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OPTN/SRTR 2012 Annual Data Report: pancreas

ABSTRACT The number of pancreas transplants has decreased over the past decade, most notably numbers of pancreas after kidney (PAK) and pancreas transplant alone (PTA) procedures. This decrease may be mitigated in the future when changes to national pancreas allocation policy approved by the Organ Procurement and Transplantation Network Board of Directors in 2010 are implemented. The new policy will combine waiting lists for PAK, PTA, and simultaneous pancreas-kidney (SPK) transplants, and give equal priority to candidates for all three procedures. This policy change may also eliminate geographic variation in waiting times caused by geographic differences in allocation policy. Deceased donor pancreas donation rates have been declining since 2005, and the donation rate remains low. The outcomes of pancreas grafts are difficult to describe due to lack of a uniform definition of graft failure in the transplant community. However, long-term survival is better for SPK versus PAK and PTA transplants. This may represent the difficulty of detecting rejection in the absence of a simultaneously transplanted kidney. The challenges of pancreas transplant are reflected in high rates of rehospitalization, most occurring within the first 6 months posttransplant. Pancreas transplant is associated with higher incidence of rejection compared with kidney transplant.

KEY WORDS Pancreas after kidney transplant, pancreas allocation policy, pancreas transplant alone, simultaneous pancreas-kidney transplant.

There are so many things I want to do... Just being able to go for a walk or a run ... I plan on traveling and even going skiing for the first time. What I really want is to someday have a family... My list just goes on and on.

waiting for a double lung transplant

Introduction

The number of pancreas transplants has decreased over the past decade. In light of this decline, this chapter describes changes in the waiting list, pancreas transplants, and post-transplant outcomes. The decreased numbers of pancreas transplants may be partly attributable to improved insulin delivery systems, concerns about outcomes after solitary pancreas transplant [1], and islet transplant. The most notable decreases in numbers of pancreas transplants occurred for pancreas after kidney (PAK) and pancreas transplant alone (PTA) procedures.

The decrease in PAK and PTA transplants may be mitigated in the future when changes in national policy are implemented by the Organ Procurement and Transplantation Network (OPTN); changes were approved by the OPTN Board of Directors in November 2010. A combined pancreas waiting list for simultaneous pancreas-kidney (SPK) transplants and solitary pancreas transplants (PAK and PTA) will give equal priority to candidates for all three procedures within locality, human leukocyte antigen (HLA) mismatch status, calculated panel reactive antibody (CPRA) status, and waiting time duration.

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

Waiting List

The number of new candidates on the pancreas waiting list showed an increasing trend from 1998 until 2000, after which it decreased steadily until 2011, when only 1710 candidates joined the waiting list. A slight increase occurred in 2012 when 1738 candidates joined the waiting list (Figure 1.1). However, the increase was limited to new SPK candidates, while new PAK and PTA listings continued to decline. The number of prevalent active candidates, determined at the end of each calendar year, declined since its peak in 2002 to a low of 1311 active candidates in 2012, slightly less than the 1354 active candidates in 2011. The total number of candidates (active and inactive) at the end of each calendar year mirrored the trend among active candidates; counts continued to decline from 2011 to 2012, from 3174 to 3072 (Figure 1.1).

The proportion of older candidates (aged 50-64 years) gradually increased over the past decade, with a corresponding decrease in the proportion of younger candidates (aged 18-34 years) (Figure 1.2). The percentage of white candidates (66.9% in 2012) decreased over the past decade, with a corresponding increase in the percentage of black (18.7% in 2012) and Hispanic (11.5% in 2012) candidates. The percentage of candidates reported to have type 2 diabetes remained stable (8.2% in 2012). The percentage of obese candidates (body mass index [BMI] > 30 kg/m^2) gradually increased, in keeping with national trends in the general population. Although relatively fewer candidates are registered on the waiting list, time on the waiting list gradually increased over the past decade. Whether this was due to more restrictive acceptance criteria or other reasons is yet to be determined (Figure 1.2).

When waiting time was limited to active time only, transplant rates generally increased from 2003 to 2010. Since 2010, these rates have stabilized or decreased slightly, to 73 transplants per 100 active wait-list years in 2012 (PTA, 82 transplants per 100 wait-list years; SPK, 73; PAK, 71) (Figure 1.4). Including inactive time on the waiting list in the calculations causes all transplant rates to decrease dramatically from 1999 to 2012 (data not shown).

In 2012, 89 living donor kidney transplants were performed in SPK wait-listed candidates, down from 138 in 2010 (Figure 1.6). This is in keeping with a decline in living donor kidney transplants from 2010 to 2012 (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 1.7. Median time to transplant for active candidates listed in 2010-2011 was 19.1 months for PTA and 16.2 months for

SPK. The median time to transplant for PAK candidates listed in 2010-2011 cannot be estimated since less than 50% underwent transplant by December 31, 2012. The most recent estimate available for PAKs was 36.9 months, for candidates listed in 2008-2009. The disparity between SPK and PTA versus PAK transplant rates suggests significant differences between these candidate groups. Waiting times for SPK, PAK, and PTA vary by donation service area (DSA) (Figure 1.5). In six DSAs, no transplant program performed pancreas transplants in 2011-2012. Currently, OPTN policy allows for local organ procurement organizations (OPOs) to use their discretion in prioritizing SPK or solitary pancreas (PTA or PAK) offers; this lack of national policy may contribute to the overall geographic variation. A universal SPK and pancreas-alone allocation policy approved by OPTN in November 2010 is pending implementation. The combined pancreas waiting list will treat SPK, PAK, and PTA candidates equally. This may eliminate variation caused by geographic differences in allocation policy.

The 2012 pretransplant mortality rate for candidates wait-listed for pancreas transplant was 5.3 deaths per 100 wait-list years (Figure 1.10), lower than for candidates wait-listed for kidney transplant. Mortality has been consistently higher among SPK candidates (6.9 patient deaths per 100 wait-list years in 2012, versus 2.0 and 2.1 for PTA and PAK, respectively).

Donation

Deceased donor pancreas donation rates have been decreasing steadily since 2005. Only the pancreata that were recovered for the purpose of pancreas transplant (not islet transplant) were included in this analysis. In 2011, the overall rate reached a low of 2.2 donors aged younger than 75 years per 1000 deaths (Figure 2.1). The donation rate for donors aged 15 to 34 years decreased in 2011, to 14 donors per 1000 deaths compared with 15 in 2010. Unadjusted geographic heterogeneity in donation rates is substantial (Figure 2.2). The pancreas discard rate per donor varies significantly with donor age. In 2011, pancreata were discarded from 26.2% of all pancreas donors (Figure 2.3). However, the discard rate is based on pancreata discarded after recovery; it does not take into account pancreata never recovered due to lack of suitability.

The pancreas donor risk index [2] steadily decreased over the past decade. The donor-specific components of the pancreas donor risk index show that frequency of most risk factors declined over the past decade, except that use of pancreata from black donors increased (Figure 2.4). Procurement of pancreata from donation after circulatory death (DCD) declined from its peak in 2009; DCD donors accounted for 3.1% of procured pancreata in 2012, comparable to the percentage in 2004 (Figure 2.5). Head trauma was the most common cause of death for pancreas donors. Anoxic brain injury as a cause of death has steadily increased, reaching 21.0% of donors in 2012 (Figure 2.6).

Transplant

The number of pancreas transplants decreased every year since 2004; 1043 pancreas transplants were performed in 2012 and 1082 in 2011 (Figure 3.1). The greatest percentage decrease was for PAK, followed by SPK and PTA. The 2012 count of pancreas transplants includes both adult and pediatric recipients (Figure 3.1), in contrast to the counts reported in the 2011 Annual Data Report.

Compared with 2004, the decrease in transplant numbers was greatest in the most prevalent demographic groups: recipients aged 35 to 49 years, recipients of white race, recipients with BMI 18.5 to 24.9 kg/m^2 and recipients with type 1 diabetes (Figure 3.2). In contrast, the number of pancreas transplants performed as part of a multi-organ transplant has increased since 2004. The most common multi-organ transplant was kidney-pancreas transplant, which accounted for 78.9% of all pancreas transplants in 2012. Overall, 81.0% of pancreas

transplants in 2012 were part of a multi-organ transplant (Figure 3.3).

Compared with 2004, the number of pancreas retransplants continued to decline. In 2012, only 6.0% of pancreas transplants in adult recipients were retransplants (Figure 3.4). Use of DCD donors decreased in 2010-2012 to 2.62%, versus 2.95% in 2008-2009. Characteristics of patients undergoing pancreas transplant in 2012 are summarized in Figure 3.6. In 2012, private insurance covered 43.7% of all pancreas transplants and Medicare covered 49.9%. Retransplants were most common among PAK recipients, constituting 33.1% of all PAK transplants (Figure 3.6).

Donor-Recipient Matching

The percentage of unsensitized recipients (0% PRA) has gradually decreased; 60.2% were unsensitized in 2012 and 62.4% in 2011, versus 77.4% in 1998 (Figure 4.1).

HLA matching for pancreas transplants showed that the percentages of highly mismatched transplants (5 or 6 mismatches) were 43.2% of PTA, 55.9% of SPK, and 52.1 of PAK in 2012 (Figure 4.2). Donor-recipient virology data were analyzed for 2008-2012; 26.9% of all transplants were at high-risk for cytomegalovirus disease (donor positive, recipient negative) (Figure 4.3) and 13.4% were at high risk for Epstein-Barr virus (EBV)-related complications (donor positive, recipient negative) (Figure 4.4).

Donors positive for hepatitis B virus and hepatitis C virus were extremely rare (Figures 4.5-4.7).

Outcomes

The outcomes of pancreas grafts are difficult to describe due to lack of a uniform definition of graft failure in the transplant community. Some centers report a graft failure upon resumption of any diabetes medication, whereas other centers do not report a graft failure unless diabetes medications are resumed at levels similar to or in excess of pretransplant levels. Furthermore, the definition used by any given transplant center is not publicly known. This variation led the OPTN Pancreas Transplantation Committee to attempt to standardize the definition of pancreas graft failure for future use; this work is ongoing.

Keeping this limitation in mind, unadjusted graft survival at 5 years was 53% for PTA and 65% for PAK transplants; 5-year survival of the pancreas graft in SPK transplants was 73% for transplants performed in 2007 (Figure 5.5). The better long-term survival for SPK versus PAK and PTA may represent the difficulty of detecting rejection in the absence of a simultaneously transplanted kidney. Detection of an early rejection episode is more likely after SPK transplant, since elevated serum creatinine is a marker that triggers further work-up for rejection. Unfortunately, after PTA and PAK transplants, such a surrogate marker for pancreas rejection is unavailable, and pancreas biopsies are not routinely performed at all centers.

The long-term kidney graft survival rate for SPK recipients continues to improve (Figure 5.2). For SPK transplants performed in 2007, unadjusted 5-year kidney graft failure declined to 20.3% (Figure 5.4). The excellent long-term results for kidneys transplanted as part of an SPK procedure are in part related to the highly selected nature of SPK deceased donors.

Kidney graft failure or death after a PAK transplant steadily decreased. Five-year kidney graft failure after a pancreas transplant was 20.2% (Figure 5.4, upper panel). Thus, the number of recipients alive with a functioning pancreas allograft continued to rise over the past decade and exceeded 13,000 in 2012 (Figure 5.7).

The challenges of pancreas transplant are reflected in the very high rates of rehospitalization among adults who underwent a pancreas transplant in 2007-2012. Most rehospitalizations occurred within the first 6 months posttransplant (Figure 5.9). Pancreas transplant is associated with higher incidence of rejection compared with kidney transplant,

reflecting the relatively high immunogenicity of the pancreas allograft (Figure 5.8). Figure 5.8 also shows that incidence of rejection is highest for PTA recipients. This relates in part to their healthier overall state and ability to mount a strong immune response as compared with the uremic SPK recipients. The higher immunosuppression requirements associated with PTA are reflected in the markedly higher incidence of posttransplant lymphoproliferative disorder (PTLD) in PTA recipients (Figure 5.10). PTLD incidence is higher in all EBV-negative recipients; 5.0% of EBV-negative PTA recipients who underwent transplant in 2006-2010 were diagnosed with PTLD within 12 months of pancreas transplant, versus 2.0% of SPK and 1.1% of PAK recipients.

Economics

The economics of pancreas transplant are primarily driven by two factors: first, the predominance of simultaneous transplant of both a pancreas and a kidney into diabetic end-stage renal disease patients, and second, the tendency toward selection of higher-quality kidneys and lower-risk patients compared with kidney transplant without a pancreas. Average reimbursement for pancreas recipients with primary Medicare coverage from transplant through 1-year posttransplant was $98,440 for Part A and $25,163 for Part B (Figure 6.5), totaling $123,602. For comparison, Medicare reimbursement for diabetic recipients of kidney transplant without a pancreas was similar, $71,489 for Part A and $22,054 for Part B, totaling $93,543 (Figure 8.5, Kidney chapter). Rehospitalization rates were remarkably lower in pancreas transplant recipients than in recipients of kidney transplant without a pancreas (Figures 6.2 and 6.3; Figures 8.2 and 8.3, Kidney chapter), at approximately one-third the frequency in the first year and one-fourth in the second. Annual costs following the first year were dramatically lower for Medicare Parts A and B, averaging $16,842 and $14,335, respectively, and totaling $31,177 (Figure 6.6); cost is expected to remain stable in later years. Additional costs are not accounted for here, including reimbursement to hospitals for the transplant portion of the Medicare Cost Report and Medicare Part D costs. Including estimates for these brings the average Medicare cost to approximately $230,000 in the first year posttransplant and approximately $35,000 in subsequent years. Pancreas transplant recipients accounted for 5% of all Medicare Parts A and B expenditures following solid organ transplant, or $224 million, $28,681 per patient, in 2010 (Figure 6.7).

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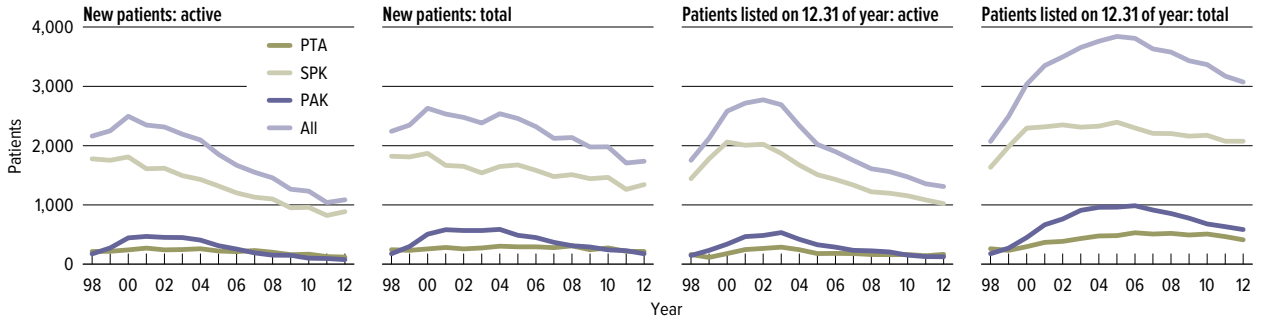
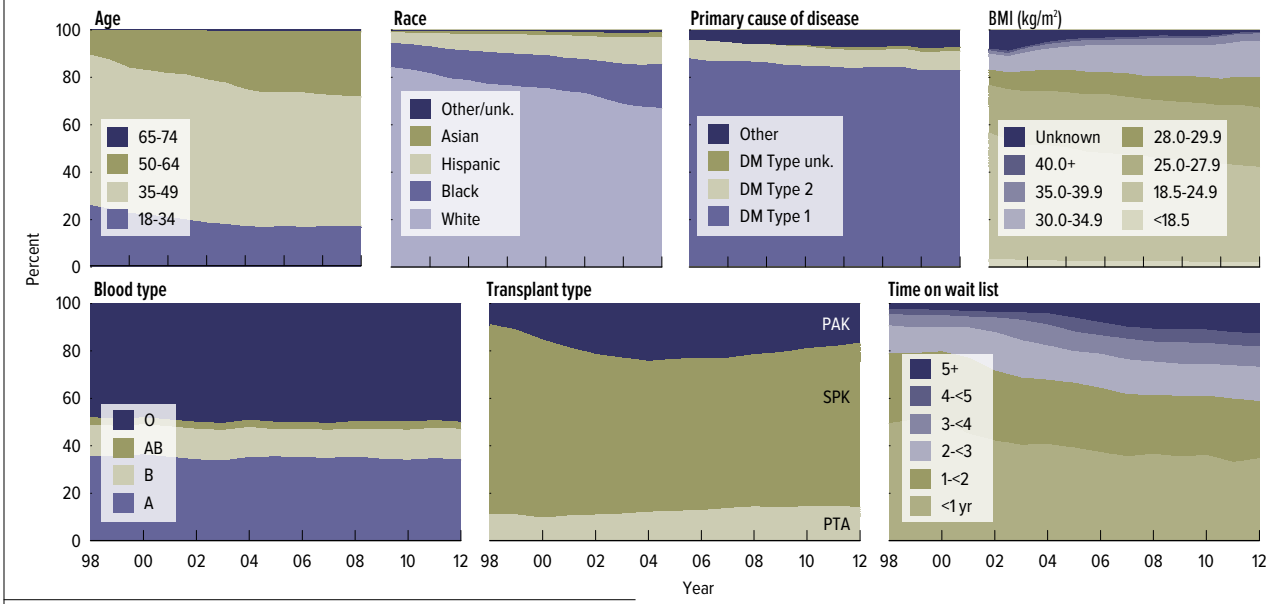
wait list



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. Death data were available only through 2011.



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.

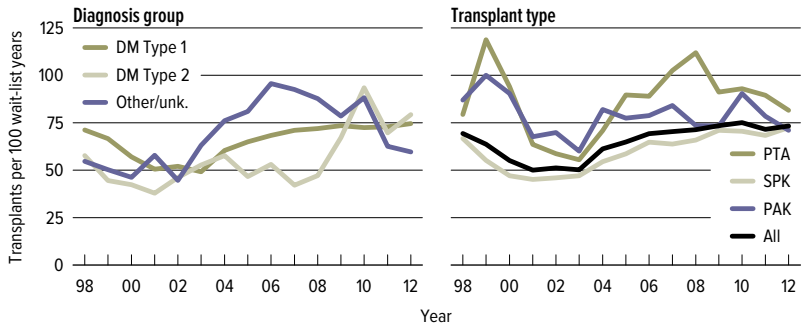
wait list

		2002						2012					
	Level	PTA N	%	SPK N	%	PAK N	%	PTA N	%	SPK N	%	PAK N	%
Age	18-34	75	19.5	541	23.0	131	17.1	84	20.1	407	19.3	57	9.6
	35-49	249	64.7	1,418	60.3	497	65.1	200	48.0	1,200	57.0	318	53.6
	50-64	58	15.1	387	16.5	135	17.7	125	30.0	487	23.1	213	35.9
	65+	3	0.8	4	0.2	1	0.1	8	1.9	11	0.5	5	0.8
Sex	Male	165	42.9	1,292	55.0	442	57.9	193	46.3	1,185	56.3	321	54.1
	Female	220	57.1	1,058	45.0	322	42.1	224	53.7	920	43.7	272	45.9
Race	White	355	92.2	1,685	71.7	649	84.9	336	80.6	1,258	59.8	443	74.7
	Black	12	3.1	415	17.7	62	8.1	33	7.9	501	23.8	73	12.3
	Hispanic	16	4.2	199	8.5	42	5.5	38	9.1	265	12.6	66	11.1
	Asian	1	0.3	35	1.5	5	0.7	6	1.4	52	2.5	9	1.5
	Other/unknown	1	0.3	16	0.7	6	0.8	4	1.0	29	1.4	2	0.3
Primary cause of disease	Diabetes Type 1	345	89.6	1,985	84.5	693	90.7	333	79.9	1,710	81.2	522	88.0
	Diabetes Type 2	10	2.6	228	9.7	25	3.3	15	3.6	215	10.2	39	6.6
	Diabetes type unk.	3	0.8	2	0.1	4	0.5	5	1.2	35	1.7	23	3.9
	Other cause/unk.	27	7.0	135	5.7	42	5.5	64	15.3	145	6.9	9	1.5
Transplant history	Listed/first tx	363	94.3	2,243	95.4	598	78.3	354	84.9	1,947	92.5	428	72.2
	Listed/subseq. tx	22	5.7	107	4.6	166	21.7	63	15.1	158	7.5	165	27.8
Blood type	A	142	36.9	681	29.0	270	35.3	146	35.0	646	30.7	240	40.5
	B	48	12.5	344	14.6	100	13.1	39	9.4	307	14.6	73	12.3
	AB	5	1.3	56	2.4	22	2.9	8	1.9	61	2.9	17	2.9
	O	190	49.4	1,269	54.0	372	48.7	224	53.7	1,091	51.8	263	44.4
PRA	<1%	264	68.6	1,412	60.1	453	59.3	324	77.7	1,794	85.2	341	57.5
	1-<80%	95	24.7	718	30.6	265	34.7	55	13.2	196	9.3	195	32.9
	80-100%	26	6.8	220	9.4	46	6.0	38	9.1	115	5.5	57	9.6
Time on list	<1 year	143	37.1	1,140	48.5	383	50.1	148	35.5	919	43.7	136	22.9
	1-<2	116	30.1	588	25.0	218	28.5	85	20.4	446	21.2	118	19.9
	2-<3	43	11.2	352	15.0	108	14.1	55	13.2	293	13.9	76	12.8
	3-<4	18	4.7	133	5.7	33	4.3	31	7.4	157	7.5	58	9.8
	4-<5	20	5.2	60	2.6	6	0.8	31	7.4	114	5.4	53	8.9
	5+	45	11.7	77	3.3	16	2.1	67	16.1	176	8.4	152	25.6
BMI (kg/m^2)	<18.5	8	2.1	60	2.6	12	1.6	18	4.3	41	1.9	10	1.7
	18.5-24.9	202	52.5	1,113	47.4	335	43.8	153	36.7	831	39.5	226	38.1
	25.0-27.9	94	24.4	551	23.4	190	24.9	96	23.0	533	25.3	156	26.3
	28.0-29.9	31	8.1	202	8.6	89	11.6	51	12.2	257	12.2	83	14.0
	30.0-34.9	25	6.5	243	10.3	80	10.5	67	16.1	333	15.8	91	15.3
	35.0-39.9	2	0.5	64	2.7	12	1.6	24	5.8	73	3.5	14	2.4
	40.0+	3	0.8	28	1.2	8	1.0	1	0.2	18	0.9	1	0.2
	Unknown	20	5.2	89	3.8	38	5.0	7	1.7	19	0.9	12	2.0
Total		385	100	2,350	100	764	100	417	100	2,105	100	593	100

PA 1.3 Characteristics of adult patients on the pancreas transplant waiting list on December 31, 2002 & December 31, 2012

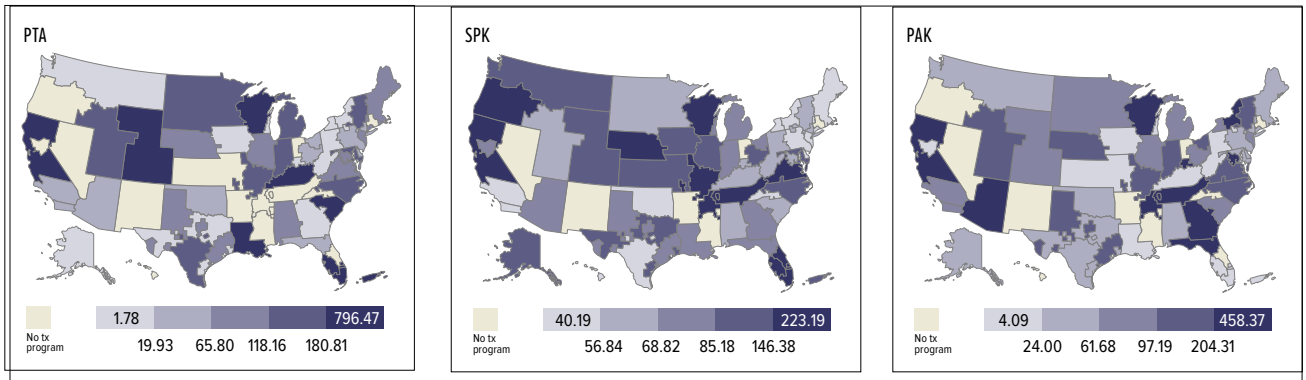
Patients waiting for a transplant on December 31, 2002 and December 31, 2012, regardless of first listing date; active/inactive status is on this date, and multiple listings are not counted.

wait list



PA 1.4 Deceased donor pancreas transplant rates among active adult waiting list candidates

Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active waiting time in a given year. Age is calculated on the first active listing date in a given year.



PA 1.5 Deceased donor pancreas transplant rates per 100 patient years on the waiting list among active adult candidates, by DSA, 2011–2012

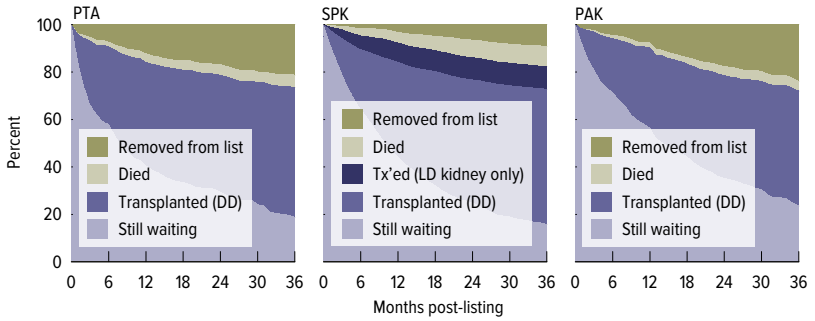
Transplant rates by DSA of the listing center, limited to those with active time on the waiting list in 2011 and 2012; deceased donor transplants only. Maximum time per listing is two years. Patients with concurrent listings in a single DSA are counted once in that DSA, and those listed in multiple DSAs are counted separately per DSA.

	PTA			SPK			PAK		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
Patients at start of year	497	512	471	2,169	2,184	2,092	782	688	643
Patients added during year	275	219	216	1,422	1,220	1,304	240	228	178
Patients removed during year	259	260	270	1,404	1,311	1,291	334	273	228
Patients at end of year	513	471	417	2,187	2,093	2,105	688	643	593
Removal reason									
Deceased donor transplant	149	142	121	876	834	838	157	115	89
Living donor kidney transplant	-	-	-	138	104	89	-	-	-
Patient died	25	21	12	196	150	159	25	23	16
Patient refused transplant	5	23	20	11	10	11	15	24	25
Condition improved, tx not needed	2	9	7	12	12	5	3	4	5
Too sick to transplant	15	16	10	81	79	66	34	34	28
Changed to kidney-pancreas list	12	8	7	0	0	0	15	9	12
Other	51	41	93	90	122	123	85	64	53

PA 1.6 Pancreas transplant waiting list activity among adult patients

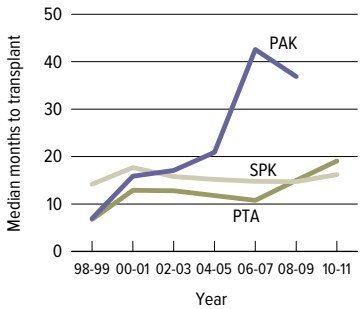
Patients with concurrent listings at more than one center are counted once, from the time of earliest listing to the time of latest removal. Patients listed, transplanted, and re-listed are counted more than once. Patients are not considered "on the list" on the day they are removed. Thus, patient counts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

wait list



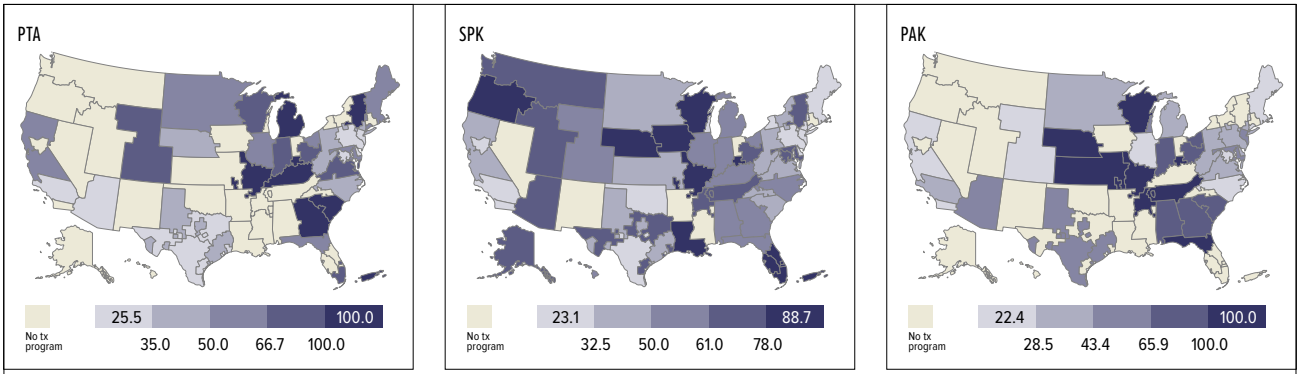
PA 1.7 Three-year outcomes for adult patients waiting for a pancreas transplant among new listings in 2009

Adult patients waiting for any pancreas transplant and first listed in 2009. 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.



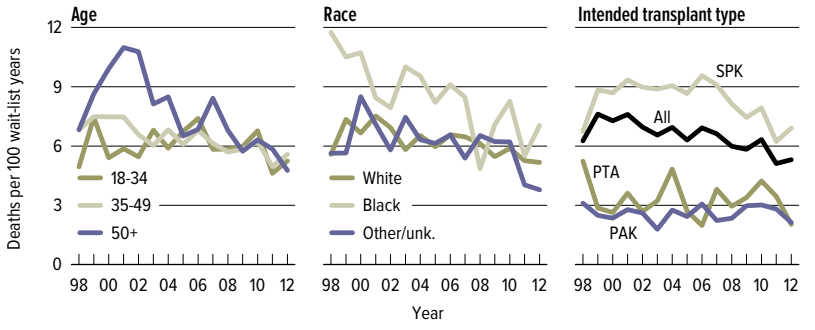
PA 1.8 Median months to pancreas tx for wait-listed adult pts

Pts waiting for a transplant, with observations censored at December 31, 2012; Kaplan-Meier methods used to estimate time to tx. If an estimate is not plotted, 50% of the cohort listed in that year had not been transplanted at the censoring date. Only the first transplant is counted.



PA 1.9 Percent of adult wait-listed patients, 2010, who received a deceased donor pancreas transplant within two years, by DSA

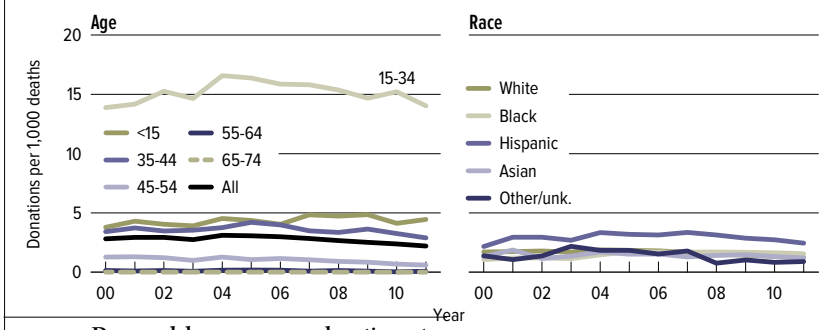
Patients with concurrent listings in a single DSA are counted once in that DSA, and those listed in multiple DSAs are counted separately per DSA.



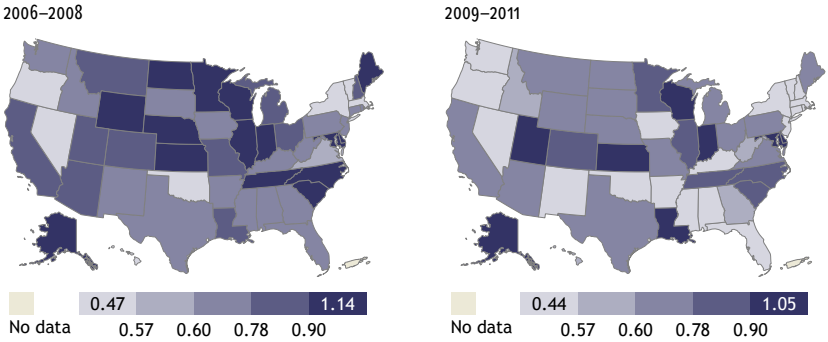
PA 1.10 Pre-transplant mortality rates among adult patients wait-listed for a pancreas transplant

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.

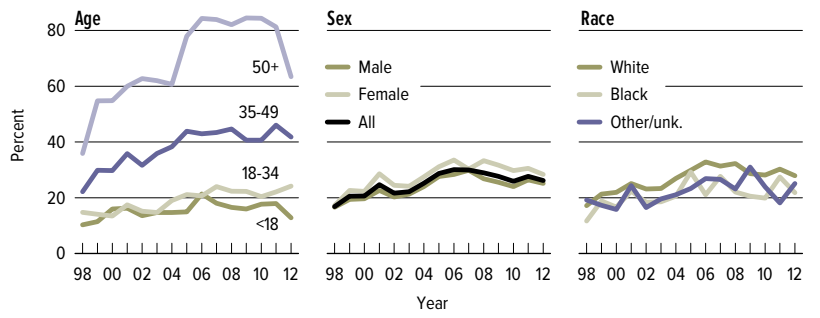
donation



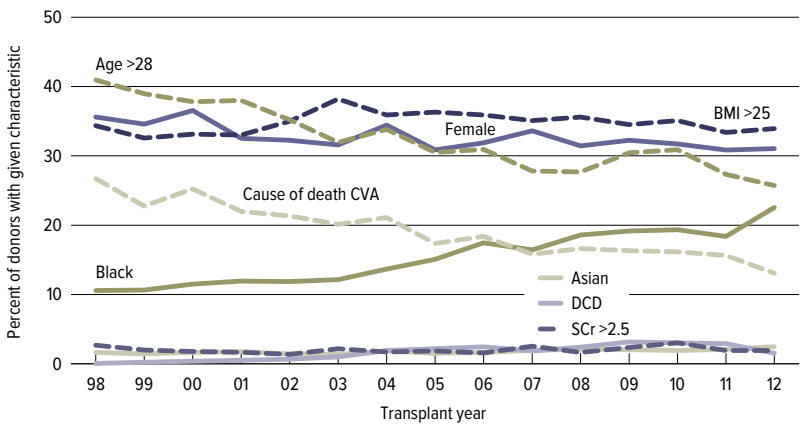
PA 2.1 Deceased donor pancreas donation rates
Numerator: Deceased donors age less than 75 with at least one pancreas recovered for transplant. Denominator: US deaths per year, age less than 75. (Death data available at http://www.cdc.gov/nchs/products/nvsr.htm.) Death data were available only through 2011. Pancreata recovered for islet transplantation are excluded.



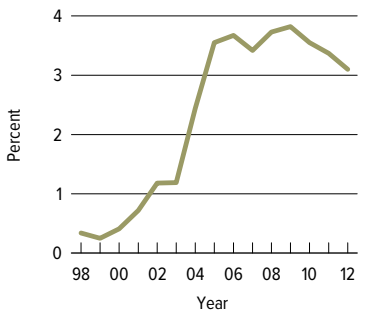
PA 2.2 Deceased donor pancreas donation rates (per 1,000 deaths), by state
Numerator: Deceased donors residing in the 50 states whose pancreas was recovered for transplant in the given year range. Denominator: US deaths by state during the given year range (death data available at http://www.cdc.gov/nchs/products/nvsr.htm). Rates are calculated within ranges of years for more stable estimates. Pancreata recovered for islet transplantation are excluded.



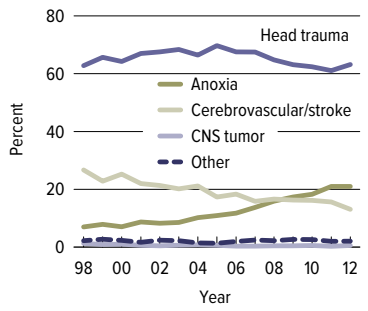
PA 2.3 Discard rates for pancreata recovered for transplant
Percent of pancreata discarded out of all pancreata recovered for transplant. Pancreata recovered for islet transplantation are excluded.



PA 2.4 Donor-specific components of pancreas donor risk (PDRI) index over time
Donors whose pancreas was transplanted are included. The donor-specific components of the PDRI are shown.

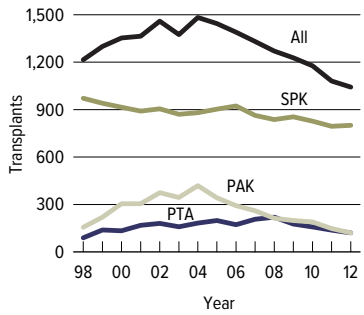


PA 2.5 Pancreas donors who are DCD
Deceased donors whose pancreas was recovered for transplant. Pancreata recovered for islet transplantation are excluded.

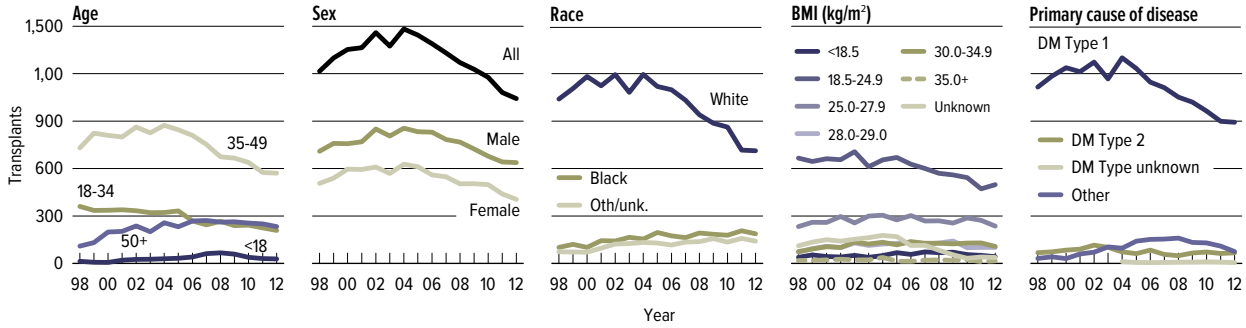


PA 2.6 Cause of death among deceased pancreas donors
Deceased donors whose pancreas was transplanted. CNS = central nervous system.

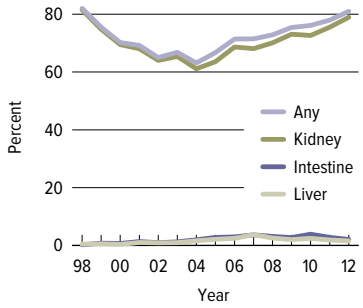
transplant



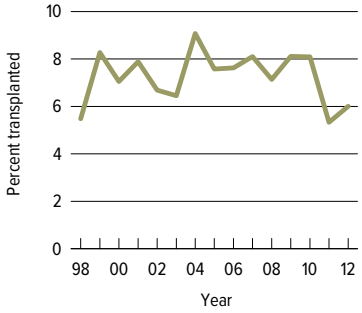
PA 3.1 Total pancreas transplants
Patients receiving a transplant, including multi-organ transplants and pediatrics. Retransplants are counted.



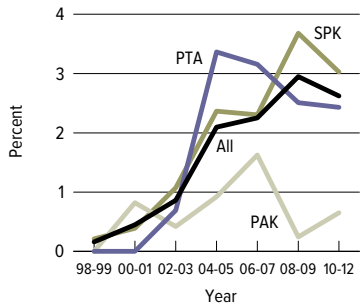
PA 3.2 Pancreas transplants
Patients receiving a transplant, including multi-organ transplants and pediatrics. Retransplants are counted.



PA 3.3 Pancreas transplants that were part of a multi-organ transplant
All adult patients receiving a deceased donor pancreas transplant with at least one additional organ. A multi-organ transplant may include more than two different organs in total; if so, each non-pancreas organ will be considered separately.



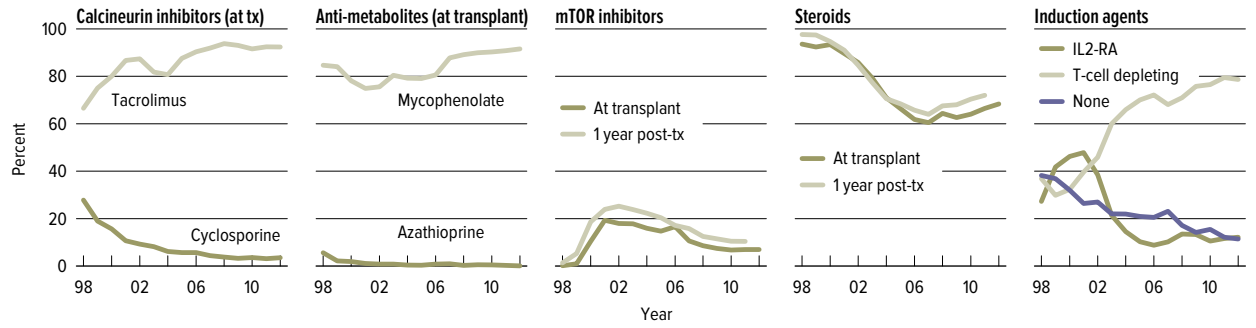
PA 3.4 Retransplants among adult pancreas transplant recipients
Patients receiving a pancreas retransplant in the given year.



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

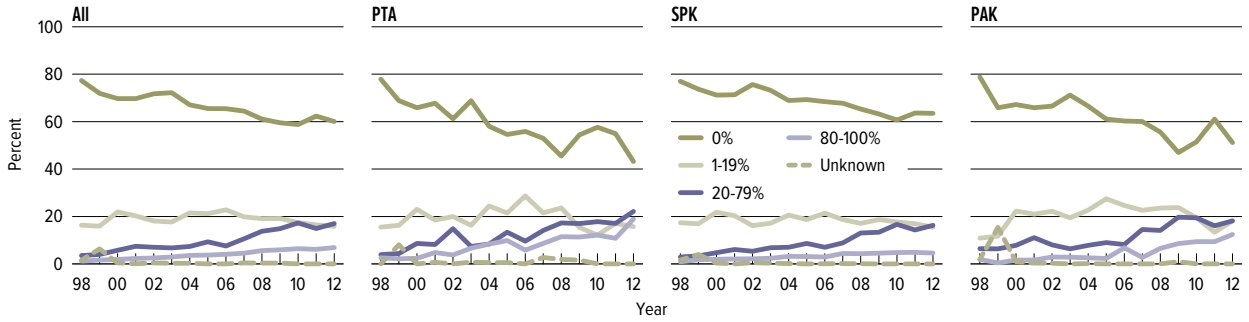
	Level	All N	All %	PTA N	PTA %	SPK N	SPK %	PAK N	PAK %
Age	18-34	209	20.6	24	25.3	169	21.2	16	13.2
	35-49	571	56.3	35	36.8	460	57.6	76	62.8
	50-64	233	23.0	35	36.8	169	21.2	29	24.0
	65+	1	0.1	1	1.1	0	0.0	0	0.0
Sex	Female	393	38.8	60	63.2	290	36.3	43	35.5
	Male	621	61.2	35	36.8	508	63.7	78	64.5
Race	White	695	68.5	84	88.4	524	65.7	87	71.9
	Black	182	17.9	4	4.2	161	20.2	17	14.0
	Hispanic	115	11.3	6	6.3	94	11.8	15	12.4
	Asian	10	1.0	1	1.1	9	1.1	0	0.0
	Other/unknown	12	1.2	0	0.0	10	1.3	2	1.7
Primary cause of disease	Diabetes Type 1	893	88.1	71	74.7	706	88.5	116	95.9
	Diabetes Type 2	68	6.7	0	0.0	66	8.3	2	1.7
	Diabetes type unk.	6	0.6	0	0.0	4	0.5	2	1.7
	Other cause/unk.	47	4.6	24	25.3	22	2.8	1	0.8
Blood type	A	392	38.7	36	37.9	299	37.5	57	47.1
	B	116	11.4	13	13.7	96	12.0	7	5.8
	AB	42	4.1	5	5.3	32	4.0	5	4.1
	O	464	45.8	41	43.2	371	46.5	52	43.0
BMI (kg/m^2)	<18.5	25	2.5	4	4.2	17	2.1	4	3.3
	18.5-24.9	505	49.8	40	42.1	413	51.8	52	43.0
	25.0-27.9	248	24.5	24	25.3	193	24.2	31	25.6
	28.0-29.9	107	10.6	12	12.6	78	9.8	17	14.0
	30.0-34.9	110	10.8	14	14.7	83	10.4	13	10.7
	35.0+	18	1.8	1	1.1	14	1.8	3	2.5
	Unknown	1	0.1	0	0.0	0	0.0	1	0.8
Time on waiting list	<30 days	105	10.4	18	18.9	77	9.6	10	8.3
	31-60 days	80	7.9	10	10.5	65	8.1	5	4.1
	61-90 days	66	6.5	11	11.6	46	5.8	9	7.4
	3-<6 months	159	15.7	18	18.9	123	15.4	18	14.9
	6-<12 months	221	21.8	19	20.0	175	21.9	27	22.3
	1-<2 years	237	23.4	8	8.4	203	25.4	26	21.5
	2-<3 years	84	8.3	5	5.3	61	7.6	18	14.9
	3+ years	62	6.1	6	6.3	48	6.0	8	6.6
Insurance	Private	443	43.7	69	72.6	320	40.1	54	44.6
	Medicare	506	49.9	14	14.7	428	53.6	64	52.9
	Other government	49	4.8	11	11.6	37	4.6	1	0.8
	Other	16	1.6	1	1.1	13	1.6	2	1.7
Pancreas tx history	First transplant	953	94.0	88	92.6	784	98.2	81	66.9
	Retransplant	61	6.0	7	7.4	14	1.8	40	33.1
Total		1,014	100.0	95	100.0	798	100.0	121	100.0

PA 3.6 Characteristics of adult pancreas transplant recipients, 2012
Patients receiving a transplant. Retransplants are counted.

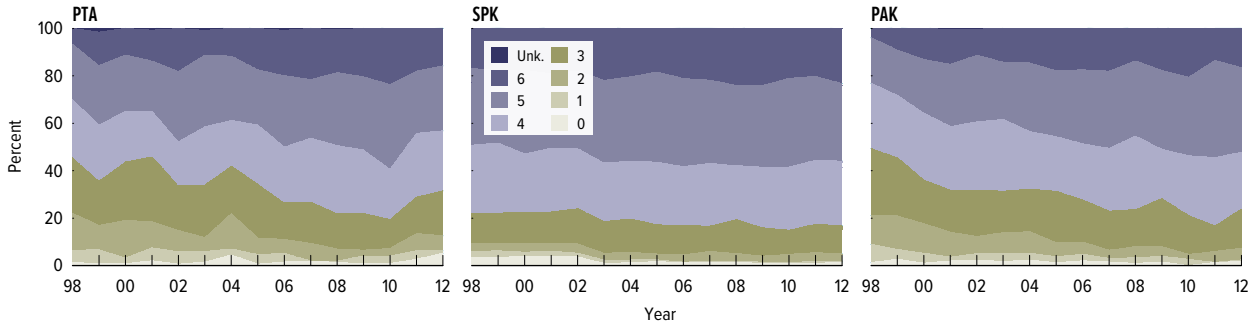


PA 3.7 Immunosuppression use in adult pancreas transplant recipients
One-year post-transplant data limited to patients alive with graft function one year post-transplant. Mycophenolate group includes mycophenolate mofetil and mycophenolate sodium.

donor-recipient matching



PA 4.1 PRA at time of pancreas transplant in adult recipients
CPRA is used unconditionally from October 1, 2009 on. Between December 1, 2007 - October 1, 2009, CPRA is used if >0; otherwise, the maximum of the most recent PRA values pre-transplant is used. Prior to December 1, 2007, the maximum of the most recent PRA values pre-transplant is used 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 2012.

donor-recipient matching

RECIPIENT	DONOR Negative	Positive	Unknown	Total
Negative	19.6	26.9	0.2	46.7
Positive	19.9	30.8	0.1	50.8
Unknown	0.9	1.6	0.0	2.5
Total	40.4	59.3	0.3	100

PA 4.3 Adult pancreas donor-recipient cytomegalovirus (CMV) serology matching, 2008–2012

Adult transplant cohort from 2008–2012. 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.

RECIPIENT	DONOR Negative	Positive	Unknown	Total
Negative	1.5	13.4	0.3	15.1
Positive	5.4	64.6	0.6	70.6
Unknown	0.8	13.2	0.2	14.2
Total	7.8	91.2	1.0	100

PA 4.4 Adult pancreas donor-recipient Epstein-Barr virus (EBV) serology matching, 2008–2012

Adult transplant cohort from 2008–2012. 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.

RECIPIENT	DONOR Negative	Positive	Unknown	Total
Negative	79.9	0.5	0.1	80.5
Positive	3.3	0.1	0.0	3.3
Unknown	16.1	0.1	0.0	16.2
Total	99.2	0.7	0.1	100

PA 4.5 Adult pancreas donor-recipient hepatitis B core antibody (HBCAb) serology matching, 2008–2012

Adult transplant cohort from 2008–2012. 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.

RECIPIENT	DONOR Negative	Positive	Unknown	Total
Negative	94.4	0.0	0.1	94.5
Positive	1.2	0.0	0.0	1.2
Unknown	4.3	0.0	0.0	4.3
Total	99.9	0.0	0.1	100

PA 4.6 Adult pancreas donor-recipient hepatitis B surface antigen (HBSAg) serology matching, 2008–2012

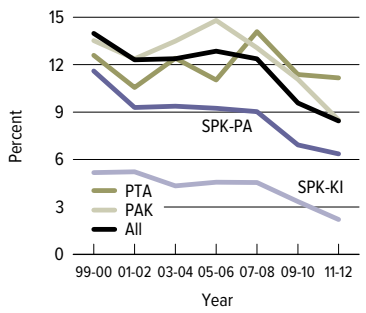
Adult transplant cohort from 2008–2012. Donor serology is reported on the OPTN donor registration forms; recipient serology is reported on the OPTN recipient registration forms. Any evidence for a positive serology is taken to indicate that the person is positive for the given serology; if all fields are unknown, not done, or pending, the person is considered to be "unknown" for that serology; otherwise, serology is assumed negative.

RECIPIENT	DONOR Negative	Positive	Unknown	Total
Negative	93.1	0.0	0.1	93.1
Positive	2.1	0.0	0.0	2.2
Unknown	4.7	0.0	0.0	4.7
Total	99.9	0.0	0.1	100

PA 4.7 Adult pancreas donor-recipient hepatitis C serology matching, 2008–2012

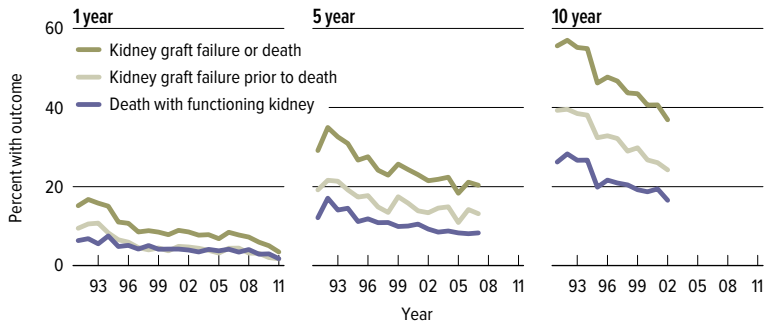
Adult transplant cohort from 2008–2012. Donor serology is reported on the OPTN donor registration forms; recipient serology is reported on the OPTN recipient registration forms. Any evidence for a positive serology is taken to indicate that the person is positive for the given serology; if all fields are unknown, not done, or pending, the person is considered to be "unknown" for that serology; otherwise, serology is assumed negative.

outcomes



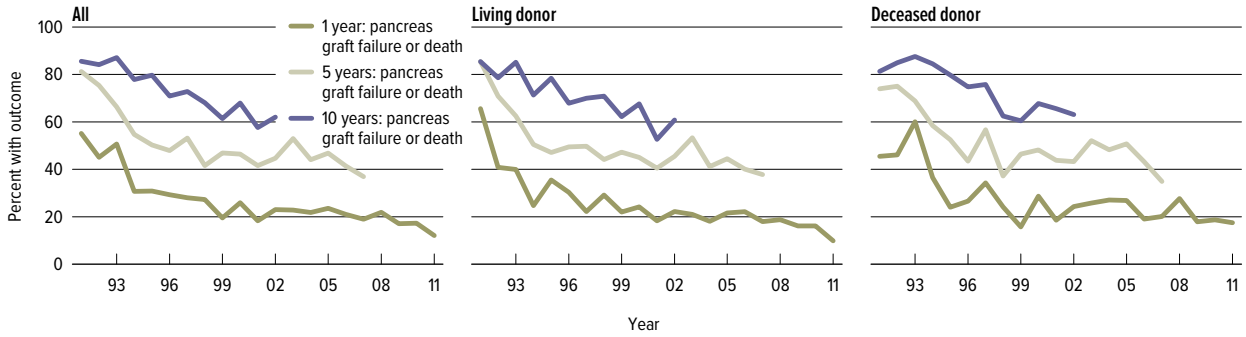
PA 5.1 Graft failure within the first 90 days after transplant among adult pancreas transplant recipients

All-cause graft failure is identified from multiple data sources, including the OPTN Transplant Recipient Registration form and OPTN Transplant Recipient Follow-up form, as well as death dates from the Social Security Administration. Transplants through September 30, 2012 are included to allow for sufficient follow-up.



PA 5.2 Outcomes among adult SPK transplant recipients: kidney outcomes

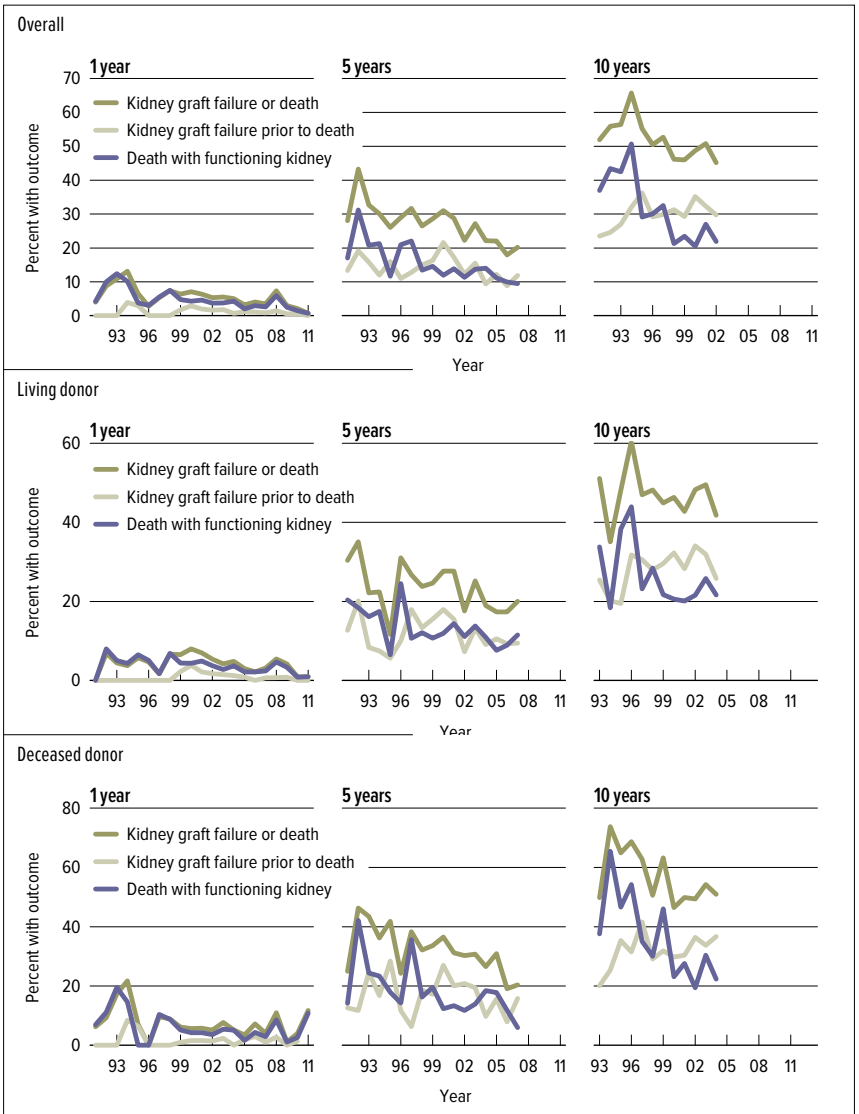
Cox proportional hazards models, adjusted for age, sex, and race. Simultaneous kidney-pancreas (SPK) transplant recipients are followed from date of transplant until the first of kidney graft failure, kidney retransplant, return to dialysis, death, or loss-to-follow-up.



PA 5.3 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.

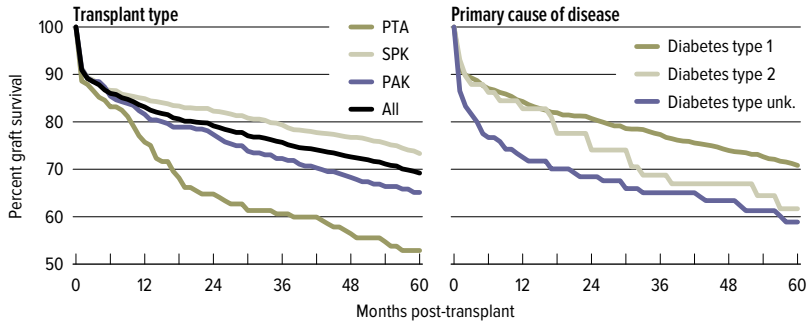
outcomes



PA 5.4 Outcomes among adult PAK transplant recipients: kidney outcomes (from time of pancreas transplant)

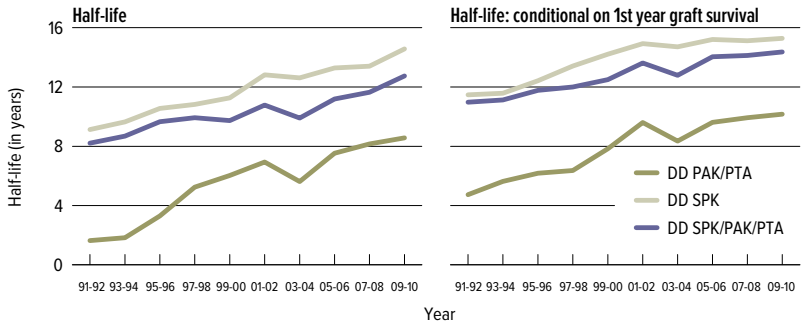
Cox proportional hazards models, adjusted for age, sex, and race. Pancreas-after-kidney (PAK) transplant recipients are followed from date of pancreas transplant until the first of kidney graft failure, kidney retransplant, return to dialysis, death, or loss-to-follow-up. Only PAK recipients with a record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

outcomes



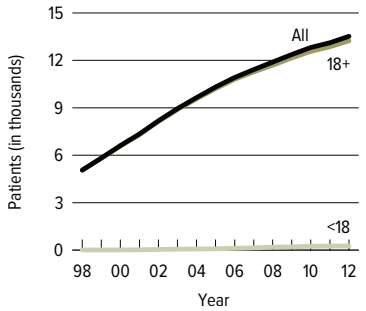
PA 5.5 Graft survival among adult pancreas transplant recipients transplanted in 2007: deceased donors

Pancreas graft survival estimated using unadjusted Kaplan-Meier methods.



PA 5.6 Half-lives for adult pancreas transplant recipients

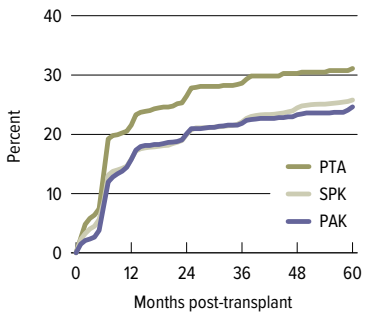
The half-life for a transplant cohort (e.g. 2009 pancrease transplants) is the time point in follow-up at which 50% of the transplanted grafts have failed. A conditional half life for a transplant cohort is the same calculation but limited to those who survive with function at least 1 year post-transplant.



PA 5.7 Recipients alive & with a functioning pancreas transplant on June 30 of the year

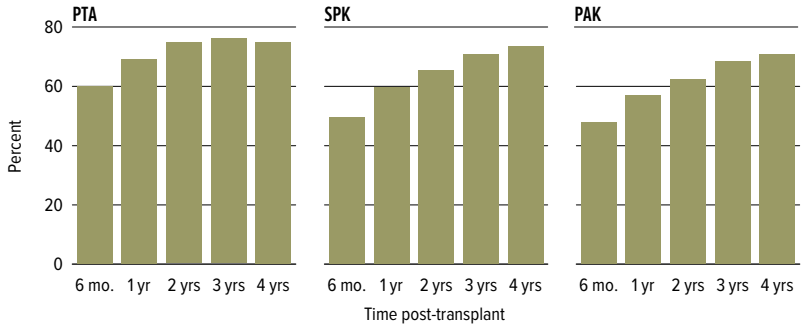
Transplants before June 30 of the year that are still functioning. Patients are assumed alive with function unless a death or graft failure is recorded. A recipient can experience a graft failure and drop from the cohort, then be retransplanted and re-enter the cohort. Age cut is based on age at transplant.

outcomes



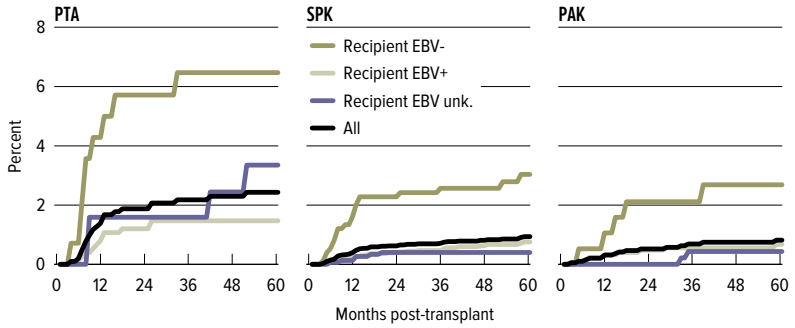
PA 5.8 Incidence of first acute rejection among adult patients receiving a pancreas transplant in 2006–2010

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. Cumulative incidence, defined as the probability of acute rejection at any time prior to the given time, is estimated using Kaplan-Meier competing risk methods.



PA 5.9 Reported cumulative incidence of rehospitalizations among adult patients receiving a pancreas transplant in 2007–2012

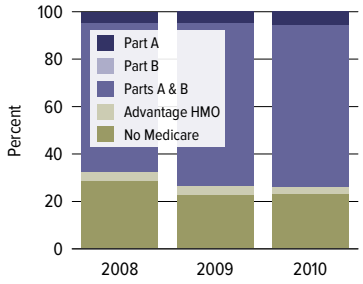
Cumulative rate of rehospitalization; hospitalization identified from follow-up form. Patients required to be alive with graft function at each time period, so denominators reduce over time.



PA 5.10 Incidence of PTLD among adult patients receiving a pancreas transplant in 2006–2010, by recipient Epstein-Barr virus (EBV) status at transplant

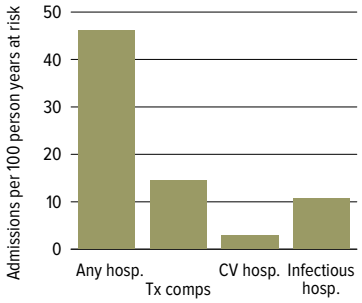
The cumulative incidence is estimated using Kaplan-Meier competing risks methods. PTLD is identified as either a reported complication or cause of death on the Transplant Recipient Follow-up forms or on the Post-transplant Malignancy form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's Disease. Only the earliest date of PTLD diagnosis is considered.

Medicare data



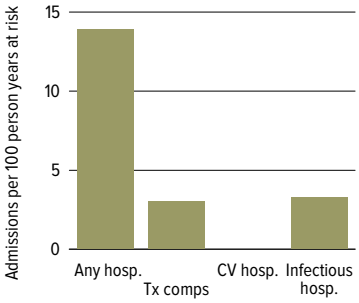
PA 6.1 Medicare coverage among pancreas transplant recipients

Coverage at the time of transplant as identified by the Medicre Beneficiary Annual Summary supplied by CMS.



PA 6.2 Rehospitalization rates among pancreas transplant recipients in the first post-transplant year

Transplant recipients, 2008, with Medicare as the primary payer at transplant. Rehospitalizations and reasons for rehospitalization determined from Medicare claims. First year rates are based on rehospitalizations occuring from initial discharge to one year later.



PA 6.3 Rehospitalization rates among pancreas transplant recipients in the second post-transplant year

Transplant recipients, 2008, with Medicare as the primary payer at transplant. Rehospitalizations and reasons for rehospitalization determined from Medicare claims. Second year rates are based on hospitalizations occuring from initial discharge+1 year to initial discharge+2 years.

Year 1 Cause of hospitalization	Percent of hospitalizations
Transplant complication	27.9
Other infection	13.5
Other	10.5
Gastro-intestinal	9.9
Electrolyte, acid-base & volume depletion	8.5
Metabolic, endocrine, nutritional	6.8
Urinary tract infection	4.3
Bacteremia, viremia and septicemia	3.2
Immune and hematologic	2.7
Genito-urinary and breast	2.7

Year 2 Cause of hospitalization	Percent of hospitalizations
Transplant complication	21.0
Gastro-intestinal	14.6
Metabolic, endocrine, nutritional	13.9
Other infection	10.0
Other	7.7
Bacteremia, viremia & septicemia	5.2
Urinary tract infection	5.2
Electrolyte, acid-base & volume depletion	4.8
Respiratory infection	2.7
Genito-urinary and breast	2.5

PA 6.4 Top ten causes of rehospitalization among pancreas recipients transplanted in 2008 with Medicare primary coverage

Transplant recipients, 2008, with Medicare as the primary payer at transplant. Reasons for rehospitalization determined from Medicare claims, denominator for percentages includes only those re-hospitalized.

Medicare data

		# patients	Total costs Part A	Total costs Part B	PPPY costs Part A	PPPY costs Part B
	All patients	1,046	91,133,188	23,294,904	98,440	25,163
Age	18-34	248	20,467,804	5,798,001	92,287	26,143
	35-49	595	50,147,424	13,123,747	96,984	25,381
	50-64	199	20,091,681	4,292,203	109,843	23,466
	65+	*	*	*	*	*
Sex	Male	672	55,751,965	14,811,920	93,554	24,855
	Female	374	35,381,223	8,482,985	107,266	25,718
Race	White	694	60,130,774	14,607,848	98,006	23,809
	Black	204	18,132,630	4,972,532	100,433	27,542
	Hispanic	126	10,269,645	3,184,558	90,262	27,990
	Asian/Pac. Isl.	16	1,712,267	378,756	134,000	29,641
	Other/unk.	*	*	*	*	*
Primary cause of disease	Diabetes Type 1	892	75,605,427	19,409,839	96,109	24,674
	Diabetes Type 2	70	6,621,616	1,796,795	102,855	27,910
	DM Type unk.	13	981,059	293,273	75,260	22,498
	Other/unk.	71	7,925,086	1,794,997	128,437	29,090

PA 6.5 Total and per-person per-year (PPPY) Medicare costs ($) among pancreas transplant recipients in the first post-transplant year

Costs among recipients transplanted in 2008 and 2009 who had Medicare as the primary payer at the time of transplant. First year costs include the transplant hospitalization. Costs incurred after a transplant failure are excluded. Values for cells with 9 or fewer patients are suppressed.

		# patients	Total costs Part A	Total costs Part B	PPPY costs Part A	PPPY costs Part B
	All patients	400	6,604,595	5,621,757	16,842	14,335
Age	18-34	104	2,095,932	1,519,943	20,638	14,966
	35-49	220	3,367,219	3,203,231	15,462	14,709
	50-64	74	1,057,612	880,522	14,933	12,432
	65+	*	*	*	*	*
Sex	Male	260	3,782,130	3,612,619	14,802	14,139
	Female	140	2,822,465	2,009,138	20,655	14,703
Race	White	261	4,350,602	3,393,734	17,113	13,349
	Black	83	1,812,105	1,451,117	22,027	17,639
	Hispanic	50	406,916	708,644	8,195	14,272
	Asian/Pac. Isl.	*	*	*	*	*
	Other/unk.	*	*	*	*	*
Primary cause of disease	Diabetes Type 1	339	5,434,798	4,683,190	16,384	14,118
	Diabetes Type 2	26	311,761	441,104	12,185	17,240
	DM Type unk.	*	*	*	*	*
	Other/unk.	27	766,658	395,083	28,566	14,721

PA 6.6 Total and per-person per-year (PPPY) Medicare costs ($) among pancreas transplant recipients in the second post-transplant year

Costs among recipients transplanted in 2008 who had Medicare as the primary payer at the time of transplant. The second post-transplant year runs from 366 to 730 days after transplant. Costs incurred after a transplant failure are excluded. Values for cells with 9 or fewer patients are suppressed.

Medicare data

Total costs

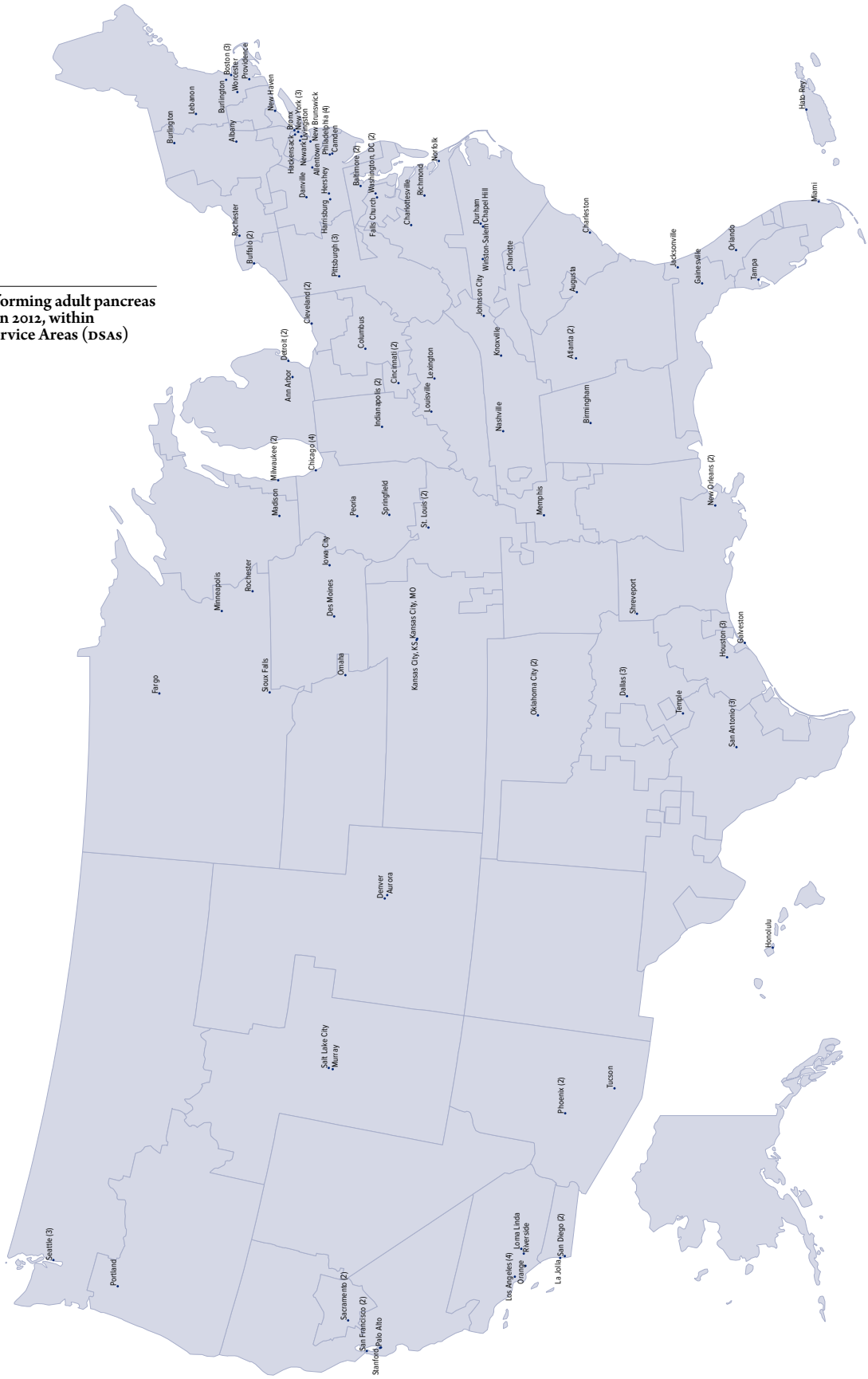
		2008 total costs			2009 total costs			2010 total costs		
		# patients	Part A	Part B	# patients	Part A	Part B	# patients	Part A	Part B
	All patients	7,359	134,601,264	55,370,281	7,633	149,704,141	70,629,865	7,808	155,230,859	68,709,534
Age	0-11	*	*	*	*	*	*	*	*	*
	12-17	*	*	*	*	*	*	*	*	*
	18-34	1,894	39,726,811	15,682,532	1,915	41,720,581	19,549,606	1,958	43,789,217	18,977,488
	35-49	4,330	71,069,443	31,336,181	4,463		40,264,491	4,528	83,098,598	38,674,969
	50-64	1,112	22,894,521	8,109,516	1,231	24,636,875	10,583,869	1,296	27,580,809	10,770,066
	65+	16	562,925	134,093	18	333,047	172,021	18	532,279	205,903
Sex	Male	4,445	79,251,852	33,485,360	4,609	86,655,657	42,808,135	4,702	88,801,380	40,626,491
	Female	2,914	55,349,412	21,884,921	3,024	63,048,484	27,821,730	3,106	66,429,480	28,083,044
Race	White	5,858	101,594,685	41,301,659	6,023	111,186,012	52,144,335	6,091	113,770,061	50,170,199
	Black	880	20,832,491	8,509,128	941	23,157,671	11,009,386	1,013	25,590,098	11,341,381
	Hispanic	517	10,077,090	4,693,295	554	12,693,185	6,353,311	584	12,287,303	6,074,537
	Asian/Pacific Islander	70	1,438,481	637,644	76	1,873,581	813,331	77	1,937,796	701,154
	Other/unk.	34	658,516	228,555	39	793,692	309,502	43	1,645,602	422,263
Primary cause of disease	Diabetes Type 1	5,979	105,759,707	44,371,166	6,215	118,912,396	57,307,999	6,379	120,385,010	55,319,580
	Diabetes Type 2	436	8,570,790	3,647,292	468	9,674,931	4,715,828	483	11,293,695	4,801,071
	Diabetes Type unk.	28	845,375	249,991	35	810,904	348,733	38	648,457	375,009
	Other/unk.	916	19,425,392	7,101,832	915	20,305,910	8,257,304	908	22,903,697	8,213,874

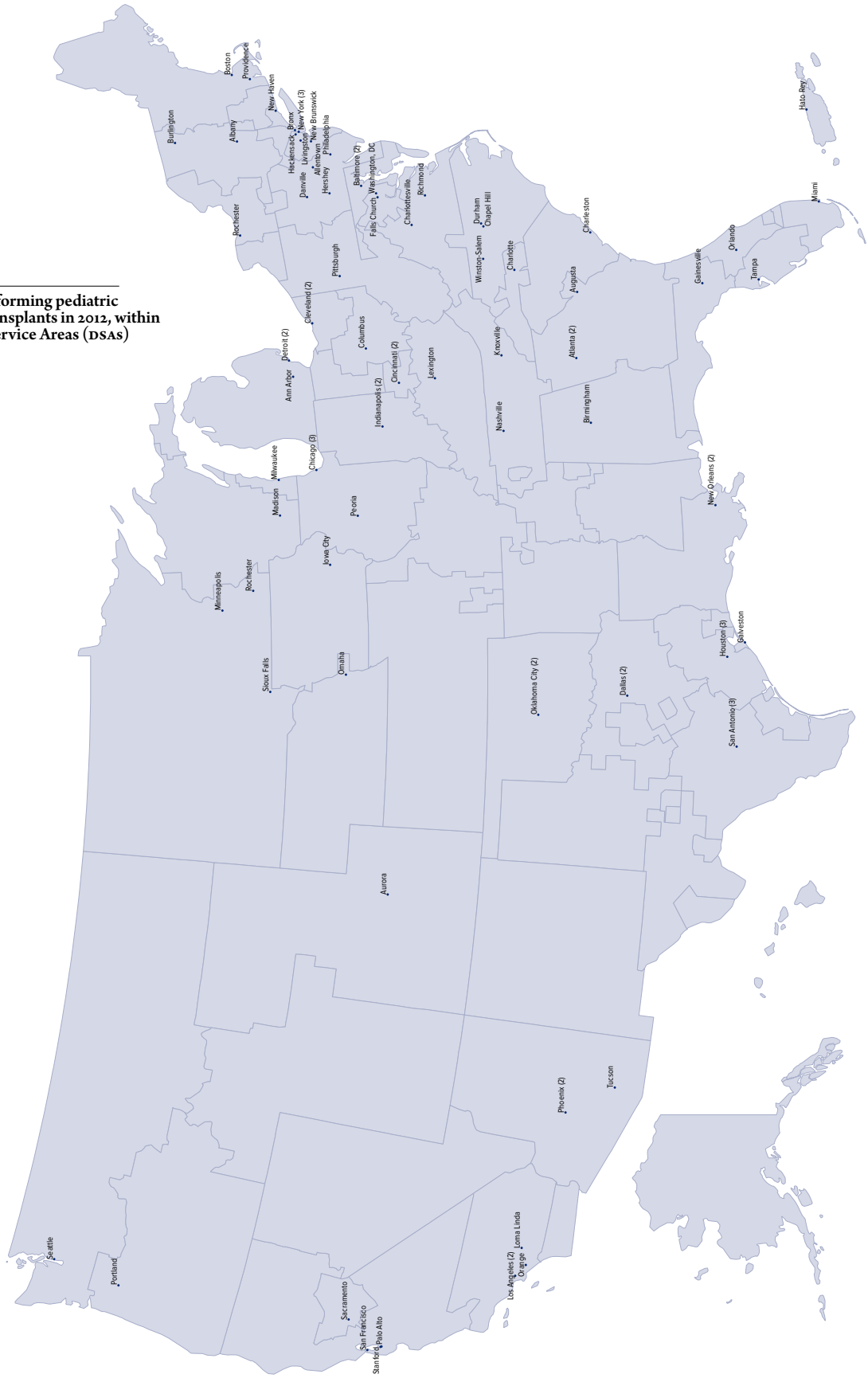
Per person per year costs

		2008 PPPY costs			2009 PPPY costs			2010 PPPY costs		
		# patients	Part A	Part B	# patients	Part A	Part B	# patients	Part A	Part B
	All patients	7,359	20,004	8,229	7,633	21,474	10,131	7,808	21,673	9,593
Age	0-11	*	*	*	*	*	*	*	*	*
	12-17	*	*	*	*	*	*	*	*	*
	18-34	1,894	22,756	8,983	1,915	23,579	11,049	1,958	24,365	10,559
	35-49	4,330	17,929	7,905	4,463	20,228	9,840	4,528	19,953	9,287
	50-64	1,112	22,953	8,130	1,231	22,613	9,714	1,296	23,424	9,147
	65+	16	37,618	8,961	18	22,512	11,627	18	35,382	13,687
Sex	Male	4,445	19,591	8,277	4,609	20,630	10,191	4,702	20,645	9,445
	Female	2,914	20,628	8,156	3,024	22,754	10,041	3,106	23,219	9,816
Race	White	5,858	18,878	7,675	6,023	20,090	9,422	6,091	20,240	8,925
	Black	880	26,504	10,826	941	27,667	13,153	1,013	28,332	12,557
	Hispanic	517	21,610	10,065	554	25,378	12,703	584	23,249	11,494
	Asian/Pacific Islander	70	22,870	10,138	76	28,606	12,418	77	26,830	9,708
	Other/unk.	34	20,728	7,194	39	23,183	9,040	43	44,123	11,322
Primary cause of disease	Diabetes Type 1	5,979	19,399	8,139	6,215	20,962	10,102	6,379	20,576	9,455
	Diabetes Type 2	436	21,190	9,017	468	22,839	11,133	483	25,799	10,968
	Diabetes Type unk.	28	34,862	10,309	35	26,650	11,461	38	19,106	11,049
	Other/unk.	916	22,908	8,375	915	24,042	9,777	908	27,273	9,781

PA 6.7 Total calendar-year Medicare costs ($) spent on pancreas transplant recipients, 2008, 2009, & 2010

Costs paid by Medicare in each calendar year among recipients alive with graft function in the given year, regardless of Medicare eligibility at the time of transplant. Costs incurred after transplant failure are excluded. Values for cells with 9 or fewer patients are suppressed.



PA 7.1 Centers performing adult pancreas transplants in 2012, within Donation Service Areas (DSAs)

PA 7.2 Centers performing pediatric pancreas transplants in 2012, within Donation Service Areas (DSAs)