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Kidney and pancreas transplantation

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Data from the Scientific Registry of Transplant Recipients offer a unique and comprehensive view of US trends in kidney and pancreas waiting list characteristics and outcomes, transplant recipient and donor characteristics, and patient and allograft survival. Important findings from our review of developments during 2002 and the decade's transplantation trends appear below.

The kidney waiting list has continued to grow, increasing from 47 830 in 2001 to 50 855 in 2002. This growth has occurred despite the increasing importance of living donor transplantation, which rose from 28% of total kidney transplants in 1993 to 43% in 2002.

Policies and procedures to expedite the allocation of expanded criteria donor (ECD) kidneys were developed and implemented during 2002, when 15% of deceased donor transplants were performed with ECD kidneys. Unadjusted 1- and 5-year deceased donor kidney allograft survivals were 81% and 51% for ECD kidney recipients, and 90% and 68% for non-ECD kidney recipients, respectively.

Although more patients have been placed on the simultaneous kidney-pancreas waiting list, the number of these transplants dropped from a peak of 970 in 1998 to 905 in 2002. This decline may be due to competition for organs from increasing numbers of isolated pancreas and islet transplants.

Key words: Deceased donors, graft survival, kidney transplantation, kidney-pancreas transplantation, living donors, organ donation, pancreas transplantation, patient survival, SRTR, waiting list

Introduction

This overview of kidney and pancreas transplantation focuses on developments during 2002 and provides an important summary of trends over the past decade. The transplant process is examined first through analyses of waiting list characteristics and outcomes, followed by assessments of transplant recipient characteristics and of patient and allograft survival. The characteristics of expanded criteria donors and the unique outcomes of patients receiving expanded criteria donor kidney transplants is described, followed by sections addressing simultaneous kidney-pancreas, pancreas after kidney, and isolated pancreas transplantation.

Unless otherwise noted, the statistics in this article come from reference tables in the *2003 OPTN/SRTR Annual Report*. Two companion articles in this report, 'Transplant data: sources, collection, and caveats' and 'Analytical approaches for transplant research', explain the methods of data collection, organization, and analysis that serve as the basis for this article (1,2). Additional detail on the methods of analysis may be found in the reference tables themselves or in the Technical Notes of the *OPTN/SRTR Annual Report*, both available online at http://www.ustransplant.org.

Kidney Transplantation

Kidney transplantation continues to be recognized as the treatment of choice for medically suitable patients with end-stage kidney disease, leading to a continued and marked growth in the size of the kidney transplant waiting list (Figure 1). The particular advantage of pre-emptive

Notes on Sources: The articles in this report are based on the reference tables in the *2003 OPTN/SRTR Annual Report*, which are not included in this publication. Many relevant data appear in the figures and tables included here; other tables from the *Annual Report* that serve as the basis for this article include the following: Tables 1.8, 1.12b, 1.13b, 1.14, 5.1–5.4c, 5.9a, 5.9b, 5.11a, 5.11b, 6.1–6.4, 6.7, 6.9, 6.11, 6.13, 7.1–7.4, 7.7, 7.9, 7.11, 8.1–8.4, 8.7, 8.9, 8.11, and 8.12. All of these tables are also available online at http://www.ustransplant.org.

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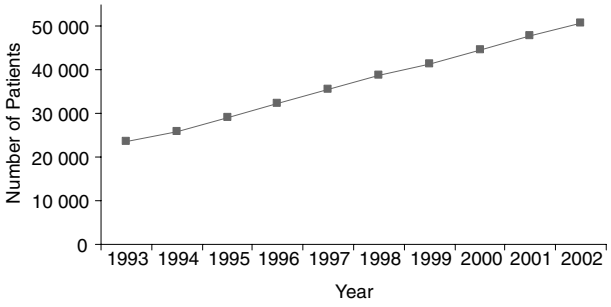


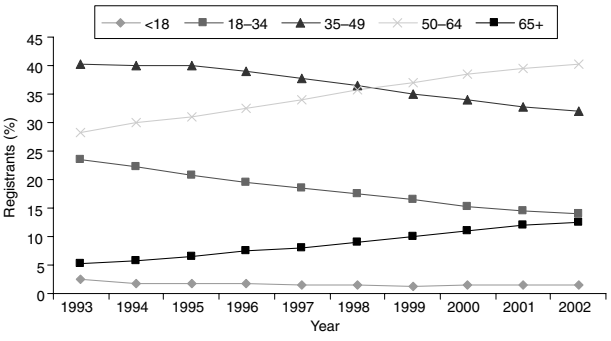
Source: *2003 OPTN/SRTR Annual Report*, Table 5.1.

Figure 1: Growth in the waiting list for deceased donor kidneys, 1993–2002.

kidney transplantation—prior to the initiation of dialysis—is now well-recognized and is being progressively exploited, especially by patients receiving living donor kidney transplants (3,4).

The kidney transplant waiting list

The number of candidates on the kidney waiting list has grown steadily, increasing from 47 830 in 2001 to 50 855 in 2002. Almost 75% of the increase occurred among patients 50 years of age or older, who now constitute over 50% of the total waiting list, compared to only 34% in 1993 (Figure 2). African-Americans continued to be disproportionately represented on the waiting list. African-Americans now represent 37% of the waiting list, a similar proportion to their 38% of the dialysis population overall (5). Of all candidates on the waiting list, 19% had received a previous kidney transplant, while 34% had a peak panel reactive antibody (PRA) of 10% or greater. As would be expected, given the relatively static deceased donor kidney supply and increase in the waiting list size, waiting times continued to increase steadily. Twenty-five per cent of new waiting list registrants for 2002 were transplanted by 341 days, compared to 297 days in 1998 and 235 days in 1993.



Source: *2003 OPTN/SRTR Annual Report*, Table 5.1

Figure 2: Percentage on the kidney waiting list, by age group, 1993–2002.

Recognition of the clear survival advantage obtained by patients undergoing kidney transplantation as compared to remaining on the waiting list—and of the adverse impact of time on dialysis on transplant survival—underscores the importance of equity in kidney transplant waiting time. Current OPTN/UNOS kidney allocation policies acknowledge children's and adolescents' disproportionate need for transplantation. As a result of the increased priority afforded them, patients younger than 18 years of age enjoy shorter waiting times. In contrast, African-American, Asian, and other nonwhite candidates experience longer waiting times. The point at which 25% of new registrants were transplanted could be calculated only for those minority candidates registered in 2001, with the 25th percentile of time to transplant being 268 days for whites, 630 days for African-Americans, 626 days for Asians and 483 days for other nonwhite patients. Other factors resulting in apparently prolonged waiting times as measured by 25th percentile of time to transplant included Hispanic-Latino ethnicity (442 vs. 326 days for non-Hispanic/non-Latino in 2002), blood type B or O (521 or 462, respectively, vs. 223 days for blood type A), having received a previous transplant (430 vs. 328 days), and anti-HLA sensitization (1018 days for peak PRA of 80% or greater, compared to only 288 days for unsensitized candidates in 2000).

These observations were supported by a multivariate analysis of transplant waiting time recently performed by the SRTR. After adjusting for recipient age, gender, cause of ESRD, blood type, race, ethnicity, current PRA, source of insurance payment, dialysis modality, transplant number, previous transfusions, HLA type, and organ procurement organization (OPO), this study showed that patients who were over 50 years of age, African-American, Hispanic, B blood type, sensitized against HLA, or had undergone a previous transplant were markedly less likely to be transplanted (Table 1). Table 2 shows the distribution of these factors among wait-listed and transplanted patients in 2002. Interestingly, the apparent prolongation in waiting time suffered by Asian-Americans was not seen when the model incorporated adjustments for HLA and OPO (6,7).

Death rates per 1000 patient years at risk among wait-listed candidates have tended to remain stable, ranging from 66 to 82 over the past 4 years. As expected, death rates increased with age but tended to be lower among nonwhite candidates.

Kidney transplant recipients

There was modest growth in deceased donor kidney transplantation in 2002, an increase of 3% (from 8065 to 8287) in contrast to the 1% increase seen the year before. At the same time, the marked growth in living donor kidney transplantation observed from 2000 to 2001 (11%) appears to

Table 1: Recipient factors resulting in prolonged kidney transplant waiting times, 1994–2000

Factor	Relative rate of transplantation	Reference group
Age 50–64 years	0.912	Age 35–49 years
Age 65 or greater	0.827	Age 35–49 years
Blood type B	0.850	Type O
African-American race	0.766	White
Hispanic/Latino ethnicity	0.904	Non-Hispanic/ Non-Latino
Current PRA 10–40%	0.707	PRA 0–9%
Current PRA 41–79%	0.483	PRA 0–9%
Current PRA ≥ 80%	0.413	PRA 0–9%
Having received previous transplant	0.559	No previous transplant

p-values for all rates < 0.0001 vs. reference group. Source: Wolfe et al. 2001 (6).

Table 2: Distribution of recipient factors resulting in increased kidney waiting time among waiting and transplanted patients, 2002

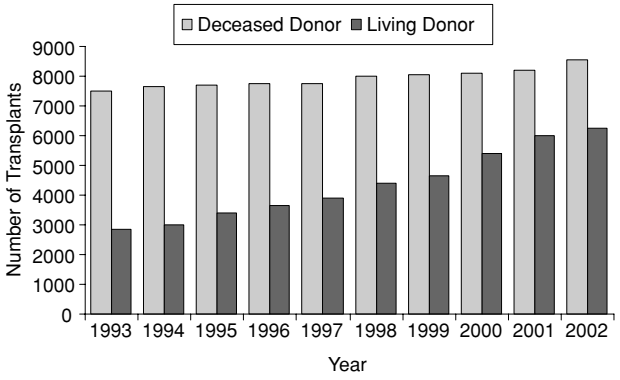
	Deceased donor		
Factor	Waiting list (%)	Recipients (non-ECD)%	Living donor transplants (%)
Age 50–64 years	40.2	37.4	30.8
Age 65 or greater	12.5	9.9	8.3
ABO Type B	16.9	12.1	12.9
African-American race	36.5	29.1	13.9
Hispanic/Latino ethnicity	15.7	14.0	12.6
Peak PRA 10–79%	19.5	21.4	14.8
Peak PRA ≥ 80%	14.0	9.9	2.7
Having received previous transplant	18.6	14.5	10.7

Source: *2003 OPTN/SRTR Annual Report*, Tables 5.1, 5.4a, 5.4c.

have slowed, with only a 4% increase in 2002. Over the decade, however, living donation has become much more common, with living donor kidney transplants increasing from 28% of kidney transplants performed in 1993 to 43% in 2002 (Figure 3).

In general, recipients in 2002 were older, with the percentages of deceased donor transplant recipients aged 50–64 years and 65 years and older having increased from 29% and 5% (1993) to 37% and 10% (2002), respectively. Among all recipients of living donor kidneys, recipients aged 50–64 years increased from 17% to 31% from 1993 to 2002, while recipients 65 years and older increased from 2% to 8%.

With the principal exceptions of retransplantation/graft failure and renovascular disease, the rank order of the etiologies of kidney failure remained relatively constant throughout the decade. Recipients listed with a primary diagnosis of retransplantation or graft failure increased from 1% to 13% of deceased donor kidney transplants, and from 0.9% to 10% of living donor transplants over the decade. The



Source: *2003 OPTN/SRTR Annual Report*, Table 1.8 .

Figure 3: Kidney transplants performed in the USA, by year and donor source, 1993–2002.

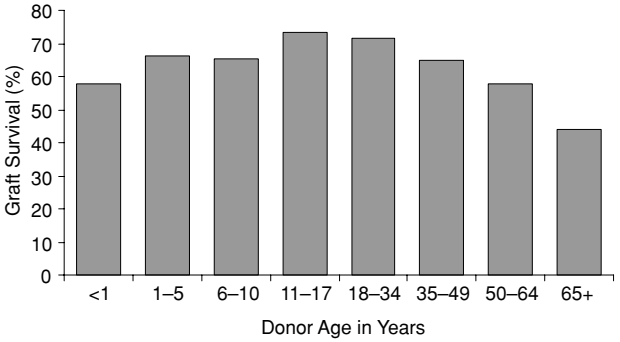
percentage with renovascular and other vascular causes increased from 0.6% to 5% of deceased donor transplants, and from 0.5% to 4% of living donor transplants.

Approximately 16% of deceased donor transplants were zero-antigen mismatched, a figure that has been stable since 1995. The vast majority of deceased donor transplants were mismatched at three or more antigens (73% in 2002). Only 4% of deceased donor and 1% of living donor transplants were performed in patients whose PRA at transplant was 80% or greater.

Concern regarding potential inequities in the current kidney allocation system has led the OPTN to modify the weight assigned to HLA identity in the kidney allocation system. In particular, African-American and Asian recipients—who suffer longer waiting times for transplantation—have been found to receive a much lower percentage of zero HLA mismatched kidneys (6% and 5% of transplants, respectively, compared to 16% for whites) and to receive relatively more kidneys with higher degrees of mismatch (61% and 69% with HLA mismatch of four or greater, respectively, compared to 46% for whites) (8). Further analysis by the SRTR showed that identity for HLA A and HLA B no longer appeared to significantly impact graft survival, and projected that elimination of HLA B from the kidney allocation system would assist in addressing the lower rate of transplantation among African-American candidates (9).

Outcomes following kidney transplantation

Mean unadjusted kidney graft survival rates progressively improved between 1992 and 2001 for recipients of first deceased donor and first living donor kidney transplants. One-year deceased donor graft survival increased from 84% in 1992 to 89% in 2001, while 1-year living donor graft survival improved from 92% to 94%. Five- and 10-year deceased donor kidney graft survival rates were 66% and 36%,



Source: *2003 OPTN/SRTR Annual Report*,Table 5.9a.
The cohort is transplants performed during the 1996-1997 year.

Figure 4: Graft survival 5 years after deceased donor kidney transplantation, by donor age.

respectively. Living donor graft survival rates reached 79% at 5 years and 55% at 10 years.

Deceased donor recipients—graft survival. Unadjusted deceased donor kidney allograft survival rates were higher among recipients who are under 50 years of age, Asian or white, and Hispanic/Latino, and were lower for those with blood type B and for individuals with prior kidney transplants. The highest unadjusted 5-year deceased donor allograft survival rates were among recipients with a primary diagnosis of polycystic kidneys (76%), neoplasm (73%), congenital and rare familial and metabolic disorders (73%), glomerular diseases (68%), or tubular and interstitial diseases (68%). Lesser unadjusted 5-year allograft survival rates were found among recipients with a primary diagnosis of retransplant/graft failure (62%), hypertension/nephrosclerosis (62%), diabetes (61%) or renovascular and other vascular diseases (60%). PRA levels below 10% at the time of transplant were associated with superior deceased donor allograft survival at each of the time intervals tested. At the fifth post-transplant year, this translated into unadjusted deceased donor allograft survival rates of 67%, 62%, and 58% for PRAs of 0–9%, 10–79%, and 80% or higher, respectively. Dialysis within the first week of transplantation was an adverse predictor of deceased donor allograft success at 3 months, 1 year, 3 years, and 5 years. By 5 years, those without post-transplant dialysis had a deceased donor allograft survival rate of 71%, whereas those who had received dialysis during the first post-transplant week demonstrated 51% survival.

Donor ages of 49 years and younger were associated with higher unadjusted deceased donor allograft survival rates. Unadjusted 5-year deceased donor allograft survival increased steadily with decreasing donor age, from a low of 44% for donors aged 65 years and older, to 58% for donors aged 50–64, to 65% at 35–49, to 72% between 18 and 34, and to 73% for donors 11–17 years old (Figure 4). Organs from the youngest pediatric deceased donors were associated with somewhat shorter survival than that seen for organs from deceased donors aged 11–17 years. Deceased donors aged 6–10, 1–5, and younger than 1 year had 5-year deceased donor allograft survival rates of 66%, 66%, and 58%, respectively. The relative risk of kidney allograft failure, adjusted for recipient age, is shown in Table 3.

The level of HLA match also influences deceased donor kidney allograft survival. By 5 years post-transplant, the highest unadjusted deceased donor allograft survival rate (72%) was seen for recipients of zero HLA mismatched kidney transplants. Intermediate 5-year deceased donor allograft survival rates of 70%, 68%, and 68% were seen with one, two, and three HLA mismatches, and the lowest rates, 63%, 61%, and 60%, were seen with four, five, and six HLA mismatched transplants, respectively. There was no consistent relationship between transplant center volume and deceased donor allograft survival rates.

Deceased donor recipients—patient survival. Unadjusted 1-year patient survival rates have remained stable over the past decade at approximately 94% for recipients of deceased donor kidneys and 97% for recipients of living donor kidneys. Five-year patient survival of deceased and living donor kidney recipients were 81% and 90%, respectively, while 10-year patient survival rates of the same categories of recipients were 58% and 77%.

Five-year unadjusted patient survival was highest for recipients younger than 35 years; survival rates fell steadily with increasing age. Asians exhibited a higher deceased donor 5-year unadjusted patient survival rate (87%) than whites (81%) and African-Americans (79%). Five-year unadjusted patient survival among those of Hispanic/Latino ethnicity (85%) was higher than that seen among those with non-Hispanic/non-Latino ethnicity (81%).

Table 3: Relative rate of graft failure for donor age, 1995–2001

Donor ages (years)	Relative risk	p value
0–17	0.97	0.35
18–44	1.00	Ref
45–54	1.31	<0.0001
55–64	1.67	<0.0001
65 +	2.33	<0.0001

42 276 deceased donor kidneys transplanted between 3/6/95 and 6/30/01, Cox proportional hazards model adjusted for NHBD, donor hypertension, donor diabetes, donor creatinine, donor race, recipient age, recipient sex, recipient race, cause of ESRD, HLA mismatch, cold ischemia time, PRA, year of transplant, ABO compatibility.
Source: SRTR analysis.

Many of the other factors that influence graft survival similarly affect patient survival. The highest unadjusted 5-year deceased donor patient survival rates were achieved by recipients with primary diagnoses of congenital and rare familial and metabolic disorders (89%), polycystic kidney disease (88%), glomerular diseases (87%), tubular and interstitial diseases (86%), and neoplasm (82%). Lesser unadjusted 5-year patient survival rates were found among recipients with primary diagnoses of renovascular and other vascular diseases (80%), hypertension/nephrosclerosis (80%), and diabetes (69%). PRA levels below 10% at the time of transplant are associated with higher deceased donor patient survival rates at each of the time intervals tested. At the fifth post-transplant year, unadjusted deceased donor patient survival rates were 81% for recipients with PRAs between 0% and 9%, and 80% and 75% for PRAs of 10–79% and 80% or higher, respectively. Dialysis within the first week of transplantation was an adverse predictor of deceased donor patient survival at each time interval. Five years following transplantation, those without dialysis had an unadjusted deceased donor patient survival rate of 83%, whereas those with dialysis in the first post-transplant week had a survival rate of 73%.

In general, organs from donors aged 49 years or younger were associated with superior unadjusted deceased donor patient survival rates. Unadjusted 5-year patient survival dropped from a range of 81–88% for recipients of kidneys from deceased donors aged 49 years or younger, to 75% for recipients of kidneys from deceased donors 50–64 years old, and to 64% for recipients of kidneys from deceased donors age 65 years or older.

Living donor recipients—graft survival. The highest unadjusted 5-year living donor allograft survival rates were demonstrated among recipients with primary diagnoses of polycystic kidneys (87%), congenital and rare familial and metabolic disorders (83%), and glomerular diseases (80%). Lesser unadjusted 5-year living donor allograft survival rates were found among recipients with primary diagnoses of diabetes (76%), retransplant/graft failure (76%), neoplasms (77%), hypertension/nephrosclerosis (73%), and renovascular and other vascular diseases (72%). PRA levels at the time of transplant that were below 10% were associated with higher living donor allograft survival at each of the time intervals tested, but differences were small by the fifth post-transplant year. Dialysis within the first week of transplantation was a strong adverse predictor of living donor allograft outcomes at each time interval. By 5 years, those without dialysis had a living donor allograft survival rate of 79%, whereas those who had required dialysis (only 6% of the sample) demonstrated 45% survival.

Pediatric unadjusted living donor 5-year allograft survival ranged from a low of 72% among recipients 11–17 years old to a high of 89% for recipients younger than 1 year old. Asians, whites, Hispanics/Latinos, and males had higher living donor kidney allograft survival at 3 years, while those with blood type B exhibited lower survival rates. Adult unadjusted 5-year allograft survival ranged from a low of 72% among recipients 65 years and older to a high of 81% for recipients 35–49 years old. Individuals with prior kidney transplants had worse unadjusted living donor allograft survival at each time point tested. At 5 years post-transplant, recipients of living donor kidney transplants who had received a prior transplant exhibited a 72% unadjusted survival rate, compared to 79% for those who had not.

The level of HLA match and the relationship between donor and recipient also influenced living kidney transplant survival. At 5 years post-transplant, the highest unadjusted living donor kidney allograft survival rate, 87%, was seen for recipients of zero HLA mismatched transplants. Among mismatched living donor kidney recipients, however, there was no relationship between the level of mismatch and 5-year allograft survival, which ranged from 76% to 80%. The highest 5-year living donor allograft survival, 82%, was seen when the donor was a sibling. Donations by parents and children resulted in identical 76% unadjusted 5-year allograft survival, while other related donors achieved a 79% success rate. Spousal and other unrelated living donation resulted in 5-year allograft survival rates of 76.7% and 77.4%, respectively.

Living donor recipients—patient survival. Five-year unadjusted patient survival among recipients of living donor kidney transplants was highest for those younger than 35 years of age. Five-year survival remained above 90% until age 50–64 years, when it dropped to 84%. There was a further decrease to 77% for those aged 65 years and older. Asians had a higher living donor 5-year unadjusted patient survival rate (94%) than whites (90%) and African-Americans (88%). The 5-year unadjusted patient survival rate among Hispanic/Latino recipients (93%) was higher than that of non-Hispanic/non-Latino recipients (90%). Unadjusted 5-year patient survival ranged from 90% (blood type O) to 94% (type AB), and was 90% for females and 91% for males.

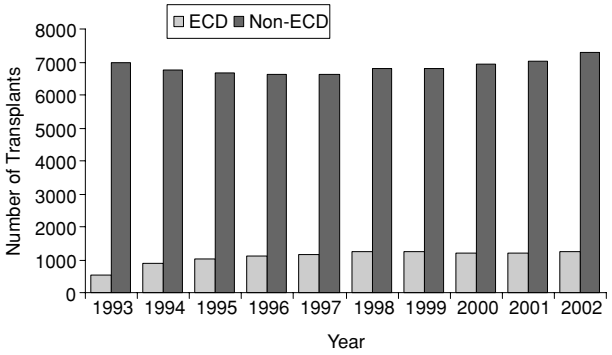
The highest unadjusted 5-year survival of recipients of living donor transplants was achieved by those with primary diagnoses of congenital and rare familial and metabolic disorders (96%), glomerular diseases (94%), polycystic kidney disease (92%), neoplasm (93%), tubular and interstitial diseases (91%), and renovascular and other vascular diseases (91%). The lowest unadjusted 5-year patient survival rates were found among recipients with primary diagnoses of hypertension/nephrosclerosis (86%), and diabetes (82%). PRA levels at the time of transplant that are below 10% were not associated with superior living donor patient survival. Dialysis within the first week of transplantation was an adverse predictor of living donor patient survival at each time interval. By 5 years, those without dialysis had an unadjusted living donor patient survival rate of 91%, whereas the patient survival of those with dialysis in the first post-transplant week was 81%.

Patient survival among recipients of zero mismatched living donor kidneys was 95% at 5 years. Five-year patient survival at other levels of mismatch ranged from 88% to 90%. As with graft survival, there was no relationship between level of HLA mismatch and patient survival among recipients of mismatched living donor kidneys. There was also no relationship between transplant center volume and living donor patient survival rates. The highest 5-year living donor patient survival, 94%, was seen when the donor was a parent. Five-year patient survival was 92% when the living donor was a sibling, 82% for living donation by an offspring, and 93% when from another category of relative. Spousal and other unrelated living donation resulted in 5-year patient survival rates of 87% and 89%, respectively.

Expanded Criteria Donor Kidney Transplantation

In an attempt to encourage and facilitate deceased donor transplantation, policies and procedures to identify and expedite the allocation of kidneys with unfavorable donor characteristics were developed and implemented by the OPTN during 2002. These expanded criteria donor (ECD) kidneys are defined as kidneys with a relative risk of graft loss of 1.7 or greater, based on a combination of donor factors including age, history of hypertension, death from cerebrovascular accident, and elevated creatinine at the time of kidney recovery (10). Using this definition, ECD kidneys constituted only 8% of deceased donor transplants in 1993, but this percentage increased to over 16% by 1996. In 2002, 15% of deceased donor transplants were performed with ECD kidneys (Figure 5). As expected, ECD kidneys had lower deceased donor allograft survival rates. Unadjusted 3-month, and 1-, 3-, and 5-year deceased donor kidney allograft survivals were 90%, 81%, 67%, and 51% for recipients of ECD kidneys, compared to 95%, 90%, 81%, and 68% for recipients of non-ECD kidneys, respectively.

The most appropriate use of expanded criteria donor kidneys continues to be debated. In 2002, patients aged 50 years or more and those with diabetic or hypertensive kidney failure were more commonly transplanted with ECD kidneys, while sensitized patients and those who had undergone kidney transplantation previously were less likely to receive them. In addition, only 8% of ECD kidneys were transplanted to zero antigen mismatched recipients, in contrast to 16% of non-ECD kidneys (Table 4). The use of ECD kidneys in older patients has become progressively more common over the past decade, with recipients 50 years of age and older now receiving 70% of ECD kidneys compared to 47% of non-ECD kidneys. It is uncertain whether this pattern of use is optimal; preliminary evidence suggests that the decrement in transplant survival between ECD and non-ECD kidneys is actually greater in older patients (11,12).



Source: *2003 OPTN/SRTR Annual Report*, Table 5.4.

Figure 5: Expanded and non-expanded criteria donor kidney transplants, 1993–2002.

Table 4: Distribution of use of expanded criteria donor kidneys, 2002

	Donor type	
Recipient factor	Non-ECD (%)	ECD (%)
Age in years		
Less than 35	20.1	7.2
65 and over	9.9	22.9
White race	64.3	60.3
Male gender	59.5	60.6
ABO Type O	43.7	46.6
Recipient of previous kidney transplant	14.5	7.2
Current PRA > 10	15.5	10.6
Peak PRA > 10	31.3	24.2
0 Antigen mismatch	15.6	8.3
Cause of kidney failure		
DM	19.9	28.2
Hypertension	16.1	22.2
Other	64.0	49.6

Source: *2003 OPTN/SRTR Annual Report,* Table 5.4.

Simultaneous Kidney-Pancreas (SPK) Transplantation

The kidney-pancreas waiting list

The number of potential recipients on the kidney-pancreas (SPK) transplant waiting list increased from 855 in 1993 to 2425 in 2002; however, the waiting list registration for SPK transplants has remained stable over the past 3 years (Figure 6). The majority of registrants were white (80%), with smaller numbers of African-Americans (18%) and Hispanic/Latino candidates (9%). The percentage of African-American candidates increased from 13% in 1999 to 18% in 2002. Since 1993, the proportion of registrations in the 18–34 year age group have declined from 35% to 23%, while the 50–64 year age group increased from 6% to 17%. In the 35–49 year age group, the proportion of candidates has remained stable at about 60% over the past decade.

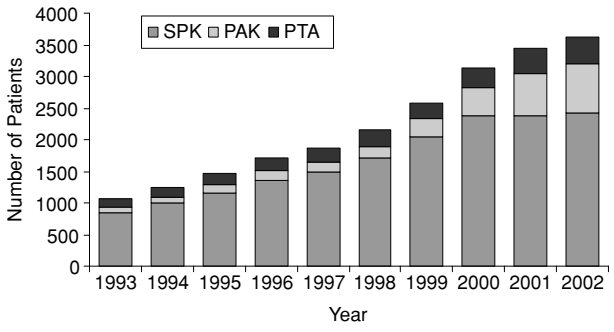
There was little change in the gender distribution of the waiting list over the decade, with 55% of candidates being male and 45% female in 2002. Twelve percent of the waiting list had received an organ previously, compared to 20% on the kidney-only waiting list.

Although more patients have been placed on the SPK waiting list, the number of SPK transplants has declined from a peak of 970 transplants in 1998 to 905 transplants in 2002. This decline may be due to the increasing numbers of pancreas after kidney (PAK) transplants during this period. The lack of increase in SPK procedures has resulted in increasing waiting times. Until 1997, the median waiting time was less than a year. Since 1997, the median waiting time has increased, reaching 491 days in 2001. Longer waiting times are associated with increasing age (584 days for those aged 50–64 years compared to 470 days for those aged 18–34 years in 2001). Whites waited a median of 468 days in 2002, less than African-American candidates (640 days) and Hispanic/Latino candidates (586 days). The median waiting time for candidates with A and AB blood types was less than a year for a SPK transplant in 2001; those with O and B blood types waited 588 days and 548 days, respectively. Previously transplanted candidates experience twice the waiting time of candidates with no previous transplants.

The death rate on the waiting list has increased slightly over the past 10 years, from 76 deaths per 1000 patient years at risk in 1993 to 86 in 2002. As expected, the risk of death on the waiting list increased with increasing age. The death rate in 2002 on the waiting list for candidates aged 18–34 years was 58/1000 patient years at risk, compared to 114/1000 patient years at risk for ages 50–64.

Kidney-pancreas transplant recipients

There has been little change in SPK recipient characteristics over the past decade; the majority of SPK recipients are white and/or male. The number of African-American SPK transplant recipients more than doubled since 1993, but still only accounted for 12% of total SPK transplants in 2002. Whites accounted for 86% of SPK transplants, down from 93% in 1993. SPK transplant recipients continued to have a significant degree of HLA mismatch, with 75% receiving organs with more than three HLA mismatches.



Source: *2003 OPTN/SRTR Annual Report*, Tables 6.1, 7.1, 8.1.

Figure 6: Patients on the pancreas waiting list, by category, 1993–2002.

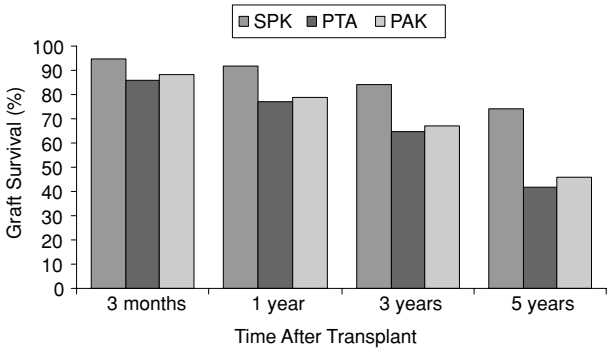
Outcomes following kidney-pancreas transplantation

Graft survival—kidney. Overall unadjusted kidney graft survival 1 and 5 years following SPK transplantation were 92% and 74%, respectively. African-Americans had poorer 5-year graft survival than whites or Asians (66%, 75%, and 82%, respectively). Kidneys from the youngest and oldest (<5 years and >50 years) donors were associated with poorer 5-year graft survival; kidneys from donors aged over 50 years had 64% 5-year graft survival compared to 77% in donors 11–35 years of age. Although few in number, donors aged 6–10 years exhibited the best 5-year graft survival (85%). High PRA, retransplantation, and HLA mismatching did not appear to be significant long-term risk factors for graft loss. Male recipient gender was associated with 6% higher kidney graft survival at 5 years compared to female gender.

Graft survival—pancreas. Overall, the unadjusted 1- and 5-year pancreas graft survival rates following SPK transplantation were 85% and 70%, respectively (Figure 7). As noted for kidney graft survival, African-Americans and recipients of organs from older donors experienced poorer 5-year graft survival. For recipients with a previous transplant, there was a 6% lower graft survival at 5 years. HLA sensitization was also associated with more pancreas graft loss at 5 years (pancreas graft survival was 70% for unsensitized recipients and 43% for recipients with a current PRA of 80% or greater).

Simultaneous kidney-pancreas recipient survival. The death rate in the first year following SPK transplant began declining in 1995, coinciding with the introduction of mycophenolate mofetil and tacrolimus immunosuppression (13). The death rate declined dramatically from 86/1000 patient years at risk in 1993 to 52/1000 patient years at risk in 1999; it has remained below 60 since then and is lower than the unadjusted death rate among wait-listed candidates. The reduction in deaths occurred despite a shift in the surgical community to more enteric drained pancreas transplants, a more technically demanding procedure (14). Risk factors that confer a higher mortality rate include increasing age, retransplantation, and PRA > 80%.

Unadjusted 1-year patient survival for SPK recipients was 95% and 5-year survival was 84%. Race, ethnicity, gender, PRA, center volume, and level of HLA mismatch were not associated with increased mortality at 5 years. Of the 8622 SPK transplants performed since 1993, 6544 patients (76%) were alive at the end of 2002.



Source: *2003 OPTN/SRTR Annual Report*, Tables 6.9, 7.9, 8.9.
Cohorts are transplants performed during 2000-2001 for 3-month and 1-year; 1998-1999 for 3-year; and 1996-1997 for 5-year survival.

Figure 7: Pancreas graft survival among pancreas transplant recipients.

Pancreas after Kidney Transplantation

Pancreas after kidney waiting list

In contrast to the SPK waiting list, the number of patients awaiting pancreas after kidney (PAK) transplantation continued to grow, increasing 16% to 781 candidates in 2002 (Figure 6). As with SPK transplants, the majority of PAK candidates were 35–49 years old, white and non-Hispanic/non-Latino. Nearly one-quarter had undergone previous pancreas transplantation. Median waiting time increased as the waiting list grew from 214 days in 1999 to 550 days in 2001. White and African-American patients experienced similar waiting times. Females, who constituted only 42% of the PAK waiting list, waited 110 days longer than males. The death rate among candidates on the PAK waiting list was much lower than that seen on the SPK list, ranging from 24.3 to 34.7 per 1000 patient years at risk from 1999 through 2002.

Pancreas after kidney transplant recipients

The number of PAK transplants also continued to increase, reaching 377 in 2002. Recipient characteristics mirrored those of candidates on the waiting list. Most recipients were 35–49 years old (62%), white (91%), non-Hispanic/non-Latino (94%), and male (58%). Twenty-one per cent had undergone previous pancreas transplantation.

Outcomes following pancreas after kidney transplantation

Graft survival. Pancreas graft survival following PAK transplantation was significantly poorer than that seen following SPK transplantation, with 1-year unadjusted graft survival of 79% falling to 46% at 5 years (Figure 7). Recipient age over 50 years and donor age over 35 years both appear to reduce graft survival. A consistent effect of HLA mismatch on graft survival was not observed.

Patient survival. Unadjusted patient survival was similar to that seen following SPK transplantation until 5 years post-transplant, when PAK was worse (77%) than SPK (84%). Older recipient and donor age were also associated with lower patient survival. Death rates during the first year after PAK transplantation were higher than that seen among wait-listed candidates, ranging from 31 to 61 per 1000 patient years between 1999 and 2002.

Isolated Pancreas Transplantation

The pancreas transplant alone waiting list

The list of candidates awaiting pancreas transplant alone (PTA) continued to show modest growth, increasing 5% to 408 in 2002. As with SPK and PAK, the majority of candidates were 35–49 years of age (60%), white (94%), and non-Hispanic/non-Latino (95%). Females, however, constituted a majority of the PTA waiting list (57%). Only 5% had previously undergone pancreas transplantation. Waiting times for PTA have tended to be relatively short. Median waiting time, which ranged from 219 to 343 days between 1999 and 2000, jumped to 501 days in 2002; the time by which 25% of candidates were transplanted increased from 62 days in 2000 to 121 days in 2001. The latter figure dropped to 59 days in 2002, however, suggesting that the prolonged waiting time seen in 2001 may have been an aberration. The death rate per 1000 patient years at risk among candidates on the PTA waiting list varied widely from year to year, ranging from 18 to 63 between 1999 and 2002.

Pancreas transplant alone recipients

The number of PTA transplants increased 8% to 175 in 2002. Recipient characteristics were similar to those of wait-listed candidates. Only five centers reported performing 10 or more PTA transplants in 2002.

Outcomes following pancreas transplant alone

Graft survival. Graft survival following PTA was similar to that seen following PAK transplantation (Figure 7). The number of cases within subgroups makes comparisons difficult but, as with PAK, there did not appear to be an effect of HLA matching on either short- or long-term unadjusted graft survival.

Patient survival. Patient survival was quite good following PTA, remaining above 90% at 3 years. Death rates during the first year post-transplant varied widely—from 0 to 39 per 1000 patient years at risk between 1999 and 2002—but have tended to be lower than those seen among wait-listed patients, which ranged from 18 to 63 per 1000 patient years at risk during the same time period.

References

1. Dickinson DM, Bryant PC, Williams MC et al. Transplant data: sources, collection, and caveats. *Am J Transplant* 2004; 4(Suppl. 9): 13–26.

2. Wolfe RA, Schaubel DE, Webb RL et al. Analytical approaches for transplant research. *Am J Transplant* 2004; 4(Suppl. 9): 106–113.
3. Mange KC, Joffe MM, Feldman HI. Effect of the use or nonuse of long-term dialysis on the subsequent survival of renal transplants from living donors. *N Engl J Med* 2001; 344: 726–731.
4. Meier-Kriesche U, Kaplan B. Waiting time on dialysis as the strongest modifiable risk factor for renal transplant outcomes: a paired donor kidney analysis. *Transplantation* 2002; 74: 1377–1381.
5. U.S. Renal Data System. USRDS 2002 Annual Data Report: Atlas of End-Stage Renal Disease in the United States. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2002.
6. Wolfe R, Ojo A, Ashby V. SRTR Final Report for the OPTN Kidney-Pancreas and Minority Affairs Committees, September 2001.
7. Distant DA, Port FK, Wolfe RA et al. Are HLA and geographic regions associated with kidney transplantation rates among wait-listed U.S. candidates by minority group? *Am J Transplant* 2002; 2 (Suppl. 3): 263.
8. Wolfe R, Ojo A, Ashby V. SRTR Final Report for the OPTN Minority Affairs Committee, April 2001.
9. Roberts JP, Wolfe RA, Bragg-Gresham JL et al. Effect of changing the priority for human leukocyte antigen (HLA) matching on kidney transplantation rates and outcomes in minority groups. *N Engl J Med* 2004; 350: 545–551.
10. Metzger RA, Delmonico FL, Feng S, Port FK, Wynn JJ, Merion RM. SRTR Report on the State of Transplantation: expanded criteria donors for kidney transplantation. *Am J Transplant* 2003; 3 (Suppl. 4): 114–125.
11. Dykstra DM, Gillespie BW, Young EW et al. Donor characteristics associated with reduced graft survival: an approach to expanding the pool of kidney donors. *Transplantation* 2002; 74: 1281–1286.
12. Merion RM, Delmonico F, Young E et al. The role of transplant recipient characteristics on graft survival for 'marginal' versus standard donor organs. *Nephrology Dialysis Transplant* 2003; 18 (Suppl. 4): 800.
13. Helderman JH, Bennett WM, Cibrik DM, Kaufman DB, Klein A, Takemoto SK. Immunosuppression: practice and trends. *Am J Transplant* 2003 (Suppl. 4); 3: 41–52.
14. Gruessner AC, Sutherland DER. Pancreas transplant outcomes for United States (US) and non-US cases as reported to the United Network for Organ Sharing (UNOS) and the International Pancreas Transplant Registry (IPTR) as of October 2002. In: Cecka JM, Terasaki PI (eds). Clinical Transplants 2002. Los Angeles: UCLA Immunogenetics Center 2003: 41–77.