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## OPTN/SRTR 2012 Annual Data Report:

# liver

**ABSTRACT** Liver transplant in the US remains a successful life-saving procedure for patients with irreversible liver disease. In 2012, 6256 adult liver transplants were performed, and more than 65,000 people were living with a transplanted liver. The number of adults who registered on the liver transplant waiting list decreased for the first time since 2002; 10,143 candidates were added, compared with 10,359 in 2011. However, the median waiting time for active wait-listed adult candidates increased, as did the number of candidates removed from the list because they were too sick to undergo transplant. The overall deceased donor transplant rate decreased to 42.3 per 100 patient-years, and varied geographically from 18.9 to 228.0 per 100 patient-years. Graft survival continues to improve, especially for donation after circulatory death livers. The number of new active pediatric candidates added to the waiting list also decreased. Almost 75% of pediatric candidates listed in 2009 underwent transplant within 3 years; the 2012 rate of deceased donor transplants among active pediatric wait-listed candidates was 136 per 100 patient-years. Graft survival for deceased donor pediatric transplants was 92.8% at 30 days. Medicare paid for some or all of the care for more than 30% of liver transplants in 2010.

**KEY WORDS** Liver transplant, model for end-stage liver disease, waiting list.

*When I awoke from surgery three and a half days later, while still on life support I spoke my first words, "She was younger than I." My surgeon teared up, "And she has three children!" I have had normal liver functions for the past seven years thanks to my 44-year old donor.*

Ronald, liver recipient

## Adult Liver Transplant

### INTRODUCTION

In 2012, 6256 liver transplants were performed in the United States (Figure 4.1). These included transplant of 5747 organs from donation after brain death (DBD) donors, 263 from donation after circulatory death (DCD) donors, and 246 from living donors. Organs were procured from across the country and transplanted at 132 transplant centers. For deceased donor recipients who underwent transplant in 2007, these life-saving operations yielded an unadjusted 5-year survival of 70.5% (Figure 6.4). Based on Medicare data, incorporated into the Annual Data Report for the first time this year, liver transplants cost an average of \$188,000 during the first year after transplant. More importantly, human costs were substantial; in 2012, 2187 patients died while on the waiting list, and 815 were removed from the list because they were too sick to undergo transplant (Figure 1.6). Ultimately, liver transplant in the US remains a successful life-saving procedure for patients with irreversible liver disease. As of June 30, 2012, more than 65,000 people were living with a liver transplant; 57,000 had undergone transplant as adults and 8700 as children (Figure 6.7).

### WAITING LIST

During 2012, 10,143 candidates were added to the liver transplant waiting list (Figure 1.6), most with active status ( $n = 9708$ , 96%; Figure 1.1). This compares with 10,359 candidates added in 2011 and represents a decrease of 216 (2.1%), the first decrease in wait-list registrations since 2002. Similarly, the number of active wait-list candidates on December 31, 2012, was 12,427, compared with 12,635 one year before. Whether such decreases will continue remains to be seen, but if future data confirm a decreasing demand for liver transplant, it will represent a reversal of a trend that has persisted since liver transplant became recognized as an established procedure. A possible explanation of the decreases may be positive, such as successful treatment of viral hepatitis or better management of patients with advanced liver disease. Conversely, the explanation may be negative, such as aging patients with hepatitis C virus (HCV) infection being rejected from transplant candidacy, or increasing comorbidity in patients with end-stage liver disease or hepatocellular carcinoma (HCC)

related to increasing prevalence of obesity and related metabolic and cardiovascular complications.

Figure 1.2 shows further trends among liver transplant wait-list candidates. The proportion of older patients (aged 65 years or older) increased. Model for end-stage liver disease (MELD) scores at registration were most commonly between 6 (the lower bound) and 14, but the proportion of scores between 15 and 34 is growing steadily. The distribution of liver disease etiology remains unchanged, except for malignancy. This trend is a part of larger phenomena of increasing incidence of HCC and rapidly increasing numbers of liver transplant candidates and recipients with HCC exceptions (also see Figure 1.3). Figure 1.4 shows a similar trend with regard to HCC; deceased donor transplant rates among active adult candidates with HCC exceptions were nearly three times higher than rates among those without HCC exceptions. The overall transplant rate has been gradually declining since 2006; greater decline was seen in candidates with HCC exceptions and in candidates aged 18 to 34 years.

The decrease in transplant rates reflects the gradually worsening donor shortage. Despite the decline in wait-list registration, the median pretransplant waiting time among active wait-listed adult patients increased from 12.9 months in 2009 to 17.6 months in 2010 and to 18.5 months in 2011 (Figure 1.8). Pretransplant mortality rates decreased in 2012, for the first time in several years (Figure 1.10).

Among active adult wait-list candidates, the overall deceased donor transplant rate was 42 per 100 patient-years on the waiting list (Figure 1.4). However, geographic variability in transplant rates was considerable. Within the continental US, rates ranged from 18.9 per 100 patient-years on the waiting list to 228.0, more than a 10-fold difference (Figure 1.5). Median MELD scores at the time of transplant also varied widely by donation service area (DSA). Within the continental US, median MELD scores were 22 in several DSAs, and the highest MELD scores were in DSAs located in California and New York (Figure 4.9).

Similarly, the proportion of adults receiving deceased donor organs within 5 years of listing ranged from 30.5% in a DSA in New York to 86.1% in the Arkansas DSA (Figure 1.9). These differences are striking, and the solution to geographic disparity remains a challenge. There is an inverse correlation

between transplant rates and median MELD scores by DSA. Increasing donation represents the most ideal solution for the donor shortage; there is no clear correlation between the organ donation rate and the median MELD score at transplant (Figure 2.2).

### DONATION

Figure 2.1 shows the trend in organ donation rates over time. Rates peaked in 2006 and have been decreasing since, despite modest increases from donors aged 15 to 34 and 35 to 44 years. Figure 2.5 shows that the proportion of donors who died of cerebral anoxia has been increasing. The proportion of DCD donors has been stable since 2005 (Figure 2.4).

The total number of living donor liver transplants has been stable since 2008 (Figure 3.1). However, right lobe donation increased slightly from 57.8% of total living donors in 2010 to 63.7% in 2012 (Figure 3.3). The most noticeable recent trend in living donor transplant is data that suggest worsening short-term outcomes for donors. The number of donors with biliary complications reported to OPTN more than doubled, from 6 cases (2.5%) in 2011 to 14 (6.4%) in 2012 (Figure 3.5). The number of vascular complications also increased, from just 1 case in 2010 and 2011 to 7 in 2012 (Figure 3.6). Complications other than biliary and vascular increased modestly (Figure 3.7). Donor rehospitalization within 6 weeks of organ donation increased from 7.8% to 9.7% between 2010 and 2011, and rehospitalization within 6 months increased from 8.6% to 11.4% (Figure 3.4). Conversely, the number of donors who required reoperation decreased and, most importantly, no donor deaths were reported in 2012.

### TRANSPLANT

Data on recipients show a continued trend toward older ages. The number of recipients aged 65 years or older more than doubled, from 363 in 2002 to 835 in 2012 (Figure 4.2). The largest group of recipients, those aged 50 to 64 years, increased from 2433 in 2002 to 3623 in 2012. However, the most noticeable trend in recipient characteristics is the rapidly rising number and proportion of recipients with a primary diagnosis of malignancy; the number increased from 432 in 2002 to 1337 in 2012 (Figure 4.2). The most common diagnosis in recipients remains HCV, which likely contributes to the number of recipients with

malignancy as the primary diagnosis at transplant (Figure 4.2). In keeping with the trend in the general population toward increasing prevalence of obesity, the proportion of recipients with body mass index (BMI) 30 kg/m<sup>2</sup> or higher increased from 29.0% in 2002 to 35.4% in 2012 (Figure 4.7). Because many liver transplant candidates have ascites and fluid retention, high BMI does not necessarily indicate obesity. However, increasing prevalence of diabetes during the same time period (18.2% to 24.6%) suggests increasing obesity (Figure 4.7).

Nationwide, the median match MELD score for transplant in 2012 was 27 (Figure 4.9). However, geographic disparity in median MELD scores remains wide. In DSAs in the continental US, the lowest median MELD score was 21 and the highest 35. In eight DSAs, median MELD scores were 30 or higher in 2012. A substantial part of this variation is due to differences in lab MELD and match MELD scores by DSA. Score adjustments are common for HCC, and nationwide the median difference between lab and match MELD scores is 2 points, but it varies from 0 to 11 points (Figure 4.10). In DSAs with the highest median match MELD scores, the median difference between lab and match MELD scores was also largest. There is a consensus that the adjustment score for patients with HCC may still be too high, disadvantaging patients with severe end-stage liver disease without HCC. Work attempting to address the gap is underway.

The proportion of multi-organ transplants is increasing, a trend led by simultaneous liver and kidney (SLK) transplants. In 2012, 8.4% of all deceased donor transplants were multi-organ; of these, 92% were SLK transplants (Figure 4.3). The issue of increasing use of SLK transplants has been a topic of many discussions, debates, and publications. The trend is due to several factors, the most important of which is the worsening condition of liver transplant candidates with end-stage liver disease, leading to higher incidence of hepatorenal syndrome and other renal complications. Of note, the current allocation system, which takes into account renal function of liver candidates, may not be the only cause of the increase in SLK. Indeed, it is possible that, given the continued organ shortage and increasing severity of end-stage liver disease, patients with adequate renal function may be left with their liver disease progressing, potentially resulting in an even greater need for SLK transplant.

Tacrolimus-based immunosuppression after transplant was reported for most patients (Figure 4.8). Reported use of mycophenolate and to a lesser extent azathioprine increased, and reported use of steroids decreased (Figure 4.8). Use of mammalian target of rapamycin (mTOR) inhibitors at transplant was reported in approximately 3% of recipients, and within the first year after transplant in 9%. The proportion of liver recipients reported to be undergoing induction therapy, particularly with an interleukin-2 receptor antagonist, has been increasing (Figure 4.8). Some of these trends may be related to the small but significant proportion of patients undergoing SLK transplant.

## OUTCOMES

Continued improvement in overall graft survival is encouraging (Figures 6.2 and 6.6). Figure 6.1 shows that 90-day graft survival for all deceased donor livers consistently improved in the past decade. Of note, DCD graft survival substantially improved over time. Living donor graft survival abruptly worsened, reversing the previous trend of consistent improvement (Figure 6.1). This, combined with less favorable donor outcomes discussed previously, may raise concerns about the practice of living donor liver transplant as a whole and may deserve closer scrutiny. Figure 6.5 shows the analysis of living donor transplant outcomes by subgroup.

In subgroup analyses, outcomes were poorest for older patients, patients with the highest MELD scores, and patients with HCV (Figure 6.4). DCD grafts survived less well than DBD grafts; the gap developed during the first year after transplant and continued over time. Survival of retransplant grafts was lower than survival of primary grafts, which is also well documented.

As of June 30, 2012, 56,900 adult liver transplant recipients were alive, a number that testifies to the success of the nationwide practice of liver transplant. This total number of liver recipients alive in 2012 was almost exactly twice the number alive 10 years before (28,500 in 2002).

## Pediatric Transplant

### WAITING LIST

The number of new active candidates added to the pediatric liver transplant waiting list has steadily decreased, and very

few have been added as inactive (Figure 7.1). A similar trend is the decreasing numbers of prevalent wait-listed patients (those on the list on December 31 of the given year), of whom most (60%) are listed as active. The age distribution of wait-listed candidates changed little over the past decade. In 2012, 22.5% of candidates were aged less than 1 year, 26.9% were aged 1 to 5 years, 15.3% were aged 6 to 10 years, and 35.4% were aged 11 to 17 years (Figure 7.2). Half of the wait-list candidates have been waiting for less than 1 year, 19.6% for 1 to less than 2 years, 11.7% for 2 to less than 4 years, and 18.9% for 4 or more years. In 2012, 13.1% of wait-list candidates ( $n = 85$ ) had undergone a previous liver transplant (Figure 7.3). Of all wait-list candidates in 2012, 10.3% (43) of those aged less than 6 years, 20.5% (16) of those aged 6 to 10 years, and 17.0% (26) of those aged 11 to 17 years were waiting for retransplant (Figure 7.3). Among candidates removed from the waiting list in 2012, 66.0% received a deceased donor liver, 7.5% received a living donor liver, 5.2% died, 13.7% were removed from the list because their condition improved, and 2.4% were considered too sick to undergo transplant (Figure 7.4). Almost 75% of patients newly listed in 2009 underwent transplant within 3 years; 6.4% died, 11.9% were removed from the list, and 7.0% were still waiting (Figure 7.5). The rate of deceased donor transplant among active pediatric wait-list candidates was 136 per 100 patient-years on the waiting list. Rates were highest for candidates aged younger than 1 year (267 per 100 patient-years on the waiting list) and lowest for candidates aged 11 years or older (87 per 100 patient-years on the waiting list) (Figure 7.6). Of note, transplant rates have been steadily increasing for candidates aged younger than 1 year; for older candidates, rates began to plateau in 2005 for candidates aged 11 years or older and in 2009 for candidates aged 1-10 years. Pretransplant mortality has decreased for all age groups, to 5.8 deaths per 100 wait-list years in 2010-2012 (Figure 7.7). The pretransplant mortality rate is highest for candidates aged younger than 1 year, at 25.4 deaths per 100 wait-list years in 2010-2012 (Figure 7.7).

### TRANSPLANT

The number of deceased donor liver transplants peaked at 542 in 2008 and decreased to 473 in 2012. The number of living donor liver transplants decreased from a peak of 120 in 2000 to

52 in 2012 (Figure 7.8). Approximately 10% of liver transplant recipients in 2012 had undergone previous transplant (Figure 7.9). In 2012, 10.1% of pediatric liver transplants were part of a multi-organ transplant: 5.5% pancreas, 5.5% intestine, and 4.2% kidney (Figure 7.10). DCD donors are rarely used in pediatric liver transplant, accounting for less than 1% in 2012 (Figure 7.12). Considering the past decade of pediatric liver transplant, age, sex, and ethnic distributions of recipients have changed little (Figure 7.13). Cholestatic disease remains the leading cause (46.9%) of liver failure. In 2010-2012, 38.4% of recipients waited less than 30 days for transplant, and 16.4% waited 31 to 60 days. Almost 60% of liver transplant recipients were not hospitalized before transplant. Considering medical urgency status, 15.4% of recipients underwent transplant as status 1A and 15.2% as status 1B; 13.8% had a MELD/pediatric end-stage liver disease (PELD) score of 35 or higher. The most common score at time of transplant was 15 to 29 (28%). Most pediatric patients (63.7%) received a whole liver; split liver transplants increased only slightly from 13.1% of transplants in 2002 to 16.1% in 2012. The proportion of living donors declined from 17.5% in 2000-2002 to 11% in 2010-2012. ABO-incompatible liver transplant occurred in 2.7% of recipients in 2010-2012, similar to the earlier era 2000-2002.

### IMMUNOSUPPRESSION AND OUTCOMES

In 2012, 95.5% of pediatric liver transplant recipients were reported to receive tacrolimus as part of their initial maintenance immunosuppressive medication regimen, 89.2% to receive steroids, 46.5% to receive mycophenolate, and 1.2% to receive mTOR inhibitors (Figure 7.15). At 1 year after transplant, 53.8% of recipients were receiving steroids and 5.6% mTOR inhibitors. In 2012, 70% of liver transplants were performed with no induction immunosuppression. Graft survival has continued to improve over the past decade among recipients of deceased donor and living donor liver transplants. Graft survival for deceased donor transplants performed in 2012 was 92.8% at 30 days; for transplants in 2011, 87.3% at 1 year; for transplants in 2009, 82.0% at 3 years; for transplants in 2007, 78.7% at 5 years; and for transplants in 2002, 67.4% at 10 years (Figure 7.16). In contrast to other organs, graft survival is remarkably similar in the various age groups (Figure 7.19). The incidence of acute rejection increases with time

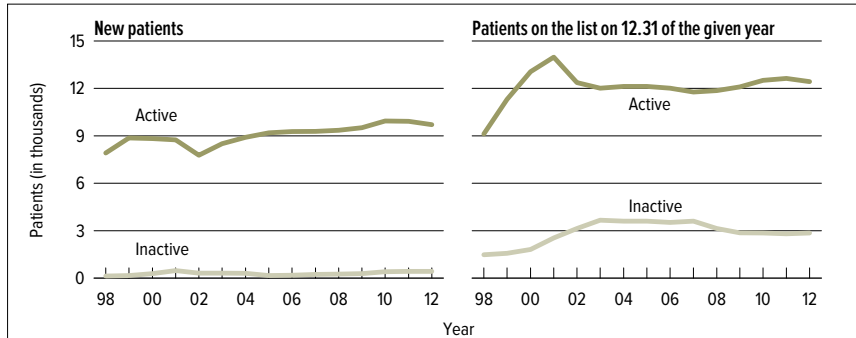
after transplant. Among liver transplant recipients from 2006 to 2011, 18% experienced acute rejection by 6 months after transplant, 27% by 12 months, and 33% by 24 months (Figure 7.18). Posttransplant lymphoproliferative disorder (PTLD) is a significant concern in pediatric transplant. The highest risk for PTLD occurs in Epstein-Barr virus (EBV)-negative recipients. The incidence of PTLD was 4.7% at 5 years after transplant in EBV-negative recipients and 3.4% among EBV-positive recipients (Figure 7.14).

### Economics

It may be surprising that Medicare is the largest single payer for liver transplant in the US, paying for some or all of the care for more than 30% of liver transplants in 2010 (Figure 8.1). Average reimbursement for liver recipients with primary Medicare coverage from transplant through 1 year after transplant was \$162,157 for Part A and \$25,447 for Part B (Figure 8.5), totaling \$187,604, approximately double the Medicare Parts A and B expenditure for a kidney transplant recipient (Figure 8.5, Kidney chapter) and approximately half the expenditure for a heart transplant recipient (Figure 7.5, Heart chapter). Rehospitalization is common after liver transplant; rates are relatively high in the first year (Figure 8.2) and drop by half in the second year (Figure 8.3). Primary causes of rehospitalization are dominated by surgical complications and infections in both the first and second years after transplant (Figure 8.4). Annual costs following the first year are dramatically smaller; Medicare Parts A and B costs average \$20,385 and \$10,240, respectively, during the second year (Figure 8.6), totaling \$30,625, and are expected to remain stable in later years. Additional costs not accounted for here include reimbursement to hospitals for the transplant portion of the Medicare Cost Report and Medicare Part D. Including estimates for these brings average Medicare cost to approximately \$250,000 in the first year after transplant and approximately \$35,000 in subsequent years, which is remarkably similar to total cost estimates for kidney and pancreas transplant. Liver transplant recipients account for 15% of all Medicare Parts A and B expenditures after solid organ transplant, \$597 million, or \$26,499 per patient in 2010 (Figure 8.7).

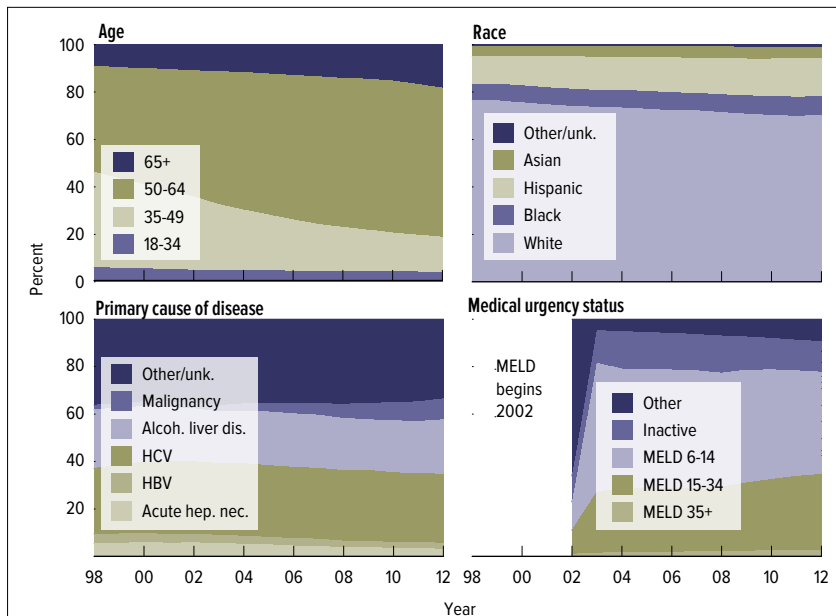


# wait list



## 11.1.1 Adult patients waiting for a liver transplant

Patients waiting for a transplant. A "new patient" is one who first joins the list 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 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.



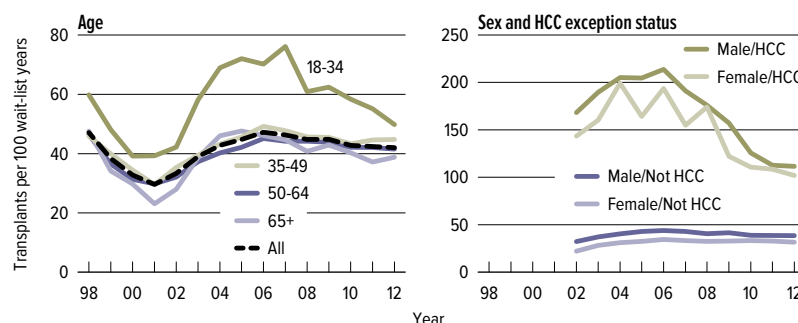
## 11.1.2 Distribution of adult patients waiting for a liver transplant

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. Malignancy as primary cause of disease includes, but is not limited to hepatocellular carcinoma (HCC); for some patients with HCC, another condition may have been cited as the primary cause of liver failure. Medical urgency status is the first known in the given year.

	Level	2002		2012	
		N	%	N	%
Age	18-34	724	4.7	611	4.0
	35-49	4,817	31.0	2,248	14.7
	50-64	8,414	54.2	9,748	63.7
	65+	1,577	10.2	2,701	17.6
Sex	Male	8,986	57.9	9,485	62.0
	Female	6,546	42.1	5,823	38.0
Race	White	11,533	74.3	10,754	70.3
	Black	1,012	6.5	1,081	7.1
	Hispanic	2,207	14.2	2,593	16.9
	Asian	678	4.4	745	4.9
	Other/unk.	102	0.7	135	0.9
Primary cause of disease	Acute hep. nec.	733	4.7	321	2.1
	HBV	572	3.7	427	2.8
	HCV	4,796	30.9	4,612	30.1
	Alcoholic liver dis.	3,519	22.7	3,657	23.9
	Cholestatic disease	1,784	11.5	1,307	8.5
	Malignancy	289	1.9	1,052	6.9
	Other/unk.	3,839	24.7	3,932	25.7
Tx history	Listed for first tx	14,557	93.7	14,903	97.4
	Listed for subseq. tx	975	6.3	405	2.6
Blood type	A	5,510	35.5	5,771	37.7
	B	1,727	11.1	1,679	11.0
	AB	410	2.6	391	2.6
	O	7,885	50.8	7,467	48.8
Time on wait list	<1 year	4,632	29.8	5,565	36.4
	1-2	3,577	23.0	2,818	18.4
	2-3	2,571	16.6	1,809	11.8
	3-4	1,762	11.3	1,171	7.6
	4-5	1,082	7.0	936	6.1
	5+	1,908	12.3	3,009	19.7
Status	Active	12,395	79.8	12,442	81.3
	Inactive	3,137	20.2	2,866	18.7
Medical urgency status	1A/1B	-	0.0	2	0.0
	MELD 35+	29	0.2	61	0.4
	MELD 30-34	35	0.2	67	0.4
	MELD 25-29	95	0.6	168	1.1
	MELD 20-24	550	3.5	943	6.2
	MELD 15-19	2,183	14.1	2,611	17.2
	MELD 10-14	5,154	33.2	4,687	30.9
	MELD 6-9	4,002	25.8	2,505	16.5
	HCC T1	72	0.5	2	0.0
	HCC T2	184	1.2	793	5.2
Other exceptions		74	0.5	447	3.0
	Inactive	3,137	20.2	2,866	18.9
Total		15,532	100.0	15,308	100.0

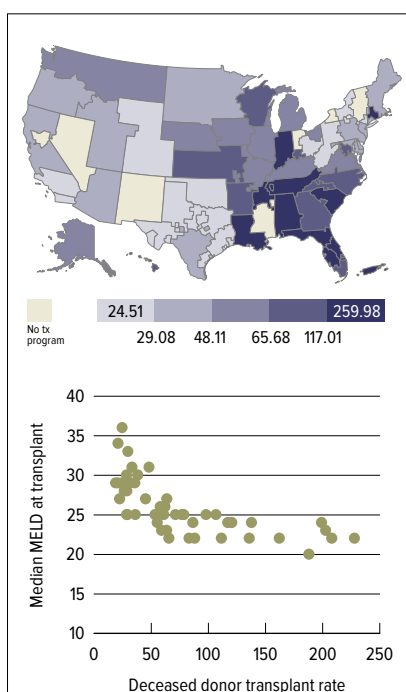
### LI 1.3 Characteristics of adult patients on the liver transplant waiting list on December 31, 2002 & December 31, 2012

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.



### LI 1.4 Deceased donor liver 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. HCC candidates are those with exception points granted in the given year.



### LI 1.5 Deceased donor liver transplant rates per 100 patient years on the waiting list among active adult candidates, by DSA, 2011-2012

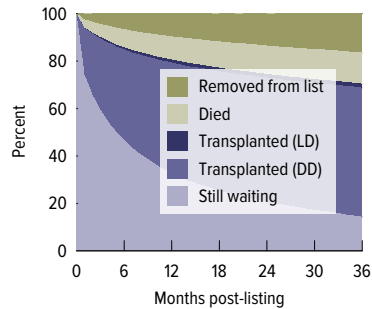
Transplant rates by DSA of the listing center, limited to those with active time on the waiting list in 2011 and 2012; deceased donor transplants only. Maximum time per listing is two years. Patients with concurrent listings in a single DSA are counted once in that DSA, and those listed in multiple DSAs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

	2010	2011	2012
Patients at start of year	14,956	15,360	15,428
Patients added during year	10,349	10,359	10,143
Patients removed during year	9,925	10,272	10,281
Patients at end of year	15,380	15,447	15,290
Removal reason			
Deceased donor transplant	5,450	5,539	5,468
Living donor transplant	209	187	192
Patient died	2,458	2,506	2,187
Patient refused transplant	53	60	73
Improved, tx not needed	552	541	644
Too sick to transplant	362	482	815
Other	841	957	902

### LI 1.6 Liver transplant waiting list activity among adult patients

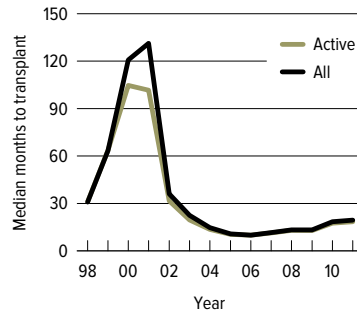
Patients with concurrent listings at more than one center are counted once, from the time of earliest listing to the time of latest removal. Patients listed, transplanted, and re-listed are counted more than once. Patients are not considered "on the list" on the day they are removed. Thus, patient counts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



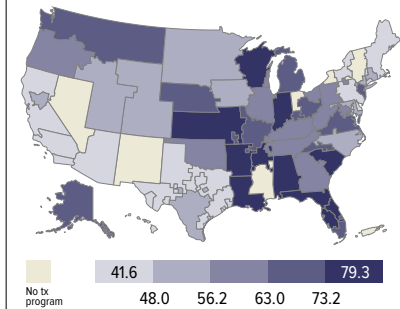
## LI 1.7 Three-year outcomes for adult patients waiting for a liver transplant among new listings in 2009

Adult patients waiting for any liver 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.



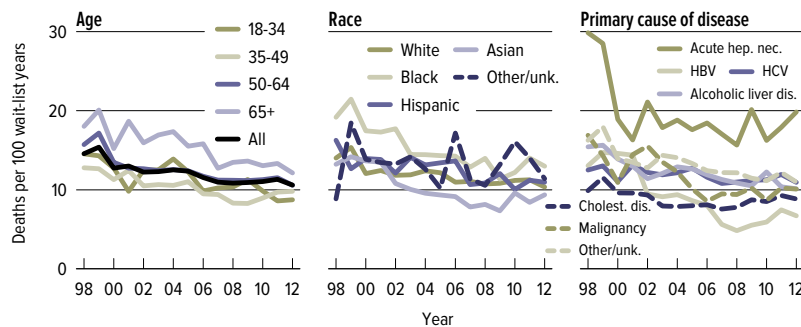
## LI 1.8 Median months to liver transplant for wait-listed adult patients

Patients waiting for a transplant, with observations censored at December 31, 2012; Kaplan-Meier methods used to estimate time to transplant. 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.



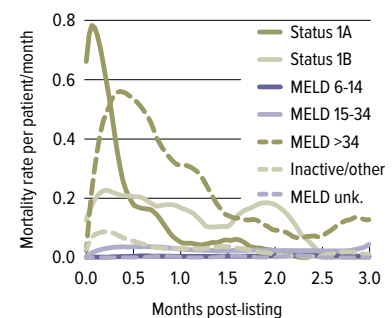
## LI 1.9 Percent of adult wait-listed patients, 2007, who received a deceased donor liver transplant within five years, by DSA

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.



## LI 1.10 Pre-transplant mortality rates among adult patients wait-listed for a liver 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.

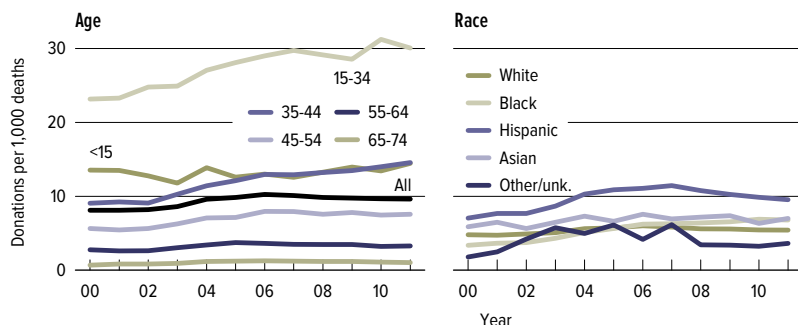


## LI 1.11 Mortality rates by medical urgency status, 2007-2012

Estimated hazard rate for death among candidates waiting for a liver transplant by medical urgency status at listing. Epanechnikov kernel-smoothed estimators were used with a bandwidth of 0.5 for Status 1B candidates and 0.25 for all other status groups.

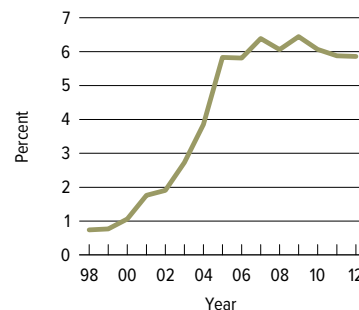


# deceased donation



## LI 2.1 Deceased donor liver donation rates

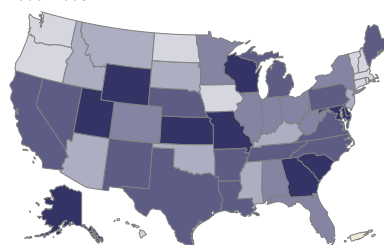
Numerator: Deceased donors age less than 75 with at least one liver recovered for transplant. Denominator: US deaths per year, age less than 75. (Death data available at <http://www.cdc.gov/nchs/products/nvsr.htm>.) Death data were available only through 2011.



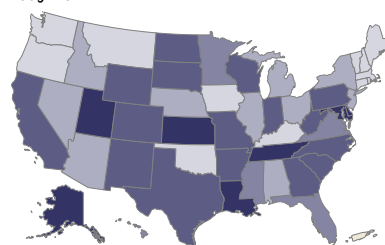
## LI 2.4 Liver donors who are DCD

Deceased donors whose liver was recovered for transplant.

2006–2008

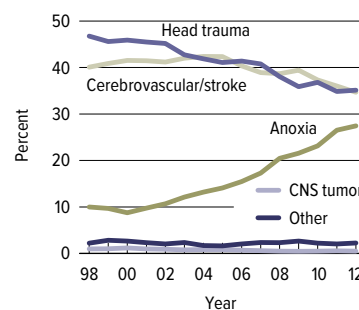


2009–2011



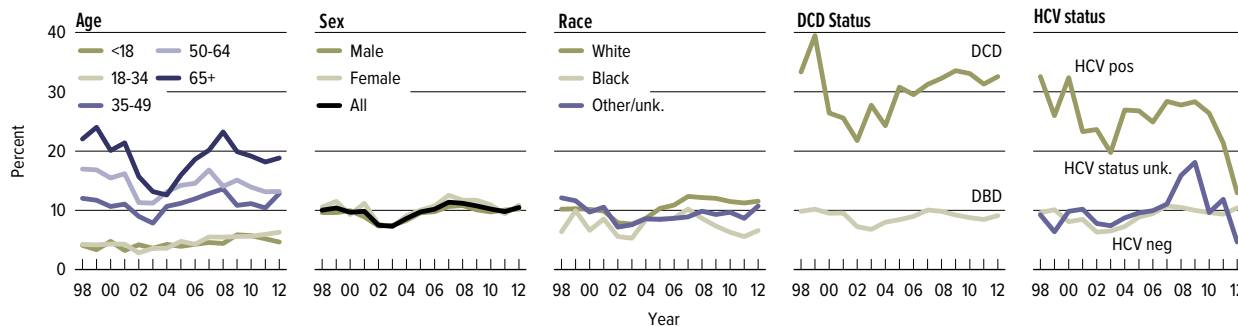
## LI 2.2 Deceased donor liver donation rates (per 1,000 deaths), by state

Numerator: Deceased donors residing in the 50 states whose liver 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.



## LI 2.5 Cause of death among deceased liver donors

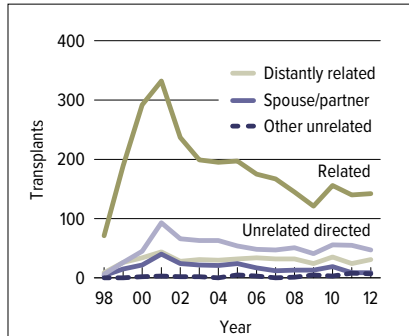
Deceased donors whose liver was transplanted. CNS = central nervous system.



## LI 2.3 Discard rates for livers recovered for transplant

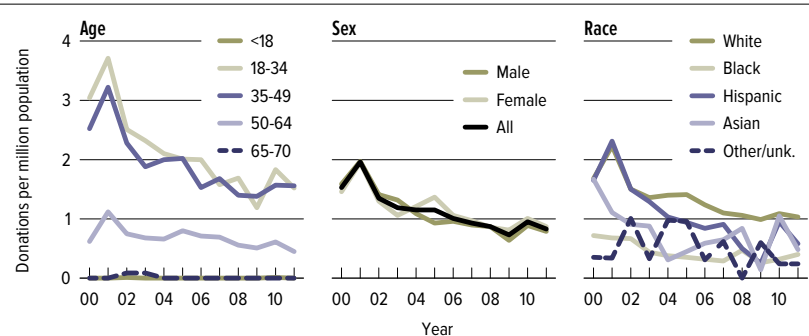
Percent of livers discarded out of all livers recovered for transplant.

# live donation



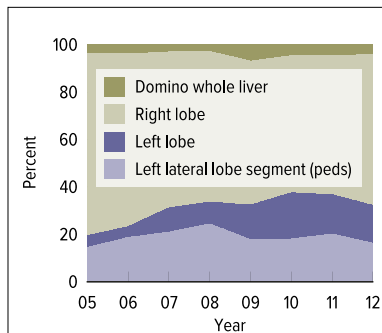
### LI 3.1 Liver transplants from living donors, by donor relation

Number of living donor donations, excluding domino liver; characteristics recorded on the OPTN Living Donor Registration form.



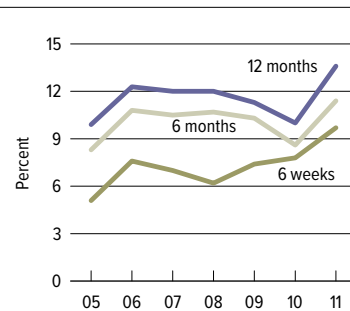
### LI 3.2 Living donor liver donation rates

Number of living donors whose liver was recovered for transplant each year. Denominator: US population age 70 and younger (population data downloaded from [http://www.cdc.gov/nchs/nvss/bridged\\_race/data\\_documentation.htm#vintage2011](http://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm#vintage2011)).



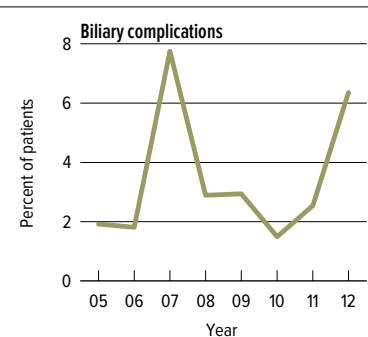
### LI 3.3 Living donor liver transplant graft type

As reported on the OPTN Living Donor Registration form.



### LI 3.4 Readmission to the hospital in the first 6 weeks, 6 months, and 1 year among living liver donors

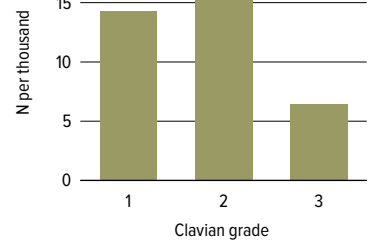
Cumulative readmission to the hospital. The six-week time point is recorded at the earliest of discharge or six weeks post-donation.



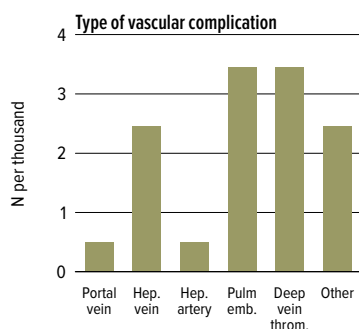
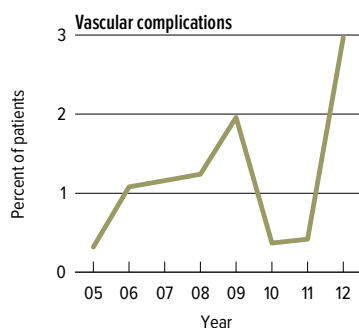
### LI 3.5 Biliary complications among living liver donors

Complications reported on the OPTN Living Donor Registration forms. Type of complication is shown among all living donors, 2005–2011.

Clavian Grade 1: biliary JP drainage more than 10 days. Clavian Grade 2: interventional procedure (ERCP, PTC, percutaneous drainage, etc.). Clavian Grade 3: surgical intervention.

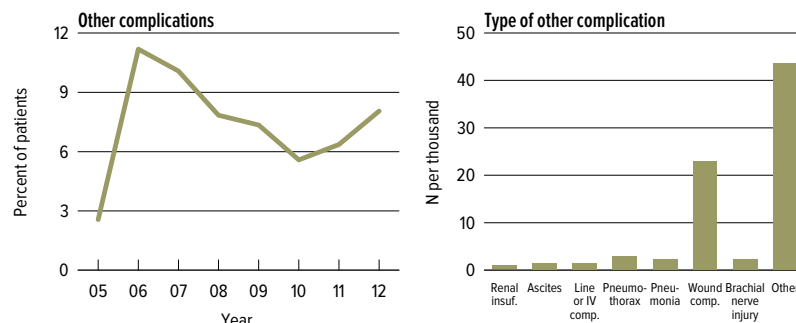


## live donation



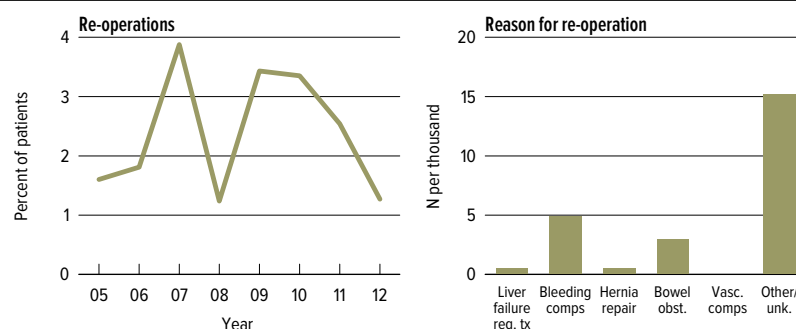
### LI 3.6 Vascular complications requiring intervention among living liver donors

Complications reported on the OPTN Living Donor Registration forms. Type of complication is shown among all living donors, 2005–2012.



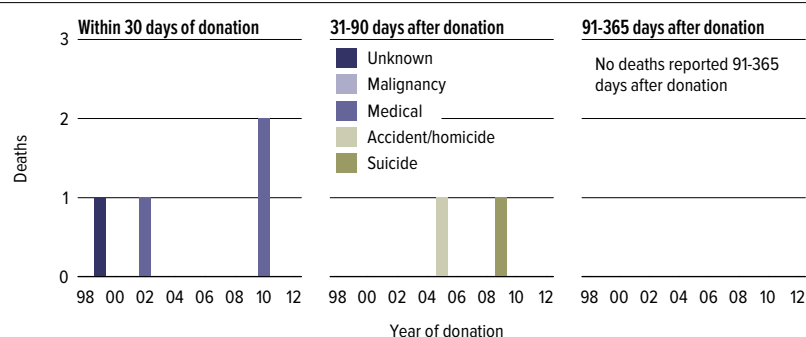
### LI 3.7 Other complications requiring intervention among living liver donors

Complications reported on the OPTN Living Donor Registration forms. Type of complication is shown among all living donors, 2005–2012.



### LI 3.8 Re-operation among living liver donors

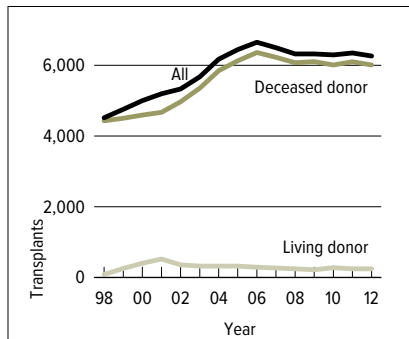
Complications reported on the OPTN Living Donor Registration forms. Type of complication is shown among all living donors, 2005–2012.



### LI 3.9 Living liver donor deaths

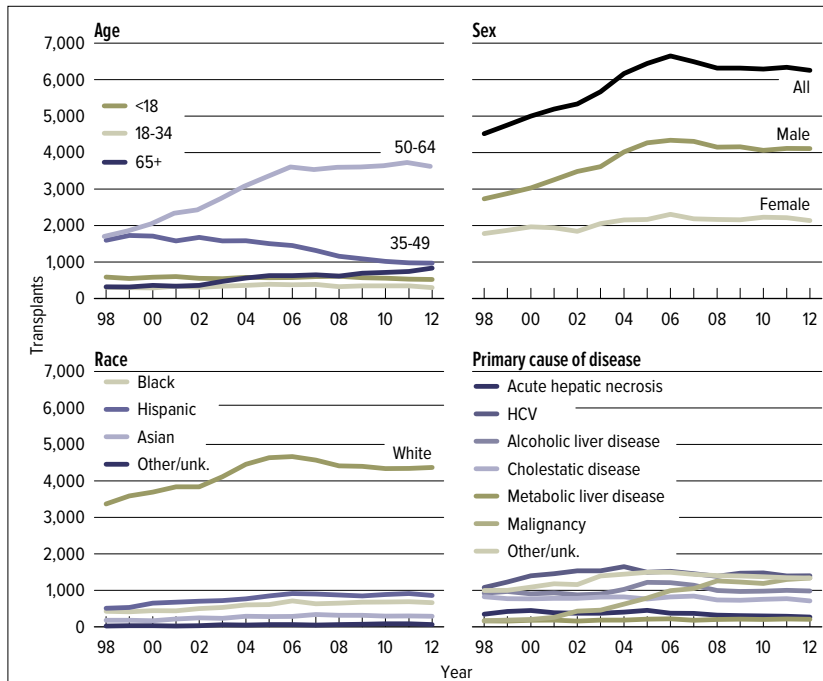
Living liver donors; domino donors excluded. Deaths as reported to the OPTN or Social Security Administration. "Donation related" deaths are included in the "Medical" category.

# transplant



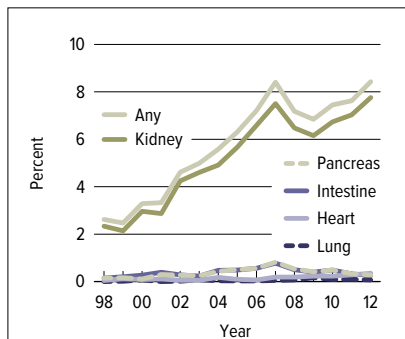
#### LI 4.1 Total liver transplants

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



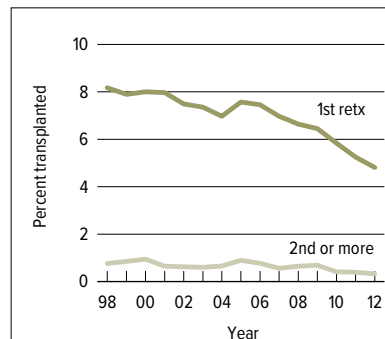
#### LI 4.2 Liver transplants

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



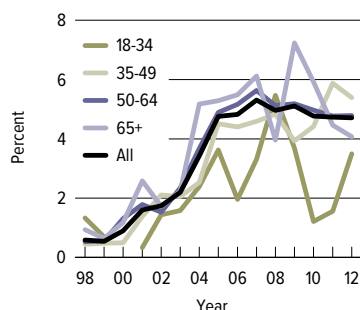
#### LI 4.3 Liver transplants that were part of a multi-organ transplant

All adult patients receiving a deceased donor liver transplant with at least one additional organ. A multi-organ transplant may include more than two different organs in total; if so, each non-liver organ will be considered separately. Kidney transplants include living donor transplants.



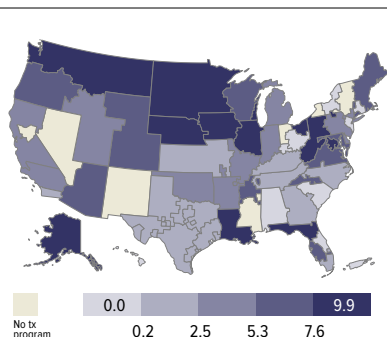
#### LI 4.4 Retransplants among adult liver transplant recipients

Patients receiving a liver retransplant (deceased or living donor) in the given year.



#### LI 4.5 Use of DCD livers among adult recipients, by recipient age

Percent of deceased donor transplants using a DCD donor. DCD = donation after circulatory death.



#### LI 4.6 Percent of adult, deceased donor liver transplants that are DCD, by DSA, 2010–2012

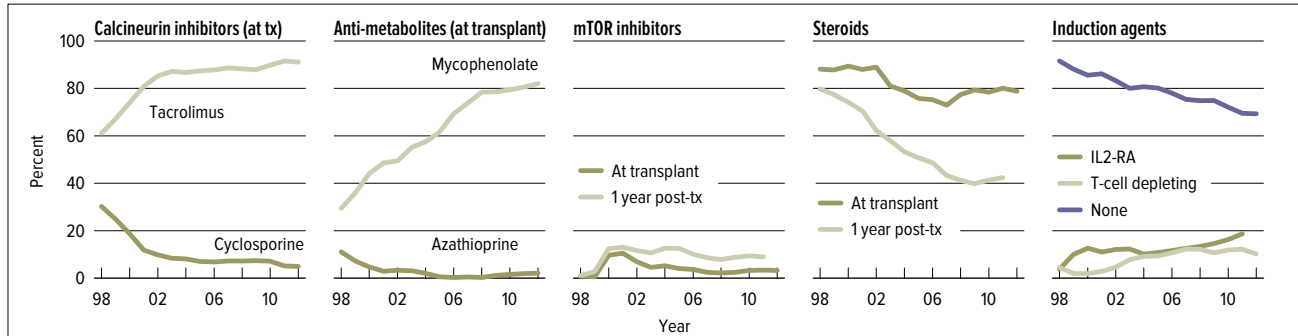
Percent of deceased-donor transplants using a DCD donor, by DSA of the transplanting center. Patients with concurrent listings in a single DSA are counted once in that DSA, and those listed in multiple DSAs are counted separately per DSA.

		2002		2012	
Level		N	%	N	%
Age	18-34	306	6.4	303	5.3
	35-49	1,675	35.1	970	16.9
	50-64	2,433	50.9	3,623	63.2
	65+	363	7.6	835	14.6
	All				
Sex	Female	1,556	32.6	1,862	32.5
	Male	3,221	67.4	3,869	67.5
Race	White	3,536	74.0	4,088	71.3
	Black	400	8.4	576	10.1
	Hispanic	589	12.3	752	13.1
	Asian	225	4.7	260	4.5
	Other/unknown	27	0.6	55	1.0
Primary cause of disease	Acute hepatic necrosis	307	6.4	210	3.7
	HCV	1,531	32.0	1,402	24.5
	Alcoholic liver disease	883	18.5	986	17.2
	Cholestatic disease	535	11.2	458	8.0
	Metabolic liver disease	114	2.4	135	2.4
	Malignancy	369	7.7	1,281	22.4
	All others	1,038	21.7	1,259	22.0
Blood type	A	1,895	39.7	2,155	37.6
	B	610	12.8	796	13.9
	AB	262	5.5	277	4.8
	O	2,010	42.1	2,503	43.7
Time on waiting list	<30 days	1,308	27.4	1,723	30.1
	31-60 days	508	10.6	577	10.1
	61-90 days	334	7.0	394	6.9
	3-<6 months	694	14.5	899	15.7
	6-<12 months	786	16.5	906	15.8
	1-<2 years	680	14.2	706	12.3
	2-<3 years	265	5.5	213	3.7
	3+ years	195	4.1	313	5.5
	Missing/unknown	7	0.1	0	0.0
BMI	<18.5	120	2.5	115	2.0
	18.5-24.9	1,537	32.2	1,656	28.9
	25.0-29.9	1,694	35.5	1,928	33.6
	30.0-34.9	941	19.7	1,299	22.7
	35.0-39.9	321	6.7	525	9.2
	40.0+	121	2.5	206	3.6
Medical condition	Unknown	43	0.9	2	0.0
	Hospitalized: ICU	619	13.0	723	12.6
	Hospitalized: not ICU	722	15.1	1,074	18.7
	Not hospitalized	3,436	71.9	3,879	67.7
Medical urgency status before transplant	Other/unknown	0	0.0	55	1.0
	Status 1A/1B	296	6.2	192	3.4
	MELD 35-40	334	7.0	1,028	17.9
	MELD 30-34	365	7.6	920	16.1
	MELD 15-29	2,431	50.9	3,421	59.7
	MELD 6-14	610	12.8	169	2.9
Primary payer	Other/unknown	741	15.5	1	0.0
	Private	3,220	67.4	3,179	55.5
	Medicaid	603	12.6	718	12.5
Procedure type	Other	954	20.0	1,834	32.0
	Whole liver	4,414	92.4	5,474	95.5
	Partial liver, rmdr not tx	290	6.1	189	3.3
Donor type	Split liver	73	1.5	68	1.2
	Deceased	4,487	93.9	5,537	96.6
	Living	290	6.1	194	3.4
Patient on life support	Yes	364	7.6	403	7.0
Previous abdominal surg.	Yes	1,740	36.4	2,484	43.3
Diabetes	Yes	870	18.2	1,412	24.6
Portal vein thrombosis	Yes	132	2.8	570	9.9
Incident tumor found at transplant	Yes	223	4.7	198	3.5
Spontaneous bacterial peritonitis (SBP)	Yes	348	7.3	523	9.1
Total		4,777	100.0	5,731	100.0

#### LI 4.7 Characteristics of adult liver transplant recipients, 2002 & 2012

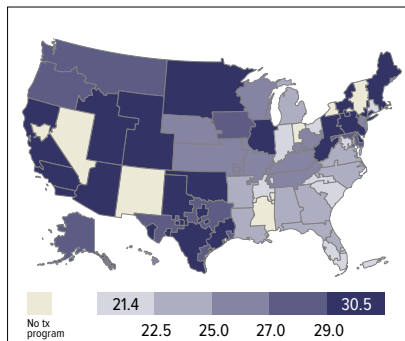
Patients receiving a transplant. Retransplants are counted.

# transplant



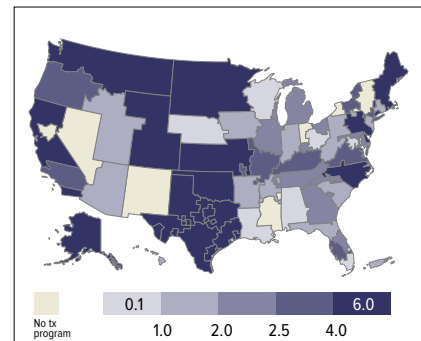
## LI 4.8 Immunosuppression use in adult liver transplant recipients

One-year post-transplant data limited to patients alive with graft function one year post-transplant. Mycophenolate group includes mycophenolate mofetil and mycophenolate sodium.



## LI 4.9 Median MELD score for adult, deceased donor liver transplants, by DSA, 2012

Deceased donor liver transplants; DSA of transplant center location. Patients with status 1A, 1B and inactive status excluded, and allocation MELD score used. 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.

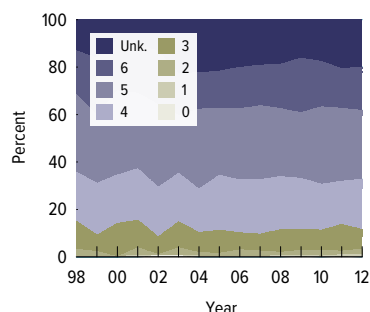


## LI 4.10 Difference in lab MELD & allocation MELD among liver transplant recipients, 2012

Deceased donor liver transplants; DSA of transplant center location. Patients with status 1A, 1B and inactive status excluded. 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.



# donor-recipient matching



## LI 5.1 Total HLA mismatches among adult liver-kidney transplant recipients

Donor and recipient antigen matching is based on the OPTN's antigen values and split equivalences policy as of 2012. Limited to liver-kidney transplants only.

RECIPIENT	DECEASED DONOR				LIVING DONOR			
	Neg.	Pos.	Unk.	Total	Neg.	Pos.	Unk.	Total
Negative	11.3	19.6	0.1	31.1	31.2	12.0	3.9	47.2
Positive	22.3	43.3	0.1	65.8	23.7	22.4	3.8	49.8
Unknown	1.0	2.2	0.0	3.2	1.6	1.2	0.3	3.0
Total	34.6	65.1	0.2	100	56.5	35.6	8.0	100

## LI 5.2 Adult liver 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	DECEASED DONOR				LIVING DONOR			
	Neg.	Pos.	Unk.	Total	Neg.	Pos.	Unk.	Total
Negative	0.6	10.5	0.1	11.2	1.0	8.8	1.2	11.0
Positive	2.8	58.9	0.1	61.9	3.9	51.9	11.8	67.6
Unknown	1.1	25.7	0.1	26.9	1.6	8.5	11.4	21.4
Total	4.6	95.1	0.3	100	6.5	69.1	24.3	100

## LI 5.3 Adult liver 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	DECEASED DONOR				LIVING DONOR			
	Neg.	Pos.	Unk.	Total	Neg.	Pos.	Unk.	Total
Negative	68.7	2.9	0.0	71.6	70.5	1.4	7.7	79.6
Positive	18.7	2.0	0.0	20.7	11.8	0.7	1.3	13.7
Unknown	7.5	0.3	0.0	7.8	2.9	0.0	3.8	6.7
Total	94.8	5.1	0.1	100	85.1	2.1	12.8	100

## LI 5.4 Adult liver 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	DECEASED DONOR				LIVING DONOR			
	Neg.	Pos.	Unk.	Total	Neg.	Pos.	Unk.	Total
Negative	90.8	0.0	0.1	90.9	83.3	0.0	7.5	90.7
Positive	4.8	0.0	0.0	4.8	2.4	0.0	0.3	2.6
Unknown	4.3	0.0	0.0	4.3	5.5	0.0	1.2	6.7
Total	99.9	0.0	0.1	100	91.1	0.0	8.9	100

## LI 5.5 Adult liver donor-recipient hepatitis B surface antigen (HBsAg) serology matching, 2008–2012

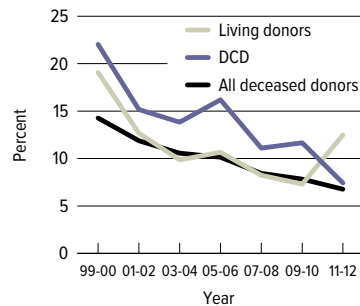
Adult transplant cohort from 2008–2012. Donor serology is reported on the OPTN donor registration forms; recipient serology is reported on the OPTN recipient registration forms. Any evidence for a positive serology is taken to indicate that the person is positive for the given serology; if all fields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

RECIPIENT	DECEASED DONOR				LIVING DONOR			
	Neg.	Pos.	Unk.	Total	Neg.	Pos.	Unk.	Total
Negative	52.9	0.1	0.0	53.0	58.8	0.4	6.5	65.8
Positive	39.6	3.2	0.0	42.8	26.7	0.3	2.7	29.7
Unknown	4.0	0.1	0.0	4.2	2.7	0.0	1.8	4.6
Total	96.6	3.4	0.0	100	88.2	0.7	11.1	100

## LI 5.6 Adult liver donor-recipient hepatitis C serology matching, 2008–2012

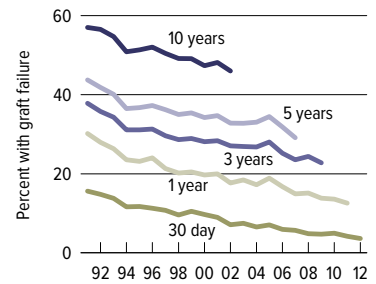
Adult transplant cohort from 2008–2012. Donor serology is reported on the OPTN donor registration forms; recipient serology is reported on the OPTN recipient registration forms. Any evidence for a positive serology is taken to indicate that the person is positive for the given serology; if all fields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

# outcomes



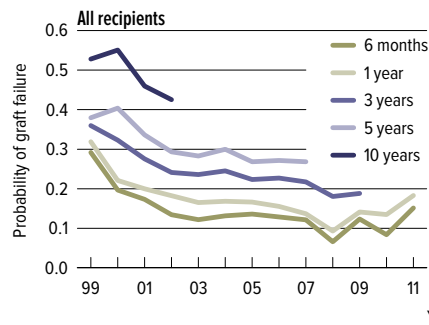
## LI 6.1 Graft failure within the first 90 days after transplant among adult liver transplant recipients

All-cause graft failure is identified from multiple data sources, including the OPTN Transplant Recipient Registration form, 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.



## LI 6.2 Graft failure among adult liver transplant recipients: deceased donor

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

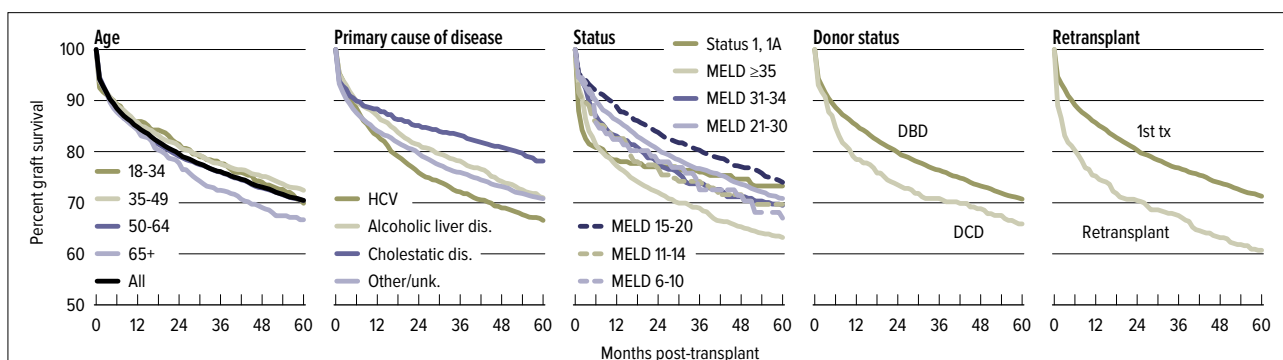


## LI 6.3 Graft failure among adult liver transplant recipients: living donor

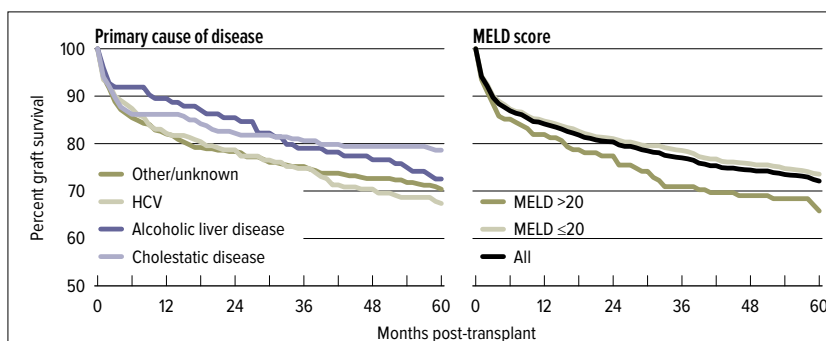
Cox proportional hazards models reporting probability, adjusting for age, sex, and race.



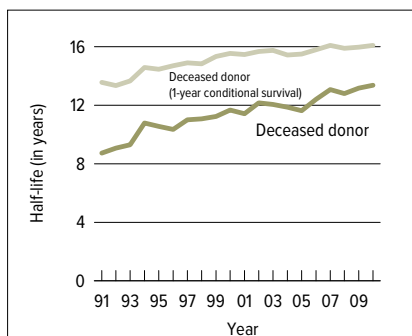
## outcomes



**LI 6.4 Graft survival among adult liver transplant recipients transplanted in 2007: deceased donors**  
Graft survival estimated using unadjusted Kaplan-Meier methods.

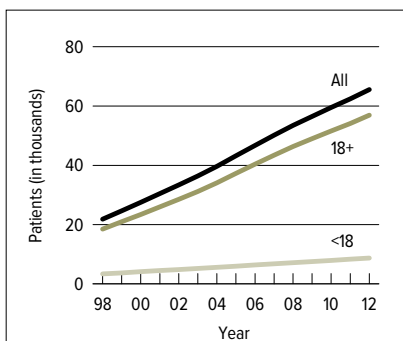


**LI 6.5 Graft survival among adult liver transplant recipients transplanted in 2003-2007: living donors**  
Graft survival estimated using unadjusted Kaplan-Meier methods.



**LI 6.6 Half-lives for adult, deceased donor liver transplant recipients**

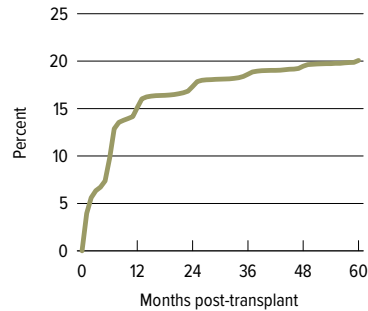
The half-life for a transplant cohort (e.g. 2009 liver transplants) is the time point in follow-up at which 50% of the transplanted grafts have failed. A conditional half-life for a transplant cohort is the same calculation but limited to those who survive with function at least 1 year post-transplant.



**LI 6.7 Recipients alive & with a functioning liver transplant on June 30 of the year**

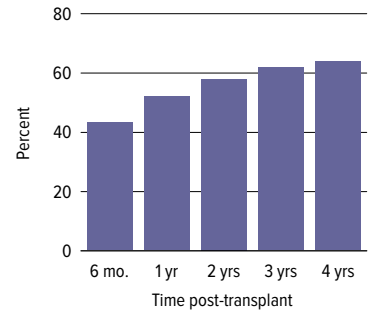
Transplants before June 30 of the year that are still functioning. Patients are assumed alive with function unless a death or graft failure is recorded. A recipient can experience a graft failure and drop from the cohort, then be retransplanted and re-enter the cohort. Age cut is based on age at transplant.

# outcomes



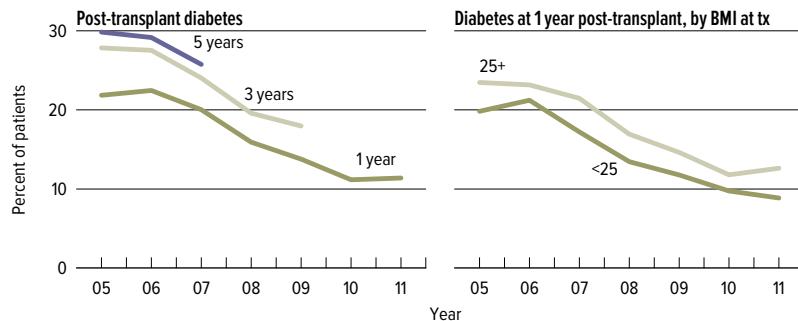
## LI 6.8 Incidence of first acute rejection among adult patients receiving a liver transplant in 2006-2010

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 is estimated using Kaplan-Meier competing risk methods.



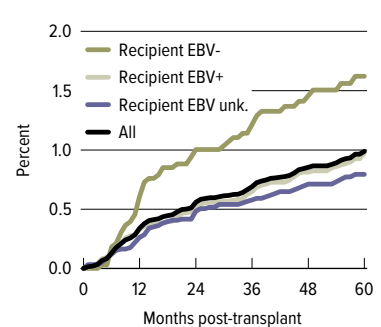
## LI 6.9 Reported cumulative incidence of rehospitalizations among adult patients receiving a liver transplant in 2007-2012

Cumulative rate of rehospitalization; 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.



## LI 6.10 Post-transplant diabetes among liver transplant recipients

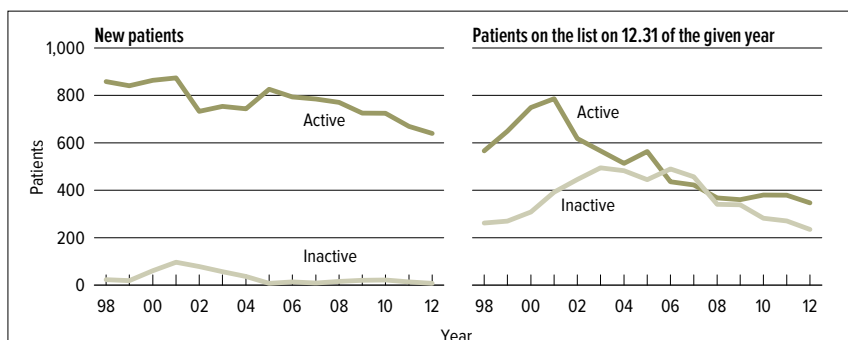
Percentage of adult deceased liver recipients who develop diabetes post-transplant out of patients who are diabetes free at transplant.



## LI 6.11 Incidence of PTLTD among adult patients receiving a liver transplant in 2006-2010, by recipient Epstein-Barr virus (EBV) status at transplant

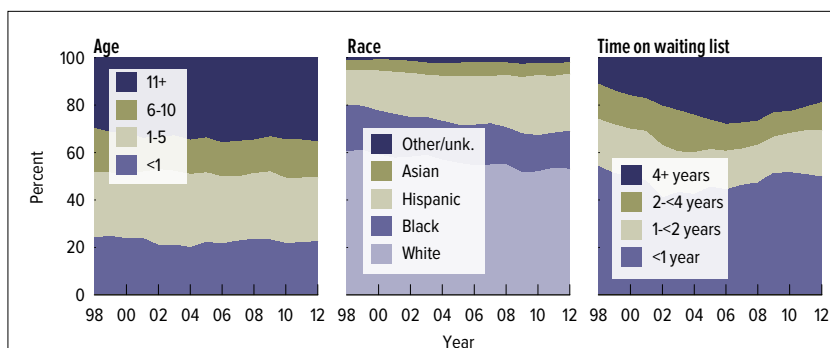
The cumulative incidence, is estimated using Kaplan-Meier competing risks methods. PTLTD is identified as either a reported complication or cause of death on the Transplant Recipient Follow-up form or on the Post-transplant Malignancy form as polymorphic PTLTD, monomorphic PTLTD, or Hodgkin's Disease.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

# pediatric transplant



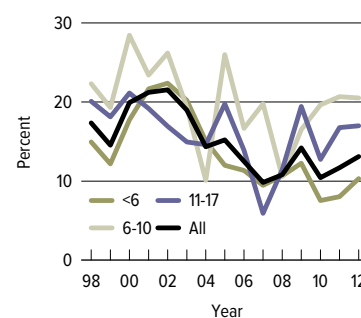
## LI 7.1 Pediatric patients waiting for a liver transplant

Patients waiting for a transplant. A "new patient" is one who first joins the list 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 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.



## LI 7.2 Distribution of pediatric patients waiting for a liver transplant

Patients waiting for a transplant any time in the given year. Age determined on the lastest of listing date or January 1 of the given year. Concurrently listed patients are counted once.



## LI 7.3 Prior liver transplant in pediatric patients waiting for a liver transplant, by age

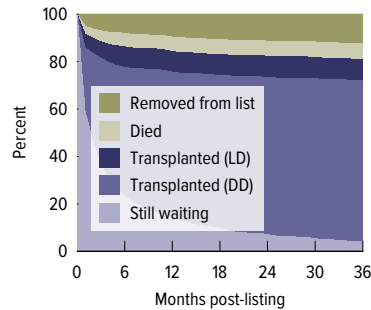
Prior transplant is obtained from the OPTN Transplant Candidate Registration form.

# pediatric transplant

	2010	2011	2012
Patients at start of year	701	666	655
Patients added during year	747	684	648
Patients removed during year	781	696	718
Patients at end of year	667	654	585
Removal reason			
Deceased donor transplant	498	479	474
Living donor transplant	66	60	54
Patient died	63	33	37
Patient refused transplant	2	1	5
Improved, tx not needed	105	77	98
Too sick to transplant	12	12	17
Other	35	34	33

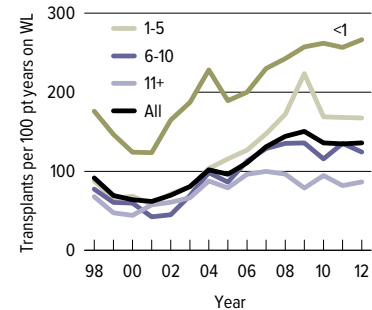
## LI 7.4 Liver transplant waiting list activity among pediatric patients

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.



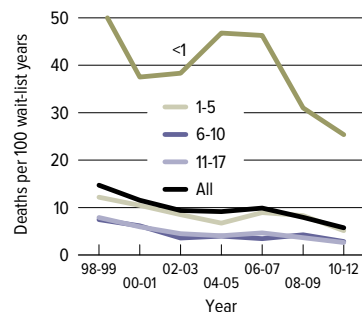
## LI 7.5 Three-year outcomes for pediatric patients waiting for a liver transplant among new listings in 2009

Patients waiting for a 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.



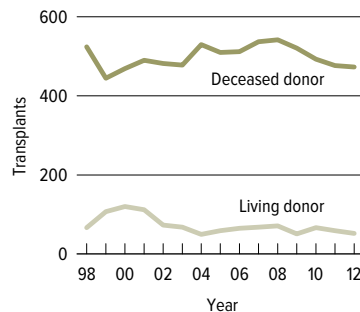
## LI 7.6 Liver transplant rates among active pediatric waiting list candidates, by age

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



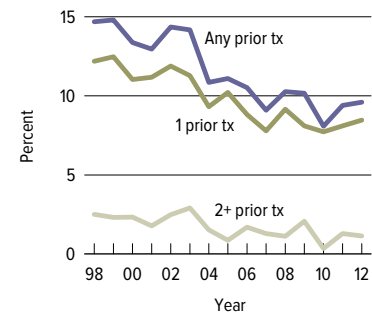
## LI 7.7 Pre-transplant mortality rates among pediatric patients wait-listed for a liver transplant, by age

Patients waiting for a transplant. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given interval. Waiting time is calculated as the total waiting time per age group in the interval. 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 period.



## LI 7.8 Pediatric liver transplants, by donor type

Patients receiving a liver transplant.

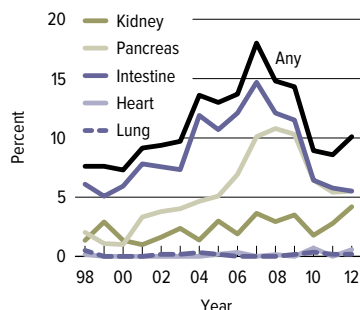


## LI 7.9 Retransplants among pediatric liver transplant recipients

Includes patients transplanted after age 17, but listed at age 17 or younger. Retransplanted patients include only those with a prior transplant of the same type.

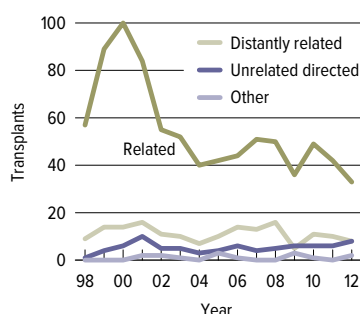


# pediatric transplant



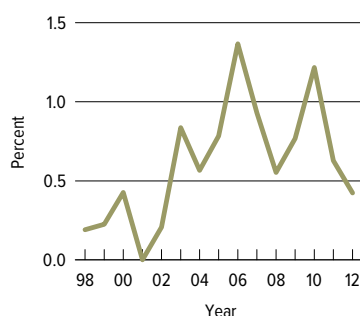
## LI 7.10 Pediatric liver transplants that were part of a multi-organ transplant

Patients receiving a deceased donor liver transplant with at least one additional organ. A multi-organ transplant may include more than two different organs in total; if so, each non-liver organ will be considered separately.



## LI 7.11 Pediatric liver transplants from living donors

Relationship of live donor to recipient is as indicated on the Living Donor Registration form.



## LI 7.12 Use of DCD donors in pediatric liver transplant recipients

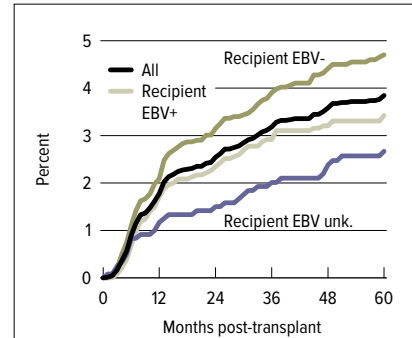
Patients receiving a DCD liver transplant.

		2000–2002		2010–2012	
Level		N	%	N	%
Age	<1	497	28.5	462	28.5
	1-5	621	35.6	587	36.2
	6-10	214	12.3	228	14.1
	11-17	414	23.7	344	21.2
Sex	Female	938	53.7	833	51.4
	Male	808	46.3	788	48.6
Race	White	954	54.6	858	52.9
	Black	324	18.6	267	16.5
	Hispanic	378	21.6	356	22.0
	Asian	79	4.5	103	6.4
	Other/unknown	11	0.6	37	2.3
Primary cause of disease	Acute hepatic necrosis	215	12.3	182	11.2
	HCV	30	1.7	4	0.2
	Cholestatic disease	749	42.9	761	46.9
	Metabolic liver disease	155	8.9	224	13.8
	Malignancy	192	11.0	211	13.0
	All others	405	23.2	239	14.7
Transplant history	First transplant	1,505	86.2	1,476	91.1
	Retransplant	241	13.8	145	8.9
Blood type	A	603	34.5	530	32.7
	B	252	14.4	215	13.3
	AB	65	3.7	72	4.4
	O	826	47.3	804	49.6
Primary payer	Private	954	54.6	718	44.3
	Medicaid	598	34.2	688	42.4
	Other public	119	6.8	160	9.9
	Other	75	4.3	55	3.4
Time on wait list	<30 days	601	34.4	622	38.4
	31-60 days	221	12.7	266	16.4
	61-90 days	172	9.9	149	9.2
	3-<6 months	270	15.5	266	16.4
	6-<12 months	241	13.8	178	11.0
	1-<2 years	125	7.2	91	5.6
	2-<3 years	34	1.9	26	1.6
	3+ years	42	2.4	22	1.4
	No listing date	40	2.3	1	0.1
Medical condition	Hospitalized: ICU	568	32.5	365	22.5
	Hospitalized: not ICU	268	15.3	296	18.3
	Not hospitalized	910	52.1	959	59.2
	Missing/Unknown	0	0.0	1	0.1
Medical urgency status	1A	.	.	249	15.4
	1B	.	.	247	15.2
	MELD/PELD 35+	.	.	223	13.8
	MELD/PELD 30-34	.	.	216	13.3
	MELD/PELD 15-29	.	.	454	28.0
	MELD/PELD < 15	.	.	229	14.1
	Other/unknown	.	.	3	0.2
Procedure type	Whole liver	1062	60.8	1,032	63.7
	Partial liver, rest not tx	455	26.1	328	20.2
	Split liver	229	13.1	261	16.1
	Unknown	0	0.0	0	0.0
Donor type	Deceased	1,441	82.5	1,443	89.0
	Living	305	17.5	178	11.0
Previous abdom. surgery	Yes	872	49.9	878	54.2
Portal vein thrombosis	Yes	64	3.7	84	5.2
Incident. tumor found at tx	Yes	8	0.5	8	0.5
Spon. bac. peritonitis (SBP)	Yes	52	3.0	34	2.1
ABO	Compatible or identical	1,701	97.4	1,577	97.3
	Incompatible	45	2.6	44	2.7
All patients		1,746	100.0	1,621	100.0

## LI 7.13 Characteristics of pediatric liver transplant recipients, 2000–2002 & 2010–2012

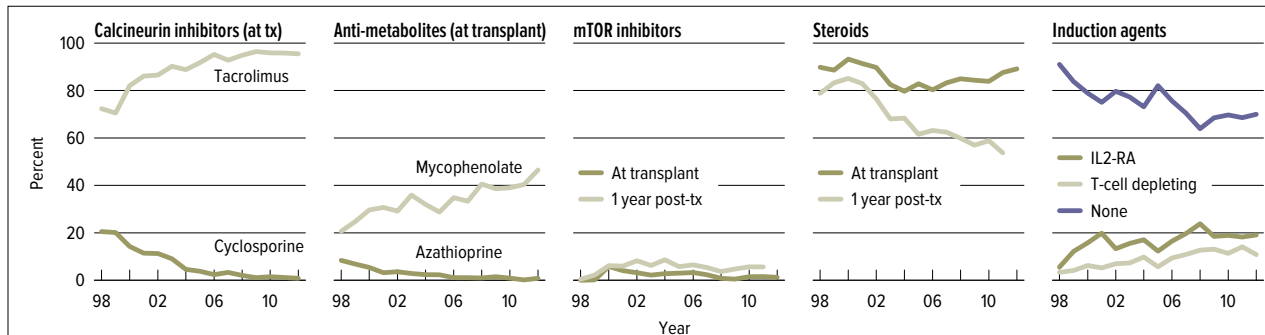
Patients receiving a transplant. Retransplants are counted. MELD / PELD began in 2002.

# pediatric transplant



**LI 7.14 Incidence of PTLD among pediatric patients receiving a liver transplant, 2000–2010, by recipient Epstein-Barr virus (EBV) status at transplant**

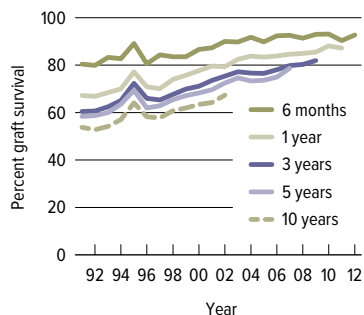
The cumulative incidence is estimated using Kaplan-Meier competing risks methods. PTLD is identified as either a reported complication or cause of death on the Transplant Recipient Follow-up form or on the Post-transplant Malignancy form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's Disease. Only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



**LI 7.15 Immunosuppression use in pediatric liver transplant recipients**

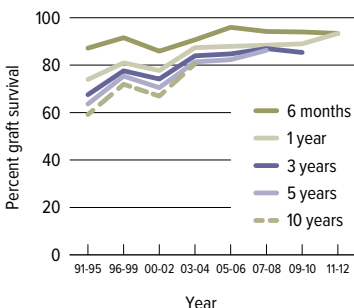
One-year post-transplant data limited to patients alive with graft function one year post-transplant. Mycophenolate group includes mycophenolate mofetil and mycophenolate sodium.

# pediatric transplant



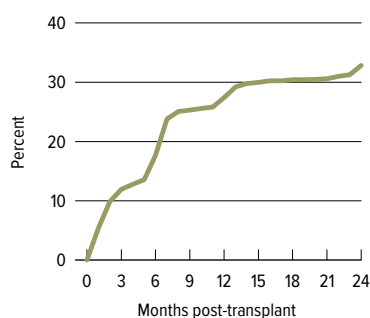
**LI 7.16 Graft survival among pediatric liver transplant recipients: deceased donor**

Estimates computed with Cox proportional hazards model, adjusted for age, sex, and race.



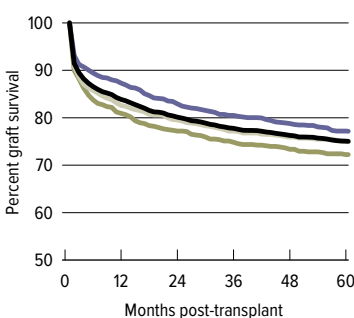
**LI 7.17 Graft survival among pediatric liver transplant recipients: living donor**

Estimates computed with Cox proportional hazards model adjusted for age, sex, and race.



**LI 7.18 Incidence of first acute rejection among pediatric patients receiving a liver transplant in 2006–2011**

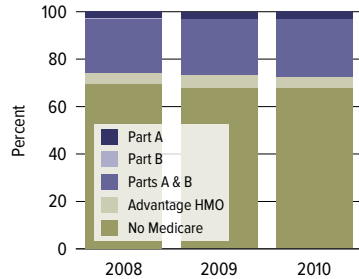
Acute rejection defined as a record of acute or hyperacute rejection, or a record of an anti-rejection drug being administered on either the Transplant Recipient Registration form or the Transplant Recipient Follow-up form. Only the first rejection event is counted. Cumulative incidence, defined as the probability of acute rejection at any time prior to the given time, is estimated using Kaplan-Meier competing risk methods.



**LI 7.19 Graft survival among pediatric liver transplant recipients transplanted in 2003–2007: deceased donors**

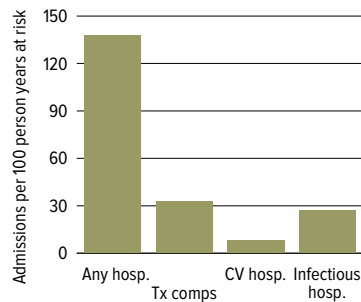
Graft survival estimated using unadjusted Kaplan-Meier methods.

# Medicare data



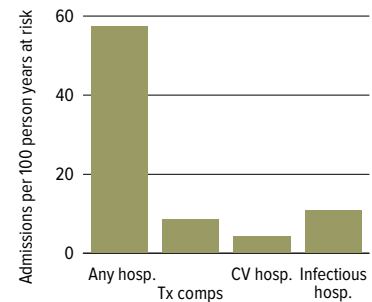
## LI 8.1 Medicare coverage among liver transplant recipients

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



## LI 8.2 Rehospitalization rates among liver 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 occurring from initial discharge to one year later.



## LI 8.3 Rehospitalization rates among liver 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 occurring from initial discharge+1 year to initial discharge+2 years.

Year 1 Cause of hospitalization	Percent of hospitalizations	Year 2 Cause of hospitalization	Percent of hospitalizations
Transplant complication	28.1	Transplant complication	18.1
Other	13.0	Gastro-intestinal	11.5
Other infection	11.6	Other	9.9
Gastro-intestinal	9.1	Other infection	8.8
Genito-urinary and breast	4.8	Genito-urinary and breast	7.3
Immune and Hematologic	4.2	Skin and musculoskeletal	4.5
Electrolyte, acid-base & volume depletion	3.7	Respiratory infection	4.0
Bacteremia, viremia and septicemia	3.4	Immune and hematologic	4.0
Respiratory infection	3.2	Metabolic, endocrine, nutritional	3.8
Metabolic, endocrine, nutritional	2.8	Bacteremia, viremia & septicemia	3.5

## LI 8.4 Top ten causes of rehospitalization among liver 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		PPPY costs	
			Part A	Part B	Part A	Part B
All patients		2,226	321,013,987	50,376,613	162,157	25,447
Age	0-11	*	*	*	*	*
	12-17	*	*	*	*	*
	18-34	59	8,525,181	1,329,656	158,098	24,658
	35-49	306	45,367,415	7,230,266	170,079	27,106
	50-64	1,163	165,706,546	25,690,236	158,519	24,576
	65+	693	100,539,999	15,997,704	164,664	26,201
Sex	Male	1,467	205,927,523	32,595,328	158,441	25,079
	Female	759	115,086,464	17,781,286	169,260	26,151
Race	White	1,537	216,645,202	34,462,220	158,953	25,285
	Black	234	36,707,952	5,284,950	176,625	25,429
	Hispanic	333	48,107,530	7,756,420	161,175	25,986
	Asian/Pac. Isl.	100	16,651,937	2,376,311	184,695	26,357
	Other/unk.	22	2,901,366	496,712	143,399	24,550
Primary cause of disease	Acute hep. nec.	62	11,881,080	1,471,088	220,995	27,363
	HBV	51	7,076,348	1,014,221	159,220	22,820
	HCV	661	99,707,480	15,142,500	173,839	26,401
	Alco. liver disease	386	53,006,877	8,406,637	151,912	24,093
	Malignancy	287	35,765,011	6,070,074	135,309	22,965
	Cholestatic dis.	195	29,024,359	4,507,489	170,591	26,493
	Other/unk.	584	84,552,832	13,764,604	161,209	26,244

## LI 8.5 Total and per-person per-year (PPPY) Medicare costs (\$) among liver 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		PPPY costs	
			Part A	Part B	Part A	Part B
All patients		901	17,601,901	8,841,674	20,385	10,240
Age	0-11	*	*	*	*	*
	12-17	*	*	*	*	*
	18-34	22	159,996	161,552	7,411	7,483
	35-49	127	2,023,578	1,248,482	16,385	10,109
	50-64	483	10,579,258	4,902,490	22,806	10,569
	65+	267	4,793,386	2,514,049	18,985	9,957
Sex	Male	585	10,718,295	5,587,032	19,193	10,005
	Female	316	6,883,606	3,254,642	22,568	10,670
Race	White	634	12,469,845	6,308,993	20,650	10,447
	Black	82	2,242,840	837,614	28,049	10,475
	Hispanic	134	2,211,934	1,351,120	16,728	10,218
	Asian/Pac. Isl.	41	639,102	294,756	17,108	7,890
	Other/unk.	10	38,179	49,192	3,807	4,906
Primary cause of disease	Acute hep. nec.	28	375,950	202,251	13,787	7,417
	HBV	19	238,143	121,625	12,500	6,384
	HCV	247	5,946,784	2,468,917	25,393	10,542
	Alco. liver disease	174	2,849,612	1,615,970	16,882	9,573
	Malignancy	110	2,022,833	1,050,306	19,851	10,307
	Cholestatic dis.	80	1,679,529	863,743	21,812	11,217
	Other/unk.	243	4,489,051	2,518,861	19,082	10,707

## LI 8.6 Total and per-person per-year (PPPY) Medicare costs (\$) among liver 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

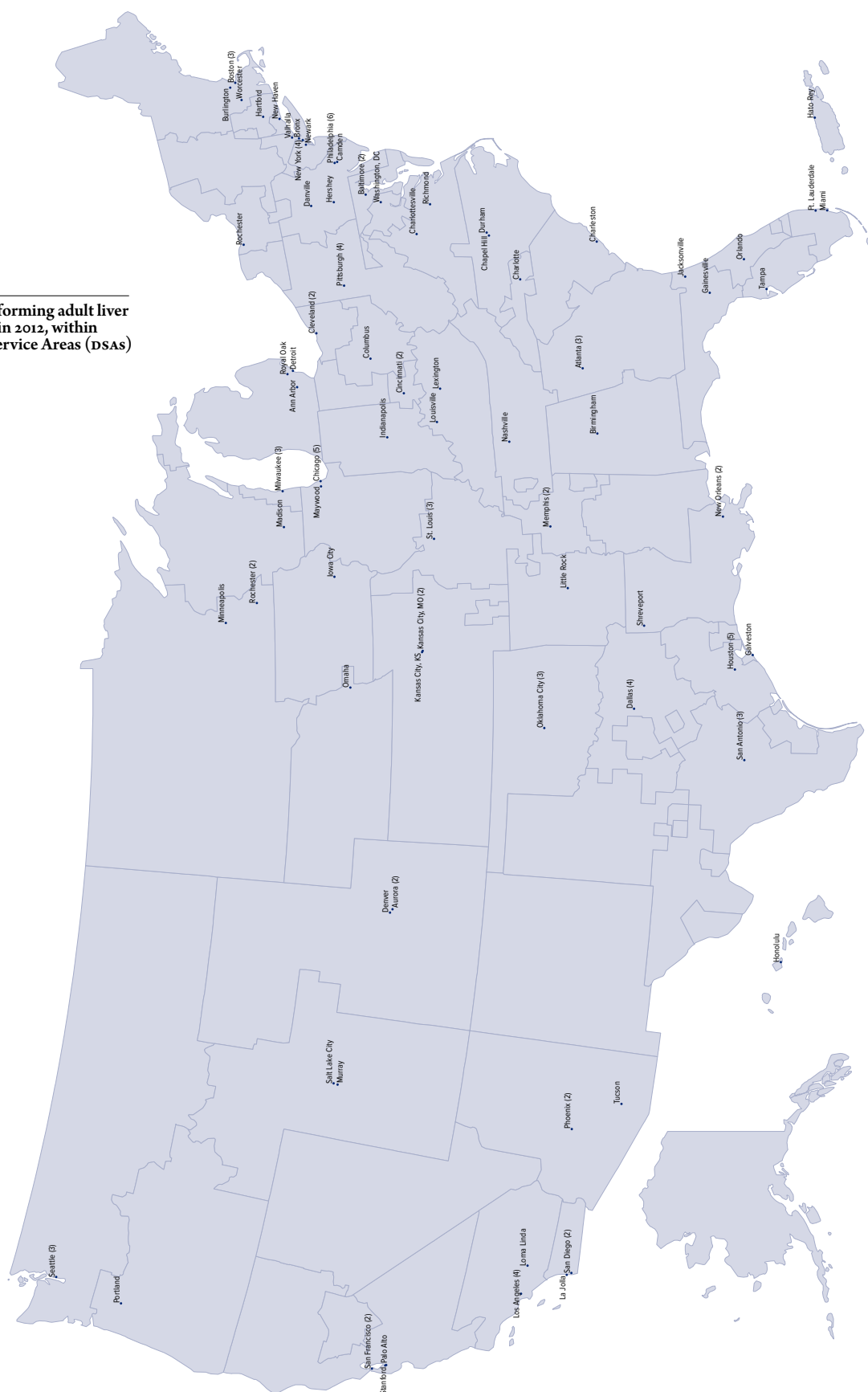
Total costs		2008 total costs			2009 total costs			2010 total costs		
		# patients	Part A	Part B	# patients	Part A	Part B	# patients	Part A	Part B
All patients		21,211	391,716,094	106,411,609	22,865	426,160,552	137,055,352	24,365	453,906,521	143,195,584
Age	0-11	75	2,219,698	473,923	77	2,220,116	503,599	88	2,494,070	652,442
	12-17	59	1,602,803	378,525	64	1,288,962	402,352	69	670,922	326,394
	18-34	864	15,373,334	3,881,979	907	16,512,642	5,045,785	955	18,611,775	5,325,707
	35-49	5,614	86,191,262	24,454,700	5,744	97,964,453	30,870,301	5,938	97,832,440	30,817,207
	50-64	11,661	210,685,697	57,157,300	12,818	220,515,882	72,296,815	13,837	243,154,740	76,799,362
	65+	2,938	75,643,300	20,065,181	3,255	87,658,497	27,936,500	3,478	91,142,574	29,274,472
Sex	Male	13,660	246,772,183	66,277,504	14,807	270,658,553	85,321,176	15,789	287,182,529	89,741,437
	Female	7,551	144,943,911	40,134,105	8,058	155,501,999	51,734,176	8,576	166,723,992	53,454,147
Race	White	16,304	283,825,238	80,185,940	17,424	302,009,851	101,716,758	18,477	327,816,618	106,467,904
	Black	1,546	39,026,215	8,109,682	1,730	42,987,954	10,884,473	1,900	48,131,500	12,100,417
	Hispanic	2,480	51,038,045	13,659,474	2,720	58,651,882	18,474,960	2,915	57,094,919	18,594,032
	Asian/Pacific Islander	736	14,844,170	3,652,742	831	20,031,072	5,113,957	877	16,696,382	4,860,874
	Other/unk.	145	2,982,427	803,772	160	2,479,793	865,205	196	4,167,102	1,172,357
Primary cause of disease	Acute hep. nec.	948	18,375,230	4,303,138	1,004	17,455,776	5,568,307	1,060	18,822,755	5,464,659
	HBV	622	10,170,925	2,612,558	664	12,157,520	3,500,814	697	10,097,232	3,376,485
	HCV	5,376	106,105,213	26,646,476	5,850	115,329,702	35,247,138	6,247	124,237,312	36,273,427
	Alco. liver disease	4,202	73,552,556	19,683,136	4,486	75,302,460	24,282,247	4,729	83,225,747	25,362,360
	Malignancy	975	24,529,998	5,751,010	1,288	30,197,857	8,749,112	1,518	33,901,209	10,034,446
	Cholestatic dis.	2,507	36,188,606	11,717,986	2,674	41,442,763	15,296,468	2,851	40,984,258	15,443,301
	Other/Unk.	6,581	122,793,566	35,697,306	6,899	134,274,474	44,411,267	7,263	142,638,009	47,240,907
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		21,211	19,940	5,417	22,865	20,194	6,495	24,365	20,106	6,343
Age	0-11	75	30,796	6,575	77	30,439	6,905	88	29,015	7,590
	12-17	59	29,879	7,056	64	21,330	6,658	69	10,098	4,912
	18-34	864	18,837	4,757	907	19,395	5,927	955	20,664	5,913
	35-49	5,614	16,326	4,632	5,744	18,077	5,696	5,938	17,402	5,481
	50-64	11,661	19,481	5,285	12,818	18,585	6,093	13,837	18,898	5,969
	65+	2,938	28,990	7,690	3,255	30,934	9,859	3,478	30,039	9,648
Sex	Male	13,660	19,539	5,248	14,807	19,871	6,264	15,789	19,648	6,140
	Female	7,551	20,661	5,721	8,058	20,784	6,915	8,576	20,947	6,716
Race	White	16,304	18,742	5,295	17,424	18,753	6,316	18,477	19,106	6,205
	Black	1,546	27,897	5,797	1,730	27,486	6,959	1,900	27,884	7,010
	Hispanic	2,480	22,364	5,985	2,720	23,352	7,356	2,915	21,139	6,884
	Asian/Pacific Islander	736	21,598	5,315	831	25,921	6,618	877	20,511	5,971
	Other/unk.	145	22,361	6,026	160	16,602	5,792	196	23,563	6,629
Primary cause of disease	Acute hep. nec.	948	20,507	4,802	1,004	18,452	5,886	1,060	18,902	5,488
	HBV	622	17,234	4,427	664	19,402	5,587	697	15,086	5,045
	HCV	5,376	21,514	5,403	5,850	21,521	6,577	6,247	21,702	6,336
	Alco. liver disease	4,202	18,790	5,028	4,486	18,106	5,838	4,729	18,895	5,758
	Malignancy	975	29,344	6,880	1,288	27,046	7,836	1,518	25,356	7,505
	Cholestatic dis.	2,507	15,300	4,954	2,674	16,440	6,068	2,851	15,179	5,720
	Other/Unk.	6,581	20,093	5,841	6,899	21,063	6,967	7,263	21,149	7,004

## LI 8.7 Total calendar-year Medicare costs (\$) spent on liver 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.



**LI 9.1** Centers performing adult liver transplants in 2012, within Donation Service Areas (DSAs)



**LI 9.2 Centers performing pediatric liver transplants in 2012, within Donation Service Areas (DSAs)**

