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Infections after Kidney Transplantation. Does Age Matter?

Marion Hemmersbach-Miller[1,2], **Barbara D. Alexander**[1], **Debra L. Sudan**[3], **Carl Pieper**[4], and **Kenneth E. Schmader**[5,6]

[1]Infectious Diseases Division. Duke University Medical Center, Durham, NC

[2]Duke Clinical Research Institute, Duke University, Durham, NC

[3]Division of Abdominal Transplant Surgery. Duke University Medical Center, Durham, NC

[4]Department of Biostatistics and Bioinformatics. Duke University. Durham, NC

[5]Division of Geriatrics. Duke University Medical Center. Durham, NC

[6]Geriatric Research Education and Clinical Center (GRECC), Durham VA, Durham, NC

Abstract

Infections threaten successful outcomes after kidney transplantation. Our aim was to determine if the number, types of infections and the risk factors for common infections differed between older compared to younger kidney transplant (KT) recipients in the first year after surgery. We performed a single center retrospective cohort study. Between 2011–2015, 91 KTs were performed in patients ≥ 65 years of age; these were matched 1:1 (by year of transplantation, sex and race) to controls aged 40–60 years. Over 90% of both groups had an infectious complication. Urinary tract infections (UTIs) and CMV viremia were significantly more frequent in older recipients. Older adults had more late onset UTIs, including after stent removal. CMV viremia was more frequent in older adults in the 1–6 months post-transplant period. Due to our center-specific protocol utilizing pre-emptive monitoring in the CMV recipient-seropositive population, the higher CMV incidence in the aged recipient was driven by this subpopulation of older adults. No difference in pneumonias or bloodstream infections were found, nor in surgical complications, rejection or graft loss. Mortality was higher at one-year post transplant in the older recipients (9.9% vs 1.1%; p=0.018). Prophylactic and immunosuppressive strategies may need to be altered for older KT recipients.

Keywords

Kidney Transplantation; Aged; Infection

Introduction:

In the U.S., older adults represent 39% of the total population with ESRD[1]; over 250,000 persons 65 years and older are suffering from end-stage-renal-disease (ESRD).

Corresponding author: Marion Hemmersbach-Miller, MD PhD. Division of Infectious Diseases. Duke University Medical Center. Box 102359. Durham, NC 27710. USA. marion.hemmersbach@dm.duke.edu Phone: 919-668-0789. Fax 919-684-8902.

Transplantation is the treatment of choice for ESRD including in older adults for whom transplantation offers a survival benefit over dialysis, and outcomes such as mortality, graft loss and death-censored graft loss are favorable [2–4]. Accordingly, age is no longer a contraindication for kidney transplantation[5] and the number of older adults receiving kidney transplants has increased substantially[6], representing for the first time in 2017 over 20% (3,666) of the total kidney transplants performed nationally [based on OPTN data as of August 28, 2018].

Despite acceptable outcomes[2,7], infection has been associated with significant morbidity and mortality in older kidney transplant (KT) recipients[8–10]. Older adults are at high risk of infections[11,12] due to immunosenescence, frailty, functional impairment and multiple comorbidities[13]. In the aged KT recipient, ESRD, the stress of surgery and immunosuppressive therapies further increase the risk of infections, and as such, increase the chance of a poor outcome[10]. To date, no change in immunosuppressive or prophylactic therapy is recommended based on the age of an adult KT recipient. The concept of individualized maintenance immunosuppression has been explored in KT recipients but has yet to be implemented in every center[14–17].

There is a gap in the knowledge regarding infectious complications after kidney transplantation in older adults and in how infections differ from their younger counterparts. The primary objectives of this study were to determine if the number, type and risks for common infections differed among older compared to younger KT recipients. Secondary objectives were to determine if the number of rejection episodes, graft survival, patient survival, and hospital admission differed among older compared to younger KT recipients.

Materials and methods:

Study design and Study Center

This was a single center retrospective cohort study of kidney-only transplants performed between 2011–2015 at Duke University Medical Center in Durham, NC, a high volume transplant center; 551 kidney transplants were performed during the study period. Older KT recipients were defined as adults aged ≥65 years; younger KT recipient “controls” were defined as 40–60 years of age.

The study was approved by the Duke University Health System Institutional Review Board for Clinical Investigation (Pro00076804).

Patient cohorts

An institutional tool, the Duke Enterprise Data Unified Content Explorer (DEDUCE)[18], was used to identify all KT recipients during the 5-year study period and their age. All 91 patients aged ≥65 that received a kidney-only transplant were included. Of the 257 potential controls aged 40–60 years, 91 patients were randomly matched 1:1 to the older KT recipients by year of transplantation, sex and, if possible, race.

Antimicrobial prophylaxis

The typical antimicrobial prophylaxis after KT included *Pneumocystis jiroveci* pneumonia (PJP) prophylaxis for twelve months and/or for three months after an acute rejection, whichever was longer. CMV prophylaxis depended on CMV serostatus. For donor and recipient negative CMV serostatus, valacyclovir or acyclovir was used for 90 days if the herpes simplex (HSV) serostatus was positive. For CMV seropositive recipients, preemptive monitoring was performed, which included weekly CMV monitoring for 12 weeks. High risk patients (CMV mismatch, or CMV seropositive recipients receiving anti-thymocyte globulin induction) received ganciclovir/valganciclovir for 180 days; following cessation of prophylaxis, CMV PCR monitoring was performed every 2 weeks for a minimum of 3 months. Additionally, viral prophylaxis was given after treatment with alemtuzumab or anti-thymocyte globulin for acute rejection, either until CD4>100 cells/mcl, or in the case of anti-thymocyte globulin, for 30 days. Standard perioperative antibacterial prophylaxis included cefazolin, or, if penicillin allergic, clindamycin +/− ciprofloxacin; this could be continued to up to 24 hours after surgery end time.

Data Extraction

Demographic, clinical, microbiological and outcome data were extracted manually from the medical charts. Data collected were managed using REDCap™ electronic data capture tool hosted at Duke[19]. Infection data collection included information about infectious syndromes, microbiological data (sample collection with culture type, serologies and polymerase chain reaction (PCR) and immunohistochemistry if applicable). Standard definitions and definitions per CDC/NSHN as described elsewhere were used[20,21]. Corticosteroid dose was calculated as the mean daily dose of prednisone equivalent in the seven days prior to infection. Functional status data were available for mobility and were classified as “independent”, “needs assistance” (e.g. cane, walker) or “dependent” for ambulation. Levels of calcineurin inhibitors were not collected due to their unreliability of being true troughs in a retrospective review. The standard approach is to maintain tacrolimus levels within 5–10 ng/ml during the first year, roughly 8–10 ng/ml in the first month, 6–8 ng/ml up to month 3 and lower thereafter, depending on the individual patients’ sensitization and infection history.

Statistical Analysis

Descriptive results are shown as total numbers/percentages, mean/standard deviations and medians/ interquartile range (IQR). Several analyses were performed, including the total number of infections. Several types of infections were measured: pneumonia, urinary tract infection (UTI), surgical site infection (SSI), intraabdominal infection (other than SSI), blood stream infection (BSI), infective endocarditis (IE), skin and soft tissue infection (SSTI), *Clostridium difficile* colitis, meningitis, osteomyelitis, prosthetic joint infection (PJI), hepatitis, sepsis, central line-associated bloodstream infection (CLABSI), candidemia, other (not listed previously), as well as cytomegalovirus (CMV) and BK polyomavirus (BKV) viremia and disease. Along with standard definitions of uncomplicated, complicated and catheter-associated UTI consistent with CDC/NHSN guidelines[20], asymptomatic bacteriuria was also included in the definition of UTI for the first year after kidney

transplantation. Concerning coagulase-negative *Staphylococcus* BSI, only cases not deemed to be contaminants were included in the analysis.

Analysis methods: The primary aim was to assess the predictors of infections within groups, and differences between groups. Patients were followed until death, or the one-year mark after transplant, whichever occurred first. Thus, the rates of infections controlled for the 'time on study'. Several versions of infections were assessed. First, the total number of all types of infections was analyzed by Poisson regression to incorporate differing time on study due to death. Second, the total number of unique types and the number of infections within types was analyzed by Poisson regression. Third, since infections often co-occur on the same date, we calculated the number of unique dates (episodes) when an infection occurred. These were analyzed by Proportional Hazards to assess the (1) risk of infection, (2) differences between age groups in that risk, and, (3) the change in risk of subsequent infection following an infection. In an exploratory analysis, a stepwise logistic regression model was employed to determine risk factors for infections and UTI. The candidate variables for the prediction model were: diabetes mellitus, cardiovascular disease (CVD), history of pre-transplant genitourinary conditions, prior transplant, donor age, deceased donation, extended criteria donor (ECD), donor after cardiac death (DCD), anti-thymocyte globulin induction and ureteral stent use. Those variables found to be significant ($p<0.05$) were carried to the final analysis. Statistical analysis was performed using SAS software, version 9.4. Copyright© SAS Institute Inc., Cary, NC, USA.

Results:

Baseline characteristics

Ninety-one kidney-only transplants were performed in adults aged ≥65 years at our institution between January 1, 2011 and December 31, 2015. Ninety-one younger KT controls aged 40–60 years were matched randomly to these older KT recipients. Baseline characteristics are shown in Table 1. Four older Asian KT recipients did not have controls matched for race. Diabetes mellitus and cardiovascular disease were significantly more frequent in the older adults. Regarding donor characteristics, there was a significant difference in age with a median of 46 years (range 2–69) for the older adults, versus 40 (range 3–65) for the younger adults, but no difference in sex, type of donation (deceased/living) or race. Older adults were more likely than younger adults to receive extended criteria donors, 22.7% (n=15) versus 3.3 (n=2), p=0.002, and organs classified as donation after cardiac death (DCD), 33.3% (n=22) versus 9.84% (n=6), p=0.002. There was no statistically significant difference in the kidney donor profile index (KDPI), a median of 66 (range 10–93) in older adults versus 51 (range 5–92) in the younger group, or the presence of positive donor urine or blood cultures.

CMV serostatus was defined as high risk (donor seropositive, recipient seronegative), intermediate risk (recipient seropositive) and low risk (donor and recipient seronegative) for CMV infection. There was no statistically significant difference between old and young KT recipients in high (18.7% vs 18/7%), intermediate (69.2% vs. 59.4%) and low (12.1% vs. 22.0%) CMV serostatus risk category. Table 2 outlines selected peritransplant

characteristics. Only length of stay was different between older adults (median 6 days) and younger adults (median 5 days).

Functional status: Mobility

Functional status assessed as independent for ambulation, dependent (needs cane or walker), or dependent was significantly better in the younger group than in older adults. In the pre-transplant setting, 75.8% of the older adults were independent for ambulation, 20.9% needed assistance and 1.1% were dependent, vs 95.5%, 5.5% and 0%, respectively in the younger group, p=0.005. At one-year after KT, 47.6% of the mobility of older adults remained independent, 23.8% needed assistance and 2.4% were dependent, vs 85.7%, 11.1% and 1.1% of the patients in the younger group; p<0.001. This information was missing at the one-year mark in 26% of the older group.

Infectious complications

The majority of the patients experienced an infectious complication in the first year after kidney transplantation; 92.3% (n=84) of the older adults and 90.1% (n=82) of the younger group, p=0.79 experienced an infectious complication. Per table 3, the most frequent infections were UTIs which were significantly more frequent in older adults. In those patients with a UTI, the mean number of UTIs in did not differ significantly, 2.11 (SD 1.0) in the older group vs 1.83 (SD 1.34) in the younger group, p=0.31. Pathogens isolated from available blood and urine cultures are shown in table 4.

As only 16 patients in both age groups had no infection, the model to predict risk, including diabetes mellitus, cardiovascular disease, history of pre-transplant genitourinary conditions, prior transplant, donor age, deceased donation, ECD donation, DCD donation, anti-thymocyte globulin induction and ureteral stent use as infection risks, was not reliable. There was no difference in the mean prednisone dose at the time of first infection (median 20mg (IQR 2–25mg) in the older group vs 20mg (IQR 5–28.93mg) in the younger group, p=0.576).

UTIs—UTIs were analyzed separately as UTIs were significantly more frequent in older adults compared to younger adults (52.4% vs 36.6%, p<0.05) even after exclusion of asymptomatic bacteriuria. Figure 1 shows the timing and type of UTIs after transplantation. Table 4 shows the most frequently isolated pathogens in the available urine cultures.

In an exploratory analysis, a stepwise regression logistic model was employed to evaluate additional factors associated with an increased risk for UTI. The same variables mentioned above were used in addition to recipients' gender. Three variables entered the final model: recipients' sex (female), genitourinary conditions and donor risk classification "donation after cardiac death" (DCD). The DCD classification was driven by the older group, whereas a history of pre-transplant genitourinary condition and sex were driven by the younger group. All three variables were significantly associated with an increased risk of UTI after KT.

CMV—CMV viremia was significantly more frequent in older compared with the younger group: 69 episodes in 51 patients vs 47 episodes in 34 patients, respectively. Figure 2 shows the timeline and type of CMV infections. Older patients had later CMV reactivation compared to the younger group. As shown in figure 2, most of these were episodes of viremia and only a few met definitions for CMV syndrome and tissue-invasive disease.

Hospital admission

There were a total of 116 hospital admissions among the older (65 admissions) and younger (51 admissions) groups in the first year after KT. The number one reason for hospital admission during the first year after KT in both groups were infectious complications (65.5%). Admissions for infections were significantly more frequent in older adults, 53.9% (n=49) vs 29.7% (n=27), p=0.0015. Other frequent reason for admissions were surgical complications (24.2% vs16.5%, p=0.27), and lab abnormalities (34.1% vs 20.9%, p=0.067). Only one older KT recipient (1.1%) was admitted for a cardiovascular event, vs 5 (5.5%) (p=0.21) younger patients.

Patient and graft survival, rejection

There was no significant difference in the number of rejections in older KT recipients compared to younger KT recipients: 7.7% (n=7) vs 14.3% (n=13) (p=0.24). There were three graft losses in each group (3.3%). Mortality was higher in older KT vs younger KT recipients, 9.9% (n=9) vs 1.1% (n=1), p=0.018. All but one death in the older group occurred with a functioning graft. The primary causes of death in older adults were malignancies (33.3%), followed by infections (22.2%); the only death in the control group was secondary to an infection.

Discussion:

In this study we describe differences in infectious complications during the first year after KT in older compared with younger adult KT recipients. In fact, infections were the *number one reason for hospital admission in the first year after surgery*, and as such were more frequent than admissions secondary to cardiovascular disease (CVD). Given the higher prevalence of CVD and diabetes mellitus in the older age group, this was an unexpected finding[22]. Notably, pneumonia, which is a common infection and cause of mortality in older adults[11], was not more frequent in older adults in the post-kidney transplant setting whereas UTIs and CMV viremia were. In addition, while there was not more rejection in the older recipients, there was significantly higher mortality, longer transplant hospitalizations and decrease in functional status during the first year post transplant.

The increased rate of UTIs in older KT recipients mirrors results of those reported in a case-control study in the literature assessing infection in younger and older KT recipients[9]. With advancing age, we expect functional and dynamic outflow changes that predispose to UTIs, and a higher frequency of bacteria in the urine[11]. Given this increased vulnerability of older adults to UTIs and given the effect of immunosuppression is typically highest during the first year after KT, the high incidence of UTIs in the older KT population is not unexpected[9]. We found that UTIs most commonly occurred more than one-month post-transplant in both

groups but more so in older adults. The most frequent pathogens were enteric organisms, specifically, gram negatives among which *Klebsiella* spp. were the most common, closely followed by *Enterococus* spp. The predominance of enteric pathogens would support a local source for the infection with pathophysiology linked to low flow state or other permissive urodynamic changes.

Traditional risk factors for UTI in KT recipients include female sex, prolonged use of indwelling urinary catheter, ureteral stent use, age and delayed graft function[23–26]. We found that history of genitourinary conditions and female sex were risk factors for UTIs in younger KT recipients whereas DCD donor status was predictive of UTI in older KT recipients. Renal stents had already been removed by the one month post-transplant and were not found to be a risk for UTIs in our study. While prolonged ischemia-reperfusion injury or delayed graft function might predispose to low flow states, neither of these factors were more common in our older adult population. How DCD may influence risk for UTI in the absence of delayed graft function requires further study. DCD has been related to increased rejection rates and mortality in older recipients[27] but not infectious complications specifically.

Use of antibiotics may have impacted the timeline of UTIs post-transplant. Asymptomatic bacteriuria is generally treated during the first three months after KT in this population[23,28] which potentially impacted timing of UTIs. Interestingly, the UTIs occurred despite trimethoprim-sulfamethoxazole used for PJP prophylaxis, although this could certainly affect the incidence and potentially shift the prevalence of certain pathogens.

CMV was not only the most common infectious complication in adults[29] after KT but also significantly more frequent in older recipients. Consistent with current guidelines[30], pre-emptive monitoring is performed in intermediate risk seropositive recipients at our institution. Thus, CMV reactivation/asymptomatic viremia during months 2–6 post-transplant is not unexpected. However, the overall percentage of patients with CMV viremia (47.8%) is higher than anticipated in most seropositive recipients (15–25%), and even higher for older KT recipients (60.7%). Further analysis is needed to understand if these were self-limited episodes, required treatment and what their clinical impact was. Historically, risk factors for CMV have included age, positive donor serostatus, T-cell depleting induction, rejection and other co-infections[31,32]. Although the increased incidence of CMV reactivation could be interpreted as a marker of over-immunosuppression, we would have expected a difference in episodes of BKV viremia and rejections, but these were not found. Given the importance of CMV, both through direct as well as indirect effects[33] on the graft, we believe further research into its clinical impact on older recipient is needed. Furthermore, CMV has been linked to the process of “inflammaging[34]“. The concept of inflammaging relates to a continuous pro-inflammatory state that is involved in immunesenescence. The role of CMV in the maintenance of this pro-inflammatory state has been a topic of controversy[35–37] and is beyond the scope of this article. That said, current prophylactic guidelines don’t take into account age or immunesenescence when defining CMV risk. This is an area where immune profiling could help decide who is at highest risk of reactivation.

There were no differences in rejections and graft-losses between groups, which might be a result of the older recipients in this series receiving kidneys from older donors. Although

there's still controversy about incidence of rejection in aged recipients, it is generally thought that acute rejections are less frequent[38–41] secondary to changes in the humoral and cellular immune system. As expected, our older group had an increased mortality[42] at the one year-mark but the majority of older recipients that died, did so with a functioning graft. Although not the main cause of death, infections were important in both groups, with malignancies constituting the number one cause of death in older adults. Age and immunosuppression increases the risk for malignancy[43–45]. Considering these issues as a whole, older adults may indeed require less immunosuppression compared with younger KT recipients.

Our data on functional was limited to mobility, and unfortunately there was some missing data, especially at the one-year mark for older KT recipients. However, we found a significant difference in functional status between older and younger KT recipients at baseline, that is, before surgery. This finding raises two important questions: 1. "Would the improvement of functional status in the pre-transplant setting decrease infectious complications?"; and 2. "If we are able to decrease the number of infections, could we improve functional status and survival?". Functional status, including mobility, has been studied in KT recipients[46–48]. Even patients with low function seem to have a survival benefit over dialysis[49] but its impact on non-traditional outcomes needs to be examined in prospective studies[46,50]. Finally, it might be prudent to address the patients "biological" rather than "chronological" age[51] upon pre-transplant assessment in order to carefully select the most appropriate candidates for KT. Biological aging denotes the heterogeneity of different biomarkers, genomic predictors, epigenetic clocks and biological processes in individuals. While biological aging is seen in many chronic diseases, we have little understanding on how it could be utilized as a true biomarker[52].

This study has several limitations. First, it is a single-center retrospective study, which limits the generalizability of our findings to other populations with different antimicrobial strategies or resources. Second, the sample size is too small for accurate modeling due to the high prevalence and incidence of infections and therefore, as mentioned above, some of the analyses were underpowered. However, the study presents new data on different infection dynamics between older and younger KT recipients and ultimately addresses a knowledge gap regarding infectious complications in this growing subpopulation of older KT recipients.

In conclusion, adult KT recipients have a high incidence of infectious complications during the first year. Infections were the most frequent reason for hospital admission and older KT recipients were at higher risk than younger KT recipients for this event. Older recipients have a very high incidence of UTIs and CMV reactivations. Older adults also have more late onset UTIs when compared to the younger group. Risk factor for UTIs in older recipients was the receipt of a DCD graft, whilst in the younger group a history of pre-transplant genitourinary condition and sex played a significant role. CMV reactivation is significantly more frequent in the older group, with the majority being delayed onset. Further analysis is needed to elucidate the risk factors, impact and patterns of CMV reactivation in this subpopulation, and clarify if a different antimicrobial prophylactic and/or immunosuppressive approach is needed.

Future projects should include prospective multicenter studies to evaluate post-transplant complications in renal transplant populations aged 65 years and greater. It is likely that risks for infections in the new era of contemporary immunosuppression[14] and antimicrobial prophylaxis need to be revised. Immune profiling could help understand who is at highest risk of certain infections. Immunosuppression regimens might need adjustment for this growing population of KT recipients. Additionally, the absence of standardized measurements regarding non-classic transplant outcomes that older adults rate as critically important (e.g. quality of life, independence) is a major gap and opportunity for research in this population.

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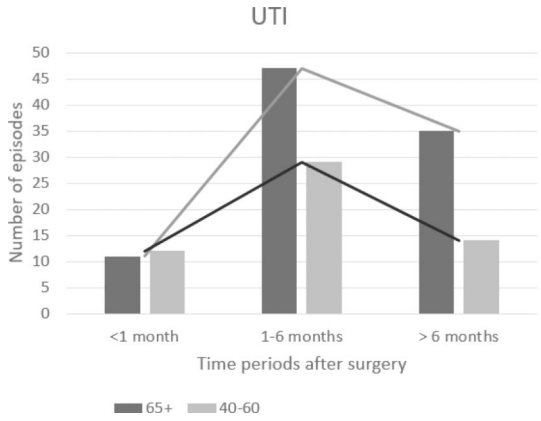
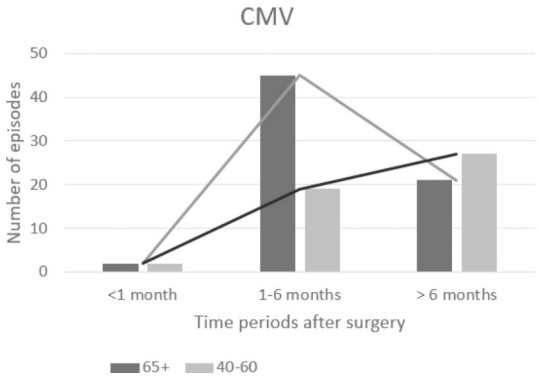


Type of UTI	65+ n=92 n (%)	40-60 years n=55 n (%)
Uncomplicated	39 (42.4)	17 (30.9)
Complicated / pyelonephritis	22 (23.9)	12 (21.8)
Asymptomatic bacteriuria	17 (18.5)	17 (30.9)
Catheter-associated	12 (13.0)	4 (7.3)
Unknown	2 (2.2)	5 (9.1)

Figure 1.
Timeline and types of urinary tract infections (UTIs).



CMV infection	65+ n=69 n (%)	40-60 years n=49 n (%)
Viremia	62 (89.9)	47 (95.9)
Syndrome	4 (5.8)	1 (2.0)
Tissue-invasive disease	0 (0)	1 (2.0)
Unknown	3 (4.3)	0 (0)

Figure 2.

Timeline and total number of CMV episodes in the first year after KT. 56% of older KT recipients and 37.4% of the younger group had at least one episode of CMV viremia.

Table 1.

Baseline characteristics of older and younger KT recipients.

	Older adults (65+) n=91	Younger adults (40–60 years of age) n=91	p value
Age, median [range]	68 [65, 75]	49 [40, 60]	N/A
Male n(%)	55 (60.4)	55 (60.4)	N/A
Race n(%)			N/A
African-American	29 (31.9)	29 (31.9)	
Caucasian	56 (61.5)	60 (65.9)	
Asian	6 (6.6)	2 (2.2)	
Prior dialysis n(%)	70 (77)	72 (79)	0.86
Comorbidities n(%)	91 (100)	91 (100)	1
Diabetes mellitus	43 (47.3)	16 (17.6)	<0.001
Hypertension	85 (93.4)	78 (85.7)	0.15
CV disease	45 (49.5)	16 (17.6)	<0.001
GU conditions	14(15.4)	6 (6.6)	0.10
Recurrent UTIs	1 (1.1)	4 (4.4)	0.36
Prior abdominal surgery	45 (49.5)	42 (46.15)	0.77
Prior transplant	8 (8.8)	18 (19.8)	0.06
Prior KT	4 (50)	15 (83.3)	0.08
Data on immunization n(%)	56 (61.5)	69 (75.8)	0.05

N/A: not applicable. CV: cardiovascular. UTI: urinary tract infection. GU: genitourinary. KT: kidney transplant. NS: not significant.

Table 2.

Other peritransplant characteristics.

	Older adults (65+) n=91	Younger adults (40–60 years of age) n=91	p value
Time from dialysis to transplant in days, median (range)	1308 [38, 4971]	1372 [14, 7037]	0.83
Time on the waiting list in days, median [range]	589 [0,2336]	467 [0,4598]	0.83
Ischemia & surgical times in minutes, median [range]			
Cold	996 [10,2505]	858 [32,2197]	0.30
Warm	28 [5,63]	34 [18,60]	0.06
Surgery	234 [132, 628]	236 [148, 439]	0.95
PRA (%), median [range]	0 [0,99]	0 [0,100]	NS
Induction regimen, n(%)			
Basiliximab	44 (48.4)	45 (49.5)	0.88
ATG	27 (29.7)	31 (34.1)	0.53
None[†]	18 (19.8)	15 (16.5)	0.56
Ureteral stent used, n(%)	71 (78.0)	69 (75.8)	0.86
Maintenance immunosuppression, n(%)			
Prednisone	89 (97.8)	88 (96.7)	0.61
MMF	88 (96.7)	88 (96.7)	1
Tacrolimus	90 (98.9)	88 (96.7)	0.62
Sirolimus	0 (0.0)	1 (1.1)	*NS*
Everolimus	2 (2.2)	0 (0.0)	*NS*
Belatacept	0 (0.0)	1 (1.1)	*NS*
Total length of mechanical ventilation in days, median (IQR)[≠]	0(0,0)	0(0,0)	*NS*
Any versus none n (%)	10 (11.0)	7(7.69)	0.62
Transfusions (PRBCs) during transplant surgery, n(%)	7 (7.69)	9 (9.89)	0.79
Length of hospital stay (days), median (IQR)	6 (5,9)	5 (4,8)	0.04
Delayed graft function, n(%)	24 (26.4)	15 (16.7)	0.15
Days on dialysis after transplant, median (IQR)	9 (5, 16)	7 (1, 11)	0.26
Discharge location			
Home	87(95.6)	91(100.00)	*NS*
Nursing Home	1(1.10)	0.0(0.00)	
Hospice	1(1.10)	0.0(0.00)	
Death during transplant admission	2(2.20)	0.0(0.00)	

PRA: panel reactive antibodies. ATG: Anti-thymocyte globulin. MMF: mycophenolate mofetil. PRBCs: packed red blood cells NS: not significant.

[†]No induction immunosuppression would still involve methylprednisolone as per protocol.

[≠]Total days of mechanical ventilation during transplant admission.

Table 3.

Infectious complications in the first year after KT at a patient level.

	Older adults (65+) n=84 n (%)	Younger adults (40–60 years of age) n=82 n (%)	p value
UTI	44 (52.4)	30 (36.6)	0.049
Pneumonia	9 (10.7)	7 (8.5)	0.79
Surgical site infections	11 (13.1)	17 (20.7)	0.30
BSI †	17 (20.2)	10 (12.2)	0.28
Sepsis	8 (9.5)	5 (6.1)	0.57
SSTI	4 (4.7)	9 (11.0)	0.25
C. difficile colitis	7 (8.3)	6 (7.3)	1
CMV viremia	51 (60.7)	34 (41.5)	0.0131
BK viremia	28 (33.3)	23 (28.0)	0.51
BKV nephropathy	1 (3.6)	2 (8.7)	

84/91 (92.3%) of the older adults had an infection, versus 82/81 (90.1%) of the younger group. UTI: urinary tract infection; BSI: bloodstream infections; SSTI: skin and soft tissue infection; *C. difficile*: Clostridium difficile. CMV: cytomegalovirus; BK: BK polyomavirus.

†The bloodstream infections were all bacteremias; there were no catheter-associated BSIs. There were no episodes of infective endocarditis (IE) or prosthetic joint infection (PJI). NS: not significant.

Table 4.

Most frequent pathogens isolated from urine and blood cultures in older and younger adults in the first year after KT.

Pathogens	Older adults (65+) n (%)	Younger adults (40–60 years of age) n (%)
Blood cultures	n=23 †	n=12
Gram negatives		
Klebsiella spp	8 (34.8)	2 (11.1)
E. coli	5 (21.7)	4 (22.2)
Serratia spp	1 (4.3)	2 (11.1)
Pseudomonas spp	3 (13.0)	0 (0)
Citrobacter spp	1 (4.3)	0 (0)
Gram positives		
Enterococcus	2 (8.7)	2 (11.1)
CoNS	5 (21.7)	1 (5.5)
Other		
Candida	0 (0)	1 (5.5)
M. abscessus	1 (4.3)	0 (0)
Urine cultures	n=79	n=50
Gram negatives		
Klebsiella spp	25 (31.6)	22 (44.0)
E. coli	14 (17.7)	6 (12.0)
Enterobacter spp	11 (13.9)	3 (6.0)
Pseudomonas spp	9 (11.4)	0 (0)
Serratia spp	1 (1.3)	2 (4.0)
Citrobacter spp	3 (3.8)	2 (4.0)
Proteus spp	0 (0)	1 (2.0)
Morganella morganii	2 (2.5)	0 (0)
Gram positives		
Enterococcus spp	10 (12.7)	10 (20)
Streptococcus spp	3 (3.8)	0 (0)
Other		
Yeast	2 (2.5)	3 (6.0)

† Three bacteremias in the older group were polymicrobial. CoNS: coagulase-negative staphylococci.