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OPTN/SRTR 2011 Annual Data Report: pancreas

ABSTRACT Numbers of pancreas transplants have been decreasing over the past decade, but outcomes continue to improve for all types: simultaneous pancreas-kidney transplant, pancreas after kidney transplant (PAK), and pancreas transplant alone (PTA). The most notable decrease occurred for PAK transplants, possibly due in part to decreases in numbers of living donor kidney transplants. The number of new candidates on the pancreas transplant waiting list has decreased steadily since 2000; only 1005 active candidates were added in 2011. Transplant rates for all pancreas transplant types reached a low in 2011 of 34.9 transplants per 100 wait-list years. Deceased donation rates have also been decreasing since 2005, but use of donation after circulatory death has been gradually increasing. The discard rate in 2011 was 27.7%, and higher for pancreata recovered from older donors. Improved outcomes during the early posttransplant period largely reflect improved donor and recipient selection and improved technical strategies. Inconsistent definitions of graft failure across reporting centers creates an ongoing challenge in the interpretation of outcome data for pancreas transplants. Rates of posttransplant re-hospitalization are high, most occurring in the first 6 months. Rejection rates are highest for PTA recipients, who also experience higher incidence of posttransplant lymphoproliferative disorder.

KEY WORDS Diabetes mellitus, pancreas transplant, transplant outcomes, transplant waiting list.

A second chance in life is the greatest gift I'll ever receive. My donor – he still lives inside of me. His legacy lives on. And he's never forgotten.

Cherilyn, kidney/pancreas recipient

Introduction

Pancreas transplant remains a viable option for beta cell replacement in insulin-dependent diabetes mellitus, mostly type 1. Although the number of pancreas transplants has been decreasing in the past decade, outcomes continue to improve for all groups of pancreas transplant: simultaneous pancreas-kidney transplant (SPK) and solitary pancreas transplant (pancreas after kidney transplant [PAK] and pancreas transplant alone [PTA]). The improving outcomes are mainly due to improvements in immunosuppression, surgical technique, and donor-recipient selection.

The decrease in the number of pancreas transplants is partly attributable to improved insulin delivery systems, concerns about outcomes after solitary pancreas transplant (1), and potentially a renewed interest in islet transplant. Even though isolated reports suggest that 5-year islet transplant outcomes at a single center have matched pancreas transplant outcomes, the current consensus seems to be that pancreas transplant is superior to islet transplant in efficiency and durability. This view may change in the future, resulting in more islet transplants being performed.

The most notable decrease in pancreas transplants occurred in the PAK group. This could be partially due to a decrease in the number of living donor kidney transplants. Pancreas survival after PAK clearly lags behind pancreas survival in SPK, although the kidney survival benefit in PAK (usually performed with a living donor kidney) may offset this disadvantage.

The decrease in PAK transplants may be mitigated by changes in national policy when implemented by the Organ Procurement and Transplantation Network (OPTN). This national policy was approved by the OPTN Board of Directors in November 2010. A combined pancreas list for SPK and solitary pancreas transplant (PAK and PTA) will give equal priority to SPK and solitary pancreas candidates within locality, HLA mismatch, calculated panel reactive antibody (CPRA) division, and waiting time.

A detailed analysis of pancreas transplant trends over the past decade is presented in the following sections.

Waiting List

Over the past decade, the number of new candidates on the pancreas waiting list showed an increasing trend until 2000, after which it decreased steadily until 2011, when only 1,005 candidates joined the waiting list as active candidates (Figure 1.1). The proportion of older candidates (aged 50 to 64 years) has gradually increased, with a corresponding decrease in the proportion of younger candidates (aged 18 to 34 years) (Figure 1.2). The percentage of white candidates (67.4% in 2011) has decreased, with a corresponding increase in the percentage of black candidates (17.8% in 2011). The percentage of candidates reported to have type 2 diabetes has remained stable (8.0% in 2010 and 2011). The percentage of obese candidates (body mass index [BMI] > 30 kg/m^2) is gradually increasing, in keeping with national trends in the general population. Although relatively fewer candidates are on the waiting list, time on the waiting list has gradually increased over the past decade. Whether this is due to more restrictive acceptance criteria or the effect of redundancy on the waiting list is yet to be determined (Figure 1.2).

The distribution of newly listed candidates is similar to that of all candidates on waiting list (Figures 1.2, 1.3). With the introduction of the CPRA measure, the proportion of candidates with a CPRA of less than 1% has increased to approximately 80% in the past 2 years (Figure 1.3).

The transplant rates for all three pancreas transplant groups have decreased over the past few years, to an overall low in 2011 of 34.9 transplants per 100 wait-list years (PTA, 29.2 transplants per 100 wait-list years; SPK, 41.8; PAK, 16.7) (Figure 1.4).

In 2011, 106 living donor kidney transplants were performed in SPK wait-listed candidates, down from 143 in 2009 and 138 in 2010 (Figure 1.5). This is consistent with the overall decrease in living donor kidney transplants in 2011 (see kidney chapter).

Outcomes for candidates on the waiting list over a 3-year follow-up period (from the time of listing) are shown in Figure 1.6. Median time to transplant for active candidates in 2010 was 7.2 months for PTA, 12.3 months for SPK, and 10.1

months for PAK. This is shorter than the overall waiting time (for active and inactive candidates) shown in Figure 1.7, especially in the PAK group, where inactive candidates are on the list for a longer time.

The geographic variation by donation service area (DSA) in waiting times for SPK is similar to that for kidney transplant (Figure 1.11 in kidney chapter). Local organ procurement organization (OPO) practices allowing for SPK prioritization for kidney allocation play a role in this overall geographic variation. A universal SPK and PTA allocation policy approved by OPTN in November 2010 is pending implementation. In brief, the combined pancreas list will treat SPK, PAK, and PTA candidates equally. This may eliminate variation caused by geographic practices in allocation policy.

Donation

Deceased donor pancreas donation rates have been decreasing since 2005. In 2010, the overall rate reached a low for the past decade of 2.4 donors per 1,000 deaths (Figure 2.1). However, the donation rate for donors aged 15 to 34 years has remained unchanged in the past 5 years, at approximately 15 donors per 1,000 deaths. Unadjusted geographic heterogeneity in donation rates is substantial (Figure 2.2). Pancreas recovery rate per donor remains low. In 2011, pancreata were recovered from 19% of all organ donors but only 13% were transplanted (Figure 2.3). This includes donors of all age groups and with all comorbid conditions (such as diabetes), so the true denominator for suitable pancreas donors is presumably lower.

Approximately 79% of pancreata were part of a multi-visceral transplant in 2011, with 74% being kidney-pancreas transplants (Figure 2.4).

The overall discard rate for pancreata recovered was 27.7% in 2011; the highest rate (81.3%) was for pancreata recovered from donors aged 50 years or older (Figure 2.5). The pancreas donor risk index has been steadily decreasing over the past decade, with a notable part of the decrease attributable to shorter cold ischemia times (Figures 2.7, 2.8). Only donors whose pancreata were transplanted are considered in these calculations. The percentage of donation after circulatory death (DCD) donors has remained relatively steady in the past 7 years, at approximately 3.5% (Figure 2.9).

Anoxic brain injury as a cause of death has been steadily increasing, reaching a rate of 21.1% in 2011, with a corresponding decrease in head trauma to 61.3% (Figure 2.10).

Transplant

The number of pancreas transplants has decreased every year since 2004; 1,051 pancreas transplants were performed in 2011. The greatest percentage decrease has been for PAK, followed by SPK and PTA (Figure 3.1). The decrease in PAKs has become the focus of discussion at meetings of the OPTN Pancreas Transplantation Committee in recent years, with recognition that the decrease may be partly attributable to the decrease in living donor kidney donation rates. In addition, variation across OPOs that allows for preferential allocation of pancreata to SPK candidates may likely be a factor.

Looking at subgroups of transplant recipients, the decrease in transplant numbers is noted to be greatest in the most prevalent demographic groups. The greatest decreases have been among recipients aged 35 to 49 years, recipients of white race, recipients with a BMI of 18.5 to 24.9 kg/m^2, and recipients with type 1 diabetes (Figure 3.2).

Over the past decade, pancreas transplant rates for waitlisted candidates have steadily decreased (Figure 3.3). Use of DCD donors has been gradually increasing. In 2011, approximately 3.1% of transplants were from DCD donors, with the highest percentage in SPK (3.5%) and the lowest in PAK (0.9%) (Figure 3.5). Geographically, transplant rates and use of DCD donors varied widely (Figures 3.6, 3.7).

The characteristics of patients undergoing pancreas transplant in 2011 are summarized in Figure 3.8. Approximately 55% of all transplants were performed in patients aged 35 to 49 years. Women predominated in the PTA group, but not in SPK or PAK. Approximately 25% of PTAs were performed for causes other than diabetes or unknown. It is unclear whether this is due to missing data or whether PTAs are being performed in

substantial numbers for other reasons, such as surgical diabetes or disabling exocrine failure. In 2011, private insurance covered 66.7% of PTAs, 42.0% of SPKs, and 48.3% of PAKs. In contrast, Medicare covered only 22.5% of PTAs, but 49.3% of SPKs and 45.6% of PAKs. Re-transplants constituted 5.3% of all pancreas transplants, but 22.8% of PAK transplants.

Donor-Recipient Matching

The percentage of unsensitized recipients (0% PRA) has been decreasing gradually; 62.4% were unsensitized in 2011 (Figure 4.1).

HLA trends for pancreas transplants showed that the percentage of highly mismatched transplants (5 or 6 mismatches) has been increasing over the past few years across all groups (Figure 4.2). However, that trend changed in the PTA group in 2011, with an increase in better-matched patients (0 to 4 mismatches) compared with 2010. Whether better matching in this group is a one-time observation or the start of a trend remains to be seen.

Donor-recipient virology data were analyzed for 2007-2011. Overall, the virology results were similar to those reported for 2005-2009 in the OPTN/SRTR 2010 Annual Data Report; however, the percentage of donors positive for the Epstein-Barr virus (EBV) increased from 61.2% in 2005-2009 to 89.1% in 2007-2011. The percentage of high-risk transplants (D+/R-) was 14.0% (Figure 4.7).

Cytomegalovirus analysis showed that high-risk transplants (D+/R-) accounted for 27.8% of all transplants (Figure 4.6).

Donors positive for hepatitis B virus, hepatitis C virus, and human immunodeficiency virus (HIV) were extremely rare. Only 0.7% of donors were positive for hepatitis B core antibody compared with 3.2% of recipients; 3.2% of recipients were positive for hepatitis C virus, and 0.2% were positive for HIV (Figures 4.8, 4.10, 4.11).

Outcomes

Despite the decreasing number of pancreas transplants being performed nationally, the overall success for the procedure continues to improve in all three categories (Figure 5.1). Improvements during the early post-transplant period largely reflect improved donor and recipient selection, as well as improved technical strategies. The greatest improvement in graft survival within the first 6 weeks after transplant has been in the PTA category. Continued improvements in the technical strategies used with these patients can be attributed in part to a better understanding of anticoagulation strategies in a non-uremic state. The pancreas transplant community is in general consensus that anticoagulation strategies are essential during the perioperative periods in non-uremic recipients. Specific anticoagulation strategies continue to evolve and remain variable between centers. These strategies take into account the risk-to-benefit ratio of clotting (allograft thrombosis) versus bleeding but are not tracked in the OPTN and SRTR database.

An ongoing challenge in the interpretation of the outcome data for pancreas transplant results from the fact that the definition of what constitutes a graft failure is not consistent across reporting centers. Some centers report as a graft failure any return to the use of agents directed at managing hyperglycemia; other centers report a graft failure only when the recipient returns to pre-transplant levels for 24-hour insulin requirements. Although insulin independence is the gold standard by which most centers report graft failure, this definition needs to be standardized across all centers to allow accurate interpretation of graft survival data. Keeping this in mind, graft failure at 5 years for PTA and PAK is 40% to 50%, whereas the 5-year failure of the pancreas graft in SPK remains less than 20% (Figures 5.2, 5.3, 5.5). The better long-term results for SPK versus PAK and PTA undoubtedly represent the difficulty of detecting rejection in the absence of a simultaneously transplanted kidney. Detection of an early rejection episode is more likely in SPK, since an elevation in serum creatinine is a strong marker that will trigger a further work-up for rejection. In PAK and PTA, such a surrogate marker for pancreas rejection is unavailable. As a result, serum hyperglycemia is frequently the first warning for pancreas allograft rejection, and by that late time the function of the pancreas allograft has been irreversibly compromised.

The 5-year kidney graft survival rate for SPK recipients continues to improve. For SPK transplants performed in 2005, the adjusted 5-year kidney graft failure dropped below 20% and rose only slightly for transplants in 2006 (Figure 5.4). The excellent long-term results for kidneys transplanted simultaneously with a pancreas are in part related to the highly selected nature of SPK deceased donors. In addition, early rejection episodes in SPK recipients have decreased markedly in the past decade (Figure 5.1); for SPKs performed in 2005-2009, the incidence of rejection by the first 12 months is 16% (Figure 5.10). Kidney graft failure or death after a PAK transplant has steadily decreased. Five-year kidney graft failure after a pancreas transplant is less than 20% (Figure 5.6). Both kidney and pancreas graft failures are predictive of patient death after PAK. However, kidney graft failure is a stronger predictor for death; therefore, preservation of kidney function after PAK is critically important.

Patients with either type 1 or type 2 diabetes are candidates for pancreas transplant, but less than 10% of adult candidates waiting for a pancreas transplant are characterized as type 2. The characterization as type 1 or type 2 diabetes is reported by the institution, but no strict data requirements (i.e., detectability of c-peptide) are required for this classification. Despite this lack of strict definition, it is interesting that graft survival using unadjusted Kaplan-Meier methods shows no great differences at 5 years, with pancreas graft survival approximating 70% in both type 1 and type 2 diabetic recipients (Figure 5.7). Again, these data must be interpreted in the context that pancreas graft survival may be defined differently for type 1 versus type 2 diabetic recipients, and illustrates the need for universal definitions and standards for reporting pancreas allograft failure.

The challenges of pancreas transplant are reflected in the very high rates of re-hospitalization among adults who underwent a pancreas transplant in 2006-2011. Most of these hospitalizations occurred within the first 6 months after the transplant (Figure 5.11). Pancreas transplant is associated with higher incidences of rejection compared with kidney transplant, reflecting the relatively high immunogenicity of the pancreas allograft (Figure 6.9 in kidney chapter). Figure 5.10 shows that PTA recipients have the highest incidence of rejection. This relates in part to their healthier overall state and ability to mount a strong immune response as compared with the uremic recipients of SPK. The higher immunosuppression requirements associated with PTA are reflected in the markedly higher incidence of post-transplant lymphoproliferative disorder (PTLD) in this category of recipients (Figure 5.12). The incidence of PTLD is higher in all EBV-negative recipients; more than 6% of PTA recipients in this group were diagnosed with PTLD within 18 months of pancreas transplant.

Immunosuppression

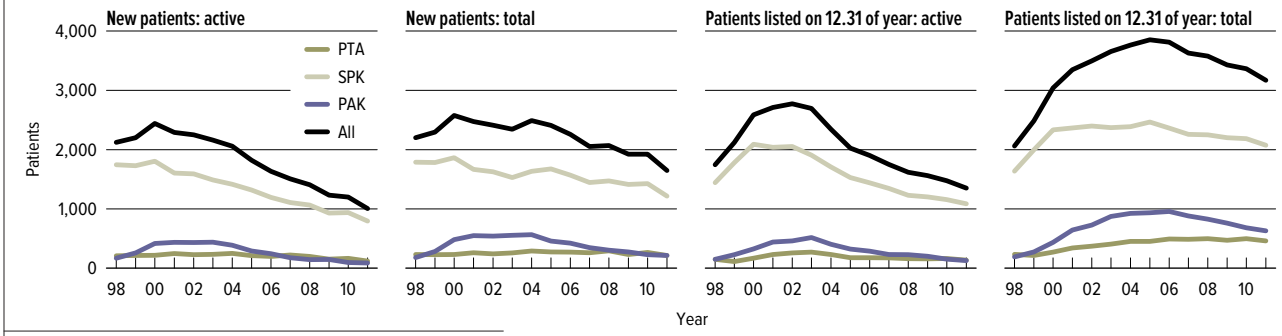
Pancreas allografts have always been regarded as highly immunogenic, perhaps related to the need to overcome both the alloimmune and autoimmune responses. Recognition of the high degree of immunogenicity is evidenced by the fact that T-cell depleting induction agents were used in more than 70% of pancreas transplants performed in 2011 (Figure 6.2). Despite the known toxicity of tacrolimus to beta cells, the combination of tacrolimus and mycophenolate mofetil (MMF) has become the heavily favored maintenance regimen (Figure 6.3).

The issue of steroid-free regimens remains controversial, although the data suggest that approximately 40% of pancreas transplant recipients are on regimens that avoid steroids. Despite the fact that mammalian target of rapamycin (MTOR) inhibitors were reported to have less toxicity to the kidney and beta cells, routine use of these agents in maintenance regimens was reported in less than 20% of pancreas transplants at discharge and 1 year after the transplant (Figure 6.4).

Reference

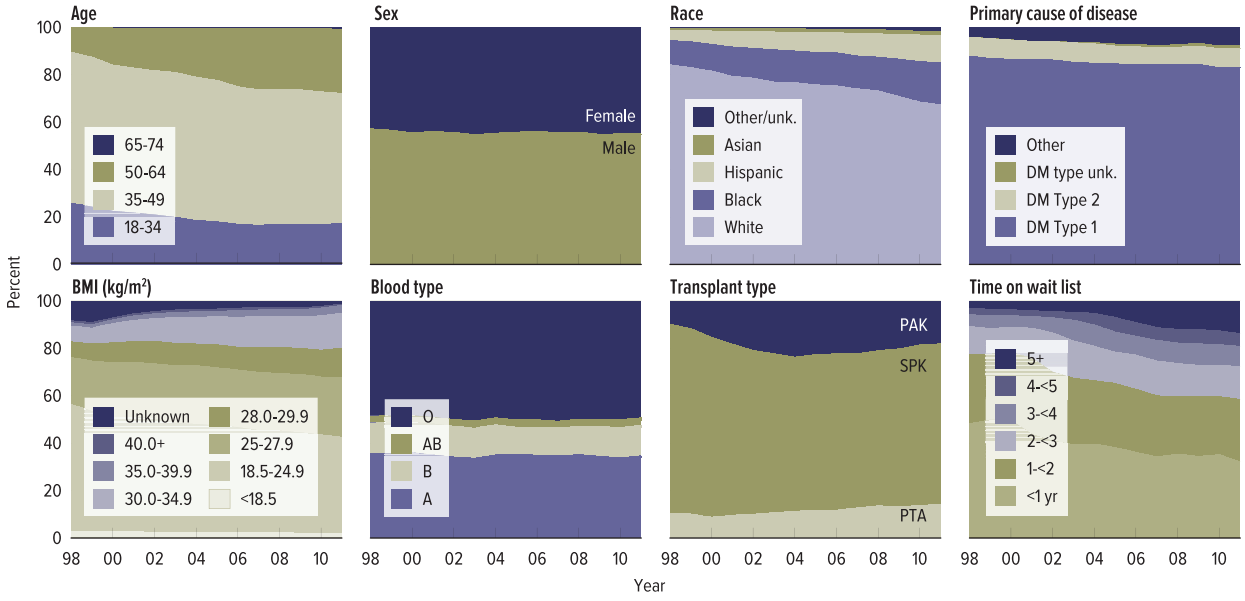
1. Venstrom J, McBride M, Rother K, Hirshberg B, Orchard T, Harlan D. Survival after pancreas transplantation in patients with diabetes and preserved kidney function. JAMA 2003; 290: 2817-2823.

wait list



PA 1.1 Adult patients waiting for a pancreas transplant

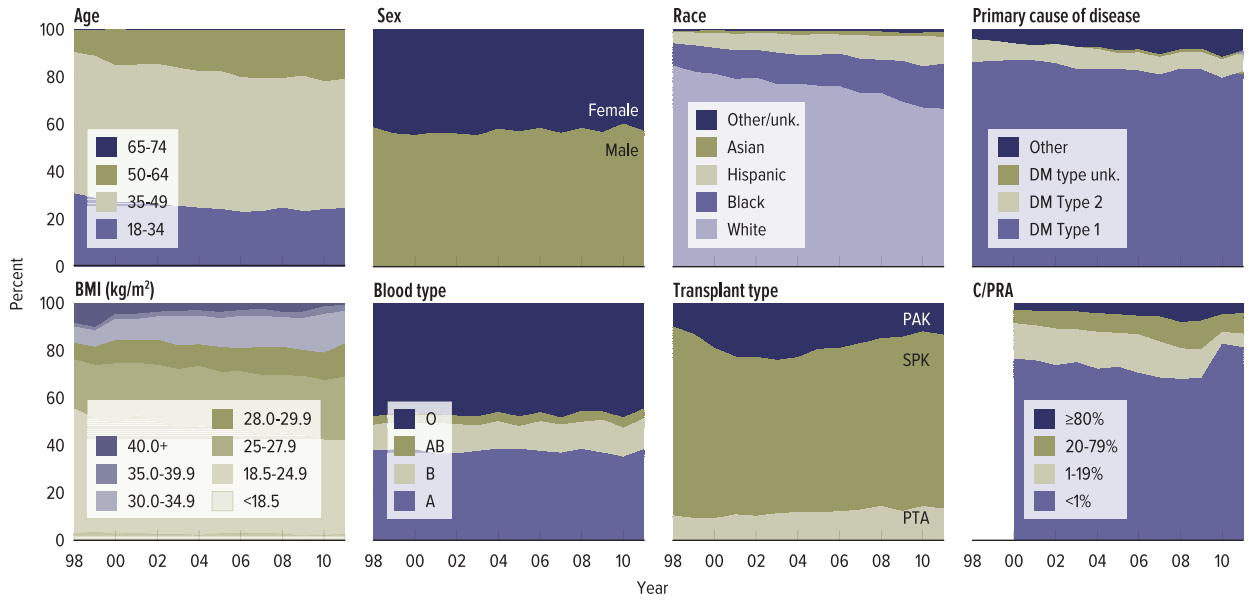
Patients waiting for a transplant. A "new patient" is one who first joins one of the three lists during the given year, without having listed in a previous year. However, if a patient has previously been on the list, has been removed for a transplant, and has relisted since that transplant, the patient is considered a "new patient." Patients concurrently listed at multiple centers or on more than one list are counted only once. Those with concurrent listings and active at any program are considered active; those inactive at all programs at which they are listed are considered inactive.



PA 1.2 Distribution of adult patients waiting for a pancreas transplant

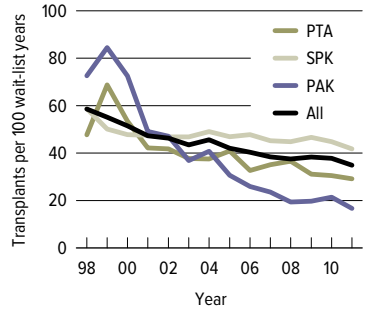
Patients waiting for a transplant any time in the given year. Age determined on the earliest of listing date or December 31 of the given year. Concurrently listed patients are counted once.

wait list



PA 1.3 Distribution of adult patients newly listed for a pancreas transplant

A newly listed patient is one who first joins one of the three lists during the given year, without having listed in a previous year. However, if a patient has previously been on the list, has been removed for a transplant, and has relisted since that transplant, the patient is considered a newly listed patient. Patients concurrently listed at multiple centers and/or on multiple lists are counted only once. C/PRA is the peak observed for that candidate during the listing.



PA 1.4 Pancreas transplant rates among adult waiting list candidates

Patients waiting for a transplant; age as of January 1 of the given year. Yearly period-prevalent rates computed as the number of deceased donor transplants per 100 patient years of waiting time in the given year within each list. All waiting time per patient per listing is counted, and all listings that end in a transplant for the patient are considered transplant events.

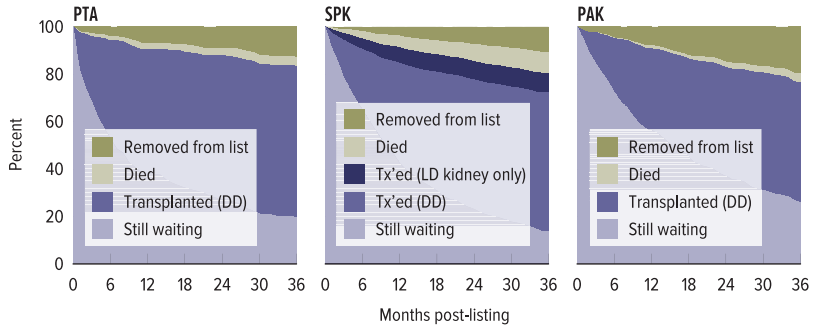
	PTA			SPK			PAK		
	2009	2010	2011	2009	2010	2011	2009	2010	2011
Patients at start of year	499	471	496	2,276	2,232	2,209	839	763	682
Patients added during year	232	267	212	1,391	1,385	1,179	273	225	216
Patients removed during year	260	241	245	1,434	1,405	1,312	349	306	267
Patients at end of year	471	497	463	2,233	2,212	2,076	763	682	631
Removal reason									
Deceased donor transplant	157	152	142	912	875	834	162	156	115
Living donor kidney transplant	-	-	-	143	138	106	-	-	-
Patient died	18	24	18	181	197	147	30	23	23
Patient refused transplant	18	5	23	11	11	10	24	15	25
Condition improved, tx not needed	7	2	9	14	12	13	5	3	4
Too sick to transplant	7	14	15	65	85	81	27	33	34
Changed to kidney-pancreas list	1	1	-	-	-	-	2	-	1
Other	52	43	38	108	87	121	99	76	65

PA 1.5 Pancreas transplant waiting list activity among adult patients

Patients with concurrent listings at more than one center are counted once, from the time of earliest listing to the time of latest removal. Patients listed, transplanted, and re-listed are counted more than once. Patients are not considered "on the list" on the day they are removed. Thus, patient counts on January 1 may be different from patient counts on December 31 of the prior year.

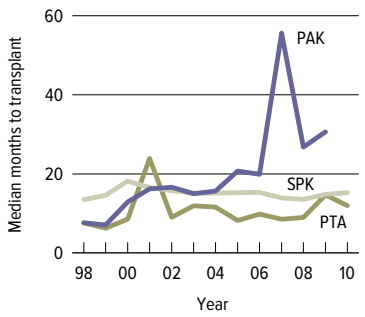
data behind the figures can be downloaded from our website, at www.srtr.org

wait list



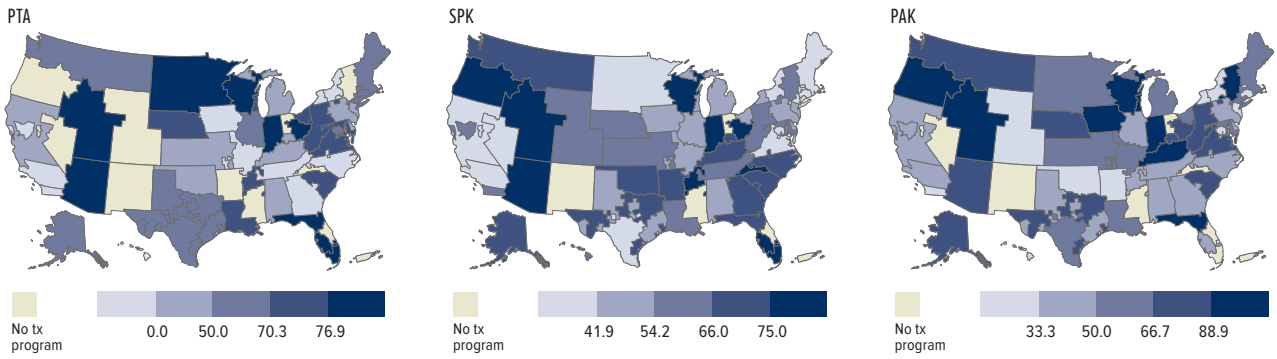
PA 1.6 Outcomes for adult patients waiting for a pancreas transplant among new listings in 2008

Patients waiting for a transplant and first listed in 2008. Patients with concurrent listings at more than one center are counted once, from the time of the earliest listing to the time of latest removal.



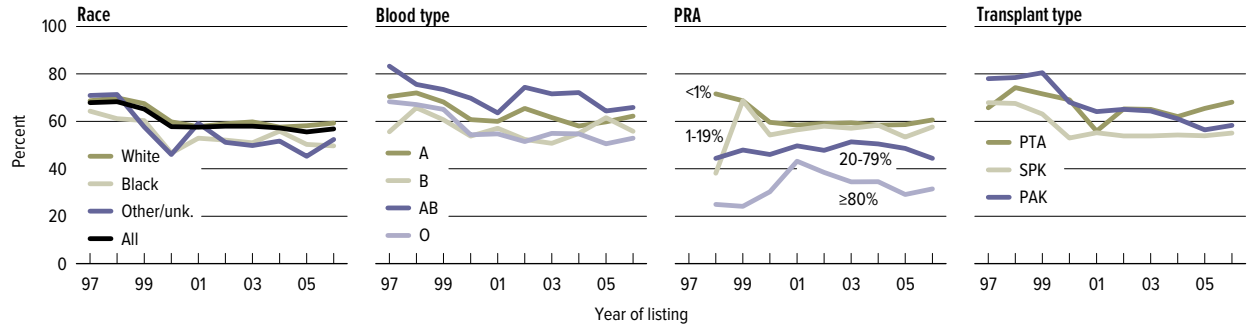
PA 1.7 Median months to pancreas transplant for wait-listed adult patients

Patients waiting for a transplant, with observations censored at December 31, 2011; Kaplan-Meier method used to estimate time to transplant. If an estimate is not plotted for a certain year, 50% of the cohort listed in that year had not been transplanted at the censoring date. Only the first transplant is counted.



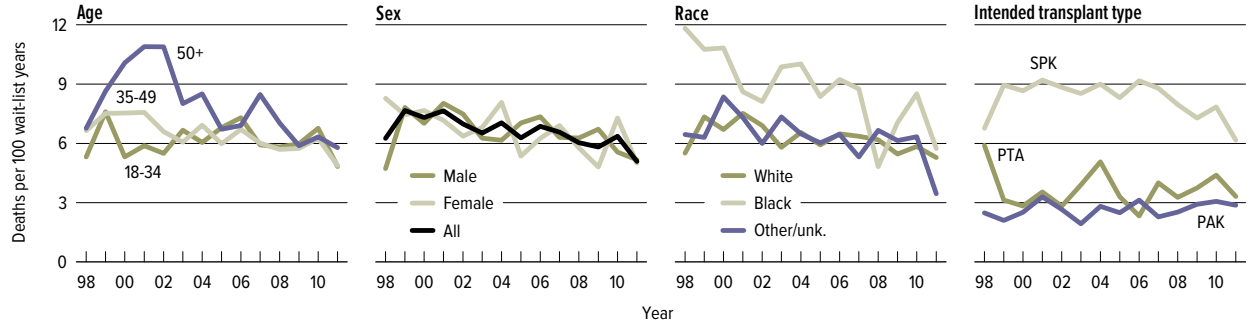
PA 1.8 Percent of adult wait-listed patients, 2006, who received a deceased donor pancreas transplant within five years, by DSA

Patients with concurrent listings in a single DSA are counted once in that DSA, and those listed in multiple DSAs are counted separately per DSA.



PA 1.9 Adult wait-listed patients who received a deceased donor pancreas transplant within five years

Patients with concurrent listings at more than one center are counted once, from the time of earliest listing to the time of latest removal. Patients listed, transplanted, and re-listed are counted more than once.



PA 1.10 Pre-transplant mortality rates among adult patients wait-listed for a pancreas transplant

Patients waiting for a transplant. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. For rates shown by different characteristics, waiting time is calculated as the total waiting time in the year for patients in that group. Only deaths that occur prior to removal from the waiting list are counted. Age is calculated on the latest of listing date or January 1 of the given year. Other patient characteristics come from the OPTN Transplant Candidate Registration form.

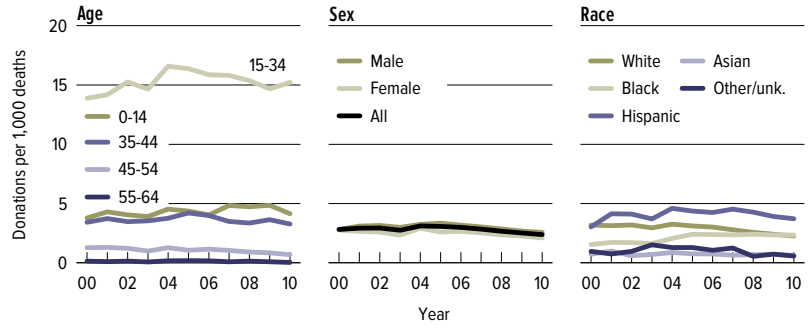
wait list

		2001						2011					
	Level	PTA N	%	SPK N	%	PAK N	%	PTA N	%	SPK N	%	PAK N	%
Age	18-34	81	23.7	548	22.8	126	19.0	89	19.2	397	19.1	62	9.8
	35-49	217	63.5	1469	61.0	420	63.4	221	47.7	1,224	59.0	365	57.8
	50-64	43	12.6	383	15.9	114	17.2	146	31.5	450	21.7	200	31.7
	65+	1	0.3	7	0.3	2	0.3	7	1.5	5	0.2	4	0.6
Sex	Male	148	43.3	1,356	56.3	388	58.6	190	41.0	1,168	56.3	354	56.1
	Female	194	56.7	1,051	43.7	274	41.4	273	59.0	908	43.7	277	43.9
Race	White	315	92.1	1,776	73.8	564	85.2	383	82.7	1,274	61.4	472	74.8
	Black	14	4.1	385	16.0	52	7.9	30	6.5	468	22.5	76	12.0
	Hispanic	12	3.5	197	8.2	36	5.4	40	8.6	261	12.6	70	11.1
	Asian	0	0.0	37	1.5	7	1.1	4	0.9	38	1.8	11	1.7
	Other/unknown	1	0.3	12	0.5	3	0.5	6	1.3	35	1.7	2	0.3
Primary cause	Diabetes Type 1	314	91.8	2,052	85.3	593	89.6	393	84.9	1,694	81.6	568	90.0
of disease	Diabetes Type 2	11	3.2	220	9.1	22	3.3	14	3.0	196	9.4	39	6.2
	Diabetes type unk.	0	0.0	1	0.0	2	0.3	1	0.2	27	1.3	13	2.1
	Other cause/unk.	17	5.0	134	5.6	45	6.8	55	11.9	159	7.7	11	1.7
Transplant	Listed/first tx	314	91.8	2,290	95.1	515	77.8	401	86.6	1,913	92.1	457	72.4
history	Listed/subseq. tx	28	8.2	117	4.9	147	22.2	62	13.4	163	7.9	174	27.6
Blood type	A	122	35.7	722	30.0	265	40.0	173	37.4	662	31.9	241	38.2
	B	43	12.6	344	14.3	76	11.5	50	10.8	297	14.3	68	10.8
	AB	6	1.8	54	2.2	24	3.6	9	1.9	52	2.5	23	3.6
	O	171	50.0	1,287	53.5	297	44.9	231	49.9	1,065	51.3	299	47.4
PRA	<1%	227	66.4	1,455	60.4	312	47.1	271	58.5	1,212	58.4	270	42.8
	1-<80%	95	27.8	741	30.8	296	44.7	104	22.5	519	25.0	247	39.1
	80-100%	20	5.8	209	8.7	46	6.9	88	19.0	345	16.6	114	18.1
Time on list	<1 year	169	49.4	1,143	47.5	372	56.2	140	30.2	832	40.1	167	26.5
	1-<2	64	18.7	717	29.8	173	26.1	86	18.6	505	24.3	96	15.2
	2-<3	35	10.2	279	11.6	49	7.4	54	11.7	267	12.9	85	13.5
	3-<4	24	7.0	112	4.7	17	2.6	41	8.9	158	7.6	65	10.3
	4-<5	17	5.0	68	2.8	8	1.2	24	5.2	103	5.0	57	9.0
	5+	33	9.6	88	3.7	43	6.5	118	25.5	211	10.2	161	25.5
BMI (kg/m^2)	<18.5	8	2.3	64	2.7	14	2.1	13	2.8	32	1.5	10	1.6
	18.5-24.9	187	54.7	1,153	47.9	293	44.3	192	41.5	836	40.3	241	38.2
	25.0-27.9	77	22.5	535	22.2	168	25.4	109	23.5	522	25.1	163	25.8
	28.0-29.9	20	5.8	217	9.0	58	8.8	52	11.2	252	12.1	87	13.8
	30.0-34.9	20	5.8	238	9.9	60	9.1	66	14.3	325	15.7	96	15.2
	35.0-39.9	5	1.5	55	2.3	13	2.0	19	4.1	71	3.4	20	3.2
	40.0+	4	1.2	20	0.8	6	0.9	3	0.6	17	0.8	2	0.3
	Unknown	21	6.1	125	5.2	50	7.6	9	1.9	21	1.0	12	1.9
Total		342	100.0	2,407	100.0	662	100.0	463	100.0	2,076	100.0	631	100.0

PA 1.11 Characteristics of adult patients on the pancreas transplant waiting list on December 31, 2001 & December 31, 2011

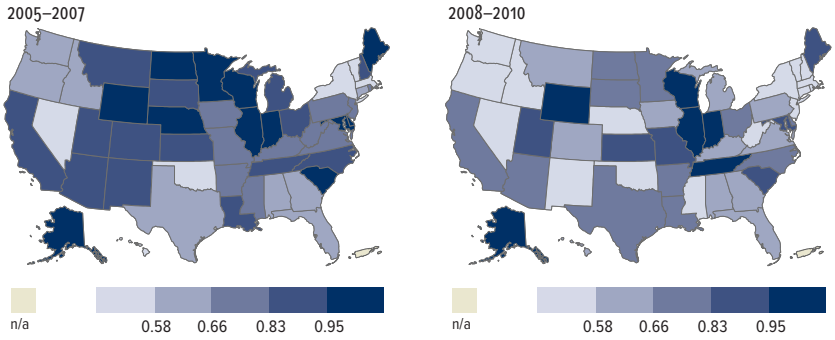
Patients waiting for a transplant on December 31, 2001 and December 31, 2011, regardless of first listing date; active/inactive status is on this date, and multiple listings are not counted.

donation



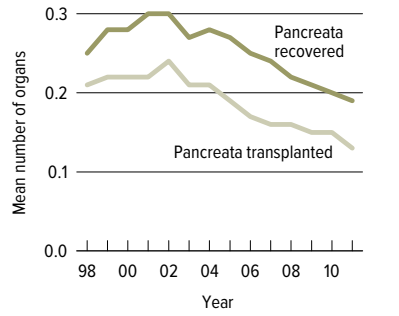
PA 2.1 Deceased donor pancreas donation rates

Numerator: Deceased donors age less than 65 whose pancreas was recovered for transplant. Denominator: US deaths per year, age less than 65. (Death data available at http://www.cdc.gov/nchs/products/nvsr.htm.)



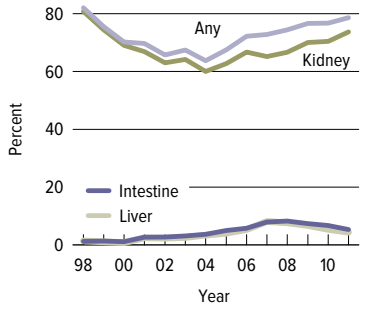
PA 2.2 Deceased donor pancreas donation rates (per 1,000 deaths), by state

Numerator: Deceased donors residing in the 50 states whose pancreas was recovered for transplant in the given year range. Denominator: US deaths by state during the given year range (death data available at http://www.cdc.gov/nchs/products/nvsr.htm). Rates are calculated within ranges of years for more stable estimates.



PA 2.3 Pancreata recovered per donor & pancreata transplanted per donor

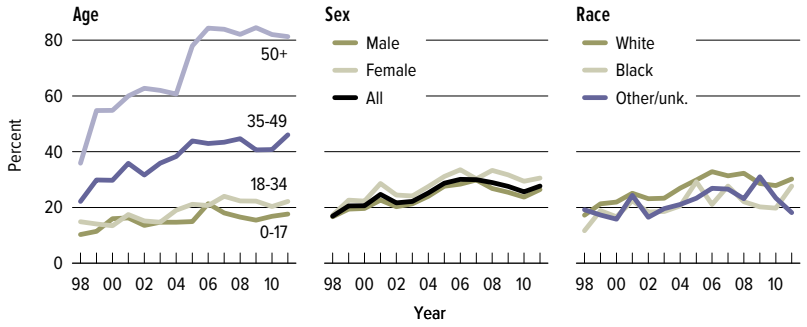
Denominator: all deceased donors with at least one organ of any type recovered for transplant. Numerator for recovery rate: number of pancreata recovered for transplant in the given year; pancreata recovered for other purposes are not included. Numerator for transplant rate: all deceased donor pancreata transplanted in given year.



PA 2.4 Deceased donor pancreata transplanted with another organ

All patients receiving a deceased donor pancreas transplant. A transplant is considered multi-organ if any organ of a different type is transplanted at the same time. A multi-organ transplant may include more than two different organs in total; if so, each non-pancreas organ will be considered separately.

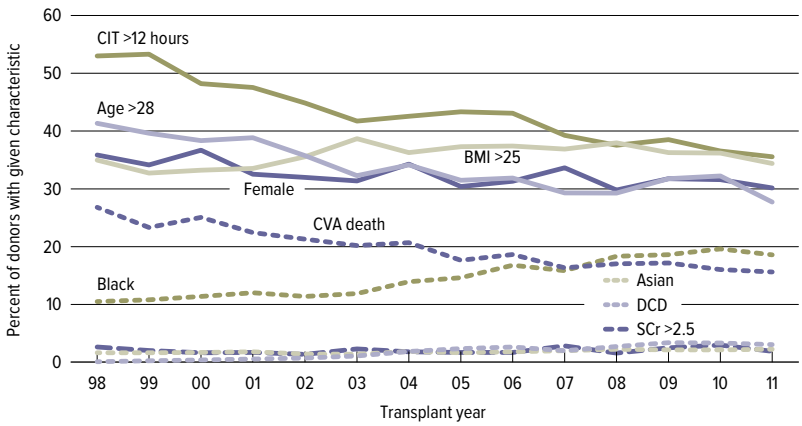
donation



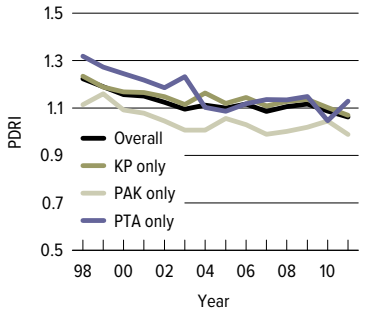
PA 2.5 Discard rates for pancreata recovered for transplant
Percent of pancreata discarded out of all pancreata recovered for transplant.

Reasons for discard	Percent	N
Other, specify	37.95	159
Anatomical abnormalities	18.38	77
No recipient located - list exhausted	10.74	45
Poor organ function	6.68	28
Diseased organ	6.21	26
Too old on ice	3.82	16
Organ trauma	3.10	13
Vascular damage	3.10	13
Recipient determined to be unsuitable	2.39	10
Donor medical history	2.15	9
Organ not as described	1.43	6
Warm ischemic time too long	1.43	6
Biopsy findings	1.19	5
Donor social history	0.72	3
Infection	0.24	1
Missing	0.24	1
Positive hepatitis	0.24	1

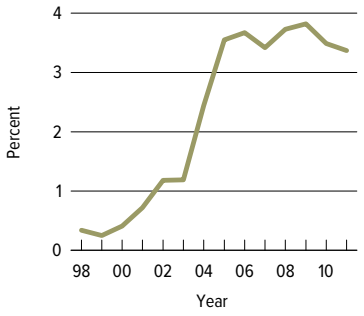
PA 2.6 Reasons for discards, 2011
Reasons for discard among pancreata recovered for transplant but not transplanted in 2011.



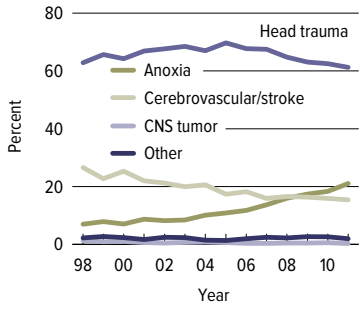
PA 2.7 Major components of pancreas donor risk index (PDRI) over time
Adult patients receiving a simultaneous kidney-pancreas or pancreas-alone deceased donor transplant. Components of the PDRI are donor age, race, sex, creatinine, cause of death, DCD, BMI, height, and cold ischemic time of pancreas.



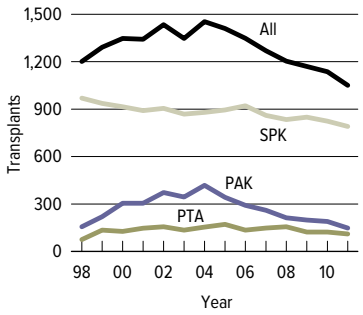
PA 2.8 Mean pancreas donor risk index (PDRI)
Adult patients receiving a simultaneous kidney-pancreas or pancreas-alone deceased donor transplant.



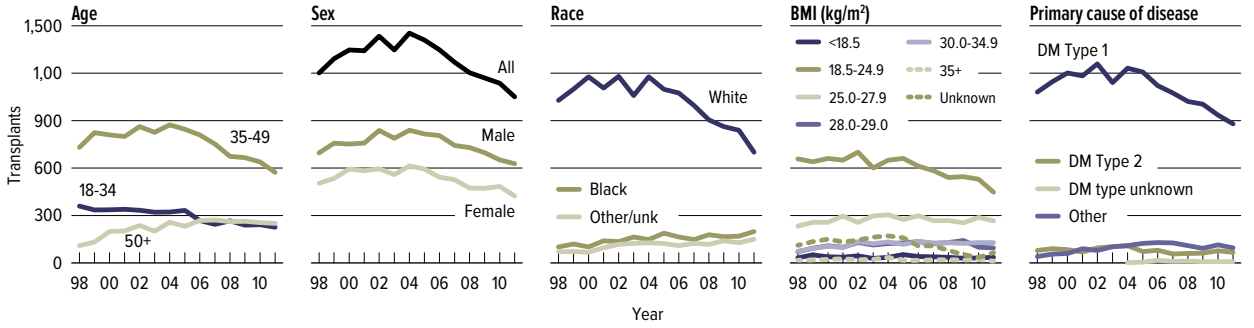
PA 2.9 Pancreas donors who are DCD
Deceased donors whose pancreas was recovered for transplant. DCD status is reported on the OPTN Deceased Donor Registration form.



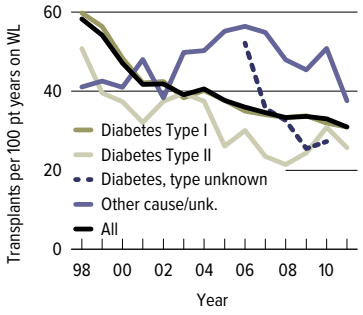
PA 2.10 Cause of death among deceased pancreas donors
Deceased donors whose pancreas was transplanted. CNS = central nervous system.



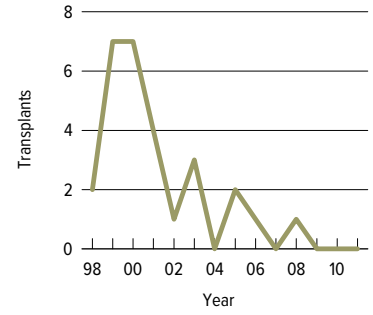
PA 3.1 Total adult pancreas transplants
Patients receiving a transplant. Retransplants are counted.



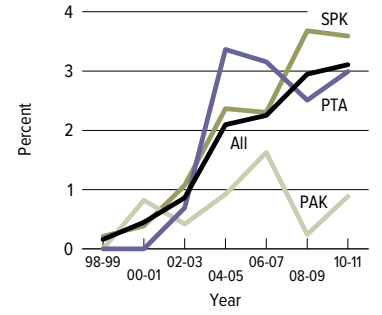
PA 3.2 Adult pancreas transplants
Patients receiving a transplant. Retransplants are counted.



PA 3.3 Pancreas transplant rates in adult waiting list candidates
Patients waiting for a transplant. Transplant rates are computed as the number of transplants per 100 patient-years of waiting time in the given year. All waiting time per patient per listing is counted, and all listings that end in a transplant for the patient are considered transplant events. Yearly rates based on fewer than 10 transplants (for unknown diabetes type) are not shown.

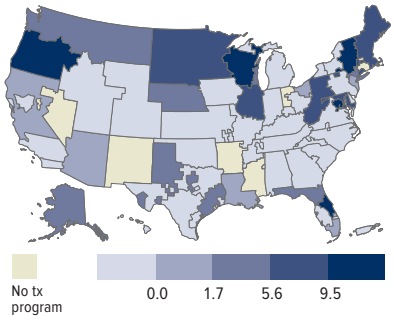


PA 3.4 Adult pancreas transplants from living donors
Living donor transplants.



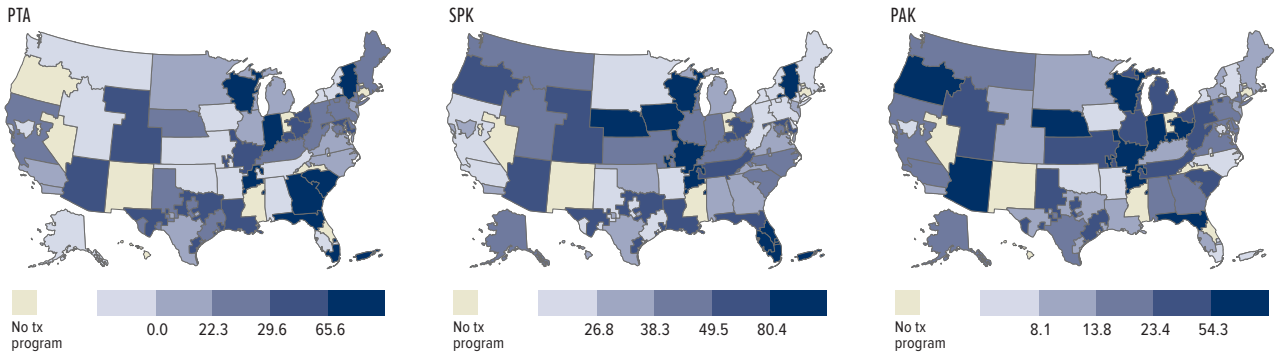
PA 3.5 Use of DCD pancreata among adult recipients, by transplant type
Percent of deceased donor transplants using a DCD donor.

transplant



PA 3.6 Percent of adult deceased donor pancreas transplants that are DCD, by DSA, 2009–2011

Percent of deceased donor transplants using a DCD donor, by DSA of the transplanting center.

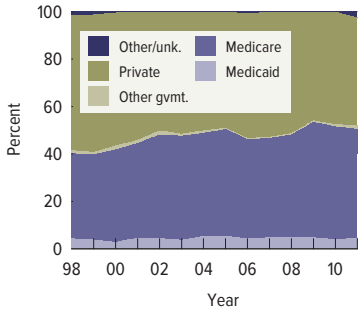


PA 3.7 Deceased donor pancreas transplant rates per 100 patient years on the waiting list among adult candidates, by DSA, 2010–2011

Transplant rates by DSA of the listing center, limited to those on the waiting list in 2010 and 2011; deceased donor transplants only. Maximum time per listing is two years.

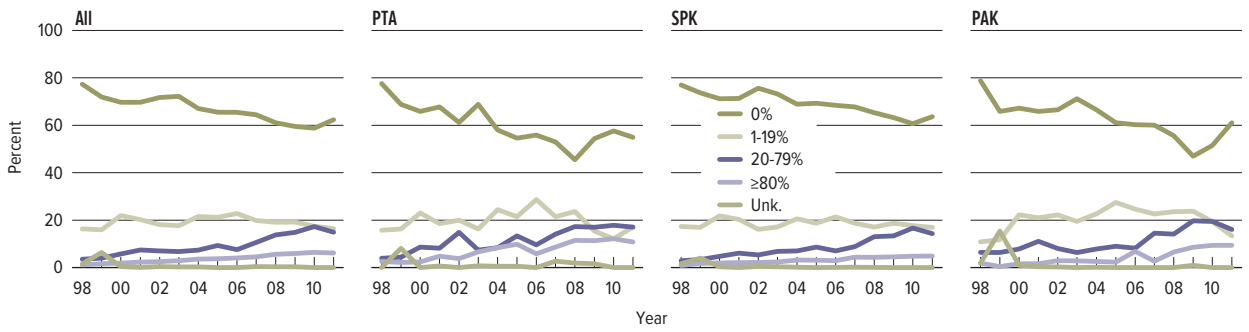
		All		PTA		SPK		PAK	
	Level	N	%	N	%	N	%	N	%
Age	18-34	226	21.5	23	20.7	169	21.4	34	22.8
	35-49	574	54.6	48	43.2	444	56.1	82	55.0
	50-64	249	23.7	39	35.1	177	22.4	33	22.1
	65+	2	0.2	1	0.9	1	0.1	0	0.0
Sex	Female	423	40.2	70	63.1	288	36.4	65	43.6
	Male	628	59.8	41	36.9	503	63.6	84	56.4
Race	White	702	66.8	99	89.2	499	63.1	104	69.8
	Black	199	18.9	3	2.7	179	22.6	17	11.4
	Hispanic	118	11.2	7	6.3	88	11.1	23	15.4
	Asian	17	1.6	1	0.9	14	1.8	2	1.3
	Other/unknown	15	1.4	1	0.9	11	1.4	3	2.0
Primary cause of disease	Diabetes Type 1	896	85.3	82	73.9	677	85.6	137	91.9
	Diabetes Type 2	64	6.1	1	0.9	54	6.8	9	6.0
	Diabetes type unk.	9	0.9	0	0.0	7	0.9	2	1.3
	Other cause/unk.	82	7.8	28	25.2	53	6.7	1	0.7
Blood type	A	378	36.0	48	43.2	270	34.1	60	40.3
	B	123	11.7	7	6.3	98	12.4	18	12.1
	AB	52	4.9	6	5.4	40	5.1	6	4.0
	O	498	47.4	50	45.0	383	48.4	65	43.6
BMI (kg/m^2)	<18.5	38	3.6	5	4.5	24	3.0	9	6.0
	18.5-24.9	478	45.5	46	41.4	368	46.5	64	43.0
	25.0-27.9	282	26.8	24	21.6	222	28.1	36	24.2
	28.0-29.9	105	10.0	15	13.5	68	8.6	22	14.8
	30.0-34.9	136	12.9	19	17.1	99	12.5	18	12.1
	35.0-39.9	10	1.0	2	1.8	8	1.0	0	0.0
	40.0+	2	0.2	0	0.0	2	0.3	0	0.0
	Unknown	.	0.0	0	0.0	0	0.0	0	0.0
Time on waiting list	<30 days	97	9.2	18	16.2	65	8.2	14	9.4
	31-60 days	88	8.4	20	18.0	55	7.0	13	8.7
	61-90 days	59	5.6	9	8.1	44	5.6	6	4.0
	3-<6 months	185	17.6	23	20.7	140	17.7	22	14.8
	6-<12 months	229	21.8	22	19.8	168	21.2	39	26.2
	1-<2 years	231	22.0	10	9.0	199	25.2	22	14.8
	2-<3 years	95	9.0	7	6.3	72	9.1	16	10.7
	3+ years	67	6.4	2	1.8	48	6.1	17	11.4
Insurance	Private	478	45.5	74	66.7	332	42.0	72	48.3
	Medicare	483	46.0	25	22.5	390	49.3	68	45.6
	Other government	63	6.0	7	6.3	49	6.2	7	4.7
	Other	27	2.6	5	4.5	20	2.5	2	1.3
Pancreas tx history	First transplant	995	94.7	104	93.7	776	98.1	115	77.2
	Retransplant	56	5.3	7	6.3	15	1.9	34	22.8
Total		1,051	100.0	111	100.0	791	100.0	149	100.0

PA 3.8 Characteristics of adult pancreas transplant recipients, 2011
Patients receiving a transplant. Retransplants are counted.

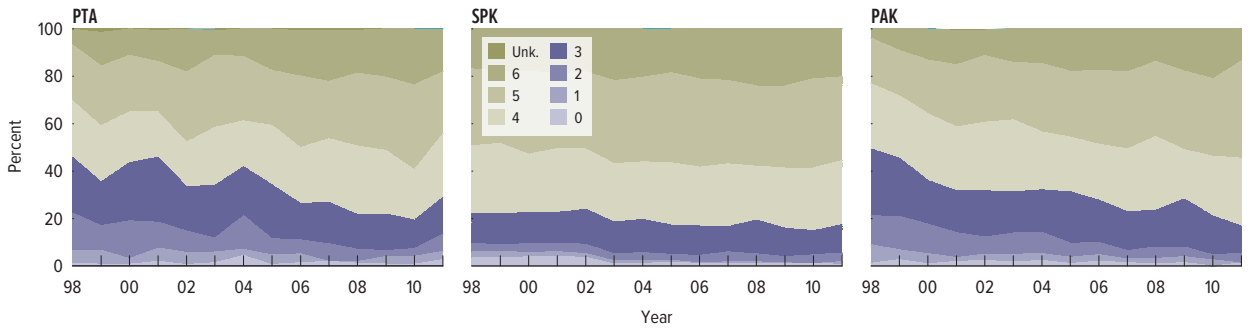


PA 3.9 Insurance coverage among adult pancreas transplant recipients at time of transplant
Patients receiving a transplant. Retransplants are counted.

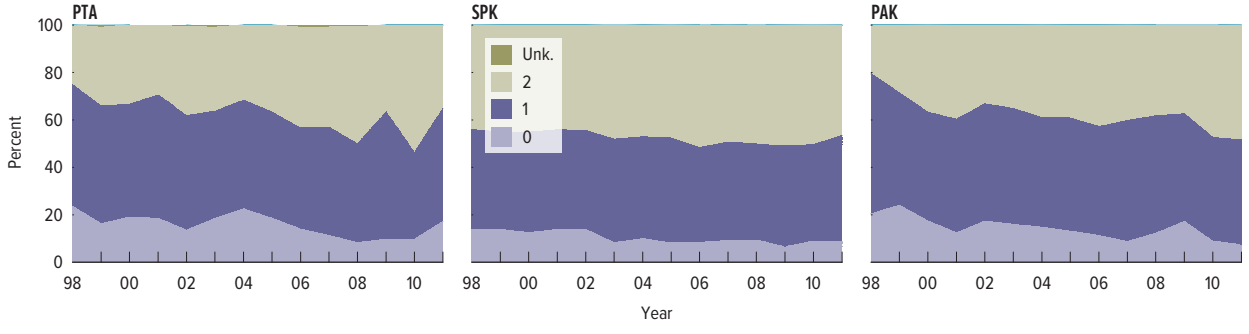
donor-recipient matching



PA 4.1 C/PRA at time of pancreas transplant in adult recipients
PRA is the maximum of the most recent values recorded at the time of transplant. If "most recent PRA" is not provided, peak PRA is used. CPRA is conditionally incorporated between December 1, 2007 – October 1, 2009 where, if CPRA is >0, the value is included but otherwise is not; from October 1, 2009, CPRA is included unconditionally.

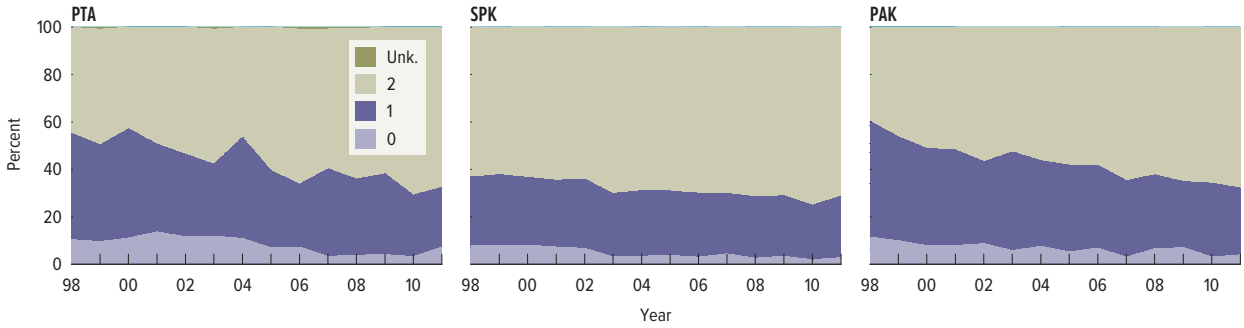


PA 4.2 Total HLA mismatches among adult pancreas transplant recipients
Donor and recipient antigen matching is based on the OPTN's antigen values and split equivalences policy as of 2011.

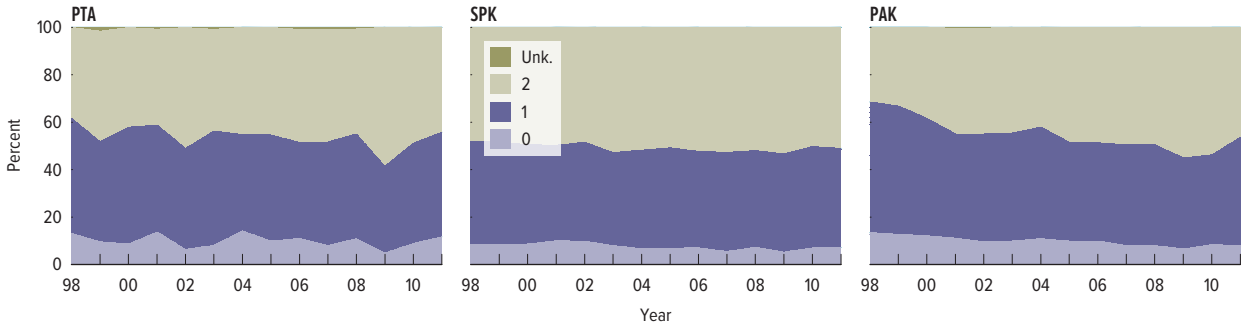


PA 4.3 HLA-A mismatches among adult pancreas transplant recipients
Donor and recipient antigen matching is based on the OPTN's antigen values and split equivalences policy as of 2011.

donor-recipient matching



PA 4.4 HLA-B mismatches among adult pancreas transplant recipients
Donor and recipient antigen matching is based on the OPTN's antigen values and split equivalences policy as of 2011.



PA 4.5 HLA-DR mismatches among adult pancreas transplant recipients
Donor and recipient antigen matching is based on the OPTN's antigen values and split equivalences policy as of 2011.

donor-recipient matching

	DONOR			
RECIPIENT	Negative	Positive	Unknown	Total
Negative	19.3	27.8	0.2	47.3
Positive	19.1	29.9	0.2	49.2
Unknown	1.5	2.1	0.0	3.6
Total	39.8	59.8	0.4	100

PA 4.6 Adult pancreas donor-recipient cytomegalovirus (CMV) serology matching, 2007–2011

Adult transplant cohort from 2007–2011. Donor serology is reported on the OPTN Donor Registration forms; recipient serology is reported on the OPTN Recipient Registration forms. Any evidence for a positive serology is taken to indicate that the person is positive for the given serology; if all fields are unknown, not done, or pending the person is considered to be "unknown" for that serology; otherwise, serology is assumed negative.

	DONOR			
RECIPIENT	Negative	Positive	Unknown	Total
Negative	1.2	14.0	0.7	15.9
Positive	5.5	60.6	1.5	67.6
Unknown	1.1	14.4	0.9	16.4
Total	7.9	89.1	3.0	100

PA 4.7 Adult pancreas donor-recipient Epstein-Barr virus (EBV) serology matching, 2007–2011

Adult transplant cohort from 2007–2011. Donor serology is reported on the OPTN Donor Registration forms; recipient serology is reported on the OPTN Recipient Registration forms. Any evidence for a positive serology is taken to indicate that the person is positive for the given serology; if all fields are unknown, not done, or pending the person is considered to be "unknown" for that serology; otherwise, serology is assumed negative.

	DONOR			
RECIPIENT	Negative	Positive	Unknown	Total
Negative	77.9	0.6	0.1	78.6
Positive	3.2	0.1	0.0	3.2
Unknown	18.1	0.1	0.0	18.2
Total	99.2	0.7	0.1	100

PA 4.8 Adult pancreas donor-recipient hepatitis B core antibody (HBcAb) serology matching, 2007–2011

Adult transplant cohort from 2007–2011. Donor serology is reported on the OPTN Donor Registration forms; recipient serology is reported on the OPTN Recipient Registration forms. Any evidence for a positive serology is taken to indicate that the person is positive for the given serology; if all fields are unknown, not done, or pending the person is considered to be "unknown" for that serology; otherwise, serology is assumed negative.

	DONOR			
RECIPIENT	Negative	Positive	Unknown	Total
Negative	92.3	0.0	0.2	92.5
Positive	1.4	0.0	0.0	1.4
Unknown	6.2	0.0	0.0	6.2
Total	99.8	0.0	0.2	100

PA 4.9 Adult pancreas donor-recipient hepatitis B surface antigen (HBsAg) serology matching, 2007–2011

Adult transplant cohort from 2007–2011. Donor serology is reported on the OPTN Donor Registration forms; recipient serology is reported on the OPTN Recipient Registration forms. Any evidence for a positive serology is taken to indicate that the person is positive for the given serology; if all fields are unknown, not done, or pending the person is considered to be "unknown" for that serology; otherwise, serology is assumed negative.

	DONOR			
RECIPIENT	Negative	Positive	Unknown	Total
Negative	90.1	0.0	0.0	90.1
Positive	3.2	0.0	0.0	3.2
Unknown	6.7	0.0	0.0	6.7
Total	100	0.0	0.0	100

PA 4.10 Adult pancreas donor-recipient hepatitis C serology matching, 2007–2011

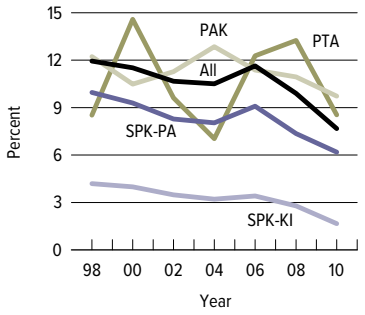
Adult transplant cohort from 2007–2011. Donor serology is reported on the OPTN Donor Registration forms; recipient serology is reported on the OPTN Recipient Registration forms. Any evidence for a positive serology is taken to indicate that the person is positive for the given serology; if all fields are unknown, not done, or pending the person is considered to be "unknown" for that serology; otherwise, serology is assumed negative.

	DONOR			
RECIPIENT	Negative	Positive	Unknown	Total
Negative	84.5	0.0	0.1	84.6
Positive	0.2	0.0	0.0	0.2
Unknown	15.2	0.0	0.0	15.2
Total	99.9	0.0	0.1	100

PA 4.11 Adult pancreas donor-recipient human immunodeficiency virus (HIV) serology matching, 2007–2011

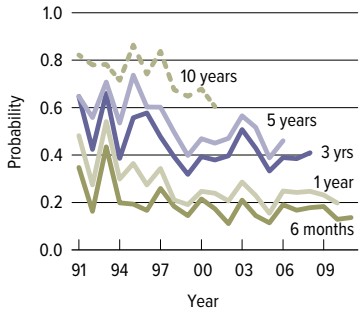
Adult transplant cohort from 2007–2011. Donor serology is reported on the OPTN Donor Registration forms; recipient serology is reported on the OPTN Recipient Registration forms. Any evidence for a positive serology is taken to indicate that the person is positive for the given serology; if all fields are unknown, not done, or pending the person is considered to be "unknown" for that serology; otherwise, serology is assumed negative.

outcomes



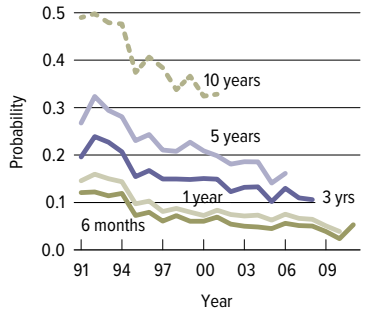
PA 5.1 Graft failure within the first 6 weeks after transplant among adult pancreas transplant recipients

All-cause graft failure is identified from multiple data sources, including the OPTN Transplant Recipient Registration, OPTN Transplant Recipient Follow-up, as well as death dates from the Social Security Administration.



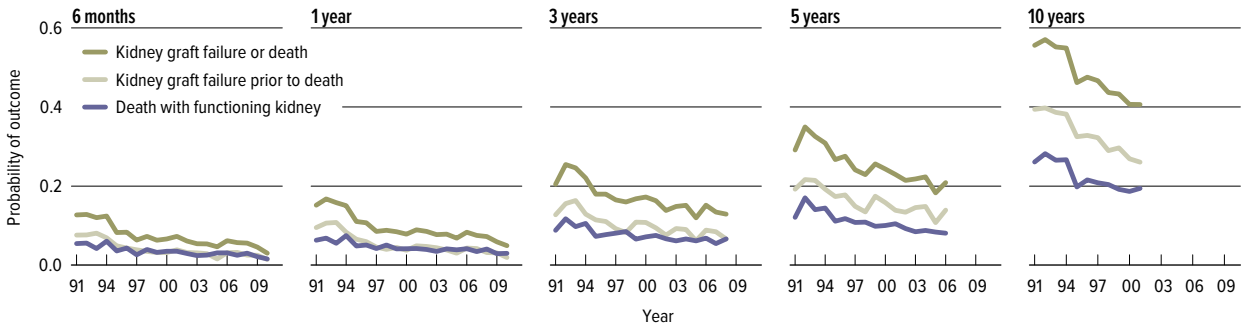
PA 5.2 Graft failure among adult PTA transplant recipients

Cox proportional hazards models reporting probability, adjusted for age, sex, and race.



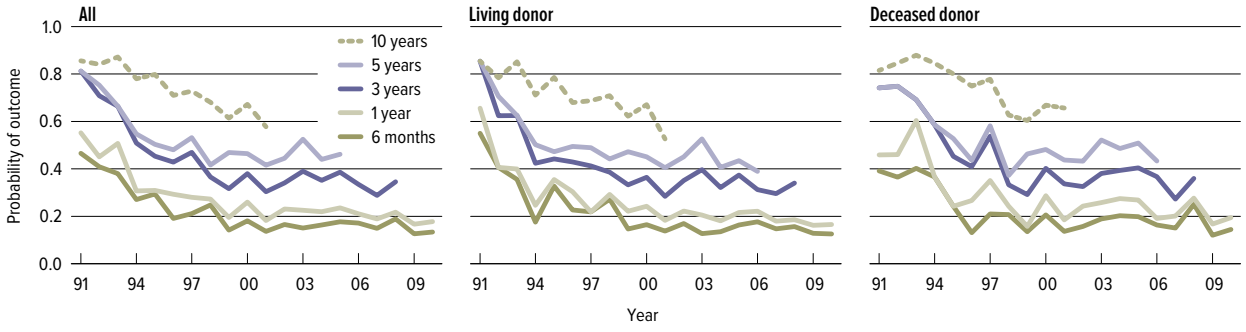
PA 5.3 Graft failure among adult SPK transplant recipients: pancreas outcomes

Cox proportional hazards models, adjusted for age, sex, and race. Simultaneous kidney-pancreas (SPK) transplant recipients are followed from date of transplant until the first of reported pancreas graft failure, pancreas retransplant, death, or loss-to-follow-up.



PA 5.4 Outcomes among adult SPK transplant recipients: kidney outcomes

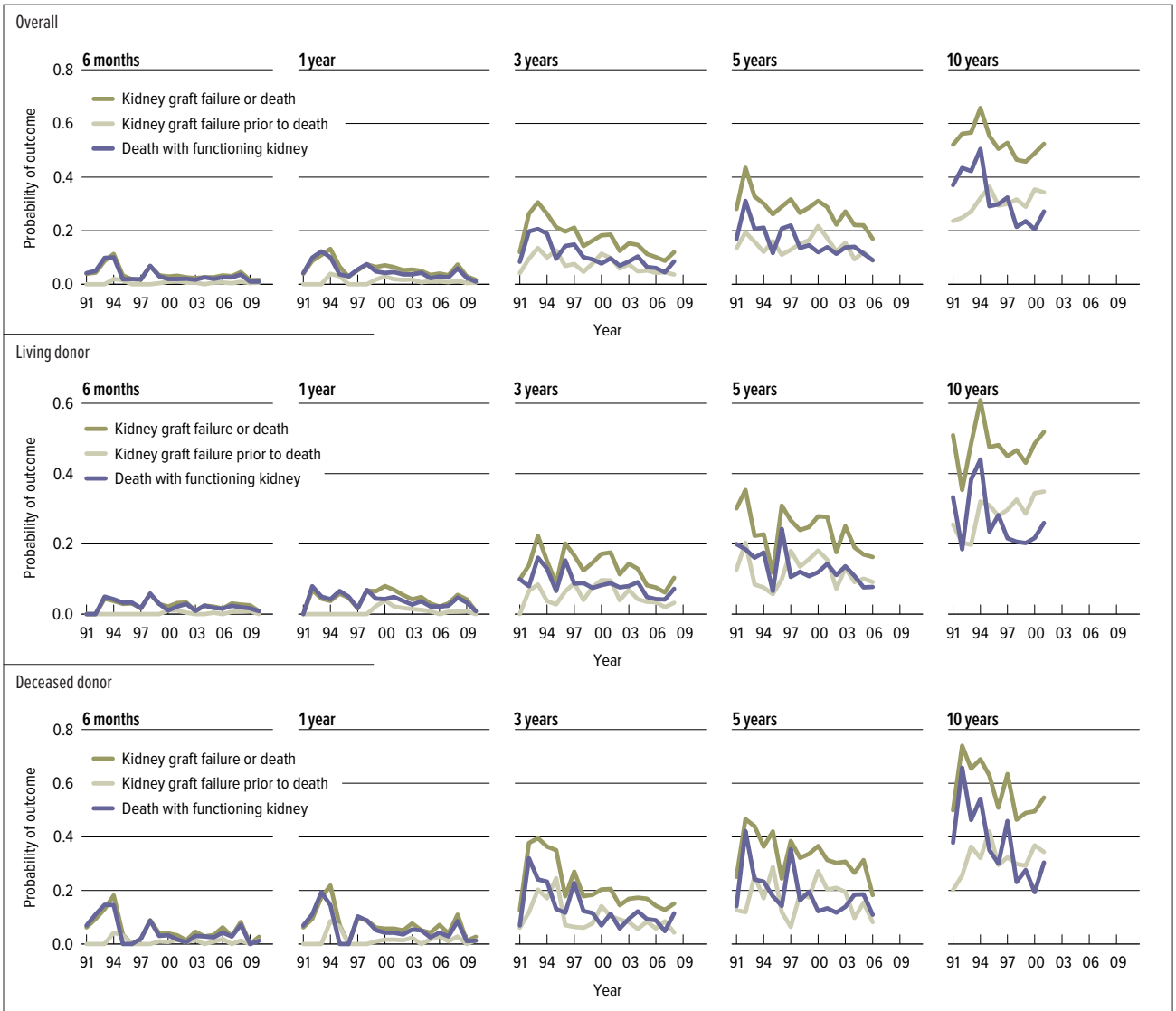
Cox proportional hazards models, adjusted for age, sex, and race. Simultaneous kidney-pancreas (SPK) transplant recipients are followed from date of transplant until the first of kidney graft failure, kidney retransplant, return to dialysis, death, or loss-to-follow-up.



PA 5.5 Pancreas graft failure among adult PAK transplant recipients by kidney donor type

Cox proportional hazards models, adjusted for age, sex, and race. Pancreas-after-kidney (PAK) transplant recipients are followed from date of transplant until the first of pancreas graft failure, pancreas retransplant, death, or loss-to-follow-up. Only PAK recipients with a record of a previous KI/KP transplant are included.

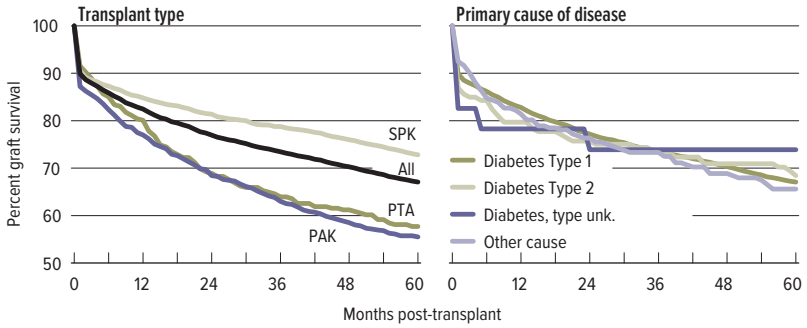
outcomes



PA 5.6 Outcomes among adult PAK transplant recipients: kidney outcomes (from time of pancreas transplant)

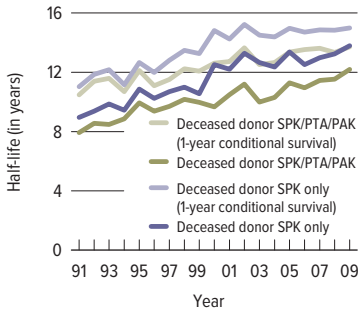
Cox proportional hazards models, adjusted for age, sex, and race. Pancreas-after-kidney (PAK) transplant recipients are followed from date of pancreas transplant until the first of kidney graft failure, kidney retransplant, return to dialysis, death, or loss-to-follow-up. Only PAK recipients with a record of a previous KI/KP transplant are included.

outcomes



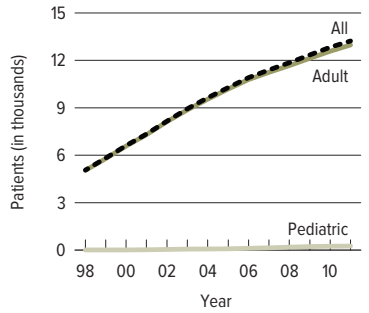
PA 5.7 Graft survival among adult pancreas transplant recipients transplanted in 2006: deceased donors

All-cause graft survival estimated using unadjusted Kaplan-Meier methods; pancreas outcomes only.



PA 5.8 Half-lives for adult pancreas transplant recipients

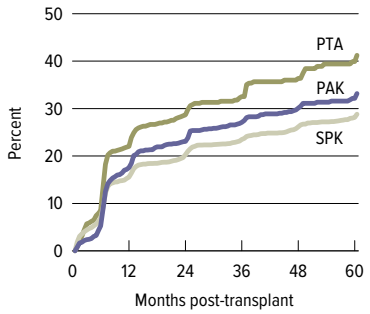
Estimated graft half-lives and conditional half-lives. Half-lives are interpreted as the estimated median survival of grafts from the time of transplant. Conditional half-lives are interpreted as the estimated median survival of grafts which survive the first year.



PA 5.9 Recipients alive & with a functioning pancreas transplant on June 30 of the year

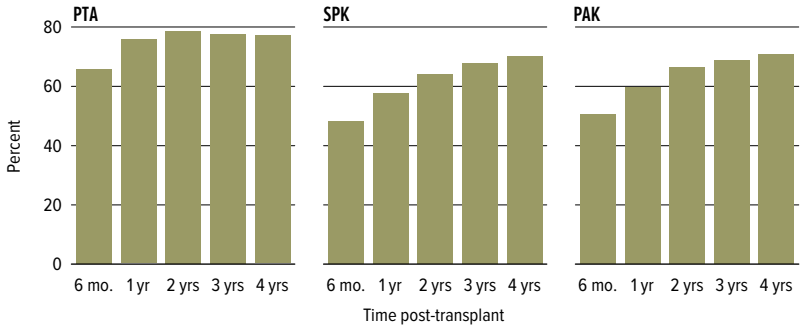
Transplants before June 30 of the year that are still functioning. Patients are assumed alive with function unless a death or graft failure is recorded. A recipient can experience a graft failure and drop from the cohort, then be retransplanted and re-enter the cohort.

outcomes



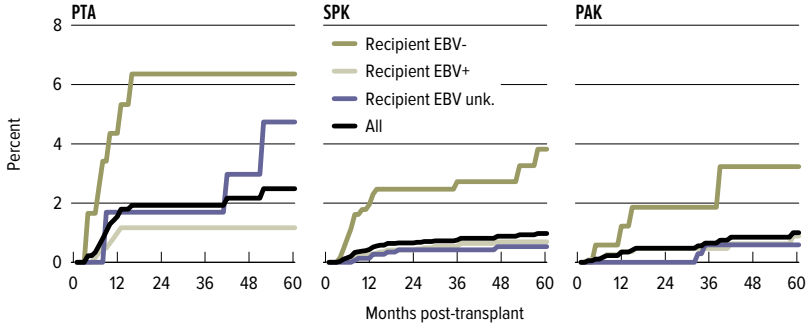
PA 5.10 Incidence of first acute rejection among adult patients receiving a pancreas transplant in 2005–2009

Acute rejection defined as a record of acute or hyperacute rejection, or a record of an anti-rejection drug being administered on either the Transplant Recipient Registration form or the Transplant Recipient Follow-up Form. Only the first rejection event is counted, and patients are followed for acute rejection only until graft failure, death, or loss to follow-up. For simultaneous kidney-pancreas recipients, an acute rejection may be of the kidney or pancreas, and graft failure is the first of kidney or pancreas graft failure. Cumulative incidence, defined as the probability of acute rejection at any time prior to the given time, is estimated using Kaplan-Meier methods.



PA 5.11 Reported cumulative incidence of rehospitalizations among adult patients receiving a pancreas transplant in 2006–2011

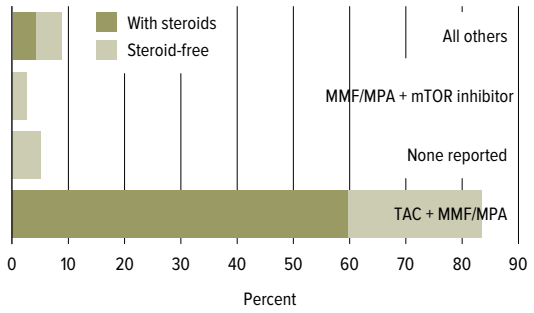
Cumulative incidence of rehosptalization post-transplant; hospitalization identified from the OPTN Transplant Recipient Follow-up form. Patients required to be alive with graft function at each time period, so denominators reduce over time.`



PA 5.12 Incidence of PTLD among adult patients receiving a pancreas transplant in 2003–2009, by recipient Epstein-Barr virus (EBV) status at transplant

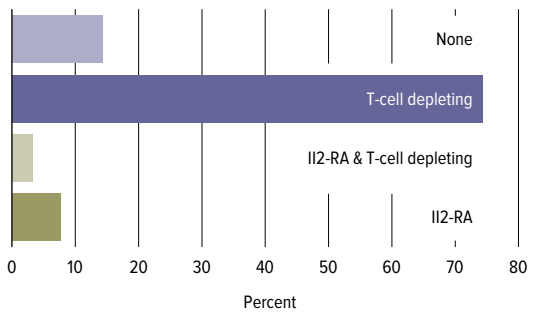
The cumulative incidence, defined as the probability of post-transplant lymphoproliferative disorder (PTLD) being diagnosed between the time of transplant and the given time, is estimated using Kaplan-Meier methods. PTLD is identified as either a reported complication or cause of death on the Transplant Recipient Follow-up forms or on the Post-transplant Malignancy form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's Disease. Only the earliest date of PTLD diagnosis is considered, and patients are followed for PTLD until graft failure, death, or loss to follow-up. Patients are censored at graft failure because malignancies are not reliably reported after graft failure.

immunosuppression



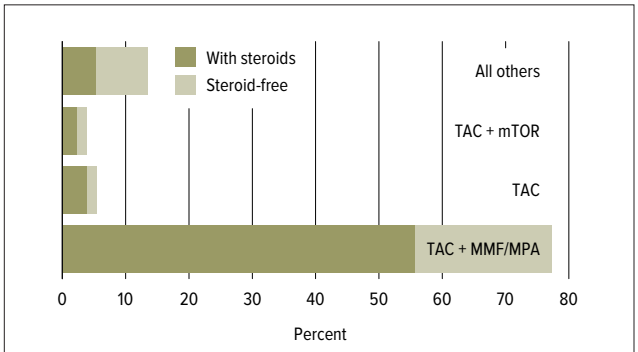
PA 6.1 Initial immunosuppression regimen in adult pancreas transplant recipients, 2011

Patients transplanted in 2011 and discharged with a functioning graft. Top three baseline immunosuppression regimens are given, plus the "all others" group. Regimens are defined by use of calcineurin inhibitors (TAC=Tacrolimus, Cyclo=Cyclosporine), anti-metabolites (AZA=Azathioprine, MMF/MPA=Mycophenolate), and mTOR inhibitors (mTOR). Data within each regimen are reported separately by steroid use.



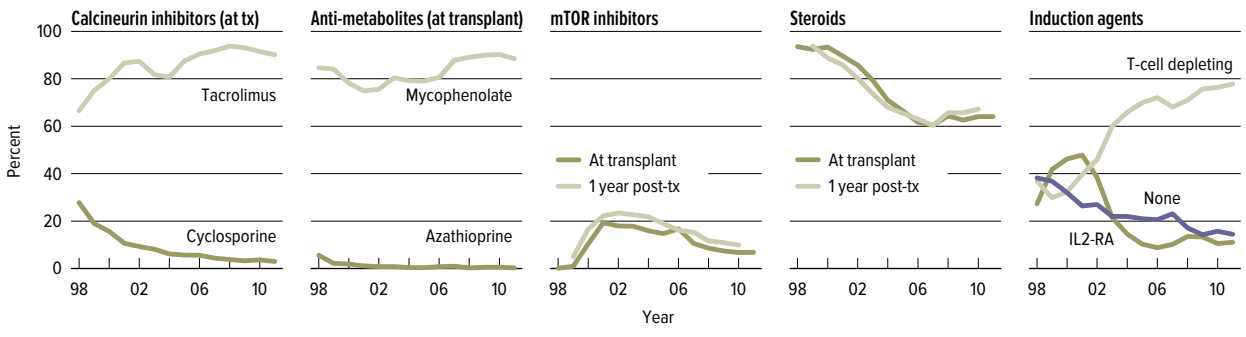
PA 6.2 Induction agents used at time of pancreas transplant, adult recipients, 2011

Patients transplanted in 2011 and discharged with a functioning graft.



PA 6.3 Immunosuppression regimen at one year in adult pancreas transplant recipients, 2010

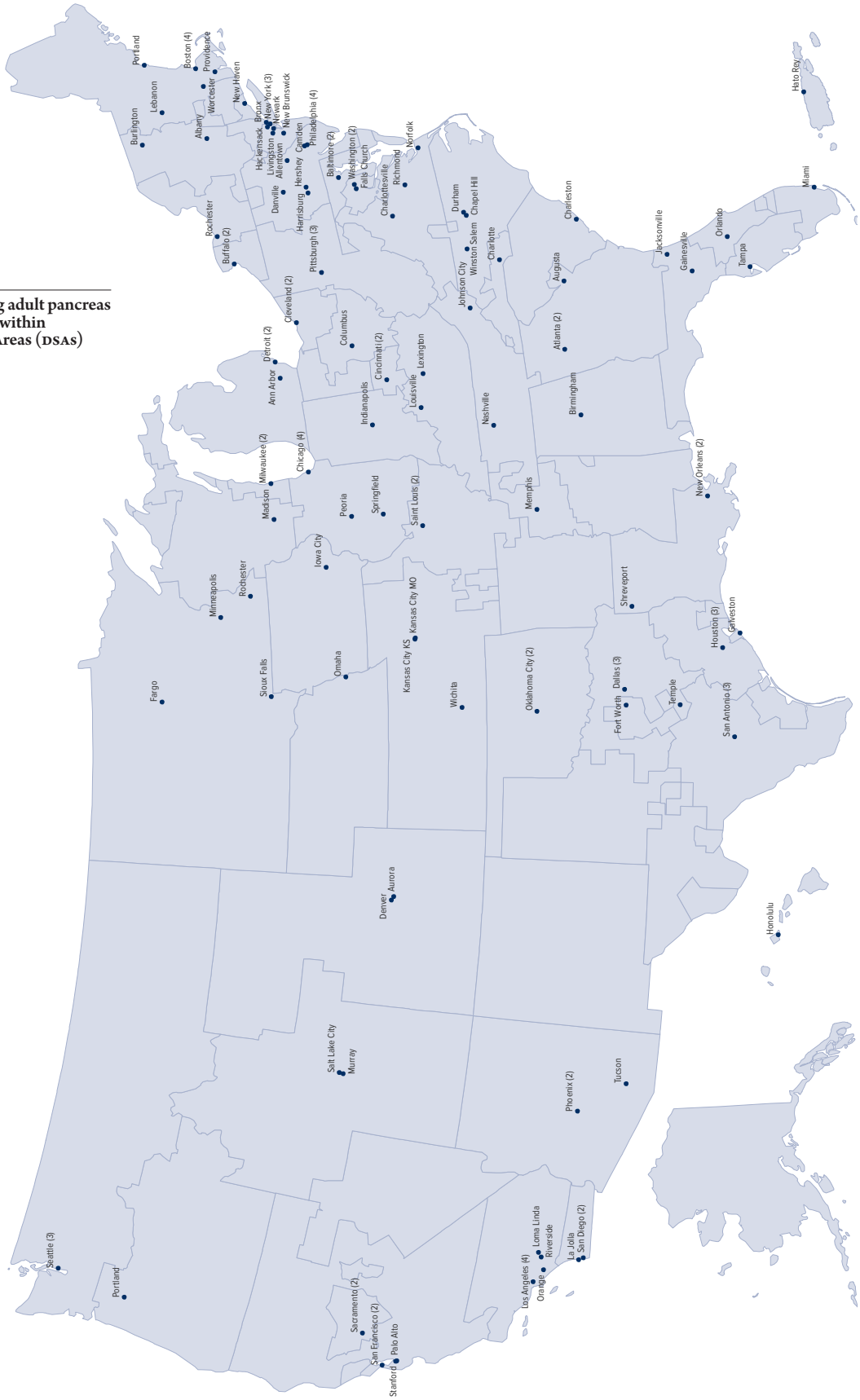
Patients transplanted in 2010 and remaining alive with graft function one year post-transplant. Top three one-year immunosuppression regimens are given, plus the "all others" group. Regimens are defined by use of calcineurin inhibitors (TAC=Tacrolimus, Cyclo=Cyclosporine), anti-metabolites (AZA=Azathioprine, MMF/MPA=Mycophenolate), and mTOR inhibitors (mTOR). Data within each regimen are reported separately by steroid use.



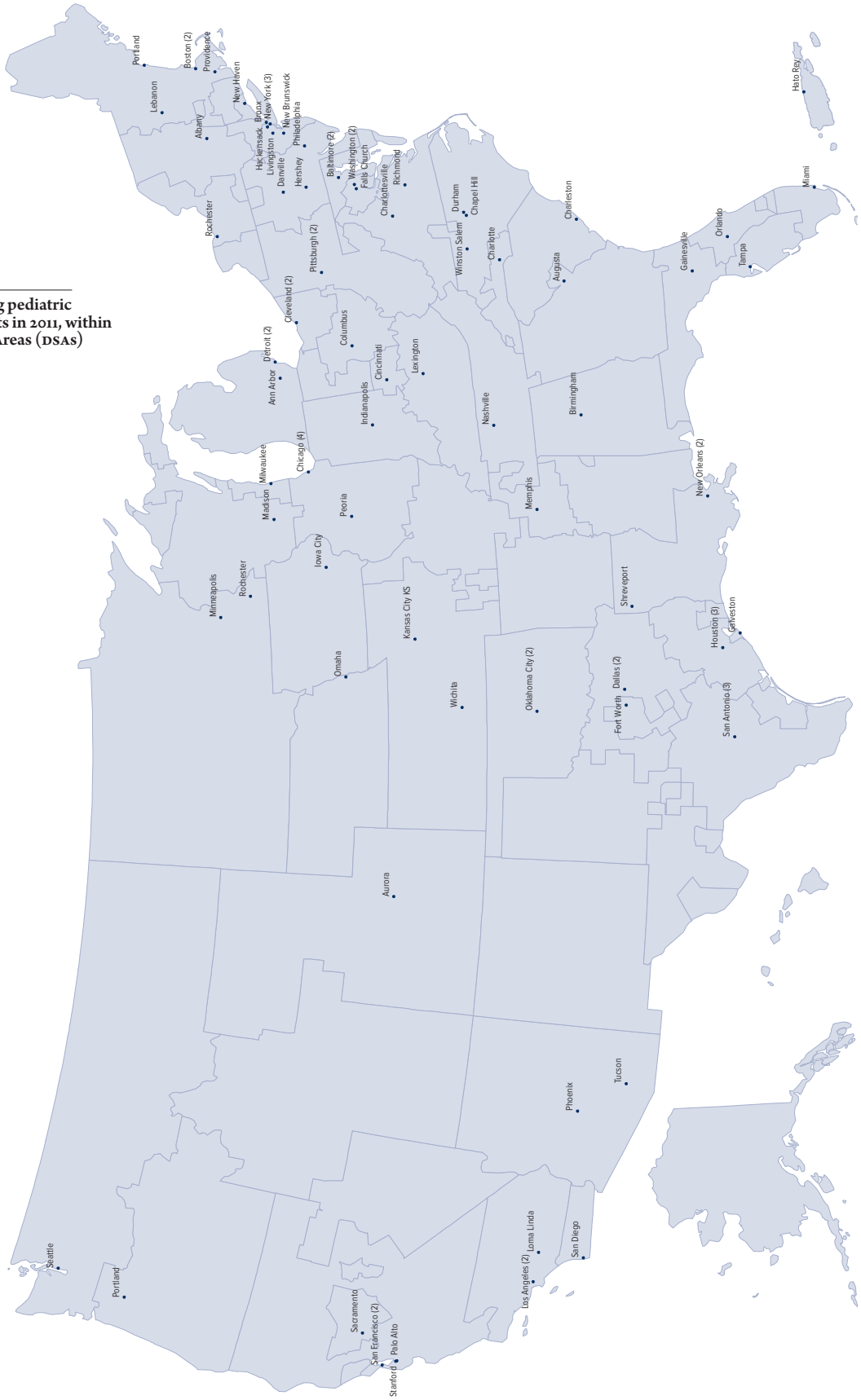
PA 6.4 Immunosuppression use in adult pancreas transplant recipients

One-year post-transplant data for mTOR inhibitors and steroids limited to patients alive with graft function one year post-transplant. One-year post-transplant data are not reported for 1998 transplant recipients, as follow-up data were very sparse.

PA 7.1 Centers performing adult pancreas transplants in 2011, within Donation Service Areas (DSAs)



PA 7.2 Centers performing pediatric pancreas transplants in 2011, within Donation Service Areas (DSAs)



PA 7.3 Centers performing adult pancreas transplants in 2011, within OPTN regions