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Simulation Modeling of the Impact of Proposed New Simultaneous Liver and Kidney Transplantation Policies

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1. Yaojen Chang: Participated in construction and validation of simulation model, estimates of input parameters, interpretation of results, the writing of the paper
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4. Yuchia Chang: Participated in data analysis
5. Colleen Jay: Participated in research design
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Abstract

Background—Increasing use of kidney grafts for simultaneous liver and kidney (SLK) transplants is causing concern about the most effective utilization of scarce kidney graft resources. This study evaluated the impact of implementing the proposed United Network for Organ Sharing (UNOS) SLK transplant policy on outcomes for end-stage liver disease (ESLD) and end-stage renal disease (ESRD) patients awaiting transplant.

Methods—A Markov model was constructed to simulate a hypothetical cohort of ESLD patients over a 30-year time horizon starting from age 50. The model applies the different criteria being considered in the UNOS policy and tallies outcomes, including numbers of procedures and life years after liver transplant alone (LTA) or SLK transplant.

Results—When1-week pre-transplant dialysis duration is required, the numbers of SLK transplants and LTAs would be 648 and 9,065, respectively. If the pre-transplant dialysis duration is extended to 12 weeks, there would be 240 SLK transplants and 9,426 LTAs. These change results in a decrease of 6,483 life years among SLK transplant recipients and an increase of 4,971 life years among LTA recipients. However, by increasing the dialysis duration to 12 weeks from 1 week, 408 kidney grafts would be released to the kidney waitlist due to the decline in SLK transplants; this yields 796 additional life years gained among ESRD patients.

Conclusion—Implementation of the proposed SLK transplant policy could restore access to kidney transplants for patients with ESRD albeit at the detriment of patients with ESLD and renal impairment.

Keywords

Simultaneous Liver and Kidney Transplantation; microsimulation; dialysis duration; end-stage liver disease

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Introduction

Implementation of the Model for End-Stage Liver Disease (MELD) allocation system in the United States has prioritized transplantation in end-stage liver disease (ESLD) patients with renal impairment [1-2]. Survival after liver transplant alone (LTA) in individuals with renal impairment is poor [3-4]. Consequently, simultaneous liver and kidney (SLK) transplant, which affords improved survival compared to LTA in patients with irreversible renal impairment, has steadily increased [5-8]. However, there is great variation amongst transplant centers regarding the indications for SLK transplant.

United Network for Organ Sharing (UNOS) policy does not include listing requirements for SLK transplant candidates, but development of policy is currently underway [9]. Policy development has garnered much attention recently due both to a decline in post-SLK transplant survival over time and the deleterious effect of lengthening the kidney transplant queue with increasing SLK utilization [1]. Under the proposed policy, many individuals currently receiving SLK transplants would not be eligible. Briefly, the criteria recommend SLK listing for ESLD patients with: (1) chronic kidney disease stage 4/5; (2) acute renal failure with glomerular filtration rate (GFR) ≤25 mL/min/1.73 m^2 for ≥6 weeks, and (3) metabolic disease such as hyperoxaluria [9]. Consequently, implementation of the proposed UNOS SLK policy might reduce the number of SLK transplants performed rendering more kidney grafts available to patients on the kidney wait list. Arguably, such a policy would have profound implications on patients with either cirrhosis or end-stage renal disease (ESRD) or both.

Simulation modeling has been widely employed to address different types of transplantation research questions, including graft allocation process, use of extended criteria donor graft vs. standard criteria donor graft, comparison of different transplant strategies, etc. [10-15]. However, simulation modeling has not been used to assess implementation of the proposed SLK transplant policy. Therefore, the objective of this study was to utilize simulation modeling to project the impact of implementing the proposed SLK policy on the net benefit/loss of life years for both ESLD and ESRD patients on their respective waitlists and to inform policy debates about how to best allocate limited number of kidney grafts.

Results

Incremental Gain/Loss in Life Years

Of 1,000,000 trials in the base case model, 935,059 LTAs and 32,580 SLK transplants (including 70,655 re-LTAs and 479 re-SLK transplants) were performed over the 30-year simulation period under the proposed SLK listing requirements. The proportion of the number of SLK transplants to the number of LTA was 3.49%. As the required pre-transplant dialysis duration increased from 1 week to 12 weeks for SLK transplant, the proportion of the number of SLK transplants to the number of LTA declined from 7.15% at 1-week to 2.54% at 12-weeks.

The total numbers of life years of ESLD patients on the waitlist undergoing LTA or SLK transplant from the one million trials over the 30-year simulation period in the base case were 16,831,550 and 525,579, respectively. Given that the range of actual annual number of LTA transplants in the OPTN/SRTR data from 1998 to 2007 was 9,538 - 11,126 per year, we calculated the number of life years gained/lost per 10,000 trials for LTA and SLK transplant. When the 1-week pre-transplant dialysis duration served as the baseline strategy and the 2-, 3-, 4-, 6-, and 12-week pre-transplant dialysis duration served as the comparator strategies, the incremental life years lost per 10,000 trials for SLK recipients was -2,623, -3,954, -4,278, -5,053, and -6,482, respectively. The incremental life years per 10,000 trials gained for LTA recipients was 2,823, 3,719, 3,686, 4,188, and 4,971, respectively. The total incremental life years gained/lost for LTA recipients and SLK transplant recipients due to implementation of stricter SLK listing requirements were 200, -236, -591, -865, and -1,512, respectively.

Meanwhile, the incremental number of kidney grafts released due to decrease in number of SLK transplant was 171, 255, 275, 322, and 408, respectively. Based on the OPTN/SRTR Data as of May 1, 2008, the difference in the remaining life expectancy between kidney transplant recipients and candidates on a waitlist ages 50-64 calculated by the Declining Exponential Approximation of Life Expectancy method (DEALE) was 1.95 years. Therefore, the incremental number of life years gained due to an increase in the number of kidney grafts to ESRD patients on the kidney waitlist was 333, 497, 537, 628, and 796, respectively. From this, the net benefit/loss of life years at 2-, 3-, 4-, 6-, and 12-week pre-transplant dialysis duration was 534, 262, -55, -237, and -715 life years, respectively (in Table 2).

Sensitivity Analysis

Given the fact that dialysis might occur prior to transplant registration, we varied the pre-registry dialysis duration in the sensitivity analysis to assess impact of increase in pre-transplant dialysis duration on the model outcomes. The sensitivity analysis showed that the number of SLK transplants per 10,000 trials in the base case model has consistently increased from 326 to 456, as the pre-registry dialysis duration increased from 0 week to 12 weeks. In comparison with the 0-week pre-registry dialysis duration, additional number of kidney grafts consumed by SLK transplant increased from 46 at the 2-week pre-registry dialysis duration to 130 at the 12-week pre-registry dialysis duration. Concurrently, the proportion of the number of SLK transplants to the number of LTA increased from 3.49% to 4.93%. The incremental increase in the proportion of SLK transplant to LTA was 0.50%, 0.71%, 0.20% and 0.03%, as the pre-registry dialysis duration was serially extended from 0 to 2, 4, 6, and 12 weeks, respectively.

Model Validation

To validate the model outcomes, the projected survival rates in the base case model were compared observed survival rates in the OPTN/SRTR annual report and published literature targeting ESLD patients with renal impairment. For example, the projected 3-, 12-, 60-, and 120-month survival rates of LTA recipients with MELD score 21-30 and >30 in the model outcomes were 93.60% - 90.69%, 88.14% - 83.73%, 70.81% - 66.35%, and 55.18% - 49.71%, respectively. As compared to the observed corresponding survival rates in the OPTN/SRTR 2008 annual report (93.30% - 89.30%, 86.40% - 79.30%, 71.50% -68.00%, and 58.04% - 55.20%) [16], the differences in survival rates between the model outcomes and the observed data over the 10-year period were approximately ± 5%. The projected 12-, 24-, 36-month survival rates of SLK transplant recipients in the MELD score 21-30 and >30 categories from the model were 84.40% - 82.76%, 79.70% - 77.45%, and 75.24% - 72.08%, respectively, which was very close to the observed SLK survival rates (83.6%, 79%, and 74.8%) in the Gonwa' s study [3]. Thus, the model accurately projected the trend of survival rates for LTA recipients and SLK transplant recipients.

Discussion

This is the first study to use simulation modeling to assess the impact of implementing the proposed UNOS SLK transplant policy on both of ESLD patients with renal impairment and ESRD patients on each respective waitlist in the US. Overall, implementation of the proposed SLK transplant policy will lower number of SLK transplants and release kidney grafts to ESRD patients on kidney waitlist in the US. However, net loss of life years will occur when strict SLK transplant listing requirements are implemented. Finally, the pre-registry dialysis duration has a modest impact on increase in number of SLK transplants.

The model output showed that maximum net benefit of life years and net loss of life years occurred when the required pre-transplant dialysis duration was extended from 1 week to 2 weeks and ≥ 4 weeks, respectively. These findings were based upon survival advantage of kidney transplant recipients over candidates on waitlist calculated from the 2008 OPTN/SRTR annual report [16]. Therefore, whether implementation of strict SLK transplant listing requirements increased the net benefit in life years or not was contingent upon the difference between the incremental life years gained per KTA among kidney transplant recipients and the incremental life years lost among LTA recipients without renal recovery per kidney graft released due to LTA.

The pre-registry dialysis duration was not included in the UNOS/OPTN or SRTR dataset. As such, zero pre-registry dialysis duration was considered in the base case model. In the sensitivity analysis, we tested various durations of pre-registry dialysis and found that the pre-registry dialysis duration had modest effect on increase in number of SLK transplant. The peak in incremental increase in the proportion of SLK transplant to LTA occurred when the pre-registry dialysis duration was 4 weeks.

Transplant research is complex and involves many ethical and other challenges to conducting large population-based clinical trials to determine net outcomes. Accordingly, decision analysis and simulation modeling have been used to synthesize the best available data to inform clinical policy [17-18]. For example, investigators have used registration data to examine decline in renal function after liver transplant, and these risk prediction results have been validated and informed use of SLK transplant [19-22]. A recent decision analysis by Kiberd and colleagues [13] suggested that when both ESLD patients and ESRD patients are considered together, SLK transplantation does not maximize the total quality adjusted life years. Our study confirms that conclusion and extends Kiberd's results to identify the pre-transplant dialysis duration threshold that provides the best balance of the net benefit/loss of life years for both ESLD and ESRD patients, thereby providing new data that can be used by decision makers when developing policies for equitable and effective allocation of scarce kidney grafts.

An increase in SLK transplant as an unintended consequence of MELD-based liver allocation policy in the US has generated two competing patient populations (ESLD with renal impairment versus ESRD) for rare deceased donor kidney grafts. In Europe, the MELD allocation system, which was introduced in 2006, has led to a similar dilemma [23]. However, according to the Eurotransplant manual [24], SLK transplant has been excluded from the Approved Combined Organ policy, such that kidney grafts are not allocated preferentially with liver grafts according to medical urgency. Given that the MELD score does not adequately characterize the mortality associated with ESLD in the setting of chronic kidney disease, region-specific variances in allocation policy have been implemented. For instance, MELD exception points are granted to patients with polycystic liver and kidney disease in Germany when specific criteria are met (e.g., creatinine clearance ≤20-30 ml/min in combination with ascites or variceal bleeding). As such, SLK transplant still claims the largest proportion of combined organ transplants performed in Europe. Thus, how to allocate rare deceased kidney grafts remains a challenge to the worldwide transplant community.

This study has robust results, but the results should be considered in the context of several limitations. First, our study only considered use of standard criteria donor kidney grafts. This may limit the generalizability of our results. Second, our study did not consider quality of life in calculation of the differences in life years between kidney transplant recipients and candidates on the kidney waitlist. Net benefit from implementation of the proposed SLK transplant policy might be underestimated. Finally, the waiting time from addition to the waitlist to completion of transplant for each MELD quintile in this study was based on the median values in the U.S. national transplant registry. Given the need to match two organs, waiting list time could be longer for SLK transplant. This might result in overestimated number of SLK transplants in the model.

Conclusion

An unintended consequence of the implementation of MELD-based liver transplant allocation has been a dramatic increase in SLK transplant in the US. The current UNOS SLK transplant listing requirements may restore access to kidney transplant for patients with ESRD to the detriment of patients with ESLD and renal impairment. The proposed SLK policy underscore the dichotomy of life years lost for ESLD patients on the liver waitlist and life years gained for ESRD patients on the kidney waitlist.

Materials and Methods

Markov models have the ability to simulate all events of interest in a finite set of mutually exclusive health states and transitions between those states [18]. This type of model was utilized in this study to simulate ongoing risk (e.g., renal impairment) over time and repeat occurrence of an uncertain event (e.g., initiation or discontinuation of renal replacement therapy).

Model Overview

In this study, we constructed a discrete time state transition Markov model depicted in Figure 1 to simulate a hypothetical cohort of ESLD patients 50 years of age on a waitlist to undergo either LTA or SLK transplant, according to the proposed UNOS SLK policy. At the beginning of the simulation, transplant candidates were categorized into 10 health states based on the MELD score quintiles (6-10, 11-14, 15-20, 21-30, or >30) and dialysis status (yes or no). In addition, 5 interim dialysis states corresponding to each MELD score quintile were created to accommodate candidates who were transitioning among the dialysis states (yes or interim or no) to calculate an intermittent dialysis duration over the simulation period. When dialysis was suspended for greater than 3 weeks, the previous dialysis duration was changed to zero and the candidate entered the no dialysis state. In contrast, if the candidate returned to dialysis within 3 weeks, the previous dialysis duration was considered in the calculation of total dialysis duration. To accurately emulate the clinical situation, the model considers both the transition between MELD quintiles and changes in dialysis status. The eligible SLK transplant candidates in the base case model have received dialysis for 6 weeks prior to transplant. In the base case model, the LTA recipients who did not recover native renal function and SLK transplant recipients with neither kidney graft function nor native renal recovery by 3 months post-transplant were then placed on the kidney transplant waiting list. Chronic liver and/or kidney failure could occur post-transplant in either the LTA or SLK strategy. Liver and/or kidney re-transplant for acute and chronic graft failure were also considered in the model, despite the low likelihood of occurrence due to waitlist mortality, complication, etc. Tracker variables were used to record continuous or intermittent dialysis duration, waiting time, transplant counts (LTA, SLK, and kidney transplant alone (KTA)), waitlist mortality, duration of each GFR level in each MELD score quintile, number of LTA recipients who qualified for SLK transplant, and rate of renal function recovery. The Markov cycle length was 7 days, and a 30 year time horizon was selected as the simulation period. The model was constructed by using TreeAge Pro 2009 (TREEAGE Software Inc., Williamstown, MA, USA).

Simulation Method

Microsimulations were conducted to generate 1,000,000 trials for each scenario. A large number of microsimulations were conducted to ensure the stability of the results. The results of 1,000,000 trials in the model output were used to calculate survival rates for LTA or SLK transplant recipients. The number of life years within the waiting and post-transplant periods for LTA or SLK transplant recipients was calculated from the sum of survival period of each LTA or SLK transplant recipient over the 30-year simulation period. In calculation of incremental gain/loss in life years, numbers of LTA/SLK transplants per 10,000 trials were adopted, in accordance with actual annual number of liver transplants. The model outcomes were analyzed using STATA 11 (StataCorp LP, College Station, TX, USA).

Assumptions

The following assumptions were incorporated into the model due to limitations of the available data to derive transition probabilities. First, in the base case model, the same transplant probability was applied to both LTA and SLK transplant and varied according to

MELD score quintile. Second, while duration of GFR ≤25 ml/min and proteinuria >3gms/day were among the criteria used in the proposed UNOS SLK transplant policy, survival rates of LTA recipients according to pre-transplant GFR or proteinuria levels were not available. Thus, we assumed survival of LTA recipients with a pre-transplant GFR ≤25 ml/min was identical to recipients with a pre-transplant serum creatinine (Cr) >2.0 mg/dL. For LTA recipients with a pre-transplant GFR >30 ml/min, post-transplant survival was assumed to be same as the unadjusted survival of LTA recipients in the Organ Procurement and Transplantation Network (OPTN)/Scientific Registry of Transplant Recipients (SRTR) annual report [16].

Validation

Validity of the model output was examined by comparison with data from the OPTN registry and published literature.

Data sources

The values and ranges of parameters in the model were obtained from (1) UNOS/OPTN data, (2) SRTR data, (3) United States Renal Data System (USRDS) data, (4) Northwestern University Enterprise Data Warehouse (EDW), and (5) published literature. Based on UNOS/OPTN data as of February 15, 2008, we estimated the initial dialysis prevalence rate, dialysis incidence rate, dialysis cessation rate, and dialysis recurrence rate for each MELD score quintile. For instance, the probability of dialysis cessation was determined from examination of the OPTN/UNOS data for the following dialysis histories: (1) candidates undergoing dialysis at registry and then stopping dialysis while on the waitlist, and (2) no dialysis at registration, but initiation of dialysis while on the waitlist with subsequent cessation of dialysis prior to transplant. GFR was estimated using the abbreviated MDRD formula: 186 ×[serum creatinine(mg/dL)]−1.154× [age] −0.203× [0.742 if patient is female] × [1.21 if patient is African-American] from the OPTN/UNOS and USRDS data [9]. The level of proteinuria and corresponding GFR values were estimated from the Northwestern University Enterprise Data Warehouse. Table 1 depicts the values and ranges of the parameter estimates used in the model.

Sensitivity analysis

Several studies have demonstrated that pre-transplant dialysis duration was the most critical parameter in predicting post-LTA native renal recovery [3-4, 25-26]. In our study, various durations of pre-transplant dialysis were used to select SLK transplant candidates.

In addition, pre-transplant dialysis duration was not accurately captured by either the UNOS/OPTN or SRTR datasets [16]. Calculation of dialysis duration in the base case model started on the transplant registration date, which might underestimate the true dialysis duration. Thus, the different pre-registration dialysis durations of 0 week, 2 weeks, 4 weeks, 6 weeks and 12 weeks were examined in the sensitivity analysis.

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Abbreviation

Cr	creatinine
ESLD	end-stage liver disease
ESRD	end-stage renal disease

GFR	glomerular filtration rate KTA, kidney transplant alone
LTA	liver transplant alone
MELD	Model for End-Stage Liver Disease
OPTN	Organ Procurement and Transplantation Network
SLK	simultaneous liver and kidney
SRTR	Scientific Registry of Transplant Recipients
UNOS	United Network for Organ Sharing
USRDS	United States Renal Data System

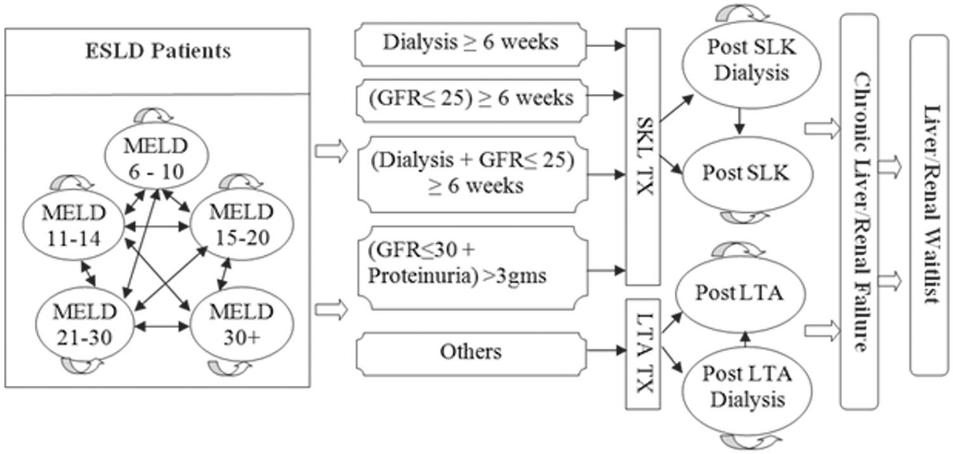
ESLD Patients
MELD 6 - 10
MELD 11-14
MELD 15-20
MELD 21-30
MELD 30+
Dialysis ≥ 6 weeks
(GFR≤ 25) ≥ 6 weeks
(Dialysis + GFR≤ 25) ≥ 6 weeks
(GFR≤30 + Proteinuria) >3gms
Others
SKL TX
LTA TX
Post SLK Dialysis
Post SLK
Post LTA
Post LTA Dialysis
Chronic Liver/Renal Failure
Liver/Renal Waitlist

Figure 1.

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Table 1

The values and ranges of the parameter estimates used in the model

Parameter Names	Base case	Range	Sources
Percentage of liver transplant candidates in MELD quintile			16
MELD ≤ 10	43.1%		
10 < MELD < 15	32.6%		
15 ≤ MELD ≤ 20	20.0%		
20 < MELD ≤ 30	3.6%		
30 < MELD	0.5%		
Time to liver transplant (days)			16
MELD ≤ 10	589.3[1]		
10 < MELD < 15	523.8[1]		
15 ≤ MELD ≤ 20	303.4	261.8 – 329.3[2]	
20 < MELD ≤ 30	56	47.2 – 65[2]	
30 < MELD	16.6	13.2 – 21.4[2]	
Time to kidney transplant (days)	1,326		16
Annual Liver Waitlist Death Rates Per 1,000 Patient-Years			16
MELD ≤ 10	33.7		
10 < MELD < 15	62.9		
15 ≤ MELD ≤ 20	141.6		
20 < MELD ≤ 30	707.4		
30 < MELD	4,654		

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Parameter Names	Base case	Range	Sources
Annual Kidney Waitlist Death Rates Per 1,000 Patient-Years	87.1		16
Annual Dialysis Death Rates Per 1,000 Patient-Years	133		27
Prevalence of dialysis at registry			UNOS/OPTN data[3]
MELD ≤ 10	0.1%		
10 < MELD < 15	0.1%		
15 ≤ MELD ≤ 20	0.6%		
20 < MELD ≤ 30	4.6%		
30 < MELD	9.5%		
Probability of starting dialysis on waitlist			UNOS/OPTN data[3]
MELD ≤ 10	0.4%		
10 < MELD < 15	0.8%		
15 ≤ MELD ≤ 20	1.8%		
20 < MELD ≤ 30	3.8%		
30 < MELD	9.5%		
Probability of dialysiscessation on waitlist			UNOS/OPTN data[3]
MELD ≤ 10	0.2%		
10 < MELD < 15	0.2%		
15 ≤ MELD ≤ 20	0.5%		
20 < MELD ≤ 30	3.4%		
30 < MELD	9.6%		

Parameter Names	Base case	Range	Sources
Probability of dialysis recurrence on waitlist			UNOS/OPTN data[3]
MELD ≤ 10	0.0%		
10 < MELD < 15	0.0%		
15 ≤ MELD ≤ 20	0.1%		
20 < MELD ≤ 30	0.7%		
30 < MELD	1.5%		
Probability of liver transplant operative mortality	3%		28-30
Probability of kidney transplant operative mortality	1.3%		31
Probability of SLK transplant operative mortality	4.3%		28-31
Probability of Proteinuria <= 3gm & GFR <= 25 in MELD > 30	90.9%		NMH[4]
Probability of Proteinuria <= 3gm & GFR <= 25 in 20 < MELD ≤ 30	77.8%		NMH[4]
Probability of dialysis and GFR > 30 in MELD > 30	36.6%		NMH[4]
Probability of dialysis and GFR > 30 in 20 < MELD ≤ 30	14.3%		NMH[4]
Probability of dialysis and GFR ≤ 25 in MELD > 30	76.9%		NMH[4]
Probability of dialysis and GFR ≤ 25 in 20 < MELD ≤ 30	100%		NMH[4]
Probability of no dialysis and GFR > 30 in MELD > 30	41.7%		NMH[4]
Probability of no dialysis and GFR > 30 in 20 < MELD ≤ 30	90.7%		NMH[4]
Probability of no dialysis and GFR > 30 in 15 ≤ MELD ≤ 20	100%		NMH[4]
Probability of no dialysis and GFR > 30 in 10 < MELD < 15	100%		NMH[4]
Probability of no dialysis and GFR > 30 in MELD ≤ 10	100%		NMH[4]

Parameter Names	Base case	Range	Sources
Probability of proteinuria > 3 in 20 < MELD ≤ 30	36.4%		NMH[4]
Probability of proteinuria > 3 in MELD > 30	35.3%		NMH[4]
Probability of post LTA renal recovery, given pre-transplant RRT < 30 days	70.8%		26
Probability of post LTA renal recovery, given 30 days < pre-transplant RRT < 60 days	56.3%		26
Probability of post LTA renal recovery, given 60 days < pre-transplant RRT < 90 days	23.5%		26
Probability of post LTA renal recovery, given pre-transplant RRT > 90 days[3]	11.5%		26
LTA recipient survival at 5 years,, when GFR ≥ 30	72%		3
LTA recipient survival at 5 years, when 25 < GFR < 30	67.5%[5]		3
LTA recipient survival at 5 years, when GFR ≤ 25	63%		3
LTA recipient survival without renal recovery at 90 days	64%		26
LTA recipient survival without renal recovery at 1500 days	15%		26
SLK recipient survival at 5 years	68%		3
Post SLK liver graft survival at 5 years	62%		32
Post SLK kidney graft survival at 5 years	60%		32
Post SLK renal graft survival at 3 months	97.3%		NMH[4]
Post LTA liver graft survival at 5 years, when GFR < 25	62%		1, 32
Post LTA kidney graft survival at 5 years, when GFR < 25	59%		33
Post LTA liver graft survival at 10 years, when GFR > 30	51.7%		16
Post LTA kidney graft survival at 3 years, when GFR > 30	86.1%		34

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[1] The number of waiting days was estimated from average of 25th percentile of time to transplant in 2002-2007

[2] 95% confidence interval of national median waiting time in 2003-2007

[3] United Network for Organ Sharing/Organ Procurement and Transplantation Network (UNOS/OPTN) data as of February 15, 2008

[4] Northwestern University Enterprise Data Warehouse (EDW)

[5] Survival of LTA recipients with $25 < GFR < 30$ was obtained from average survival of LTA recipients with $GFR \geq 30$ and $GFR \leq 25$

[6] The declining exponential function was used to convert the parameter values in the literature into weekly values. To convert rate to probability, the following equation was used: $p=1-e^{-r*t}$ where r=weekly rate; t= a week

Table 2

The numbers of life years of LTA and SLK transplant recipients under different durations of pre-transplant dialysis

Pre-transplant dialysis duration	1 week	2 weeks	3 weeks	4 weeks	6 weeks	12 weeks
Number of life years of LTA recipients	164,128	166,951	167,847	167,814	168,316	169,099
Incremental number of life years		2,823	3,719	3,686	4,188	4,971
Number of life years of SLKrecipients	10,309	7,686	6,354	6,031	5,256	3,826
Incremental number of life years		−2,623	-3,954	−4,278	−5,053	−6,482
Sum of life years of LTA and SLK	174,437	174,637	174,201	173,845	173,571	172,925
Life years gained/lost among LTA and SLK		200	−236	−591	−865	−1,512
Number of LTA cases	9,065	9,234	9,296	9306	9,351	9426
Number of SLK cases	648	477	393	373	326	240
Proportion of SLK to LTA	7.15%	5.17%	4.23%	4.01%	3.49%	2.54%
Number of kidney grafts released		171	255	275	322	408
Life years gained per kidney[1]		1.95	1.95	1.95	1.95	1.95
Incr life years gained from ESRD patients		333	497	537	628	796
Net benefit/loss of life years		534	262	−55	−237	−715

[1]The difference in the remaining life expectancy between kidney transplant recipients and candidates on the waitlist ages 50-64, based on the OPTN/SRTR Data as of May 1, 2008