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**Update on kidney transplantation in human immunodeficiency virus infected recipients**

Nashar K *et al.* Kidney transplant in HIV infected patients

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**Abstract**

Improved survival of human immunodeficiency virus (HIV) infected patients with chronic kidney disease following the introduction of antiretroviral therapy resulted in the need to revisit the topic of kidney transplantation in these patients. Large cohort studies have demonstrated favorable outcomes and proved that transplantation is a viable therapeutic option. However, HIV-infected recipients had higher rates of rejection. Immunosuppressive therapy did not negatively impact the course of HIV infection. Some of the immunosuppressive drugs used following transplantation exhibit antiretroviral effects. A close collaboration between infectious disease specialists and transplant professionals is mandatory in order to optimize transplantation outcomes in these patients. Transplantation from HIV+ donors to HIV+ recipients has been a subject of intense debate. The HIV Organ Policy Equity act provided a platform to research this area further and to develop guidelines. The first HIV+ to HIV+ kidney transplant in the United States and the first HIV+ to HIV+ liver transplant in the world were recently performed at the Johns Hopkins University Medical Center.

**Key words:** End-stage kidney disease; Antiretroviral therapy; Human immunodeficiency virus; Kidney transplantation

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**Core tip:** Experience with kidney transplantation in human immunodeficiency virus (HIV) positive patients is evolving. With appropriate selection of candidates, the outcomes appear similar to that in HIV negative population. There are challenges with kidney transplantation in HIV positive patients including increased risk for acute rejection and drug-drug interactions. Optimal immunosuppressive regimen is unknown. This article discusses the recent advances in kidney transplantation among HIV positive patients.

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**INTRODUCTION**

Human immunodeficiency virus (HIV) infection continues to be a healthcare problem worldwide. According to the Centers for Disease Control and Prevention, it is estimated that roughly 50000 people get infected with HIV each year in the United States. At the end of 2012, around 1.2 million people were living with HIV infection in the United States[1]. HIV infection used to be lethal in the past. The advent of highly active antiretroviral therapy resulted in a paradigm shift in that chronic illnesses now surpass opportunistic infections as causes of death in patients infected with HIV. Kidney disease continues to cause significant morbidity and mortality among the HIV infected population[2-4]. Currently, HIV-related nephropathies are considered as the third leading cause of end stage renal disease (ESRD) among African Americans[5,6].

There are several known etiologies for chronic kidney disease (CKD) in HIV infected patients. There is paucity of accurate epidemiological data due to the lack of renal biopsies performed in suspected cases and due to the inconsistent reporting of the disease. In the pre anti-retroviral therapy (ART) era, HIV associated nephropathy (HIVAN) used to be the most common cause of CKD in HIV infected patients affecting primarily African Americans. However more recently, hypertension, diabetes mellitus and cardiovascular disease evolved as significant causes of renal dysfunction in this patient population. HIV associated immune complex-mediated disease, IgA nephropathy, HIV-associated thrombotic microangiopathy and antiretroviral medication related toxicities are also important etiologies for CKD. Furthermore, most HIV sero-positive patients are co-infected with hepatitis C virus which can also cause CKD[7]. Progression to ESRD in CKD patients who are also HIV infected is more rapid than those without HIV infection[8]. Kidney diseases associated with HIV infection are summarized in Table 1.

According to Medicare claims data, the number of prevalent HIV positive ESRD patients has increased more than 14-fold from 1999 to 2010[9]. Outcomes of HIV infected dialysis patients have improved dramatically[8,9]. Actual number of HIV positive patients who received kidney transplants or who are on the waiting list is unknown. This is due to the fact that the Organ Procurement and Transplantation Network (OPTN) do not collect data on HIV infection among wait-listed candidates, and some states prohibit the reporting of HIV status.

HIV was once an absolute contraindication for kidney transplantation; however recent studies highlight the safety of kidney transplantation in HIV positive patients who are well-controlled on ART. Several challenges continue to exist in this area including choice of immunosuppression drugs, drug-drug interaction and heightened risk of infections. Furthermore, the possibility of considering HIV positive donors has been a topic of discussion in the recent years in order to allow an increase in the donor pool as discussed later.

# ACCESS TO TRANSPLANTATION IN HIV INFECTED PATIENTS

Historically, HIV infected patients were excluded from the consideration for kidney transplantation due to the concern for worsening infections and rejection. Hemodialysis and peritoneal dialysis were the only forms of treatment available for these patients[10]. In a survey of 148 United States transplant centers published in 1998, the majority of responding centers would not transplant kidney from deceased (88%) or living (91%) donors into HIV-infected patients. Most centers feared that transplantation in such patients would be harmful to the recipient, and some believed that it would be a waste of scarce donor organs[11]. However, recent studies have demonstrated that kidney transplantation in HIV positive patients with ESRD who are receiving ART is safe and effective. Outcomes were comparable to recipients without HIV infection. Furthermore, HIV positive individuals have higher waitlist mortality rates than their HIV negative counterparts. This along with an understanding of the role of immune activation in HIV disease pathogenesis and how immunosuppressant drugs exert antiviral effects contributed to a renewed interest in studying the outcomes of transplantation in these patients[8].

# OUTCOMES OF KIDNEY TRANSPLANTATION IN HIV INFECTED PATIENTS

Early experience with kidney transplantation in HIV positive patients before the rollout of ART was disappointing. This experience was based on case reports and small series of patients with short follow up[12,13]. Among 39 kidney transplants in HIV positive patients between 1980 and 1996, outcomes were suboptimal with 21 deaths after a mean follow up of 48 mo[14]. These included cases where HIV was transmitted during kidney transplant. Retrospective analysis of the United States Renal Data System database from 1987 to 1997 demonstrated inferior three and five-year graft and five-year patient survivals in HIV positive deceased donor kidney transplant recipients as compared to HIV negative patients[15].

Following the introduction of ART, several small studies showed encouraging patient and allograft survivals. The largest prospective trial of kidney transplantation in HIV-infected patients was conducted by Stock *et al*[16] and included 150 patients who were followed for up to five years at 19 United States transplant centers. This study showed one and three-year patient survival rates of 94.6% and 88.2% respectively. Corresponding graft survival rates were 90.4% and 73.7% respectively. These rates were generally between those reported in the Scientific Registry of Transplantation Recipients (SRTR) database for kidney transplant recipients ≥ 65 years and all kidney transplant recipients during a similar time frame. However, there were higher rates of acute rejection at one year (31%) and three years (41%)[16]. In a study that included 40 HIV positive patients, Kumar *et al*[6]reported one and two year patient survival rates of 85% and 82% respectively. Corresponding graft survival rates were 75% and 71% with a 22% acute rejection rate. HIV viral load remained undetectable and CD4 T-cell counts were > 400 cells/mm3. No opportunistic infections or progression to AIDS up to 2 years were observed in these patients[6]. Patient and graft survival rates were similar to HIV negative patients in the study by Roland *et al*[17] involving 18 HIV positive kidney transplant recipients with median follow up of 3.4 years. In a retrospective review of the UNOS database from 2004 to 2006, no differences in patient survival were observed between 100 HIV positive and 36492 HIV negative kidney transplant recipients (95.4% *vs* 96.2%, *P* = 0.32). However, death-censored graft survival was significantly lower in the HIV positive patients (87.9% *vs* 94.6%, *P* = 0.03). Donor age, cold ischemia time of at least 16 hours and delayed graft function were associated with a greater than four-fold increase in allograft loss among the HIV positive patients[18]. A recent study reported 10 year outcomes of kidney transplantation in HIV positive patients from 2002 to 2012 using the SRTR database. When risk stratified by hepatitis C virus infection status, monoinfected HIV positive recipients had similar five-year (75.0% *vs* 75.8%, *P* = 0.58) and 10-year (55.9% *vs* 56.0%, *P* = 0.49) graft survivals when compared to matched controls who were negative for both HIV and HCV. On the contrary, patients coinfected with HIV and HCV had inferior five-year (52.0% *vs* 64.0%, *P* = 0.02) and 10-year (27.0% *vs* 36.2%, *P* = 0.004) graft survival rates when compared to HIV negative but HCV positive matched controls. Coinfection with HCV, panel reactive antibodies > 80%, acute rejection episodes and cold ischemia time > 10 h were independent risk factors for graft loss. Patient survivals were higher in monoinfected HIV positive recipients at five-years (88.7%) and 10-years (63.5%). On the other hand, patient survivals were inferior among coinfected HIV positive recipients (HV+/HCV+) at 5-year (66.3%) and 10-year (29.3%)[19]. Mate kidney analyses using SRTR database from 2000 to 2013 showed similar long term outcomes of kidney transplantation in HIV positive patients relative to noninfected recipients. HIV and HCV coinfected patients had inferior outcomes in this analysis[20].

European transplant centers have similar experience to that in the United States. In a series of 27 HIV infected patients who received kidney transplant, two-year patient and graft survival rates were 98% and 96% respectively. Acute rejection rate was at 15% which is lower than what was reported in the United States. Most patients in this study received basiliximab induction followed by maintenance with tacrolimus, mycophenolate mofetil (MMF) and steroids[21]. A more recent study from the United Kingdom included 33 HIV infected patients, 50% of whom received living donor kidneys and underwent induction with IL-2 receptor antibody and were maintained on triple immunosuppression. Three year patient and allograft survival rates were 91.3% and 87.4% respectively. Acute rejection rate was 44% and 2 patients developed BK nephropathy[22].

# LISTING CRITERIA FOR HIV POSITIVE PATIENTS

Data regarding the evaluation of HIV infected patients for kidney transplant is limited. It is believed that, compared to HIV negative patients, only a smaller percentage of HIV infected patients evaluated for kidney transplantation are actually placed on the list. Barriers to listing for transplant were discussed in a retrospective study of 309 HIV infected patients evaluated for renal transplantation in one United States center between 2000 and 2009. Only 20% were listed for transplant compared with 73% in HIV negative patients evaluated during the same period (*P* < 0.00001). The most common reason for not advancing the evaluation process was the lack of documentation of HIV control. CD4 T-cell count and viral load data were not available in 35% of patients and in 21%, CD4 T-cell count and viral load did not meet the eligibility criteria. Other factors associated with incomplete evaluation process were Black race and history of illicit drug use[23].

The European experience was slightly different, and data from the EuroSIDA cohort study included 88 HIV infected ESRD patients. Inappropriate levels of CD4 T cell count and viral load were reported in 30% of cases and two-thirds of patients were excluded because of cardiovascular diseases or diabetes[24]. Generally accepted criteria for listing HIV positive patients for kidney transplantation are shown in Table 2[25,26]. An exception is usually given to certain treatable and preventable infections such as tuberculosis, esophageal candidiasis, and Pneumocystis jiroveci pneumonia.

# SPECIAL CONSIDERATIONS AND CHALLENGES FOR KIDNEY TRANSPLANTATION IN HIV-INFECTED PATIENTS

## ***Donor factors***

In the past, most kidney transplants done for HIV infected patients were from deceased donors. However a report of 48 living donor transplants showed improved outcomes and less rejection rates[16]. Therefore, it is possible to proceed with kidney transplantation from living donors; however, donors need to be informed with the challenges associated with transplanting HIV positive recipients.

## *Infections*

It appears that the degree of immunosuppression from drug therapy and HIV itself does not necessarily lead to increased risk of infectious complications following transplantation in appropriately selected HIV positive candidates. Studies did not show increased incidence of opportunistic infections in HIV infected patients who underwent kidney transplantation[17].

## ***Rejection***

Most studies reported higher rates of acute rejection compared to HIV negative recipients. In a retrospective analysis of the SRTR database, 516 HIV infected kidney transplants performed between 2003 and 2011 were compared to uninfected counterparts within the same period. Rates of acute rejection within the first year were 15% compared to 8% in the control group[27]. Although this did not affect short-term graft survival in these studies, it merits further studying as it may impact long term graft function. The two variables in clinical studies that were frequently associated with increased risk for acute rejection were deceased donor organs and the use of cyclosporine. One hypothesis was that perhaps the use of ART with potential interaction with calcineurin inhibitors (CNIs) may have resulted in subtherapeutic blood levels of CNIs. It is also possible that intense immunosuppression was deliberately avoided in these patients to prevent infectious complications as noted in the multicenter study reported by Stock *et al*[16]. HIV contains host HLA molecules which can increase the risk for allosensitization. HIV infected recipients may also have increased memory cell phenotype. However, a report by Canaud *et al*[28] may provide a better explanation of the high rates of rejection. In this study, authors performed protocol renal transplant biopsies on 19 recipients with HIV infection who had undetectable plasma level of HIV-1 RNA. It was found that HIV-1 infected the allograft in 68% of these patients. In 62% of instances, infection was located in the podocytes while remaining 38% of the infection was located in tubular cells. Podocyte infection was associated with faster deterioration of allograft function and nephrotic range proteinuria. It was suggested that perhaps this infection may stimulate the immune system *via* recruitment of inflammatory cells and cause cross reactivity with alloantigen and therefore be partially responsible for acute rejection[28]. The authors also developed a non-invasive test for HIV infection of the allograft by performing quantitative PCR of HIV RNA and DNA in the urine. Results correlated well with biopsy findings.

***Kidney infection with HIV***

HIV-associated nephropathy is a well-described aggressive form of focal segmental glomerulosclerosis where the HIV directly infects the kidney cells. Specialized immunocytochemistry studies demonstrate the presence of the HIV core protein (p24) and the envelope glycoprotein (gp120) implicating infection of renal cells by HIV[29]. Past studies using in situ hybridization and PCR have demonstrated that HIV-1 can directly infect renal epithelial cells which act as a reservoir for HIV[29]. In the transplanted kidney, reinfection with HIV can occur early on after transplant and in the absence of HIV viremia. The mechanism is not well understood, however it is hypothesized that the virus is translocated from the recipient T-cells to the donor kidney cells. Unlike native kidney HIVAN, transplanted kidney did not demonstrate similar pathological appearance. Podocyte infection and tubular reinfection were the two salient features of HIV infection of the allograft[28].

## IMMUNOSUPPRESSANT DRUGS

The early studies of kidney transplantation in HIV positive patients used no induction immunosuppression and maintenance therapy with cyclosporine and MMF. More than half of the patients developed acute rejection requiring treatment with anti-thymocyte globulin[6].As mentioned earlier, some immunosuppressive drugs including CNIs, MMF and rapamycin, have shown efficacy against HIV with reduced viral replication. There are no studies comparing tacrolimus *vs* cyclosporine in this setting. Retrospective analysis showed that cyclosporine was associated with a higher incidence of rejection. On the other hand, some centers prefer cyclosporine over tacrolimus due to the diabetogenic effect of tacrolimus which can be enhanced by protease inhibitors (PIs).

Immunosuppressive drugs may exert antiviral effects, either by reducing cellular targets for the virus, or *via* direct antiviral effects[30]. For instance, cyclosporine can interfere with HIV gag processing. MMF interacts with nucleoside reverse transcriptase inhibitors (NRTIs) like abacavir, didanosine and tenofovir thus potentiating their anti-viral effects[31-33]. It is also thought that sirolimus may be associated with downregulation of the CCR5 receptor which may decrease HIV infectivity[34]. Sirolimus is less nephrotoxic than CNIs and is an effective anti-proliferative agent that could be beneficial against Kaposi’s sarcoma[35]. Glucocorticoids are inducers of CYP 450 system. They can also increase CD4+ T cell population, suppress HIV viral load and inhibit cytokine CCL2. As steroids are tapered following kidney transplantation, CD4 count may decrease and CNI level may go up. This may result in enhance CNI toxicity and possibility of infections. Close monitoring is therefore recommended[36,37].

In terms of induction therapies, monoclonal anti-interleukin-2 receptor antibodies have been shown to enhance CD4 T-cell counts. No negative outcomes associated with their use have been reported. On the other hand, several issues were reported with the use of antilymphocyte polyclonal antibodies. Increased risk of infections and hospitalizations was reported with the use of Thymoglobulin in 11 HIV infected patients when it was used to treat rejection[38]. In the multicenter United States study that included 150 patients, administration of Thymoglobulin as induction therapy was associated with twice as many serious infections per follow up year compared to patients who did not receive this therapy[16].

Until further evidence becomes available, we recommend induction therapy using anti-interleukin-2 receptor monoclonal antibodies such as basiliximab. We recommend using tacrolimus plus MMF with or without steroids depending on immune risk. The use of Thymoglobulin is not contraindicated but it should be used with caution due to severe depletion of lymphocytes and the potential for severe thrombocytopenia.

## USE OF ART FOLLOWING TRANSPLANTATION

There are six classes of ART drugs currently available in the United States. These include nucleoside and non-nucleoside reverse transcriptase inhibitors (NNRTI), PIs, integrase strand-transfer inhibitors, CCR5 antagonists such as maraviroc and fusion inhibitors[39]. There is no consensus on the ideal ART regimen for kidney transplant recipients. It is generally recommended that patients continue the same ART regimen prescribed pre-transplant. Goal is the maintenance of HIV suppression while minimizing interaction with immunosuppressive drugs and their side effects. Multiple drug interactions exist between ART and immunosuppressive drugs. This is discussed in length below. Integrase strand transfer inhibitors such as raltegavir and dolutegravir have no interaction with immunosuppressive drugs at the CYP 450 level. It is recommended that they be used in combination with abacavir and lamivudine/emtricitabine. Renal dosing of medications is recommended as most kidney transplant recipients will have some degree of CKD. PIs and NNRTI are metabolized through liver and therefore do not require any dose adjustments. Raltegavir does not require renal dose adjustment either. ART that usually require renal dosing include nucleosides and nucleotides. Tenofovir can cause renal toxicity and should be avoided or used with caution in patients with kidney transplant. CCR5 chemokine receptor is used by R5 tropic virus for cell entry. Maraviroc blocks this receptor and can also impair lymphocyte chemotaxis with a theoretical reduction in organ transplant rejection[40]. Collaboration between infectious disease and transplant professionals with HIV viral load monitoring is essential in these cases[14].

## **IMMUNOSUPPRESSION AND ART: DRUG-DRUG INTERACTIONS**

Complex pharmacokinetic interactions between therapies used for immunosuppression and antiretroviral drugs can happen. MMF inhibits inosine monophosphate dehydrogenase which blocks purine synthesis. It is metabolized mainly by glucuronidation in the liver. Atazanavir, an inhibitor of UDP-glucuronosyl transferase may lead to increased mycophenolic acid (MPA) levels[14]. Ritonavir on the other hand, may reduce MPA levels by inducing glucuronidation. Drugs that affect cytochrome P-450 may also influence the levels of CNIs and sirolimus. For example, PIs inhibit CYP 450 and p-glycoprotein efflux system resulting in increased serum levels of CNIs. Patients on PIs may require only small doses of CNI given less frequently. Special attention should be given when stopping PIs in these patients as this may result in acute rejection[41-43]. On the other hand drugs in NNRTI group can reduce CNI serum levels due CYP 450 induction. Stopping NNRTIs may result in CNI toxicity[44]. Maraviroc, is a P-450 3A4 substrate, but does not inhibit or induce the enzyme and hence, it is not expected to interact with CNIs. Intergrase strand transfer inhibitors such as raltegravir, has excellent anti-retroviral effects without affecting CYP system and hence no significant interaction with CNIs. This was studied by Tricot *et al*[45] in 5 patients who did not suffer any acute rejection. However lower barrier to resistance in this group of drugs may increase chances for virologic failure.

In addition to ART and immunosuppressive drug-drug interactions, several antibiotics and antifungal drugs used for treatment and prevention of infections in HIV patients can inhibit cytochrome P450 system and hence affect the CNI levels.

The complexity of drug-drug interactions highlights the importance of team approach that includes transplant nephrology, infectious disease and specialized pharmacy.

**PATIENTS COINFECTED WITH HIV AND HCV**

As mentioned, outcomes were inferior with kidney transplantation in patients coinfected with HIV and HCV when compared to HIV monoinfected transplant recipients[19,20]. Factors contributing to this may include HCV infection related increased risk for the development of post-transplant diabetes mellitus, liver damage, cardiovascular disease and infections. Coinfected patients may represent a social and biological high risk group. For instance, these patients generally are younger with lower income, have longer HIV disease duration and dialysis vintage prior to transplantation with greater likelihood of drug addiction history[20]. This raises the question whether HCV coinfection should be a relative contraindication for kidney transplantation in HIV positive patients. However over the last couple of years, there have been significant advances in the treatment of HCV infection with the introduction of directly acting antiviral agents (DAA) into the clinical arena[46]. These agents can achieve a sustained virologic response in the range of 90%-95% with minimal side effects. Moreover, unlike interferon based therapy, DAA are safe to use after organ transplantation. These therapeutic advances are likely to improve long-term outcomes in HCV infected organ transplant recipients.

## **HIV TO HIV TRANSPLANTATION**

A study from South Africa by Muller *et al*[47,48] reported the outcomes in 27 HIV positive patients who received deceased donor kidneys from HIV positive donors. All donors had normal kidney function and all kidneys were biopsied. At one, three and five years after transplant, patient survival rates were 84%, 84% and 74% respectively with corresponding death-censored graft survival rates of 93%, 84% and 84%. HIV viral loads remained suppressed without evidence for opportunistic infections during the follow-up in all patients. Three patients developed HIVAN in the transplanted kidneys on protocol biopsies despite the lack of HIV viremia[47,48]. Whether the South African experience can be applied to the United States is not fully clear. In addition to the ethical dilemmas, concerns include possibility of superinfection with more virulent strains and development of drug resistance[49,50]. Viral tropism is another concern with theoretical risk for super infection with a more aggressive strain such as X4 tropic virus compared to R5 tropic virus. Tropism studies are available but may take up to a week to complete making it less useful for decision making during the narrow time window available to make transplant decisions[40]. Quality of donor organs and the risk for recurrence of HIVAN are also potential issues in HIV to HIV transplantation.

On November 21, 2013, President Obama signed the HIV Organ Policy Equity (HOPE) Act into law. This law reversed the federal ban on considering HIV positive donors and authorized clinical research in the area of transplantation from HIV positive organ donors[51]. As a result, a work group from the OPTN was charged with the development of policies that permit safe recovery of such organs. OPTN granted permission to Johns Hopkins University Hospital, Baltimore, MD to perform organ transplantation between HIV positive donors and recipients as of February 9, 2016. The transplant team at this center now has performed the first HIV+ to HIV+ kidney transplant in the United States and the first HIV+ to HIV+ liver transplant in the world. Experts estimate that using HIV infected donors will make available an additional 500 solid organ donors a year[52,53]. Moreover, this may reduce the discard of organs due to false positive results from nucleic acid testing currently being used which has false positive rates between 0.1% and 0.85%.

**CONCLUSION**

Key point regarding kidney transplantation in HIV infected patients are summarized in Table 3. Evidence thus far supports the viability of kidney transplantation in appropriately selected HIV positive patients with acceptable outcomes. Ideal immunosuppressive regimen is not yet defined in this population. Special attention should be paid to potential drug interactions between some of the ART medications and immunosuppressive drugs. Studies have shown increased incidence of acute rejection episodes and achieving therapeutic CNI levels can be challenging especially if the patient is on ART regimens which include PIs and NNRTIs. ART regimens containing integrase strand transfer inhibitors such as raltegravir may be preferred due to minimal drug interactions. Patients coinfected with HIV and HCV have inferior outcomes with kidney transplantation. However, outcomes are likely to improve in these patients in the coming years corresponding with the availability and use of DAA to treat HCV infection. The option for HIV positive donor to HIV positive recipient organ transplantation is actively researched in the United States and could further expand donor pool for HIV infected patients.

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**Table 1 Causes of kidney disease in human immunodeficiency virus infected patients**

|  |  |
| --- | --- |
| Cause | Characteristics |
| HIVAN | Collapsing glomerulopathy in the setting of high grade HIV viremia  Affects almost exclusively African Americans  Manifests with high-grade proteinuria in the absence of hypertension  Treated with antiretroviral therapy |
| HIV-immune complex | Manifests with hematuria and sub-nephrotic range proteinuria  Variable presentation with AKI  Poorly understood |
| Diabetic nephropathy | Similar presentation to patients without HIV. Proteinuria followed by decreased GFR |
| Hypertension | Similar presentation to patients without HIV |
| Thrombotic microangiopathy | Typically presents with AKI, subnephrotic range proteinuria with hematuria along with features of microagiopathic hemolytic anemia |
| IgA nephropathy | Hematuria with variable degree of proteinuria and decreased GFR |
| Tenofovir toxicity | Variable degree of decreased GFR with features of proximal tubular injury |
| Immune-complex membrano-proliferative glomerulonephritis and cryoglobulinemia in the setting of HCV co-infection | Nephritic syndrome picture with positive cryoglobulin and hypocomplementemia |

HIV: Human immunodeficiency virus; HIVAN: HIV-associated nephropathy; AKI: Acute kidney injury.

**Table 2 Inclusion criteria for kidney transplant listing in human immunodeficiency virus positive patients**

|  |
| --- |
| Meet standard criteria for placement on transplant waiting list for kidney transplantation plus the following:  Well-controlled HIV disease with viral load < 50 copies/ml and CD4 count > 200 cells/mm3  Absence of opportunistic infections or neoplasms  Stable antiretroviral regimen  Psycho-social clearance with demonstration of no active history of drug and/or alcohol use. Patients on stable methadone maintenance program can be considered |

HIV: Human immunodeficiency virus.

**Table 3 Key points**

|  |
| --- |
| Kidney transplantation in patients with HIV infection is a viable therapeutic option  Ideal immunosuppressive regimen remains uncertain  Higher rates of rejection are reported in clinical trials  Immunosuppressive therapy does not seem to negatively impact the course of HIV infection  Some immunosuppressive drugs may exert antiretroviral actions  Special attention should be paid to the potential interaction between ART and immunosuppressive drugs  A close collaboration between infectious disease specialists and transplant professionals is mandatory in order to optimize transplantation outcomes in these patients  Transplantation from HIV+ donors to HIV+ is currently being researched |

HIV: Human immunodeficiency virus.