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# Kidney allograft survival outcomes in combined intestinal-kidney transplant: An analysis of the UNOS/OPTN database 2000-2014

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## Abstract

**Background and objectives**: Intestinal transplants carry a high morbidity/mortality. Kidney allograft outcomes after combined intestinal (IT) with kidney transplant (CIKT) remain largely uninvestigated.

**Materials and methods**: The UNOS STAR database was queried to identify all such combined organ transplants from 2000 to 2015.

**Results**: Out of a total 2215 (51.4% peds vs 48.6% adults) intestinal transplants, 111 (5.0%) CIKT were identified (32.4% peds vs 67.6% adults). Over the study period of CIKT, a total of 45.9% of these cases died with a functioning kidney graft. DGF rate was 9.0%. The 1-year reported kidney acute rejection rate was 6.3%. For the entire CIKT population over the entire study era, the 1-, 3-, and 5-year unadjusted kidney graft survival was 57%, 39%, and 34%, while death-censored kidney graft survival was 93%, 90%, and 86%, respectively. Overall conditional 5-year kidney graft survival (defined as 1-year kidney graft survival) was 58%. Overall, patient survival was significantly lower in recipients of CIKT compared to intestinal transplant (IT) ($P < .005$); However, the 5-year conditional (1 year kidney graft) patient survival in adults was not significantly different between IT and CIKT overall ($P = .194$).

**Conclusions**: Kidney allograft survival is primarily dependent on 1-year patient survival. Guidelines regarding allocation of kidney allografts in CIKT need to take into consideration utility and urgency.

KEYWORDS

allograft, combined, intestine, kidney, multivisceral, rejection, transplantation

## 1 | INTRODUCTION

Intestinal transplantation has become a treatment option for a variety of patients, and the success rates have improved over the last 2 decades. Intestinal transplant (IT) can be isolated or it can include the simultaneous transplantation of the liver, stomach, pancreaticoduodenal complex, and the small intestine (termed multivisceral transplantation [MVT]). The modified MVT (mMVT) includes transplantation of the multivisceral graft without the donor liver. A minority (19%-20%) of multivisceral transplantations include a kidney allograft for patients who concomitantly have progressive CKD or who are on dialysis. Candidates for MVT generally have a terminal condition that is nonresponsive to standard medical or surgical therapy. Intestinal rejection in the first year post-transplantation has been reported to be up to 50%[1] and results in significant graft loss and patient mortality. Even though 1-year patient survival has improved to 76%, 5-year patient survival remains at 56% and 10-year survival is 43%.[2] Even though intestinal rejection has been reduced

since the 1990s, acute cellular rejection, chronic rejection, and post-transplant lymphoproliferative disorder (PTLD) remain the most common causes of graft loss.[3]

It is known that there can be significant progression of chronic kidney disease in native kidneys of patients with MVT and mMVT[4-6]; however, the kidney allograft outcome in MVT and mMVT (hereafter referred to as CIKT, combined intestinal, and kidney transplant) has not received much attention. Although it is known that progression of CKD in native kidneys is a significant contributor to patient mortality, it is not known whether immunological injury to the kidney allograft is an important contributor to progression of CKD, graft loss, or patient survival. The current study seeks to primarily study the outcomes of the kidney allograft in the population who received a combined kidney CIKT with any form of intestinal transplant (IT).

## 2 | MATERIALS AND METHODS

The clinical and research activities being reported are consistent with the Principles of the Declaration of Istanbul as outlined in the Declaration of Istanbul on Organ Trafficking and Transplant Tourism. Given the de-identified national data, this study is exempt from institutional review board.

This is a retrospective database review of the UNOS database (acquired via inquiry to the STAR database as of March 2016) on all reported CIKT transplants performed between January 2000 and September 2015 with data reported till December 2015. The study included both the adult and pediatric population. Demographic data (including age, gender, race, dialysis at the time of transplant, total parental nutrition [TPN] dependence, median wait time, en bloc kidneys, inclusion of liver and pancreas, median KDPI, mean donor age, mean HLA mismatch, DGF, treatment for kidney rejection, and treatment for intestinal rejection) were analyzed. Recipients with other combined organs such as heart and lung were excluded from the analyses.

The primary outcome of interest was kidney allograft survival and patient survival in CIKT. Kidney allograft outcomes were also evaluated separately in liver inclusive intestinal transplant MVT and nonliver inclusive intestinal transplant (mMVT). Kidney allograft outcomes in en bloc vs non-en bloc kidney after MVT/IT were also analyzed. Recipient characteristics that were evaluated were race, gender, age, and maintenance immunosuppression. Kidney allograft survival was defined as return to dialysis or patient death. Death censored kidney allograft survival was analyzed separately. Five-year conditional survival was defined as 1-year kidney graft survival.

Pre- and post-transplant creatinine (Cr) values or glomerular filtration rate (GFR) is not available in the STAR database. Similarly, Cr or GFR at the time of transplant is also not available in the STAR database. Moreover, unfortunately, the STAR database does not capture pretransplant CKD status of patients who received an IT alone.

Patient and graft survival analyses and log-rank tests were performed to determine whether there were differences between CIKT and IT, between the adult and pediatric populations, between kidney allografts in MVT and mMVT. All analytic assumptions were verified for each model, and all analyses were performed using SPSS software version 24.0.

## 3 | RESULTS

### 3.1 | Characteristics

Out of a total 2215 (51.4% peds vs 48.6% adults) intestinal transplants during the study period, 111 (5.0%) CIKT were identified (32.4% peds vs 67.6% adults). For the CIKT group, the recipient and donor characteristics are shown as in Table 1. The majority of these patients received CIKT for short gut syndrome due to various reasons.

The median cold ischemia time was 9.4 hours (n = 88). The warm ischemia time for the kidney transplant in the STAR database was not reliably or accurately entered for many cases prior to 2010, which limits the generalizability of the data outcomes. It is also not known how many cases had a delayed (staged) kidney transplant vs actual simultaneous transplant. Only 7.2% of the kidneys were pumped.

Over the study period, among the CIKT group, a total of 45.9% of cases died with a functioning kidney graft. DGF rate, as defined in the database as needing dialysis within 7 days of kidney transplant, was 9.0%. The 1-year reported kidney acute rejection rate was 6.3%.

For the entire CIKT population over the entire study era, the 1-, 3-, and 5-year unadjusted kidney graft survival was 57%, 39%, and 34%, while death-censored kidney graft survival was 93%, 90%, and 86%, respectively. Overall conditional 5-year kidney graft survival (defined as 1-year kidney graft survival) was 58%. The differences between adult and pediatric CIKT survivals are shown in Table 2.

A univariate logistic regression analysis of over 20 variables looking for association with kidney graft loss is detailed in Table 3. Donor age and lack of recipient requirement for TPN or intravenous fluid (IVF) administration were associated with a significant beneficial association with kidney survival. Recipient age >18 years and higher donor terminal serum creatinine were the only variables which had a significant adverse contribution to kidney graft loss.

Kaplan-Meier kidney survival analysis for actuarial or conditional survival was significantly different between the adult and pediatric recipients (Figure 1). Pediatric CIKT had a better survival as compared to adult CIKT ($P = .035$).

Actuarial overall patient survival was significantly lower in recipients of CIKT compared to IT ($P < .005$) (Figure 2). However, the 5-year conditional (1-year kidney graft) patient survival in adults was not significantly different between IT and CIKT overall ($P = .194$).

## 4 | DISCUSSION

IT, MVT, and MMVT are effective treatments for intestinal failure, severe pancreatitis, liver cirrhosis, tumors involving the mesenteric root (but sparing the liver), and many other indications. The complexity of the procedures and the high-risk nature of the patients

**TABLE 1** Demographic data on the combined intestinal, and kidney transplant (CIKT) patient population

| | CIKT group (n = 111) |
|---|---|
| Mean age (y) | 33.6 ± 22.1 (range 0-68) |
| Adult/Pediatric | 46.3 ± 14/7.1 ± 5.5 |
| Gender M/F (%) | 55.0/45.0 |
| Race W/AA/O (%) | 78.4%/11.7.0/9.9 |
| On dialysis at time of transplant (%) | 26.1% |
| BMI at time of transplant | 22.4 ± 6.1 (7.1-43.3) |
| Blood type A/AB/B/O (%) | 39.6/1.8/9.9/48.6 |
| Recipient CMV IGG positive (%) | 54.1% |
| Recipient EBV seropositive (%) | 57.7% |
| Recipient HCV seropositive (%) | 5.4% |
| TPN dependent (%) | 21.3 |
| IVF dependent (%) | 27.9 |
| Serum albumin (mg/dL) | 3.02 ± 0.7 (1.3-4.5) |
| Median wait time (d) | 39.0 (1-1205) |
| En-bloc/Left/Right kidney (%) | 27.0/29.7/43.2% |
| Simultaneous liver (%) | 73.9 |
| Simultaneous pancreas (%) | 75.7 |
| Visceral organs transplanted (%) | |
| Duodenum | 56.8% |
| Large intestine | 20.7% |
| Small intestine | 99.1% |
| Stomach | 45.9% |
| Prior kidney or KP Tx (%) | 5.6 |
| Median KDPI/> KDPI 85 (%) | 33 (range 1-92)/4.5% |
| Mean donor age | 16.3 ± 12.8 (range 0-49) |
| Mean donor BMI | 21.0 ± 4.7 (11.3-34.2) |
| HLA A mismatch 0/1/2 (%) | 9.0/36.0/52.3 |
| HLA B mismatch 0/1/2 (%) | 2.7/22.5/72.1 |
| HLA DR mismatch 0/1/2 (%) | 3.6/45.0/48.6 |
| Mean HLA mismatch | 4.62 ± 1.03 |
| Organ received on ice/Pump (%) | 82.9/7.2 |
| Donor CMV IgG positive (%) | 56.8 |
| Donor needing anti-HTN treatment pre-cross clamp (%) | 19.8 |
| Donor terminal serum creatinine (mg/dL) | 0.72 ± 0.41 (0.2-2.5) |
| Donor terminal AST/ALT/T.Bili | 81.2 ± 107/71/8 + /-32/0.9 + /-0.8 |
| Donor infection (Urine/Blood/Pulm) (%) | 10.8/4.5/36.9 |
| Donor protein in urine (%) | 36.9% |
| Pre-recovery donor steroid use (%) | 81.1% |
| Pre-recovery donor diuretic use (%) | 73% |
| Donor inotropic support at time of procurement (%) | 51.4% |
| Donor history of tobacco/HTN/Cocaine/PHS/DM | 3.6/3.6/5.4/7.2/0 |
| Delayed graft function (%) | 9.0% |
| Serum creatinine at time of disharge (mg/dL) | 1.0 ± 0.69 (0.2-3.5) |
| Median length of stay (d) | 48.0 |
| 1 year reported treated for kidney rejection (%) | 6.3% |
| 1 year reported treated for intestine rejection (%) | 16.1 |

IVF, intravenous fluid; TPN, total parenteral nutrition.

**TABLE 2** Kidney graft and patient survival in combined intestinal, and kidney transplant (CIKT)

| | Total | Adult | Pediatric |
|---|---|---|---|
| Uncensored kidney graft survival in CIKT | | | |
| 1 year | 57% | 53% | 67% |
| 3 year | 39% | 33% | 52% |
| 5 year | 34% | 26% | 48% |
| Conditional 5 year | 58% | 50% | 71% |
| Death-censored kidney graft survival in CIKT | | | |
| 1 year | 93% | 91% | 94% |
| 3 year | 90% | 86% | 94% |
| 5 year | 86% | 86% | 86% |
| Patient survival in CIKT over entire study period | | | |
| 1 year | 61% | 57% | 69% |
| 3 year | 44% | 39% | 54% |
| 5 year | 39% | 31% | 54% |

requires precise attention to all medical and surgical details in order to maximize patient survival. Indeed, at our institution, Indiana University, with a learning curve, patient survival between 2004-2007 and 2008-2010 improved from 67% to 80% in MMVT, 46% to 100% in pediatric MVT, and 44% to 56% in adult MVT. However, there is no critical turning point, such as novel immunosuppression or novel surgical technique, which can be considered contributory to these chronological improvements in outcomes, which are likely to be gradual and multifactorial.

CIKT is done very infrequently; CIKT peaked in 2007 (16 transplants) and since then has averaged about 6 transplants per year (see Figure 3); overall, only about a quarter of the MVT group receives a kidney allograft. However, little attention has been devoted to the contributions of the kidney allograft in CIKT. Here we studied the national outcomes of this group receiving a combined intestinal and kidney transplant (CIKT).

In this cohort overall, there is a low percentage (26.1%) of CIKT recipients who were on dialysis at the time of kidney transplant as compared to the national percentage for kidney alone transplant

**TABLE 3** Univariate logistic regression for kidney graft loss

| Risk factor | Hazard ratio | 95% CI | *P*-value |
|---|---|---|---|
| Adult (>18) | 2.46 | 1.07-5.64 | .035 |
| Recipient age | 1.018 | 0.99-1.03 | .060 |
| Female | 0.804 | 0.36-1.77 | .590 |
| Recipient BMI | 1.066 | 0.99-1.14 | .082 |
| Recipient serum albumin | 0.863 | 0.47-1.56 | .625 |
| Recipient days on waitlist | 0.998 | 0.99-1.00 | .168 |
| DGF | 0.47 | 0.09-2.37 | .367 |
| Kidney received on ice vs pump | 1.12 | 0.25-5.01 | .877 |
| Simultaneous pancreas | 0.80 | 0.32-1.9 | .639 |
| Simultaneous liver | 0.95 | 0.38-23.2 | .91 |
| HLA DR mismatch | 1.09 | 0.54-2.19 | .811 |
| HLA mismatch level | 1.09 | 0.74-1.60 | .645 |
| Donor age | 1.035 | 1.0-1.07 | .049 |
| Donor terminal serum creatinine | 5.25 | 1.5-18.1 | .009 |
| Donor pulm infection | 1.06 | 0.46-2.39 | .889 |
| Donor BMI | 1.02 | 0.93-1.11 | .649 |
| KDPI | 0.32 | 0.06-1.56 | .162 |
| On dialysis at time of transplant | 0.44 | 0.068-3.26 | .445 |
| Treated for kidney rejection 1 y | 0.38 | 0.06-2.16 | .279 |
| Treated for intestinal rejection 1 y | 1.45 | 0.52-4.04 | .477 |
| Length of stay | 1.004 | 0.99-1.013 | .377 |
| Recipient not on TPN | 0.57 | 0.007-0.46 | .008 |
| Recipient not on IVF | 0.144 | 0.037-0.566 | .005 |
| En bloc vs kidney after IT | 0.6923 | 0.29-1.63 | .418 |
| Large intestine/colon inclusion | 0.508 | 0.19-1.31 | .162 |

IVF, intravenous fluid; TPN, total parenteral nutrition; IT, intestinal transplant.

(which is approximately 75%-80%). In the pediatric group, dialysis-independent CKD stages 4-5 may be more readily maintained. Also, in general, there may be aversion to invasive dialysis lines due to fear of bacteremia and sepsis. These patients also clearly are not peritoneal dialysis candidates. However, we postulate that the predominant reason for the low percentage of dialysis patients in the CIKT recipients is the short waiting time (median 39 days) for this multiorgan transplant population. Furthermore, intestinal transplant

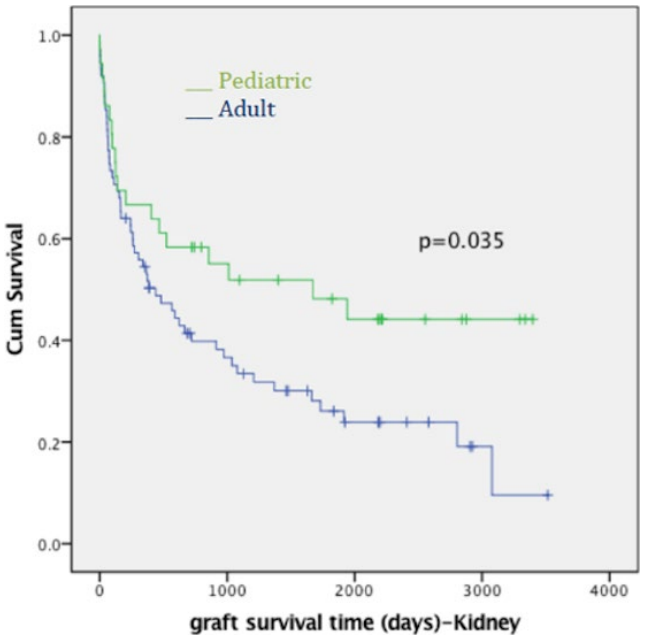


**FIGURE 1** There is no difference in patient survival outcomes between adults and pediatric combined intestinal, and kidney transplant (CIKT) patients overall in the time period between 2000 and 2014

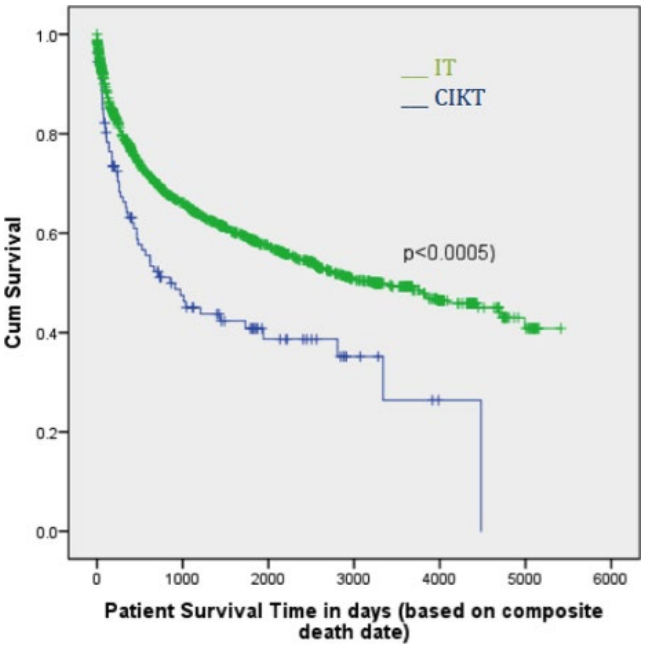


**FIGURE 2** Patient survival is significantly lower in the combined intestinal, and kidney transplant (CIKT) population as compared to the intestinal transplant (IT) population

recipients can be listed at a GFR >20 mL/min as per current UNOS criteria; GFR <20 mL/min, on the other hand, is a prerequisite for kidney alone transplantation.

Interestingly, in our UNOS study, 45.9% of patients died with a functioning kidney graft. The reported 1-year kidney allograft rejection rate was 6.3%, which is on the lower end of standard rejection

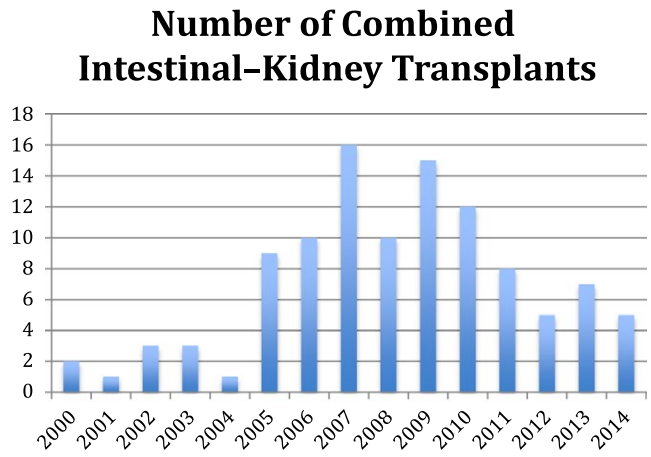


**FIGURE 3** Number of combined intestinal, and kidney transplant (CIKT) transplants performed yearly since 2000

rates, suggesting that most kidneys are not lost due to rejections or due to immunologic complications. We postulate here that the cause of graft loss, aside from death with functioning graft, is mainly infection or tubular injury/necrosis related to complications of the intestinal grafts. Moreover, intestinal rejection has been reported to be as high as 50% in the first year, and patient survival is closely associated with intestinal rejection; hence, most patients die with a functioning kidney allograft.

This database analysis shows that patient survival was significantly lower in adult recipients of CIKT compared to IT ($P < .005$). A single-center study from our institution, however, did not show an adverse affect on patient survival with the inclusion of a kidney allograft ($P = .45$).[7] Therefore, although it appears that the CIKT group faces an increased patient mortality, when looking at conditional survival, the patient survival is similar between the IT and CIKT groups. Thus, this higher mortality seems unrelated to the inclusion of the kidney allograft; the increased mortality in the CIKT population is likely related to the complications of the intestinal transplant itself, patient selection, severity of patient illness at the time of transplant, and donor variables.

Chronic kidney disease is significantly associated with decreased patient survival in general and specifically in intestinal transplants as well. Mangus et al showed that 25% of MVT had acute kidney injury of the native kidney at the time of transplant, and these patients had an inferior long-term survival (three- year survival difference between the absence and presence of renal failure was as follows: MVT-63% vs 49%; MMVT-80% vs 73%; All 66% vs 57%).[8] Due to lack of data on kidney function of the allograft itself, we cannot comment in our analysis on whether progression of CKD or ESRD in the kidney allograft contributes to a higher mortality or not. Other studies, such as the one by Huard et al have shown the high incidence of CKD after intestinal transplant alone, approaching 25% at 5 years and that CKD itself was associated with significantly higher hazard of death (HR 6.2).[6] This study had specifically excluded pediatric patients as well as those with combined kidney transplant.

The progression of CKD is vicious and cyclic, whereby progression of CKD leads to morbidity and intestinal rejection/treatments leads to further CKD; intestinal rejection leads to mucosal injury which damages the intestinal epithelial barrier leading to sepsis, progression of CKD, and patient mortality.[9] Factors associated with progression of CKD include preoperative GFR, pretransplant ICU status, tacrolimus levels, increased age, female gender, Hepatitis C infection, hypertension, and diabetes mellitus.[10,11]

Progression of CKD in the kidney transplant graft itself has not been studied well in the CIKT population, and the UNOS database does not capture renal function. It is possible that significant progression of allograft CKD and intestinal rejection is engaged in a vicious cycle in the CIKT population thereby contributing to adverse patient survival. However, it is apparent that most CIKT patients die with a functioning kidney albeit with likely varying degrees of chronic kidney disease in the transplanted kidney. It is unclear if prolonged operative time, pretransplant dialysis, or increased antigen load contributes to worse patient survival in CIKT as compared to IT.

Some organs are more immunogenic than others because they may be associated with stronger affinity for and homing of immune cells. It is suggested that bowel grafts are less resistant to rejection than pancreas grafts; similarly, pancreas grafts are less resistant to rejection than kidney grafts.[12] Liver grafts have been proposed to confer immunity to kidney grafts. Interestingly, we did not notice any difference in kidney graft survival outcomes when comparing CIKT where liver graft was included or excluded (Table 3). We also did not notice any difference in the inclusion or exclusion of large bowel (colon) grafts, as there have been concerns that the absence of the colonic graft raises the risk of AKI due to loss of water and electrolyte balance (Table 3).

Many have advocated en bloc kidney allocation because of potential advantages in surgical techniques and procedures and because of the high frequency of preoperative CKD in IT recipients. We did not observe any difference in kidney transplant graft survival between en bloc transplants and kidney after IT transplants (Table 3).

Interestingly, the patients who were not on TPN or IVF-dependent pretransplant had a kidney graft survival advantage in our study cohort. This underscores the association between perioperative volume status optimization on graft outcomes. Unfortunately, the UNOS STAR database does not provide the indications for instituting TPN or IVF. However, the percentage of CIKT patients who were on pretransplant TPN or IVF is low. Lack of IV access, risk of infections, and volume overload in the setting of kidney failure are potential reasons for a lower than expected TPN or IVF dependence in this cohort. Adult recipients, higher donor age, and higher terminal serum creatinine were associated with a higher risk of kidney graft survival. These are known and expected risk factors which have been shown to impact kidney outcomes.

The Organ Procurement and Transplantation Network (OPTN) has the current policy of allocating kidneys to multiorgan recipients over kidney alone recipients who have been waiting longer on the waiting list. Allocation, however, must be based on ethical principles

of justice. The United Network for Organ Sharing (UNOS) ethics committees emphasize "fairness in the pattern of distribution of the benefits and burdens of an organ procurement and allocation program."[13] In intestinal transplantation, this means that one must balance utility (maximizing post-transplant survival) and urgency (minimizing waitlist mortality).[14] Based on our results, some may argue that CIKT violates the principle of utility because kidneys are allocated to multiorgan transplants that are associated with a markedly increased post-transplant patient mortality and thus its associated graft loss. To put things in perspective, in SLK, the survival advantage for liver kidney transplantation in patients with renal dysfunction is very small (5% at 1 and 5 years).[15] However, it is indisputable that intestinal failure is an urgent medical condition with greatly increased mortality if not treated promptly. The selection of candidates for CIKT, however, is complex because renal disease associated with intestinal failure may be acute or chronic in nature. As a consequence, there is no well-defined allocation policy for patients listed for CIKT. Despite "proposed" listing criteria for CIKT, transplant centers may tend to use more liberal selection criteria in efforts to minimize post-IT kidney failure.

The data by Huard et al also clearly show a high incidence and risk of CKD after IT alone. They noted 26.7% of ITx alone transplant recipients developed severe CKD at a median of 9.8 years. About 18.1% of cases had a GFR <30 mL/min, 7.4% required initiation of chronic hemodialysis, while 4.4% needed a subsequent kidney transplant. Development of severe CKD was an independent risk factor for mortality with hazard ratio of 6.2.[6]

So, which patient with intestinal failure should receive a kidney allograft? In SLK, one study suggests that GFR less than 60 mL/min is associated with worse short-term and long-term survival, longest intensive care unit stays, and delayed hospital discharge.[16] Similarly, the study by Huard et al demonstrates that a pretransplant GFR <60 mL/min is associated with a 44.8% higher risk of death after intestinal transplantation.[6] The liver kidney allocation proposal allows kidney allocation for CKD with a GFR <30 mL/min and for AKI (hemodialysis or GFR <25 mL/min for 6 weeks). IT requires high dose calcineurin inhibitor use, which lowers GFR by 10 mL/min on average[17]; hence, a GFR <30 mL/min or AKI, as above, may be an acceptable guideline for kidney allocation in IT. In liver transplant alone with AKI on CKD, there is frequent recovery from AKI to a GFR >30 mL/min; however, this is not commonly true for IT and not well reported either.[18]

Another condition that should qualify for CIKT includes loss of vascular access. If dialysis access is challenging or impossible, performing an IT alone in a population with marginal renal function is risky as, if the native kidney fails post transplant, dialysis cannot be performed leading to increased patient mortality.

Analogous to the newly proposed and implemented liver-kidney allocation, it can be argued that CKD stage 3b candidates for isolated intestinal transplant should, if they develop renal failure, be given priority on the kidney waiting list if they register 60-365 days after intestinal transplantation. This will help distinguish who should get a CIKT and who should receive an IT with subsequent priority on the kidney list should they develop post-transplant renal failure. As stated above, the 1-year graft failure rate essentially mirrors the high post-transplant patient mortality in intestinal transplantation of approximately 50% loss of functioning kidneys. Hence, careful selection of CIKT candidates is of utmost importance.

The alternative is to wait 1 year after IT alone transplant in an effort to prevent loss of functioning kidneys from the high first year patient mortality in IT. However, this must be balanced against overwhelming data that severe CKD post-IT alone transplantation has as much as a 6.2 times higher mortality rate. Furthermore, the high risk of dialysis-related complications and line-related infections post-IT alone transplantation may make waiting a year after IT alone medically hazardous in CKD 3b patients. Therefore, combined intestine and kidney transplantation should be based on clear guidelines that emphasize utility in addition to urgency.

Limitations of this study include the following: The study is retrospective, and some of the groups have small numbers. As this is a UNOS database study, criteria for diagnosing acute rejection differ from institution to institution, and clinical issues such as compliance and other clinical events such as CMV and PTLD that may have impacted the course of the graft loss are largely underreported in this database. Similarly, immunosuppression protocols, tacrolimus levels, steroid usage, and treatment of rejection episodes (intestine or kidney) vary highly between centers. These factors can bias the results and should be taken into account when looking at the results of these registry data. We also did not examine the effect of center volume on outcomes. It has been suggested that high volume centers with greater experience in intestinal transplants possibly may have superior outcomes than low-volume centers. However, intestinal transplants in the United States are primarily performed in approximately 8-10 large high volume centers. Thus, this limitation should have minimal impact on the outcomes. Due to lack of complete data and unavailable date, we also could not examine specific intestinal risk factors such as intestinal rejection episodes or hospitalization sepsis episodes, which can have an impact on kidney graft and patient survival.

Despite these registry data-based limitations, our report is the first report on kidney allografts outcomes in CIKT to our knowledge. The data on these outcomes should not discourage centers from performing combined intestine and kidney transplantation. Rather it serves as a sense of urgency for the pretransplant nephrologist and transplant team to take all measures necessary to preserve native renal function in order to avoid the need for a kidney transplantation. Moreover, there is a need to further study the causality behind these results to improve outcomes.

Prospective studies that are designed to compare the outcomes of intestinal transplant alone on a dialysis patient and the CIKT group will likely be seen as unethical. Thus, further studies to look at risk factors for patient and kidney graft loss should be identified in order to predict those at the highest risk of inferior outcomes. Hence, the

need for judicious and careful allocation of our resources also warrants careful study of all risk factors.

## ACKNOWLEDGEMENTS

None.

## CONFLICTS OF INTEREST

None of the authors have any conflicts of interest to disclose.

## AUTHORS' CONTRIBUTIONS

Irfan Moinuddin: performed concept, design, statistical analysis and critical revision; Asif Sharfuddin: performed critical revision, concept, design, statistical analysis; Tim Taber: performed drafting the article; Muhammad Yaqub: performed data analysis and critical review; Muhammad Mujtaba: performed concept and design.

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