CHAPTER IX
Repeat Organ Transplantation in the United States, 1996-2005

OVERVIEW

- The prospect of graft loss is a problem faced by all transplant recipients, and retransplantation is often an option when loss occurs. To assess current trends in retransplantation, we analyzed data for retransplant candidates and recipients over the last 10 years, as well as current outcomes.
- During 2005, retransplant candidates represented 13.5%, 7.9%, 4.1%, and 5.5% and of all newly registered kidney, liver, heart, and lung candidates, respectively. At the end of 2005, candidates for retransplantation accounted for 15.3% of kidney transplant candidates, and lower proportions of liver (5.1%), heart (5.3%), and lung (3.3%) candidates.
- Retransplants represented 12.4% of kidney, 9.0% of liver, 4.7% of heart, and 5.3% of lung transplants performed in 2005.
- The absolute number of retransplants has grown most notably in kidney transplantation, increasing 40% over the last 10 years; the relative growth of retransplantation was most marked in heart and lung transplantation, increasing 66% and 217%, respectively. The growth of liver retransplantation was only 11%
- Unadjusted graft survival remains significantly lower after retransplantation in the most recent cohorts analyzed. Even with careful case mix adjustments, the risk of graft failure following retransplantation is significantly higher than that observed for primary transplants.

INTRODUCTION

Transplantation is often the best option for patients faced with organ failure. However, while outcomes following transplantation have improved over the years, allograft loss is a problem ultimately confronted by many recipients. For such patients, repeat transplantation often provides the best chance for survival and good health. While retransplantation offers hope, previous studies have demonstrated that outcomes following repeat transplantation are, in general, inferior to those observed with first transplants (1-8). Since every organ used for repeat transplantation represents an opportunity that cannot be directed to another candidate, the potentially expanding role of retransplantation has been of growing concern to the transplant community.

While there have been multiple single center reports focusing on repeat transplantation, the overall affect of retransplantation across solid organ transplantation in the United States has not been evaluated in a comprehensive manner. Listing practices, access to transplantation, and outcomes of repeat transplantation are largely unstudied. We provide here a broad overview and selected summary data on the current state of repeat kidney, liver, heart, and lung transplantation, specifically focusing on trends among retransplant candidates and recipients.

METHODS

For the purpose of this analysis, unless otherwise noted, repeat transplantation (also referred to as retransplantation) includes only candidates or recipients of a second or subsequent organ transplant of the same type, rather than a sequential transplant of a different organ type. For example, an extra-renal transplant recipient who developed end-stage renal disease (ESRD) following transplant and then underwent kidney transplantation would not be counted as a repeat transplant recipient on the basis of that kidney transplant procedure.

Descriptive data and analysis regarding registrants and recipients were provided by the OPTN and are current as of December 31, 2005. Outcomes following retransplantation were analyzed using the SRTR database. This dataset combines OPTN data with information from the Social Security Death Master File (SSDMF) and the Centers for Medicare and Medicaid Services (CMS). The SSDMF provides extra ascertainment regarding recipient mortality, while the CMS data provide additional information regarding kidney allograft failure.

Unadjusted graft survival rates for first transplants and retransplants performed from January 1, 2000 to December 31, 2005 were calculated using the Kaplan Meier method. Adjusted graft survival was calculated using Cox proportional hazard models, following the methodology employed in SRTR center-specific reports (9). Separate models were developed for each organ

transplant investigated. The following cohorts were used: kidney and liver one-year graft survival – January 1, 2003 to June 30, 2005; kidney and liver three-year graft survival – July 1, 2000 to December 31, 2002; heart and lung one-year graft survival – July 1, 2002 to December 31, 2004; and heart and lung three-year graft survival – July 1, 2000 to December 31, 2002. Cohorts were analyzed independently to determine the relative risks of graft failure at one and three years following transplantation. Except in the case of heart transplantation, the adjustments remained constant between the one and three year cohorts, as detailed below.

In the analysis examining the risk of graft loss following kidney transplantation, adjustments were made for recipient age, race, body mass index (BMI), diagnosis, functional status, insurance type, peak panel reactive antibody (PRA), length of ESRD treatment, and level of human leukocyte antigen (HLA) mismatch. In the living donor kidney transplant analysis, the relationship between the donor and recipient and donor age and race were included in the model. The model for deceased donor kidney transplantation included donor age, race, cause of death, diabetes, hypertension, creatinine, donation after cardiac death (DCD), cold ischemia time (CIT), pumping, sharing outside of the recovering donation service area (DSA), and donor-to-recipient weight ratio.

Analyses of repeat liver transplantation are of deceased donor transplants, as the use of living donor livers for retransplant candidates was infrequent enough to preclude meaningful analysis. The liver transplant models included adjustments for recipient age, race, diagnosis, medical condition, ascites, creatinine, diabetes, life support, inotropes used for blood pressure support, and previous abdominal surgery. Donor factors included donor age, race, cause of death, and DCD. The use of shared organs outside the DSA, partial or split liver, and ABO blood-type compatibility were also accounted for in this model.

In the analysis of heart transplantation, the model for the one-year cohort included recipient age, diagnosis, medical condition, creatinine, ventilator status, use of extracorporeal membrane oxygenation, donor age, cause of death, and CIT. The model for the three-year cohort adjusted for recipient, age, race, sex, height, weight, diagnosis, ventilator status, diabetes, creatinine, intra-aortic balloon pumping, Status 1A, donor age, cause of death, and CIT.

The lung transplant model was adjusted for recipient factors including age, race, sex, diagnosis, functional status, cardiac index, forced vital capacity, and ventilator use. Donor factors included age, race, cause of death, diabetes, and body surface area.

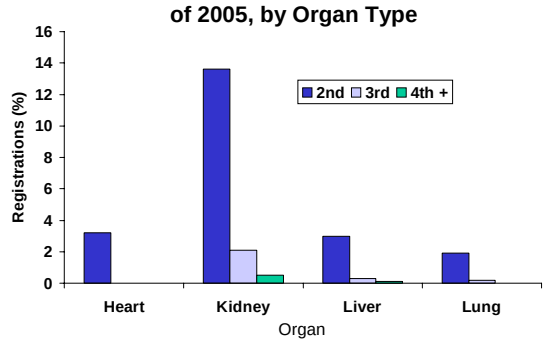
The population was restricted to adult recipients (age 18 years or greater) for kidney, liver, and heart recipients. In light of recent changes in the OPTN lung allocation policy, children age 12 years or older were included in the lung recipient models.

RESULTS

Impact of Retransplantation on Waiting Lists and Transplant Activity

The percentage of candidates on the OPTN waiting list who are waiting for repeat transplantation varies by organ. On December 31, 2005, 16.1% of kidney, 3.4% of liver, 3.2% of heart, and 2.1% of lung registrants were wait-listed for repeat transplantation. The majority of these candidates were wait-listed for a second transplant (Figure IX-1). Registration for a third

Figure IX-1. Percentage of All Registrants Listed for a Second, Third, or Fourth Transplant at End of 2005, by Organ Type



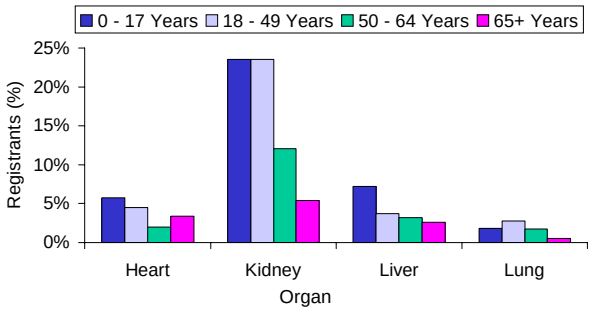
Source: OPTN Analysis, February 2006.

transplant was most common among kidney transplant recipients, followed by liver recipients. Registration for a second or subsequent transplant was rare among heart and lung recipients.

Across all organs, candidates awaiting retransplantation are notably younger than registrants on the overall waiting list (Figure IX-2). In the case of kidney transplantation, greater than 20% of registrants less than 49 years of age and 12.1% between 50 and 64 years were registered for a second or subsequent kidney transplant.

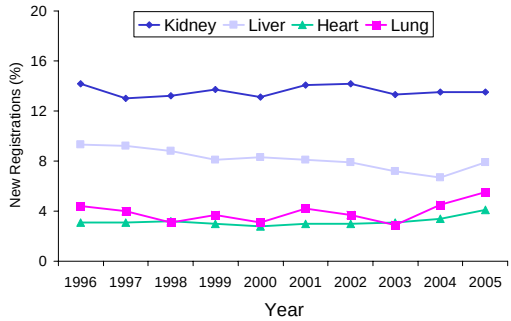
Over the last 10 years, the yearly percentage of new kidney, heart, and lung waiting list registrants who were candidates for retransplantation has remained relatively stable (Figure IX-3). In contrast, the percentage of new registrations for liver retransplantation has been falling

Figure IX-2. Percentage of Registrants in Each Age Group Listed for a Repeat Transplant at End of 2005, by Organ Type and Candidate Age



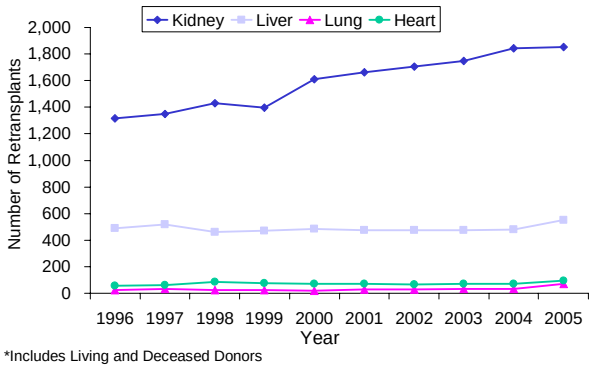
Source: OPTN Analysis, February 2006.

Figure IX-3. Percentage of All New Registrants Added to the Waiting List for a Repeat Transplant, by Organ Type,1996-2005



Source: OPTN Analysis, November 2006.

Figure IX-4. Number of Repeat Transplants, by Organ, 1996-2005*



*Includes Living and Deceased Donors

Source: OPTN Analysis, February 2006.

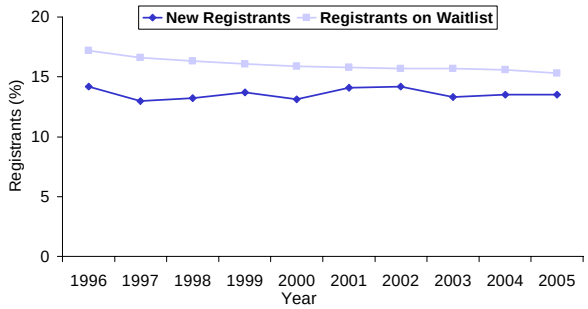
gradually, from 7.9% in 1996 to 5.1% in 2005. This modest decrease may reflect multiple factors, including identification of more suitable candidates for primary transplantation, fewer previous liver transplant recipients being accepted for retransplantation, and better selection of donor livers leading to a lower rate of graft failure.

Since 1996, there has been a steady increase in the number of kidney retransplant recipients (Figure IX-4). Despite small increments in retransplant activity in 2005, similar trends are not observed in liver, heart, and lung transplantation.

Kidney Retransplantation

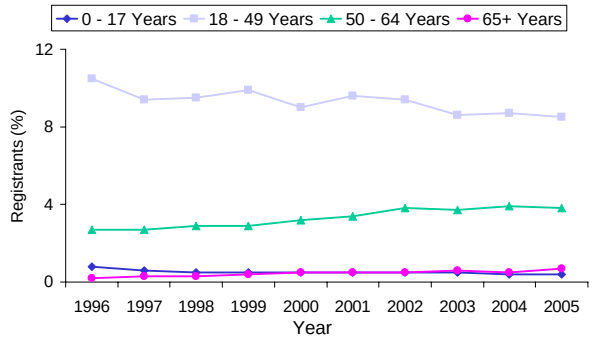
Over the course of the decade, the percentage of new kidney transplant registrants each year who were retransplant candidates remained relatively constant (Figure IX-5). In 2005, 13.5% of all new kidney registrants represented retransplants. The percentage of retransplant registrants on the waiting list at year-end decreased slowly, from 17.2% in 1996 to 15.3% in 2005. Among new registrations, the relative contribution from retransplant registrants was highest in the 18-49 year age group (Figure IX-6). However, the percentage of new registrants within this age group has fallen, from 10.5% in 1996 to 8.5% in 2005.

Figure IX-5. Percentage of All New Registrants Added to the Waiting List for Repeat Kidney Transplantation and Percentage on Waiting List at Year-End, 1996-2005



Source: OPTN Analysis, November 2006.

Figure IX-6. Percentage of All New Registrants Added to the Waiting List for Repeat Kidney Transplantation, by Age, 1996-2005

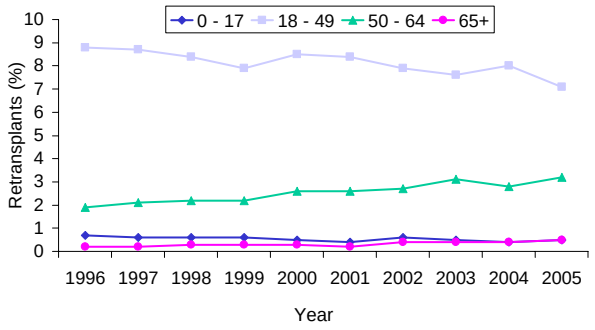


Source: OPTN Analysis, November 2006.

In 2005, 664 (10.9%) of living donor and 1,182 (13.6%) of deceased donor kidney transplants were retransplants. The relative percentages have changed little over the

decade. In 1996, the percentage of living donor transplants represented by retransplantation was 8.9%, while the percentage of deceased donor transplants represented by retransplantation was 14.4%. When stratified by recipient age, patients in the 18-49 year age group represented the greatest percentage of retransplant recipients (Figure IX-7).

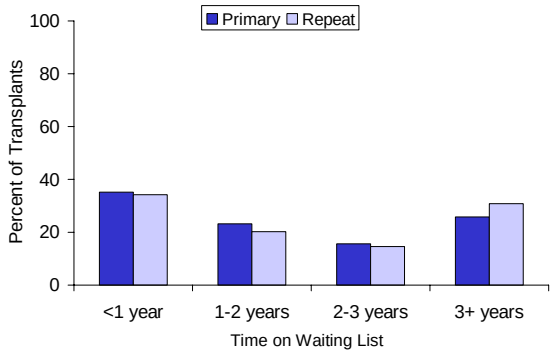
Figure IX-7. Percentage of Repeat Kidney Transplants, by Recipient Age, 1996-2005



Source: OPTN Analysis, February 2006.

Retransplant recipients tend to have been on the waiting list slightly longer compared with primary recipients (Figure IX-8). Importantly, this Figure does not reflect the fate of some retransplant candidates who continue to remain on the waiting list and never receive another transplant. At least one significant factor contributing to the difficulty finding suitable grafts for retransplant candidates is allosensitization. Retransplant recipients have a higher PRA at listing compared with primary recipients, with 31.5% having a PRA of 20% or higher at time of listing (Figure IX-9).

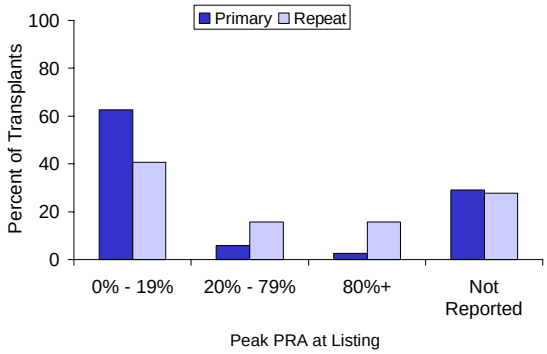
Figure IX-8. Deceased Donor Kidney Transplants in 2005, by Time on Waiting List



Source: OPTN Analysis, November 2006.

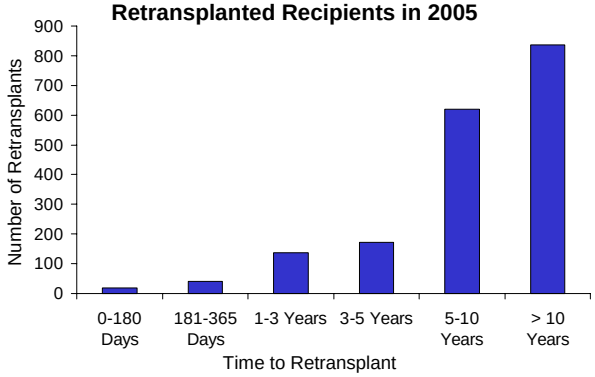
For the majority of second kidney transplants performed in 2005, the interval between the primary kidney transplant and retransplantation was greater than five years, with the largest fraction retransplanted more than

Figure IX-9. Deceased Donor Kidney Transplants in 2005, by Peak PRA at Listing



Source: OPTN Analysis, November 2006.

Figure IX-10. Time from First Kidney Transplant to Repeat Transplant, for Retransplanted Recipients in 2005



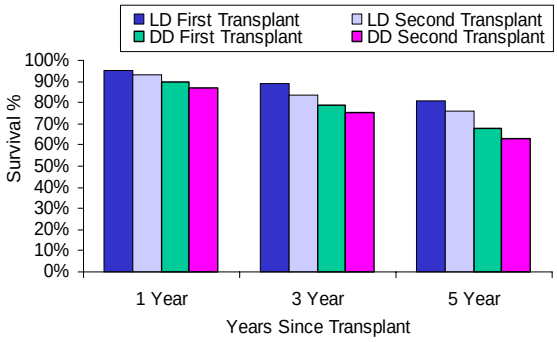
Source: OPTN Analysis, February 2006.

10 years after their first transplant procedure (Figure IX-10). Of candidates who undergo repeat kidney transplantation, the etiology of their initial graft loss varies, depending on when the graft is lost. For patients who lose their primary graft within the first year after transplantation, acute rejection and graft thrombosis are reported as the cause of graft failure in more than half the cases. For primary graft loss occurring more than one year posttransplant, chronic rejection accounts for nearly two thirds of the graft loss. In both recipient cohorts, recurrent disease accounts for less than 10% of all primary graft failures.

Outcomes Following Repeat Kidney Transplantation. Of the 35,340 living donor kidney transplants performed between 2000 and 2005, 7.1% were repeat transplants. The unadjusted one, three, and five year graft survival rates for repeat living donor transplants (93%, 83%, and 76%), were all significantly lower than observed for first living donor transplants (95%, 89%, and 81%, respectively) ($p \leq 0.01$, $p < 0.0001$, $p = 0.01$, respectively) (Figure IX-11). During the same period, of the 48,351 deceased donor kidney transplants performed, 9.7% were retransplants. A similar trend in differences in

unadjusted survival between first and repeat transplants was observed. The unadjusted one, three, and five year graft survival for repeat deceased donor transplants (87%, 76%, and 63%) were all significantly lower than observed for first deceased donor transplants (90%, 79%, and 68%, respectively) (all p<0.002) (Figure IX-11). Interestingly, outcomes for recipients of living donor retransplants remain better than those observed after primary deceased donor transplants. After adjusting for donor and recipient factors, the relative risks of graft failure for living donor kidney transplants following repeat kidney transplantation was 0.96 (p=0.7886) at one year and 1.33 (p=0.0005) at three years. For deceased donor kidney transplants, the relative risk was 1.18 (p=0.0236) and 1.24 (p=0.0001) at one and three years, respectively.

Figure IX-11. Unadjusted Living Donor (LD) and Deceased Donor (DD) Graft Survival for First and Second Kidney Transplants, 2000-2005

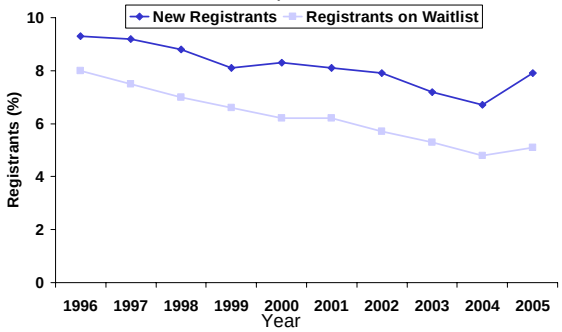


Source: SRTR Analysis, May 2006.

Liver Retransplantation

Over the last 10 years, the percentage of new liver transplant registrants who were retransplant candidates decreased slightly, from 9.3% in 1996 to a nadir of 6.7% in 2004, with a rebound to 7.9% in 2005 (Figure IX-12). The percentage of retransplant registrants on the waiting list at year-end had a similar decline over the same period. At year-end in 2005, retransplant registrations represented 5.1% of all candidates.

Figure IX-12. Percentage of All New Registrants Added to the Waiting List for Repeat Liver Transplantation and Percentage on Waiting List at Year-End, 1996-2005

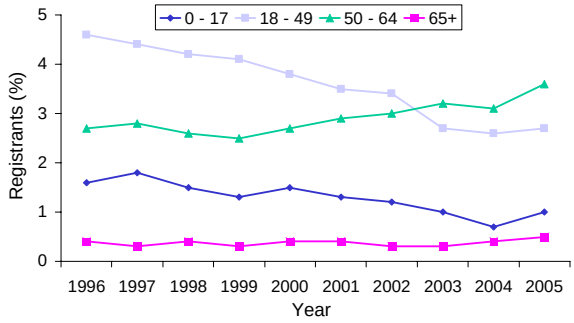


Source: OPTN Analysis, November 2006.

Of the new registrations, over the last 10 years, the proportion of recipients in the 18-49 year age group registered for retransplantation decreased from 4.6% in 1996 to 2.7% in 2005, while registrations for retransplantation increased from 2.7% in 1996 to 3.6% in 2005 for candidates in the 50-64 year age range. The proportion was stable at less than 1% for candidates greater than age 65 years (Figure IX-13).

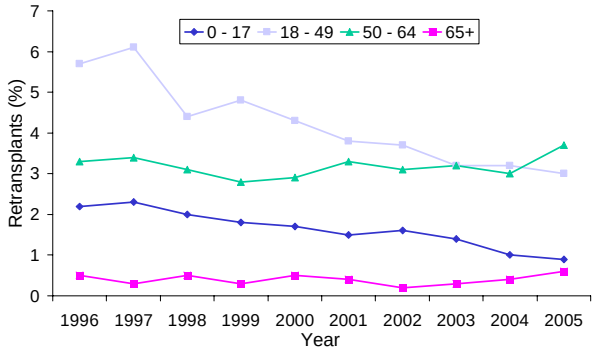
With respect to transplantation, the percentage of all liver transplants that were retransplants decreased from a peak of 11.5% in 1997 to 9.0% in 2005. When stratified by recipient age, recipients in the 18 to 49 year range demonstrated a decline in the percentage of retransplants from a high of 6.1 in 1997 to 3.0 in 2005, whereas the percentage of liver transplants that were retransplants for the age group 50-64 years remained stable between 3% and 4%. The percentage remained below 1% for those greater than age 65 years (Figure IX-14).

Figure IX-13. Percentage of All New Registrants Added to the Waiting List for Repeat Liver Transplantation, by Recipient Age, 1996-2005



Source: OPTN Analysis, November 2006.

Figure IX-14. Percentage of Repeat Liver Transplants, by Recipient Age, 1996-2005



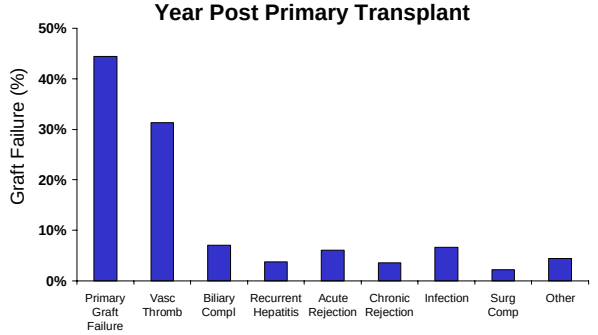
Source: OPTN Analysis, February 2006.

Of candidates who undergo repeat liver transplantation, the etiology of their initial graft loss varies, depending on when the graft is lost. For candidates who lose their primary graft in the first year, primary nonfunction and vascular thrombosis account for over 70% of the causes of graft failure leading to retransplant (Figure IX-15). For recipients retransplanted more than one year after transplantation, chronic rejection and recurrent hepatitis account for greater than half of the cases (Figure IX-16). Evaluation of time from first transplant to retransplant reflects these issues as well. There is a highly skewed distribution with the highest rate of graft loss occurring within the first week, and the majority of graft loss within the first year following transplantation (Figure IX-17).

While it is not surprising that a greater fraction of retransplant recipients, compared with primary transplant recipients, are listed as Status 1, it is interesting to note that, compared with primary transplant recipients, the retransplant population has a MELD score distribution at transplant that is higher than that seen for primary liver recipients (Figure IX-18).

Outcomes Following Repeat Liver Transplantation. Of the 29,283 deceased donor liver transplants performed between 2000 and 2005, 8.1% were retransplants. The unadjusted one, three, and five year graft survival rates for repeat deceased donor transplants (67%, 60%, and 53%), were all significantly lower than those observed following first deceased donor transplants (83%,75%, and 69%) (all $p \leq 0.0001$) (Figure IX-19). Compared with first transplants, after adjusting for donor and recipient factors, the relative risk of graft loss for retransplants was 1.59 ($p \leq 0.0001$) at one year and 1.60 ($p \leq 0.0001$) at three years following retransplantation.

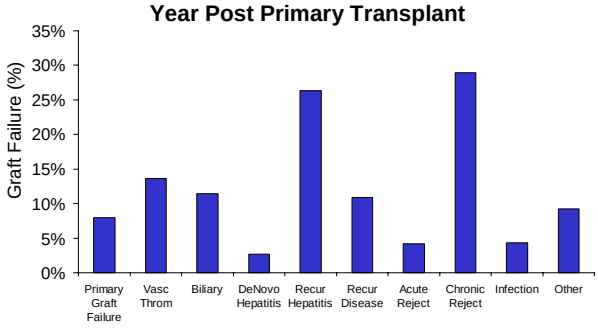
Figure IX-15. Causes of Primary Graft Failure for Liver Transplant Recipients Retransplanted Less Than One Year Post Primary Transplant



*Includes transplants Since October 1, 1987

Source: OPTN Analysis, February 2006.

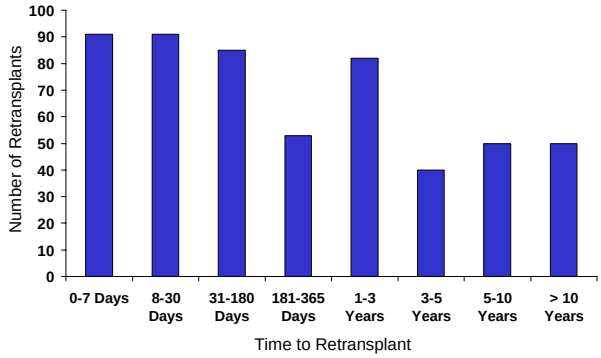
Figure IX-16. Causes of Primary Graft Failure for Liver Transplant Recipients Retransplanted More Than One Year Post Primary Transplant



*Includes transplants Since October 1, 1987

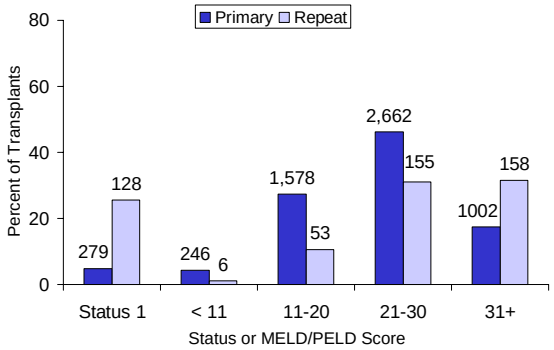
Source: OPTN Analysis, February 2006.

Figure IX-17. Time from First Liver Transplant to Repeat Transplantation for Retransplanted Recipients in 2005



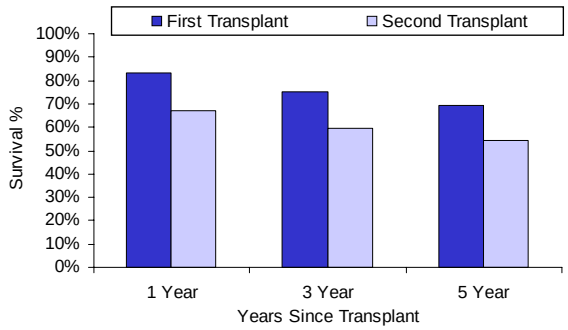
Source: OPTN Analysis, February 2006.

Figure IX-18. Repeat Liver Transplants in 2005, by Status or MELD/PELD Score at Transplantation



Source: OPTN Analysis, November 2006.

Figure IX-19. Unadjusted Deceased Donor Graft Survival for First and Second Liver Transplants, 2000-2005



Source: SRTR Analysis, May 2006.

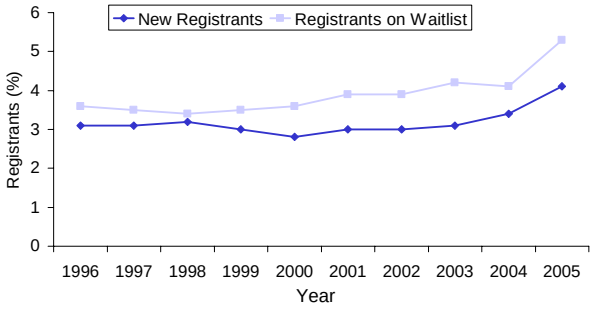
Heart Retransplantation

Over the last 10 years, the percentage of new heart transplant registrants for repeat heart transplantation was stable from 1996 to 2004, then rose from 3.4% in 2004 to 4.1% in 2005 (Figure IX-20). The percentage of retransplant registrants on the waiting list at year-end increased in a similar pattern and by a similar magnitude. At year-end in 2005, retransplant registrations represented 5.3% of all candidates.

Of the new registrations, the relative contributions from recipients aged less than 18 years, 18-49 years, and 50-64 years were similar in 2005. Registration for retransplantation in the 65 year and older age range was uncommon (Figure IX-21).

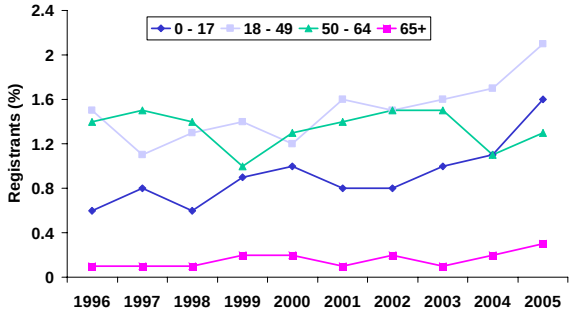
Overall, the percentage of all heart transplants that are retransplants increased over the decade from 2.6% in 1996 to 4.7% in 2005. When stratified by age, recipients less than 65 years old contributed relatively equally in 2005 to the percentage representing heart retransplantation (Figure IX-22). Retransplantation was rare in recipients age 65 years or greater.

Figure IX-20. Percentage of All New Registrants Added to the Waiting List for Repeat Heart Transplant and Percentage on Waiting List at Year-End, 1996-2005



Source: OPTN Analysis, November 2006.

Figure IX-21. Percentage of All New Registrants Added to the Waiting List for a Repeat Heart Transplant, by Age, 1996-2005



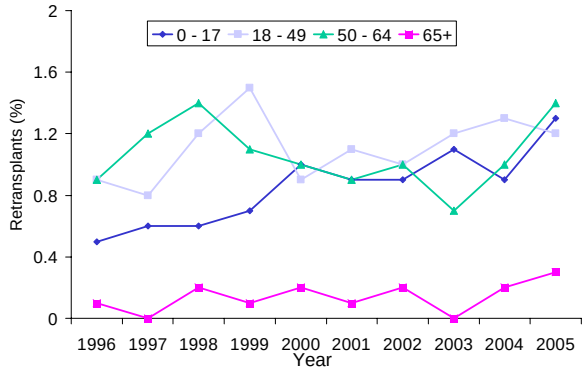
Source: OPTN Analysis, November 2006.

Outcomes Following Repeat Heart Transplantation. Between 2000 and 2005, there were 364 heart retransplants, which accounted for 2.9% of all heart transplants. As seen with kidney and liver transplants, the one, three, and five year unadjusted graft survival rates for heart retransplants (82%, 70%, and 58%) were all respectively lower than those for first heart transplants (86%, 80%, and 73%; all $p < 0.0001$) (Figure IX-23). After adjusting for donor and recipient factors, the relative risk for graft loss after retransplantation compared with first heart transplantation was 1.34 ($p=0.1514$) at one year and 1.16 ($p=0.4263$) at three years after transplantation.

Lung Retransplantation

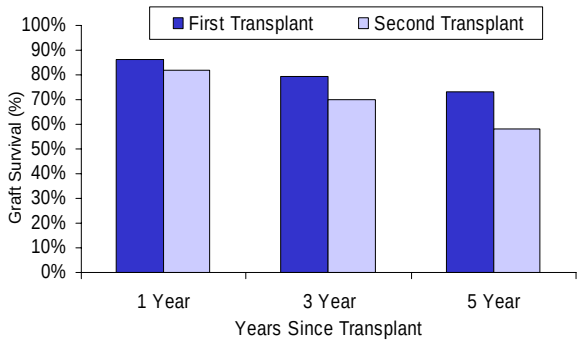
The percentage of new lung transplant registrants who were retransplant candidates was stable between 1996 and 2003, but then increased from 2.9% in 2003 to 5.5% in 2005 (Figure IX-24). The percentage of retransplant registrants on the waiting list at year-end declined over the last 10 years, from 4.2% in 1996 to a low of 2.6% in 2003, increasing slightly to 3.3% in 2005.

Figure IX-22. Percentage of Repeat Heart Transplants, by Recipient Age, 1996-2005



Source: OPTN Analysis, February 2006.

Figure IX-23. Unadjusted Graft Survival for First and Second Heart Transplants, 2000-2005



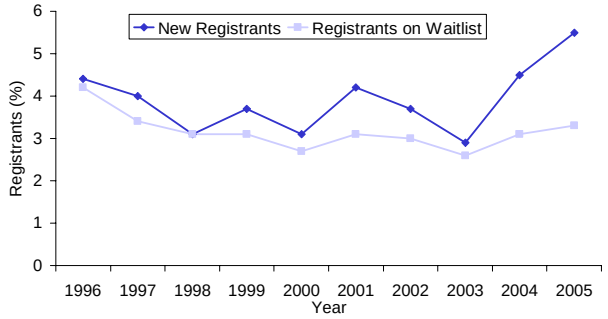
Source: SRTR Analysis, May 2006.

Of the new registrations, candidates aged 18-49 years accounted for the largest age group, though the last two years have witnessed an increase in the 50-64 year age group registered for retransplantation (Figure IX-25).

Overall, the percentage of all lung transplants that are retransplants increased over the decade, from 2.8% in 1996 to 5.3% in 2005. When stratified by recipient age, recipients in the 18-49 year age range had the greatest percentage of retransplants, though the percentage in the 50-64 year age range has grown remarkably since 2004. In 2005, the Figures in both these cohorts were equivalent (Figure IX-26).

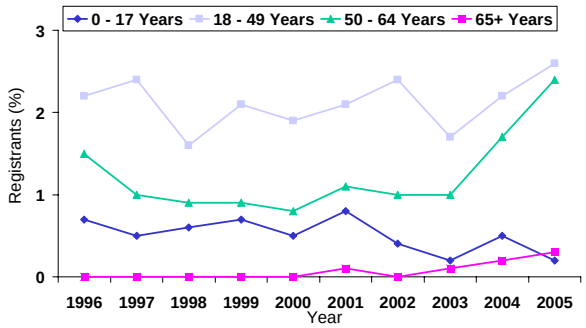
Outcomes Following Repeat Lung Transplantation. Of the 6,616 deceased donor lung transplants performed between 2000 and 2005 in recipients age 12 years and older, 3.1% were repeat transplants. The unadjusted one, three, and five year graft survivals for repeat deceased donor lung transplants (55%, 36%, and 22%) were significantly lower than those for first transplants (81%, 65%, and 50%; all p<0.0001) (Figure IX-27). After adjusting for donor and recipient factors, the relative risks of graft failure at one and three years for deceased donor lung retransplants were 2.13 (p=0.0006) and 1.82 (p=0.0016), respectively.

Figure IX-24. Percentage of All New Registrants Added to the Waiting List for Repeat Lung Transplantation and Percentage on Waiting List at Year-End, 1996-2005



Source: OPTN Analysis, November 2006.

Figure IX-25. Percentage of All New Registrants Added to the Waiting List for Repeat Lung Transplantation, by Age, 1996-2005

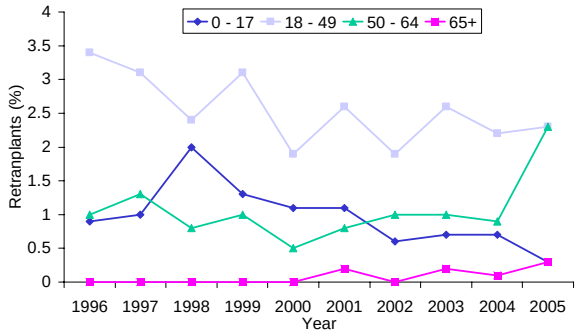


Source: OPTN Analysis, November 2006.

DISCUSSION

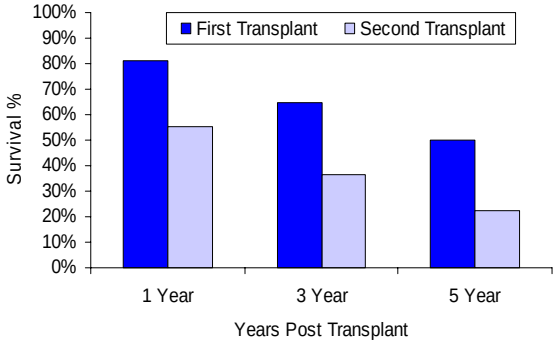
Candidates for repeat transplantation are a sizeable and stable percentage (15.3%) of the kidney transplant waiting list. For the heart, lung, and liver transplant waiting lists, candidates for retransplant make up 5% or less, a still important fraction. It appears over the last 10 years that there has been a decrease in the portion of the liver transplant waiting list that is comprised of candidates for repeat transplantation. For all organs, except kidney, virtually all of the candidates for repeat transplantation are waiting for a second transplant. In contrast, somewhat greater than 2% of the kidney transplant waiting list is registered for a third or subsequent transplant. The majority of candidates for repeat transplantation are less than 50 years of age. The

Figure IX-26. Percentage of Repeat Lung Transplants, by Recipient Age, 1996-2005



Source: OPTN Analysis, February 2006.

Figure IX-27. Unadjusted Deceased Donor Graft Survival for First and Second Lung Transplants, 2000 - 2005



Source: SRTR Analysis, May 2006.

absolute number of repeat transplants has grown, most notably among recipients of kidney transplants. Over the last 10 years, the number of repeat kidney transplants has increased 40%, with 1,846 repeat kidney transplants in 2005. The numbers of repeat liver, heart, and lung transplants are smaller by comparison. Interestingly, the growth of retransplantation for livers was only 11%, while heart and lung increased 66% and 217%, respectively. Repeat transplantation represents 12.4% of kidney (10.9% of all living donor and 13.6% of all deceased donor kidney transplants), 9.0% of liver, 4.7% of heart, and 5.3% of lung transplants performed in 2005. Most repeat kidney transplants are performed more than five years following the original transplant. However, the great majority of repeat liver transplants are performed less than five years following primary liver transplant, and the highest rates are seen in the earlier posttransplant periods. Even with careful case mix adjustments, allograft survival is good, but significantly less, among recipients of repeat kidney, liver, and heart transplants compared with the survival obtained from primary transplantation. Unfortunately, recipients of repeat lung transplants achieve only 22.4% five-year allograft survival, or about half of what is obtained for recipients of primary lung allografts.

On a yearly percentage basis, repeat transplantation represents a stable fraction of the kidney candidate and recipient pools, and results are generally accepted as adequate. However, the total number of repeat kidney transplants is increasing, and, as a consequence of the availability of dialysis to serve as a bridge to repeat transplantation, the total number of repeat kidney transplants is likely to grow. Additionally, because candidates awaiting kidney retransplantation are frequently allosensitized, they are often less likely to receive a transplant than primary kidney candidates. Ongoing efforts at many centers involving "desensitization" protocols for such individuals highlight the pressing need in this patient population. Non-immunologic interventions, such as broader sharing of deceased donor organs for highly sensitized recipients or the implementation of paired exchanges programs for living donors may offer additional options for allosensitized candidates.

In liver transplantation, the percentage of the waiting list that is identified for repeat transplantation is falling. This relative decline of repeat liver transplant registrants may reflect the substantial increase in candidates for primary transplantation, a higher threshold or greater reluctance to list recipients for retransplantation, better organ selection at primary transplantation, or better management following transplantation. Of particular interest in liver transplantation is the impact of the primary diagnosis on outcomes following retransplantation. Though not a focus of this analysis, there is growing concern regarding the detrimental effect of recurrent hepatitis C on outcomes following liver retransplantation. In a recent SRTR analysis of adult liver recipients who were retransplanted between 1997 and 2002, hepatitis C was the leading primary cause of liver disease (27%) (10). In this analysis, these recipients had a 30% higher covariate-adjusted risk of mortality compared with those without hepatitis C. While hepatitis C was shown to be associated with poorer outcomes, it is clear that many donor and recipient factors also contribute to the results, and attention to these factors may improve outcomes. Whether or not the small increase in the percentage of new registrants for retransplantation in 2005 signifies a new trend remains to be determined.

Also of interest in liver transplantation is the whether MELD accurately reflects the risk of waiting list mortality for retransplant candidates compared with primary transplant candidates. Since MELD forms the basis for allocation, any disparity between the two groups would indicate differential access to transplantation. In an analysis of the OPTN dataset, Edwards and Harper demonstrated that while MELD correlated with pretransplant mortality for both primary and retransplant liver candidates, there was better concordance with waiting list mortality for primary candidates compared with retransplant candidates (11). Additionally, it appeared that at MELD scores above 20, the risk of waiting list mortality at a given MELD score was higher for retransplant candidates. Further analysis of this finding is warranted.

Although the percentage of registrants for and recipients of heart retransplantation have remained relatively stable for the past 10 years, it will be important to determine if the increases seen in 2005 represent variability or the beginning of an upward trend. As survival following repeat heart transplant is less than that following primary transplant, it will be important to further analyze the current SRTR database to define risk factors for poor outcome following retransplantation. Indeed, a previous analysis of the Joint International Society for Heart and Lung Transplantation (ISHLT)/United Network for Organ Sharing Thoracic Registry suggested that an inter-transplant interval of less than two years resulted in decreased survival following retransplantation (3). Furthermore, an analysis of data in the Cardiac Transplant Research Database showed that an inter-transplant interval of less than six months and retransplantation for acute rejection or early graft failure resulted in poor outcome (12). With the ongoing donor shortage and the increased number of heart transplant recipients at risk for allograft failure, predictors of poor outcome following retransplantation need to be more

clearly defined and considered in selecting appropriate candidates to list for retransplantation.

In lung transplantation, the percentage of registrants for and recipients of lung retransplantation also have remained relatively stable since 1996; it remains to be determined if the increase in retransplant activity over the last year marks the start of a distinct trend. Survival following lung retransplantation is currently discouraging. Similar to the findings of this current analysis, in the most recent report of the ISHLT registry, using multivariate logistic regression, adult lung retransplant recipients were shown to have a 2.12 relative risk of death at one year following transplantation compared with primary lung recipients (13). In this analysis, the risk of being a repeat transplant recipient was only second to a recipient diagnosis of primary pulmonary hypertension as having the highest relative risk of one year mortality. This significant impact of repeat transplantation was sustained when looking at risk factors for five year mortality, where the relative risk was 1.72. In this cohort, the risk factor of being a repeat transplant recipient was only second to a recipient being on preoperative intravenous inotropes as having the highest relative risk of five year mortality. The marked impact of retransplantation on patient survival was observed in pediatric lung recipients, as well in the ISHLT Registry (13). At one year following transplantation, the actuarial survival was 50% in the retransplantation group versus 80% in the primary transplant group. The separation in the Kaplan-Meier survival curves occurred immediately after the transplant event and was most marked during the first year after transplant, with a similar slope in the curves thereafter. This suggests that the dramatic difference in survival during the first year accounted for much of this difference.

This report has focused on the abdominal organs accounting for the greatest number of retransplants. It is worthy to note that although there were only 90 pancreas retransplants performed in 2005, this accounted for the highest percentage of any organ being retransplanted (16.6% of pancreas transplants were retransplants). Similarly, while there were only 18 intestine retransplants performed in 2005, this represented 10.1% of all intestine transplants. Further analysis of these observations is warranted.

Retransplantation offers hope for transplant recipients who have had a graft fail. Unfortunately such failures, in addition to the suffering they place on the recipient, contribute to the overall demand for organs. Given the shortage of donor organs, retransplantation can create tension, especially when outcomes following retransplantation are below those observed for primary recipients. Absent eliminating primary graft failure or an infinite availability of donor organs, finding an acceptable balance among these competing issues is likely to be a continuing concern for the transplant community. Reflecting these concerns, the American Society of Transplant Surgeons, the American Society of Transplantation, and the National Institute of Allergy and Infectious Diseases recently sponsored a conference focusing on the issue of retransplantation in March 2006. The organizers are summarizing much of the data presented and formulating recommendations for publication in organ-specific manuscripts. The overarching conclusion reached, however, was the pressing need for more in-depth investigation regarding all facets of retransplantation.

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