10.1016/j.ajt.2023.07.006
7. de Boer SE, Knobbe TJ, Kremer D, et al. Kidney transplantation improves health-related quality of life in older recipients. *Transpl Int*. 2024;37:12071. doi:10.3389/ti.2024.12071
8. Naicker S, Ashuntantang G, Saraladevi N, et al. Challenges facing kidney transplantation in low- and middle-income countries. *Kidney Int Suppl*. 2020;10(1):20–27. doi:10.1016/j.kisu.2019.11.003
9. Chadban SJ, Ahn C, Axelrod DA, et al. KDIGO clinical practice guideline on the evaluation and management of candidates for kidney transplantation. *Transplantation*. 2020;104(4S1):S11–S103. doi:10.1097/TP.0000000000003136
10. Patel R, Terasaki PI. Significance of the positive crossmatch test in kidney transplantation. *N Engl J Med*. 1969;280(14):735–739. doi:10.1056/NEJM196904032801401
11. Kasiske BL, Snyder JJ, Matas AJ, et al. Preemptive kidney transplantation: the advantage and the advantaged. *J Am Soc Nephrol*. 2002;13(5):1358–1364. doi:10.1681/ASN.V1351358
12. Vincenti F, Charpentier B, Vanrenterghem Y, et al. A phase III study of belatacept-based immunosuppression regimens versus cyclosporine in kidney transplant recipients. *N Engl J Med*. 2010;362(20):1919–1930. doi:10.1056/NEJMoa0912961
13. Budde K, Prashar R, Haller H, et al. Five-year outcomes in kidney transplant patients converted from cyclosporine to everolimus: the randomized ZEUS study. *Am J Transplant*. 2011;11(12):2724–2736. doi:10.1111/j.1600-6143.2011.03742.x
14. Fishman JA. Infection in organ transplantation. *Am J Transplant*. 2017;17(4):856–879. doi:10.1111/ajt.14208
15. Halloran PF. Immunosuppressive drugs for kidney transplantation. *N Engl J Med*. 2004;351(26):2715–2729. doi:10.1056/NEJMra033540
16. Liyanage T, Ninomiya T, Jha V, et al. Worldwide access to treatment for end-stage

kidney disease: a systematic review. *Lancet*. 2015;385(9981):1975–1982. doi:10.1016/S0140-6736(14)61601-9

17. Bello AK, Levin A, Lunney M, et al. Status of care for end stage kidney disease in countries and regions worldwide: international cross sectional survey. *BMJ*. 2019;367:l5873. doi:10.1136/bmj.l5873
18. Hariharan S, Israni AK, Danovitch G. Long-term survival after kidney transplantation. *N Engl J Med*. 2021;385(8):729–743. doi:10.1056/NEJMra2014530
19. Magar RR, et al. Is Preemptive Kidney Transplantation Associated With Better Outcomes? A Systematic Review and Meta-Analysis. *Transplant Int*. 2022;35:10115. doi:10.3389/ti.2022.10315
20. Roberts LE, Luyckx VA. Kidney transplantation in low- and middle-income countries: opportunities, challenges, and scaling. *Pediatr Nephrol*. 2024;39(10):3435–3447. doi:10.1007/s00467-023-06129-z
21. Khadjibaev A, et al. Organ Donation in Uzbekistan: Achievements and Prospects. *Exp Clin Transplant*. 2020;18(Suppl 2):54–57. doi:10.6002/ect.rlgnsymp2020.L8
22. Thongprayoon C, et al. Advances and Clinical Outcomes of Kidney Transplants: A Review. *J Clin Med*. 2020;9(4):1193. doi:10.3390/jcm9041193
23. Khadjibaev A, et al. State of Transplantation in the Republic of Uzbekistan: 2024 Overview. *Exp Clin Transplant*. 2024;22(Suppl 1):66–69. doi:10.6002/ect.MESOT2023.O4
24. BMC Nephrology Editorial Board. Proteomic insights into kidney transplantation outcomes. *BMC Nephrol*. 2023;24:281. doi:10.1186/s12882-023-03401-0