lung

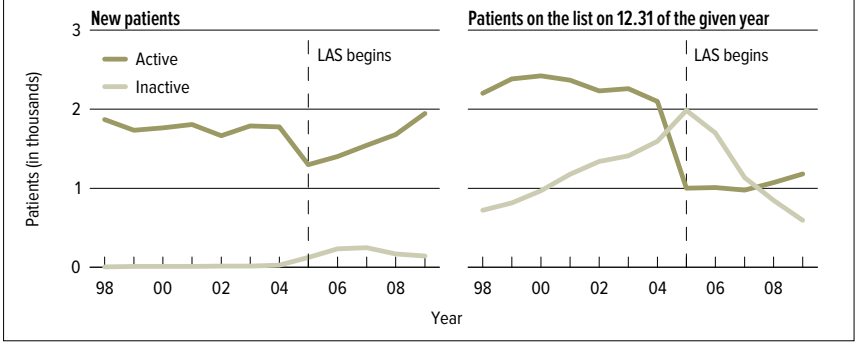
Implemented in 2005, the lung allocation score (LAS) system has had remarkable effects on the size of the lung transplant waiting list, the rate of lung transplants, and the distribution of lung allografts among diagnosis groups. As we move further from its implementation, we are now able to see clearly how the LAS system has changed lung allocation and what remains to be improved. A marked shortage in available lungs for those in need continues; 2008 was the first year since adoption of the LAS that the number of patients on the waiting list increased over previous years, a trend that continued in 2009. At the end of 2009, 1,181 people were waiting for lungs, compared with a low of 978 in 2007. Despite this increase in the waiting list, 1,670 lung transplants (1,644 lung, and 26 heart-lung) were performed in 2009 — more than ever before. Wait-list mortality has begun to rise again, after a decline following LAS implementation.

As part of the development of the LAS, disease diagnoses leading to lung transplant were grouped into 4 categories, to associate diseases with similar outcomes. The goal was to create groups that would act as predictors of disease progression. The 4 groups are: group A, obstructive lung disease (chronic obstructive pulmonary disease/emphysema, alpha-1 antitrypsin deficiency, bronchiectasis, lymphangioleiomyomatosis, etc.); group B, pulmonary vascular disease (idiopathic pulmonary arterial hypertension, Eisenmenger syndrome, etc.); group C, cystic fibrosis and immunodeficiency disorders (cystic fibrosis, hypogammaglobulinemia, etc.); and group D, restrictive lung disease (idiopathic pulmonary fibrosis, sarcoidosis, re-transplant, etc.). A fifth category, group E, comprises all pediatric patients aged younger than 12 years.

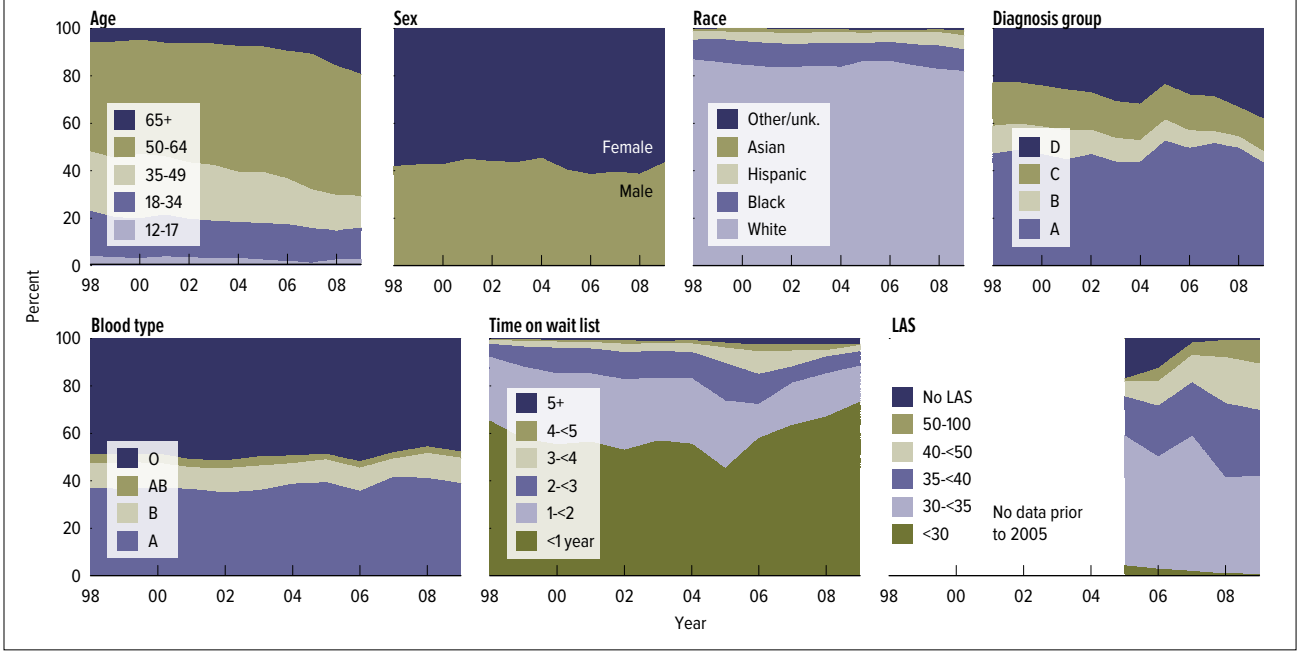
Each and every morning I give thanks for my donor. I know not the dignity of my donor's life, nor the tragedy of their death, but I do know I received the greatest gift of all, the gift of life.

Marie, lung recipient

LU 1.1 Adult patients waiting for a lung transplant



LU 1.2 Distribution of adult patients (active) waiting for a lung transplant



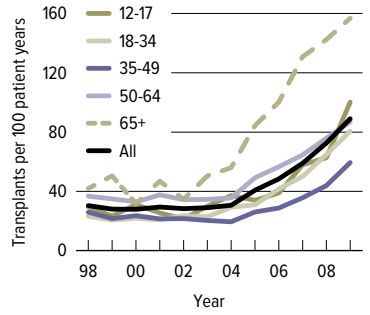
wait list

Upon the introduction of the LAS for deceased donor lung allocation in 2005, the number of active patients on the waiting list for a lung transplant in the United States sharply decreased (Figure 1.1). That trend stabilized through 2007, and since then the number of patients waiting for a lung transplant has begun to increase, by about 10% in 2008 and again in 2009.

The demographics of patients awaiting a lung transplant have remained fairly constant in terms of race, sex, and blood type (Figure 1.2). However, over the past 10 years, the age distribution of those on the waiting list has changed substantially. In 2009, 16.8% of the wait-listed patients were aged 65 years or older, up from 13.4% in 2008 and 4.6% in 2004 (before the LAS system). This reflects an increasing trend toward performing transplants for patients aged 65 years or older. Since 2005, the percentage of patients with an LAS of 35 or higher has increased from 24.1% to 57.1% of the waiting list. This shift indicates that, on the whole, patients on the waiting list are sicker and have a higher risk of mortality.

The transplant rate has been steadily increasing, with a sharp increase after 2004 (Figure 1.3). The sharpest increase is in patients aged 65 years or older, indicating that older patients are not only gaining access to the waiting list in increased numbers, but are receiving transplants more frequently as well. Transplant rates are increasing in all age groups, though the rate remains lowest in patients aged 35 to 49 years; this group appears to be decreasing in prevalence on the waiting list as well. By diagnosis, patients in

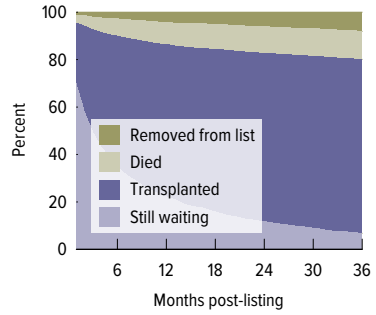
LU 1.3 **Transplant rates among adult patients wait-listed for a lung transplant, by age**



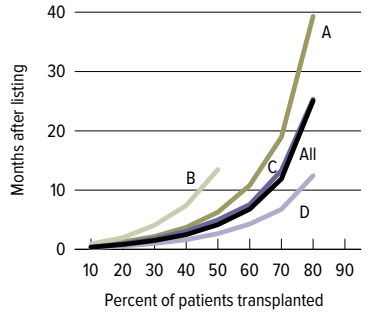
LU 1.4 **Lung transplant waiting list activity among adult patients**

	2007	2008	2009
Listings at start of year	2,736	2,128	1,926
Listings added during year	1,914	1,973	2,241
Listings removed during year	2,522	2,175	2,384
Listings at end of year	2,128	1,926	1,783
Removal reason			
Deceased donor transplant	1,470	1,490	1,666
Living donor transplant	3	0	1
Patient died	376	315	342
Patient refused transplant	18	11	7
Transferred to another ctr	35	26	26
Improved, tx not needed	376	202	140
Too sick to transplant	35	33	54
Other	209	98	148

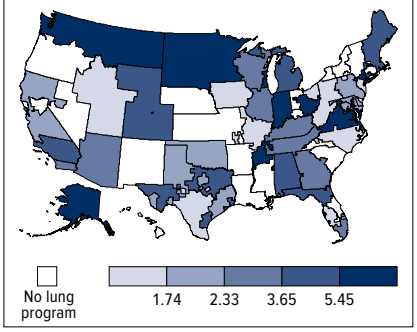
LU 1.5 **Lung tx waiting list status by month post-listing among new adult listings in 2006**



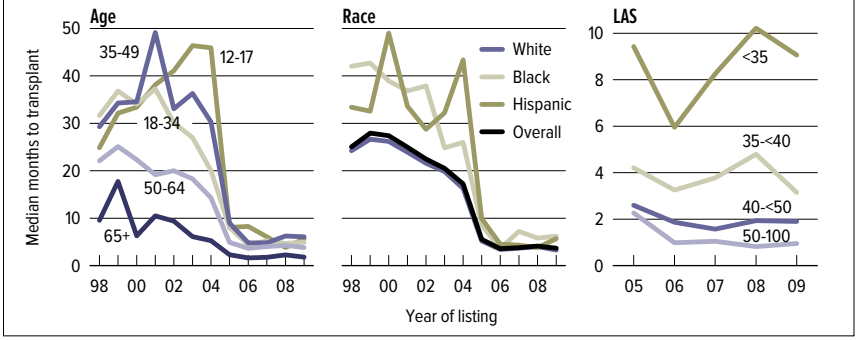
LU 1.6 **Percentiles of time to lung tx for new adult listings, by diagnosis group, 2005–2009**



LU 1.7 **Median months to lung transplant for adult patients transplanted in 2009, by DSA**



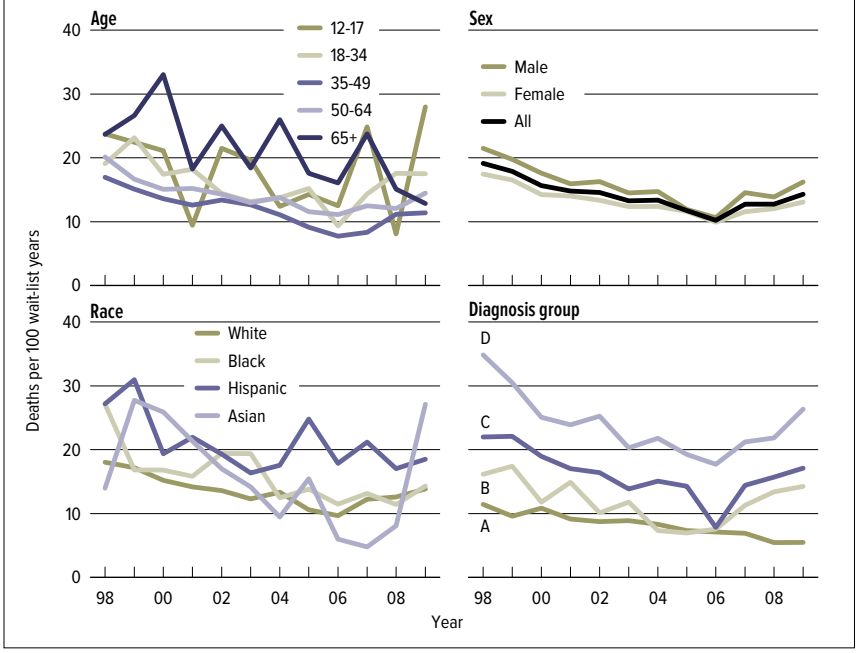
LU 1.8 **Median months to lung transplant for wait-listed adult patients**



diagnosis groups C and D are gaining access to lungs faster than those in groups A and B (Figure 1.6).

Median months to transplant from time of listing may be leveling off from the precipitous decline after the implementation of the LAS (Figure 1.8). Overall median wait time is less than 6 months, with a median wait of less than 2 months for candidates aged 65 years or older. A higher LAS corresponds to a shorter wait time, down to a median of 1 month for patients with an LAS of 50 or higher. Wait time for a lung transplant seems to have some notable geographic variation (Figure 1.7), with patients across the northern and northwestern US experiencing longer wait times than those in the central and eastern regions.

LU 1.9 **Pre-transplant mortality rates among adult patients wait-listed for a lung transplant**



LU 1.10 **Characteristics of adult patients on the lung tx waiting list on December 31, 2009**

	Level	N	%
Age	12-17	43	2.4
	18-34	220	12.4
	35-49	349	19.6
	50-64	900	50.6
	65+	266	15.0
Gender	Female	1,076	60.5
	Male	702	39.5
Race	White	1,455	81.8
	Black	178	10.0
	Hispanic	98	5.5
	Asian	33	1.9
	Other/unk.	14	0.8
Diagnosis group	A	811	45.6
	B	163	9.2
	C	229	12.9
	D	574	32.3
	Other/unknown	1	0.1
Most recent lung allocation score (LAS)	30-<35	875	49.2
	35-<40	346	19.5
	40-<50	217	12.2
	50-100	96	5.4
	No LAS*	179	10.1
Blood type	A	676	38.0
	B	187	10.5
	AB	50	2.8
	O	865	48.7
Time on waiting list	<1 month	155	8.7
	1 -<3 months	203	11.4
	3 -<6 months	241	13.6
	6 -<12 months	278	15.6
	1 - <2 years	293	16.5
	2 - <3 years	142	8.0
	3+ years	466	26.2
Status	Inactive	602	33.9
	Active	1,176	66.1
Transplant history	Listed for first tx	1,721	96.8
	Listed for sub. tx	57	3.2

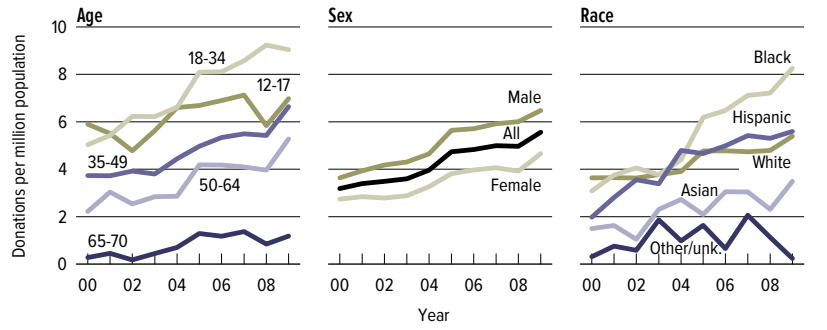
* all but 2 patients with unknown LAS were listed prior to May 4, 2005

wait list

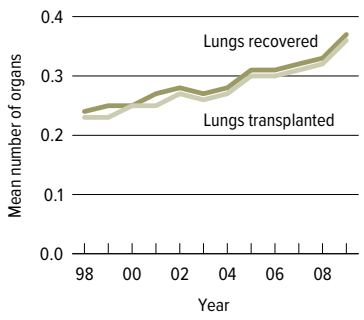
Wait-list mortality appears to have increased during the past 3 years, reversing a trend from the pre-LAS period (Figure 1.9). All diagnosis groups except group A experienced notable increases in pre-transplant mortality, with group D patients at the highest risk, at 26.4 deaths per 100 wait-list years. The most common reason for removal from the waiting list, after transplant, was death, with over 300 patients dying each year (Figure 1.4). Transplant candidates aged 65 years or older have experienced a substantial decline in wait-list mortality, from 26.0 deaths per 100 wait-list years in 2004 to 12.9 in 2009. Meanwhile, candidates aged 18 to 34 years have experienced increasing mortality rates since the LAS began, from 9.3 deaths per 100 wait-list years in 2006 to 17.5 in 2009. The variability in mortality for candidates aged 12 to 17 years is likely due to small cohort size. A recent dramatic increase also appears to have occurred in the pre-transplant mortality of Asian candidates, from 8.1 deaths per 100 wait-list years in 2008 to 27.1 in 2009. This may reflect the small number of Asian candidates.

Figure 1.10 shows basic characteristics for patients on the 2009 waiting list. The list continues to be dominated by white candidates and candidates from diagnosis group A. The age distribution reflects the increased listing of older patients, with two-thirds of listed patients aged 50 years or older.

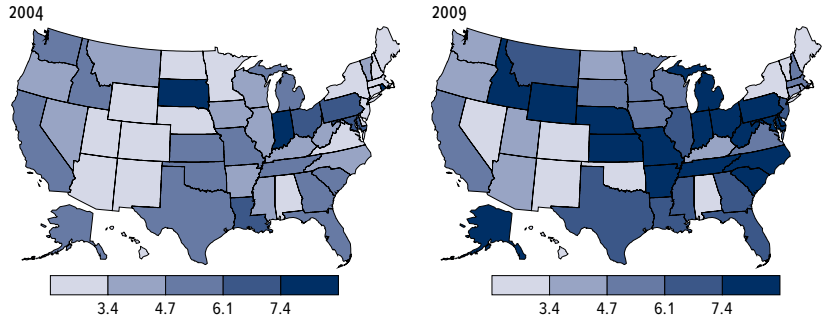
LU 2.1 Lung donations from deceased donors per million population



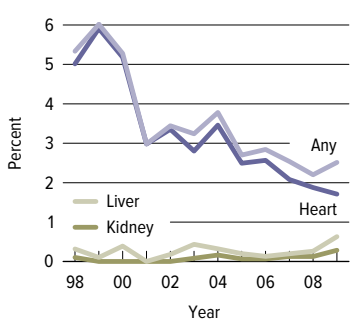
LU 2.2 Lungs recovered per donor & lungs transplanted per donor



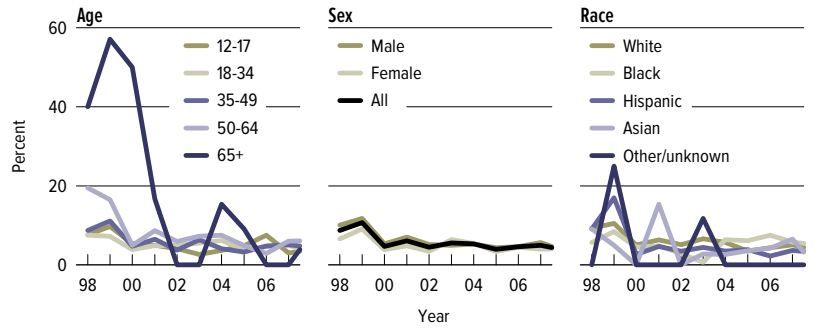
LU 2.3 Deceased donor lung donation rates (per million population)



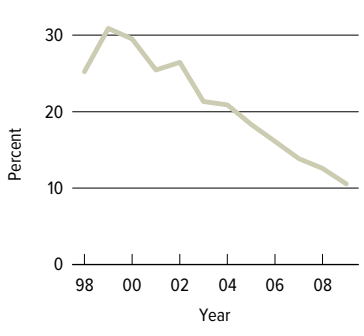
LU 2.4 Deceased donor lungs transplanted with another organ



LU 2.5 Discard rates for lungs recovered for transplant



LU 2.6 Lung donors with smoking history



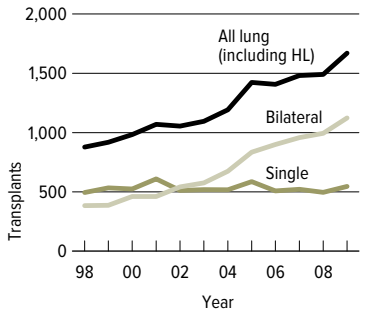
deceased donation

Lung donation rates are increasing, but continue to be low compared with other organs. The fragility of the lung makes it difficult for every willing donor to donate. The overall donation rate in 2009 was 5.6 lungs per million population. Other than a slight decline in donations from donors aged 18 to 34 years, donation rates have been slowly increasing for 10 years across age and racial groups (Figure 2.1). Given the increasing size of the waiting list, donations have not kept pace with demand.

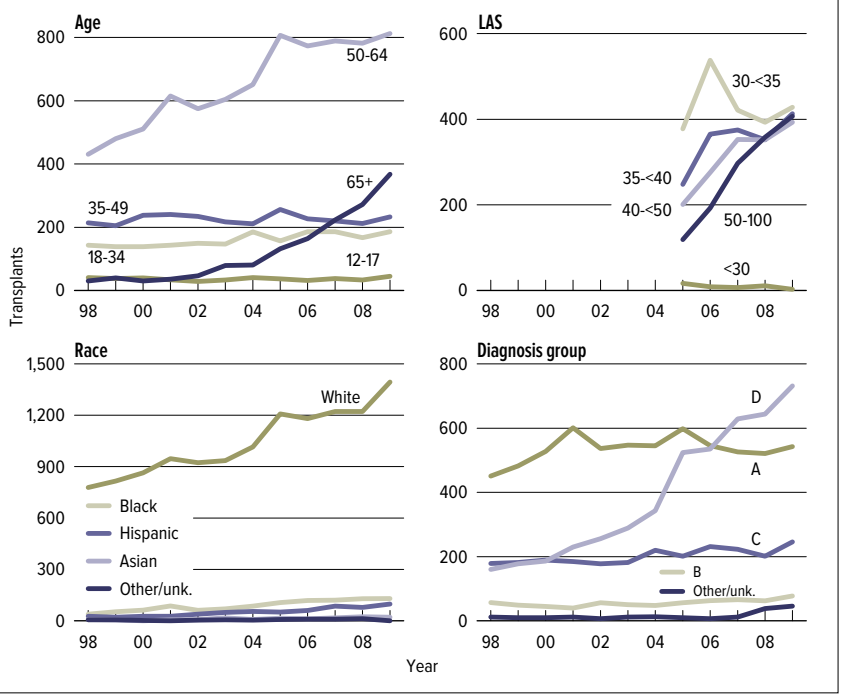
Donation rates vary substantially by geographic region, but are improving across the country (Figure 2.3). There is a band of reliable donation in the middle of the country. This is in contrast to lower donation rates in some western states, such as Nevada and Colorado. Continued efforts to increase awareness regarding deceased donation will be critical to ease growing demands.

Lungs have a low rate of discard; more than 90% of recovered lungs are used (Figure 2.5). The acceptability of lungs from donors aged 65 years or older varies, although data suggest that this variation may be easing. There is evidence that some donors may have a history of smoking, but it is unclear how recent or severe that smoking may have been (Figure 2.6). The trend appears to indicate a preference for donors with no history of smoking.

LU 3.1 Total adult lung transplants



LU 3.2 Adult lung transplants



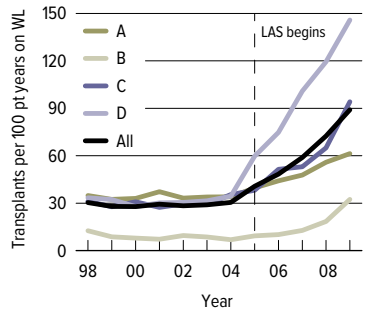
transplant In 2009, 1,670 adults underwent lung transplants (Figure 3.1). Twenty-six of these were heart-lung transplants. Adults aged 50 to 64 years continued to undergo the most transplants, but the number of adults aged 65 years or older undergoing transplants increased sharply (Figure 3.2). In 1998, 3.5% of transplants were performed in adults aged 65 years or older, but in 2009 that cohort represented 22.4% of transplants. The number of transplants among whites also increased in 2009, continuing a trend that started in the mid-1990s.

After the LAS was implemented, the diagnostic distribution of lung transplants changed dramatically. Before LAS, group A patients represented the majority of lung transplants. Today most lung transplants are in group D patients. The number of transplants in group D continues to rise, with 732 transplants in 2009, a more than 13% increase over the previous year. Transplants for all diagnosis groups continue to increase, with the largest increase occurring in group D (Figure 3.3).

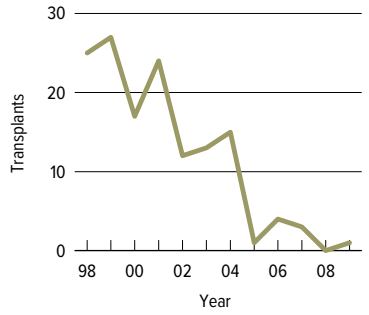
Bilateral lung transplant is increasingly chosen over single lung transplant (Figure 3.1). Bilateral transplants now account for more than two-thirds of all lung transplants.

Living lung donation has virtually ceased over the past 10 years (Figure 3.4). Never a frequently used option, living donation has dropped from a high of 27 procedures in 1999 to only 1 in 2009.

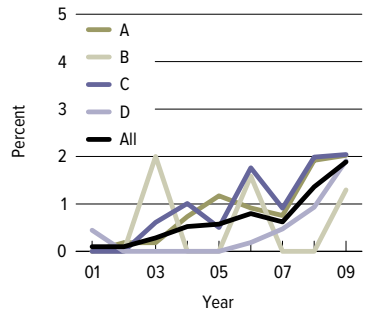
LU 3.3 Lung transplant rates in adult patients, by diagnosis group



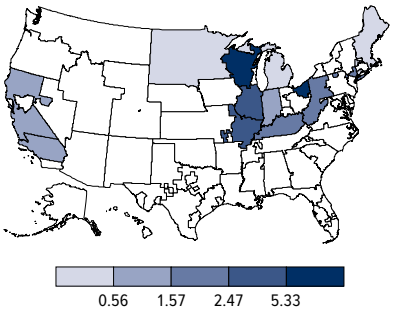
LU 3.4 Adult live donor lung transplants



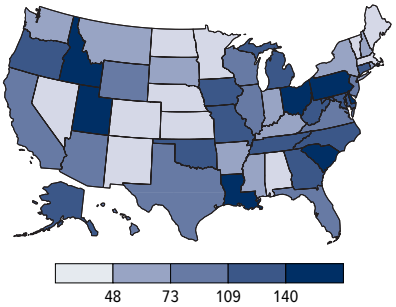
LU 3.5 Use of DCD lungs among adult lung tx recipients, by recipient diagnosis group



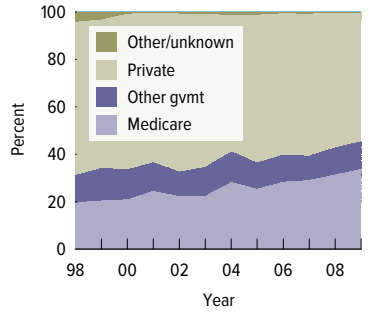
LU 3.6 Percent of adult, deceased donor lung transplants that are DCD, by DSA, 2005–09



LU 3.7 Deceased donor lung tx rates per 100 pt years on the waiting list, adult pts, 2009



LU 3.8 Insurance coverage among adult lung transplant recipients at time of transplant



LU 3.9 Characteristics of adult lung transplant recipients, 2009

	Level	N	%
Age	12-17	45	2.7
	18-34	186	11.3
	35-49	233	14.2
	50-64	812	49.4
	65+	368	22.4
Sex	Female	701	42.6
	Male	943	57.4
Race	White	1,394	84.8
	Black	130	7.9
	Hispanic	99	6.0
	Asian	21	1.3
Diagnosis group	A	543	33.0
	B	77	4.7
	C	246	15.0
	D	732	44.5
	Other/unknown	46	2.8
Lung allocation score (LAS)	<30	3	0.2
	30-<35	428	26.0
	35-<40	413	25.1
	40-<50	393	23.9
	50-100	407	24.8
Blood type	A	698	42.5
	B	183	11.1
	AB	64	3.9
	O	699	42.5
Time on waiting list	<1 month	554	33.7
	1 -<3 months	414	25.2
	3 -<6 months	243	14.8
	6 -<12 months	200	12.2
	1 - <2 years	132	8.0
	2 - <3 years	41	2.5
	3+ years	60	3.6
Pre-tx medical condition	Hospitalized: ICU	152	9.2
	Hospitalized: not ICU	159	9.7
	Not hospitalized	1,333	81.1
Pt on vent. imm.ly pre-tx	No	1,514	92.1
	Yes	130	7.9
Procedure type	Lobe	1	0.1
	Single	546	33.2
	Bilateral	1,097	66.7
Donor type	Deceased	1,643	99.9
	Living	1	0.1
Primary payer	Private	891	54.2
	Medicare	553	33.6
	Other government	192	11.7
	Other	8	0.5
Total	All patients	1,644	100.0

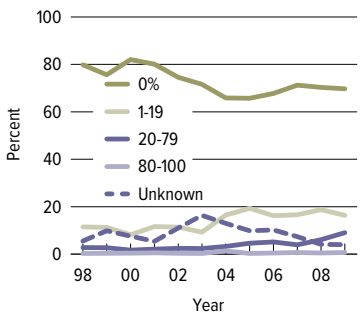
Donation after circulatory death (DCD) was thought to yield suboptimal outcomes in lung recipients, but recently outcomes for DCD lungs have been comparable to outcomes for lungs from non-DCD donors. Currently, DCD transplants are performed only at the largest transplant centers (Figures 3.6 and 8.3).

Transplant rates vary greatly by state, from a low of less than 25 transplants per 100 patient-years in Kansas and Colorado to more than 200 transplants per 100 patient-years in Utah and Louisiana (Figure 3.7). Transplant center access may affect these rates. North Dakota, a state without a lung transplant center, had zero transplants per 100 patient-years in 2009; by contrast, the District of Columbia, whose residents have access to several nearby transplant centers, had a transplant rate of 434.8 transplants per 100 patient-years.

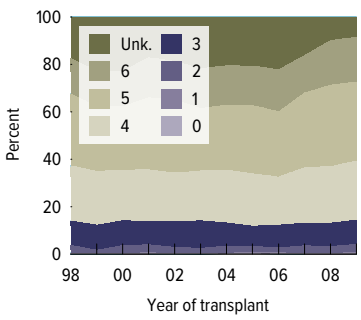
Reported insurance coverage among lung transplant recipients was 99.5% in 2009 (Figure 3.8). The trend toward increased coverage through Medicare continued. Government programs combined paid for 45.3% of lung transplants in 2009, a marked increase from 1998, when only 31.1% of transplants were covered by government-funded insurance plans.

Patients aged 65 years or older underwent 22.4% of the transplants in 2009; patients aged 35 to 49 years underwent 14.2% (Figure 3.9). Patients aged 65 or older constituted 15.0% of the list in 2009, and those aged 35 to 49 years, 19.6% (Figure 1.10).

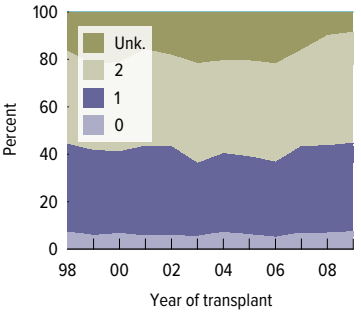
LU 4.1 PRA at time of lung transplant in adult recipients



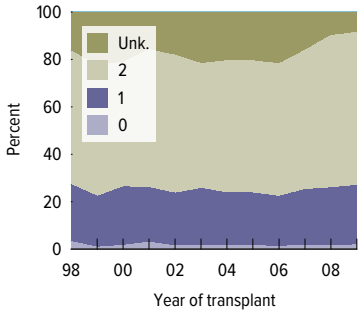
LU 4.2 Total HLA mismatches among adult lung transplant recipients



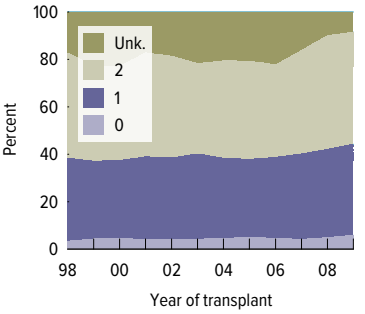
LU 4.3 HLA-A mismatches among adult lung transplant recipients



LU 4.4 HLA-B mismatches among adult lung transplant recipients



LU 4.5 HLA-DR mismatches among adult lung transplant recipients



donor-recipient matching

In general, the closer the immunological or human leukocyte antigen (HLA) match between a donor and a recipient, the less likely it is that rejection will occur. Most lung transplant recipients have 0% panel reactive antibodies (PRA) at the time of transplant; in 2009, 69.8% had 0% PRA. Since the implementation of the LAS, the percentage of transplant patients with high numbers of HLA mismatches has increased. Indeed, in the past decade there seems to be a trend toward more liberally performing transplants for patients with high PRA or HLA mismatches (Figures 4.1–4.5). It is unclear whether this is the result of changing practices at transplant centers or recent changes in methods that make the detection of anti-HLA antibodies more sensitive.

LU 4.6 Adult lung donor-recipient cytomegalovirus (CMV) serology matching, 2005–2009

	DONOR			
RECIPIENT	Negative	Positive	Unknown	Total
Negative	15.7	23.4	0.2	39.3
Positive	19.1	35.5	0.3	54.8
Unknown	2.4	3.5	0.0	5.9
Total	37.2	62.3	0.5	100

LU 4.7 Adult lung donor-recipient Epstein-Barr virus (EBV) serology matching, 2005–2009

	DONOR			
RECIPIENT	Negative	Positive	Unknown	Total
Negative	0.8	8.5	3.4	12.7
Positive	4.0	45.7	20.9	70.7
Unknown	0.8	10.9	4.9	16.6
Total	5.6	65.1	29.3	100

LU 4.8 Adult lung donor-recipient hepatitis B core antibody (HBcAb) serology matching, 2005–2009

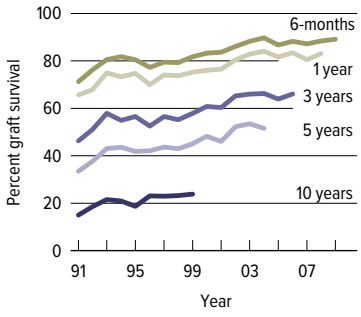
	DONOR			
RECIPIENT	Negative	Positive	Unknown	Total
Negative	74.3	1.8	0.2	76.4
Positive	3.2	0.2	0.0	3.4
Unknown	19.7	0.5	0.1	20.2
Total	97.2	2.5	0.3	100

LU 4.9 Adult lung donor-recipient hepatitis B surface antigen (HBsAg) serology matching, 2005–2009

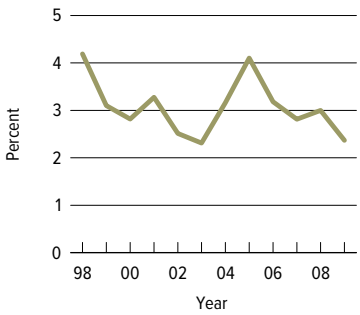
	DONOR			
RECIPIENT	Negative	Positive	Unknown	Total
Negative	90.5	0.0	0.2	90.7
Positive	1.9	0.0	0.0	1.9
Unknown	7.4	0.0	0.0	7.4
Total	99.8	0.0	0.2	100

In most transplants, donor cytomegalovirus (CMV) status and recipient CMV status are matched or CMV-positive patients receive CMV-negative lungs (Figure 4.6). This practice decreases the chances of a CMV-negative recipient being exposed to CMV and its potential consequences. However, 23.4% of lung transplants are from a CMV-positive donor to a CMV-negative recipient, which could increase the incidence of post-transplant CMV infection. Similarly, donors and recipients are often matched on the basis of Epstein-Barr virus (EBV) status; in 2005–2009, only 8.5% of lung transplants went from an EBV-positive donor to an EBV-negative recipient (Figure 4.7). No donor was hepatitis B virus (HBV) surface antigen (HBsAg) positive (Figure 4.9). HBsAg positive status indicates either prior infection or immunization. The vast majority of donors were hepatitis B core antibody negative (Figure 4.8). Positive status indicates prior HBV infection.

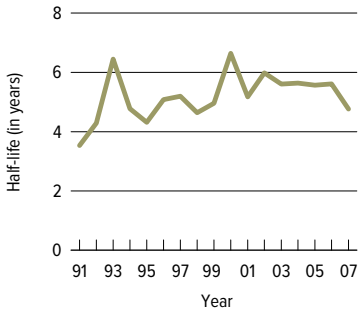
LU 5.1 Graft failure among adult lung transplant recipients



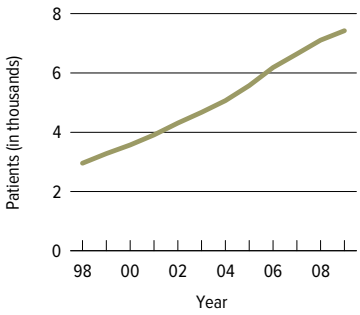
LU 5.2 Early (reported w/i 6 wks of tx) graft failure among adult lung transplant recipients



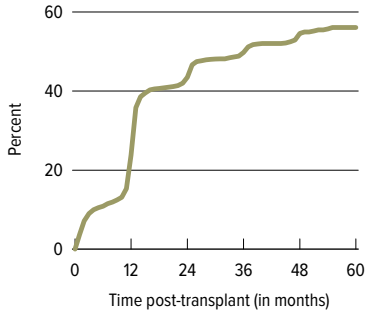
LU 5.3 Half-lives for adult lung transplant recipients surviving at least one year



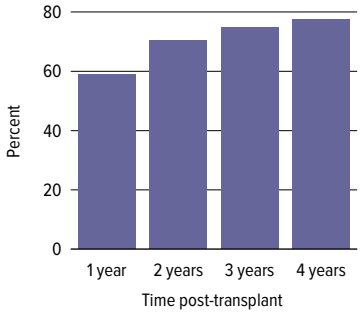
LU 5.4 Adult lung transplant recipients alive on June 30 of the year



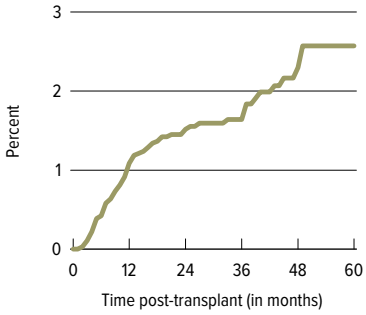
LU 5.5 Incidence of first acute rejection among adult pts receiving a lung tx in 2005–2009



LU 5.6 Reported hospitalizations among adult pts receiving a lung transplant in 2005–2009



LU 5.7 Incidence of PTLD among adult patients receiving a lung transplant in 2005–2009

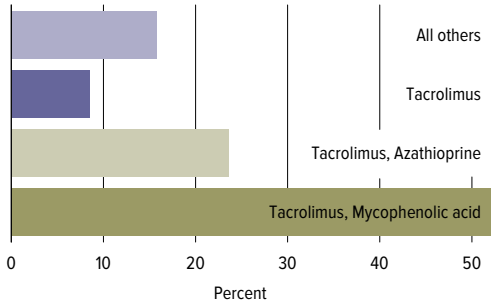


outcomes

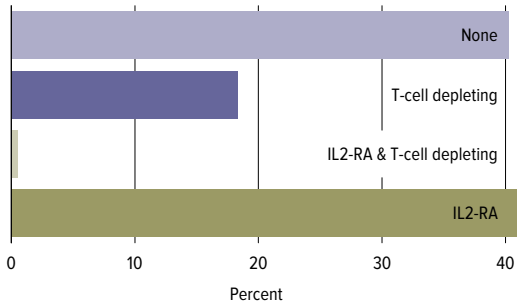
Immediately after the LAS was implemented, graft survival rates decreased, likely the result of performing transplants for the sickest patients on the waiting list. Implementation of the LAS placed patients with the highest pre-transplant urgency at the top of the waiting list, and was associated with a decrease in post-transplant graft survival from 89.8% to 86.8% at 6 months (Figure 5.1). By the end of 2007, 6-month graft survival was 87.2%, virtually unchanged from the immediate drop after LAS implementation. In 2009, graft survival rates appear to have returned to pre-LAS levels, with 6-month graft survival at 89.2% overall. Graft survival rates in the first 6 weeks post-transplant improved in 2009 compared with 2008 (Figure 5.2) Next year will mark 5 years since implementation of the LAS, and we will be able to determine the effect of the system on 5-year graft survival.

For adult lung transplant recipients who survive 1 year after transplant, the overall half-life for lung grafts is 4.8 years. This is lower than the previous high of 6.6 years in 2000 (Figure 5.3). At the end of June 2009, 7,425 people in the US were living with a lung allograft, more than twice the number of living recipients 10 years ago (Figure 5.4).

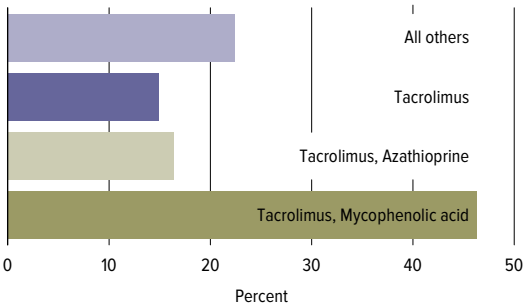
LU 6.1 Initial immunosuppression regimen in adult lung transplant recipients, 2009 (steroids not considered)



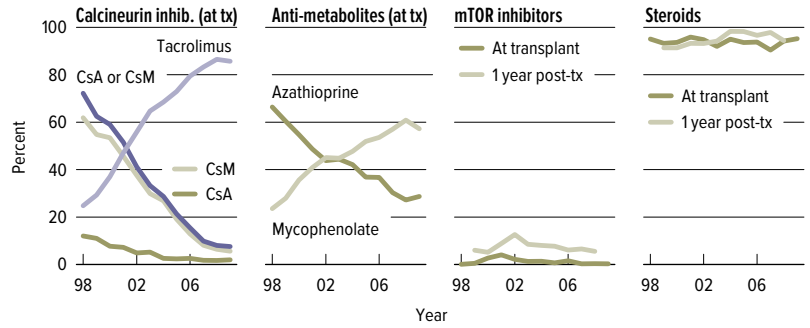
LU 6.2 Induction agents used at time of lung transplant, adult recipients, 2009



LU 6.3 Immunosuppression at one year in adult lung transplant recipients, 2008 (steroids not considered)



LU 6.4 Immunosuppression use in adult lung transplant recipients

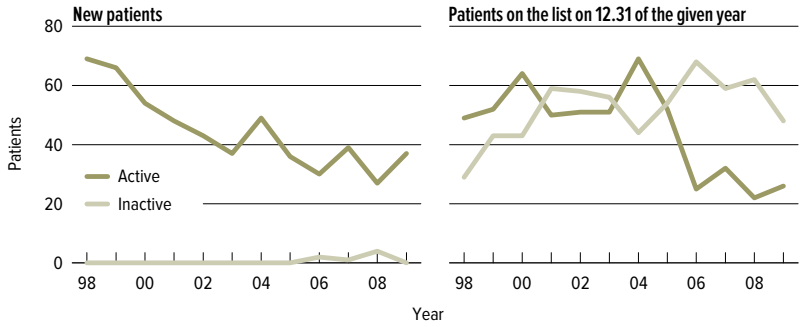


immunosuppression

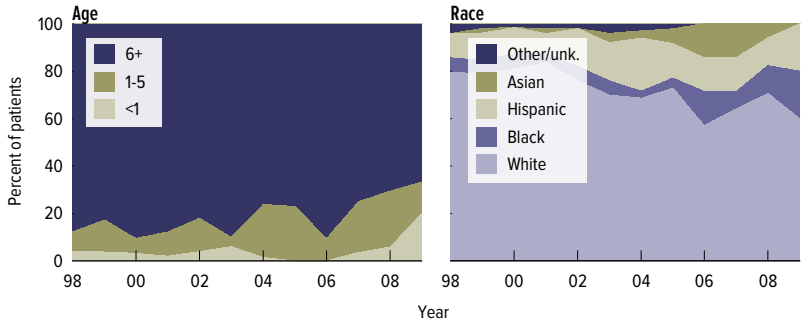
Trends in immunosuppression among lung transplant recipients have remained stable over the past several years. Since 1998, use of tacrolimus as the primary calcineurin inhibitor has steadily increased (Figures 6.1, 6.3, and 6.4). Today, it is used in virtually all lung transplant recipients. Mycophenolate is still the predominant anti-metabolite used in lung transplant recipients. Steroid use is also virtually universal and extends from the immediate post-transplant period through at least 1 year post-transplant. Mammalian target of rapamycin (mTOR) inhibitors are used rarely, if at all, immediately after transplant (Figure 6.4).

Use of induction agents after transplant is mixed, with 40.3% of patients not receiving them. For those patients who receive an induction agent, interleukin-2 receptor antagonists (IL2-RA) are the primary agents chosen, with a minority of patients receiving a T-cell depleting agent (Figure 6.2).

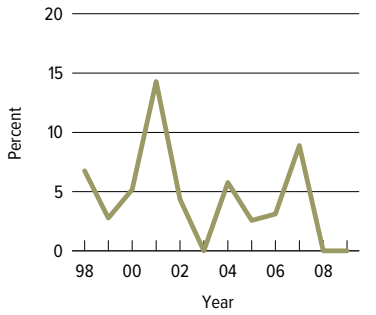
LU 7.1 Pediatric patients waiting for a lung transplant



LU 7.2 Distribution of pediatric patients waiting for a lung transplant



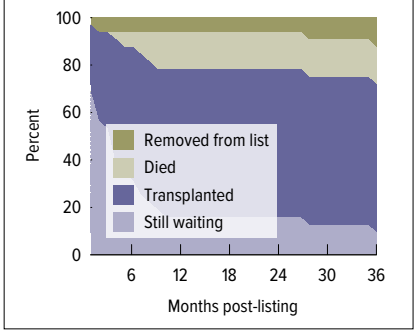
LU 7.3 Prior lung transplant in pediatric patients waiting for a lung transplant



LU 7.4 Lung transplant waiting list activity among pediatric patients

	2007	2008	2009
Listings at start of year	93	91	84
Listings added during year	45	32	39
Listings removed during year	47	39	49
Listings at end of year	91	84	74
Removal reason			
Received a transplant	18	15	22
Patient died	10	13	7
Transferred to another ctr	3	1	1
Improved, tx not needed	10	4	13
Too sick to transplant	0	3	2
Other	6	3	4

LU 7.5 Lung tx waiting list status by month post-listing among new pediatric listings in 2006

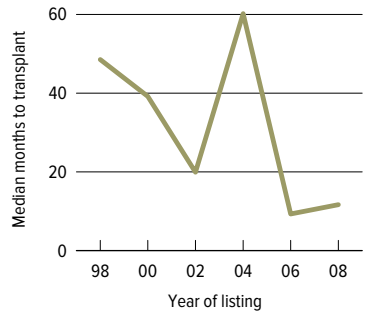


pediatric transplant

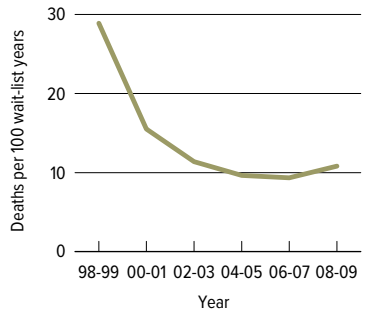
Prior to November 22, 2010, candidates aged less than 12 years received allocation priority based on waiting time. Since November, 2010, pediatric candidates receive allocation priority by medical urgency status. Since 1998, the number of active pediatric patients on the waiting list has decreased (Figure 7.1). Patients aged younger than 6 years account for one-third of the pediatric patients waiting for a lung transplant in 2009 (Figure 7.2). Since 2006, the number of patients on the waiting list aged younger than 1 year has increased. White patients made up 60.0% of the waiting list in 2009, and black and Hispanic patients 20.0% each (Figure 7.2). The number of patients with prior transplants has declined since 2007 (Figure 7.3). Reasons for removal from the waiting list in 2009 included transplant (44.9%), improvement in condition (26.5%), and death (14.3%) (Figure 7.4). For children and adolescents who were listed for a lung transplant in 2006, by 3 years after listing, 62.5% had undergone transplant, 15.6% had died, 12.5% had been removed from the list, and 9.4% were still awaiting a transplant (Figure 7.5).

The median waiting time for children and adolescents fell from 48.5 months in 1998–1999 to 11.7 months in 2008–2009 (Figure 7.6). Death rates on the waiting list have decreased since 1998 (Figure 7.7). Overall, the number of lung transplants (including heart-lung) has decreased from a total of 42 in 1998 to 20 in 2009 (Figure 7.8). While the number of wait-listed patients aged

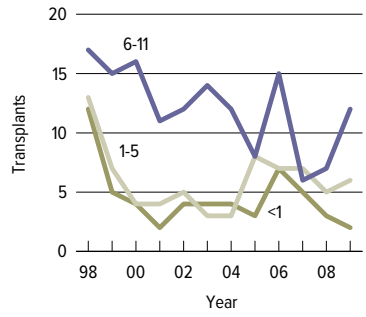
LU 7.6 Median months to lung transplant for wait-listed pediatric patients



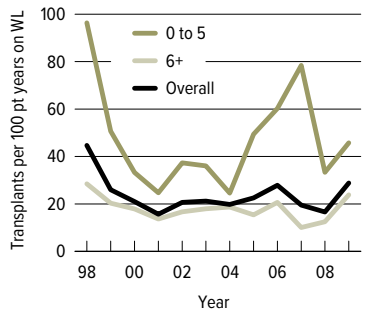
LU 7.7 Pre-transplant mortality rates among pediatric pts wait-listed for a lung transplant



LU 7.8 Pediatric lung transplants (including heart-lung), by age



LU 7.9 Pediatric lung transplant rates, by age

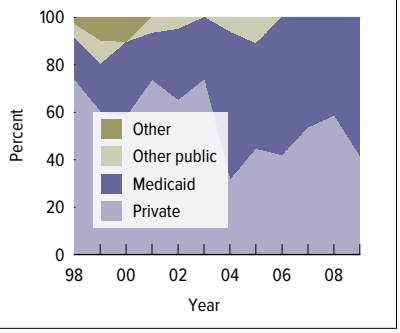


younger than 1 year is on the rise, the number of transplants for these patients is falling. In 2009, the overall pediatric lung transplant rate was 28.9 per 100 patient-years on the waiting list (Figure 7.9). Among pediatric lung transplant recipients in 2007–2009, 47.7% were aged 6 to 11 years, 31.8% were aged 1 to 5 years, and 20.5% were aged younger than 1 year (Figure 7.10); 63.6% were white, 15.9% Hispanic, 13.6% black, and 4.5% Asian. Cystic fibrosis was the primary diagnosis in 20.5% of recipients, followed by idiopathic pulmonary hypertension and obliterative bronchiolitis, each at 13.6%. Almost 60% of patients spent less than 3 months on the waiting list. Forty-one percent were hospitalized in the intensive care unit before transplant.

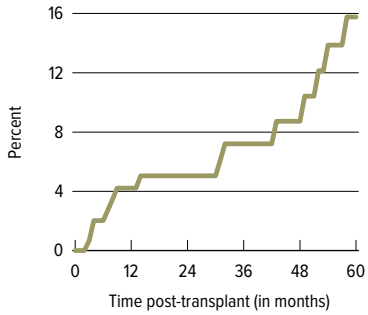
LU 7.10 Characteristics of pediatric lung transplant recipients, 2007–2009

	Level	N	%
Age	<1	9	20.5
	1-5	14	31.8
	6-11	21	47.7
Sex	Female	25	56.8
	Male	19	43.2
Race	White	28	63.6
	Black	6	13.6
	Hispanic	7	15.9
	Asian	2	4.5
	Other/unk.	1	2.3
Primary diagnosis	Cystic fibrosis	9	20.5
	Primary pulmonary HTN	6	13.6
	Obliterative bronchiolitis	6	13.6
	Surfactant B deficiency	4	9.1
	All others	19	43.2
Transplant number	First	42	95.5
	Subsequent	2	4.5
Blood type	A	15	34.1
	B	7	15.9
	AB	6	13.6
	O	16	36.4
Time on waiting list	<1 month	9	20.5
	1 -<3 months	17	38.6
	3 -<6 months	6	13.6
	6 -<12 months	10	22.7
	1 - <2 years	1	2.3
	2+ years	1	2.3
Pre-transplant medical condition	Hospitalized: ICU	18	40.9
	Hospitalized: not ICU	9	20.5
	Not hospitalized	17	38.6
Pt on vent. imm.ly pre-tx	No	25	56.8
	Yes	19	43.2
Procedure type	Bilateral sequential	40	90.9
	Bilateral en-block	4	9.1
Donor type	Deceased	44	100.0
Primary payer	Private	22	50.0
	Medicaid	22	50.0
All patients	--	44	100.0

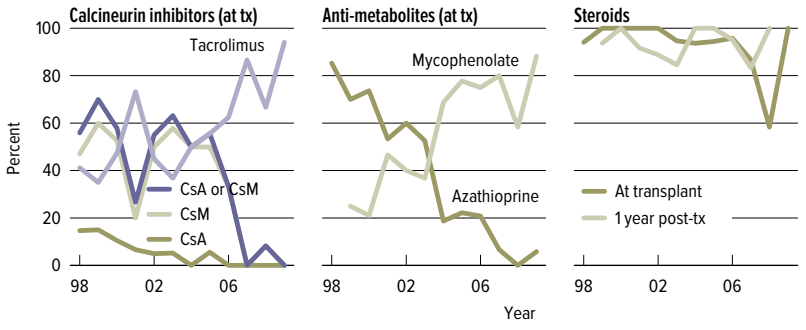
LU 7.11 Insurance coverage among pediatric lung transplant recipients at time of transplant



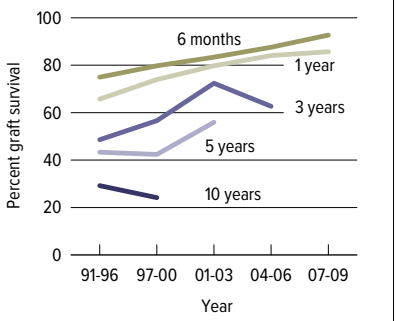
LU 7.12 Pediatric lung transplant recipients with reported PTLD, 2000–2009



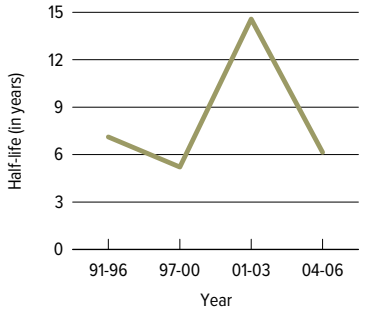
LU 7.13 Immunosuppression use among pediatric lung transplant recipients



LU 7.14 Graft failure among pediatric lung transplant recipients



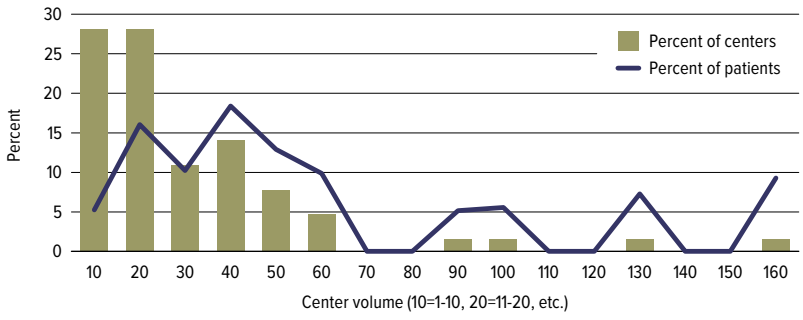
LU 7.15 Half-lives among pediatric lung transplant recipients surviving at least one year



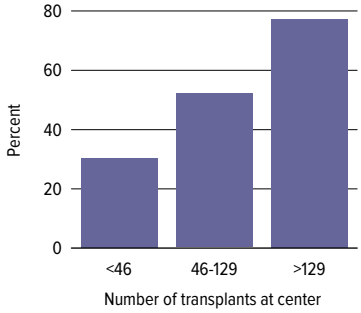
pediatric transplant

Among children and adolescents undergoing transplants in 2009, Medicaid covered payment for nearly 60% (Figure 7.11). For those undergoing transplants in 2000–2009, the incidence of post-transplant lymphoproliferative disorder (PTLD) was 2.0% at 6 months, 4.2% at 1 year, 5.0% at 2 years, 7.2% at 3 years, 8.7% at 4 years, and 15.8% at 5 years (Figure 7.12). There have been notable changes in the immunosuppression used in pediatric lung transplant recipients. The trends in pediatric lung transplant immunosuppression are similar to those seen in adult post-transplant immunosuppression. Tacrolimus is increasingly used and is now the dominant calcineurin inhibitor. Likewise, the use of mycophenolate has increased, and it is now the primary anti-metabolite. In 2009, 94.1% of patients received tacrolimus as part of the initial maintenance immunosuppressive medication regimen, 88.2% received mycophenolate, and 100% received steroids (Figure 7.13). Graft survival has continued to improve over the past decade. Graft survival for transplants performed in 2007–2009 was 92.8% at 6 months and 85.7% at 1 year; for transplants in 2004–2006, 62.7% at 3 years; for transplants in 2001–2003, 56.0% at 5 years; and for transplants in 1997–2000, 24.1% at 10 years (Figure 7.14).

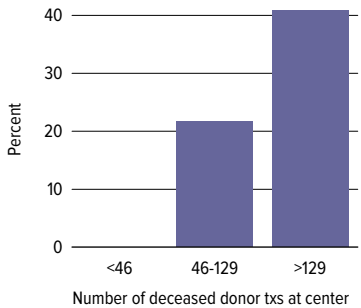
LU 8.1 **Distribution by center volume of the number of lung transplants performed (includes heart-lung), 2009**



LU 8.2 **Lung programs performing multi-organ transplants, by volume, 2005–2009**



LU 8.3 **Centers transplanting DCD lungs, by volume, 2005–2009**

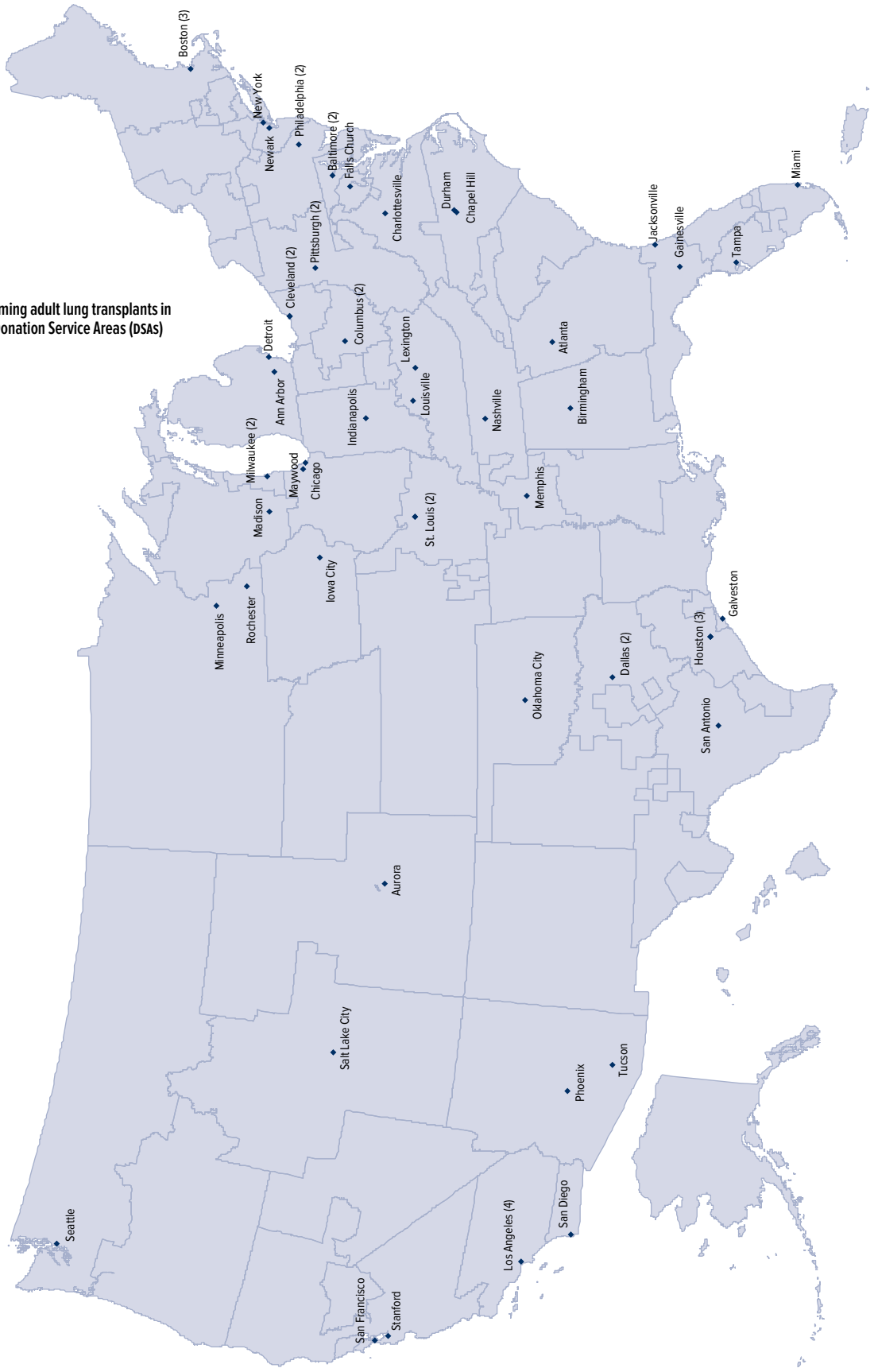


center characteristics

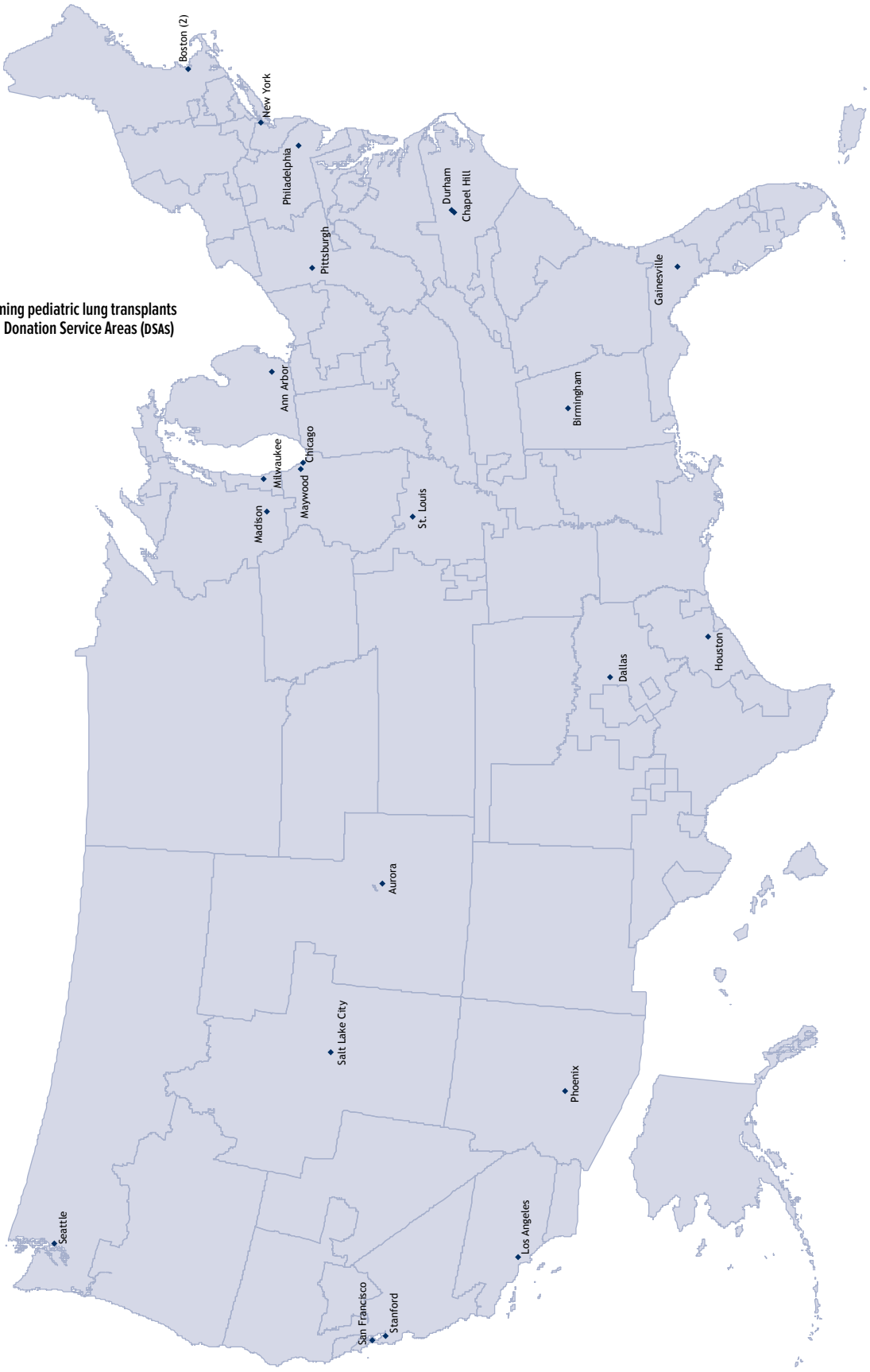
Most lung transplant centers in the US are relatively low-volume, performing 20 or fewer transplants per year, while a small number of high volume centers perform 100 or more transplants per year (Figure 8.1). Many small centers offer lung-only transplants, which results in sicker, multi-organ transplant patients being sent to higher-volume transplant programs for the more complex procedures. Multi-organ transplants were performed at 30.4% of lung transplant programs in the bottom tertile of volume, those that performed 45 or fewer transplants from 2005–2009. In contrast, 77.3% of lung transplant centers in the top tertile of volume, those performing more than 129 transplants from 2005–2009, did multi-organ transplants (Figure 8.2). It is unclear whether this practice has effects on post-transplant outcomes.

There is a trend among higher-volume centers (those with more than 46 transplants 2005–2009) to transplant DCD lungs (Figure 8.3). We will follow this trend to determine the effects on organ availability and patient survival.

LU 9.1 **Centers performing adult lung transplants in 2009, within Donation Service Areas (DSAs)**



LU9.2 **Centers performing pediatric lung transplants in 2009, within Donation Service Areas (DSAs)**



LU 9.3 **Centers performing adult lung transplants in 2009, within OPTN regions**