

OPTN/SRTR 2014 ANNUAL DATA REPORT

HEART

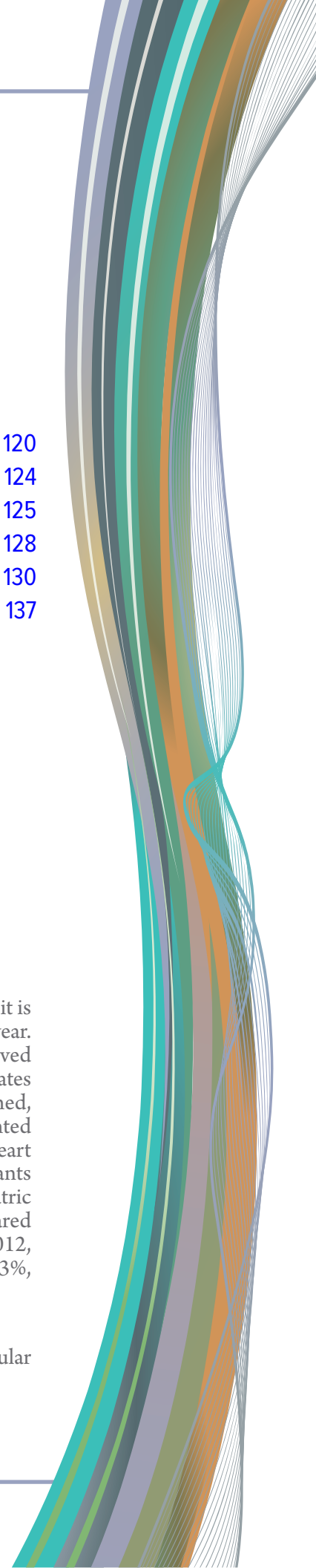
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ABSTRACT As the number of candidates listed for heart transplant continues to rise, it is encouraging that the number of heart transplants also continues to rise steadily each year. Evaluation of waitlist activity demonstrates a growing number of adult candidates removed from the list due to undergoing transplant, but also growing numbers of adult candidates added to the list over the past 3 years. In 2014, 2679 heart transplants were performed, an increase of 28.4% since 2003, and the number of people living with a transplanted heart continued to increase. The number of new pediatric candidates added to the heart transplant waiting list increased to 593 in 2014. The number of pediatric heart transplants performed each year increased from 293 in 2003 to 410 in 2014. Almost 60% of pediatric candidates waiting on December 31, 2014, had been waiting for less than 1 year, compared with 43.0% in 2004. Among pediatric patients who underwent transplant in 2008-2012, overall cumulative incidence of death at 1, 3, and 5 years was 9.2%, 14.7%, and 18.3%, respectively.

KEY WORDS End-stage heart failure, heart transplant, transplant outcomes, ventricular assist device.



Introduction

Heart transplant remains the definitive therapy for selected patients with advanced heart failure. Ventricular assist devices (VADs) provide an alternative for patients who do not qualify for transplant, and a safe bridge to transplant for patients for whom medical therapy is not sufficient. Since the first implantable left VAD (LVAD) was approved as a bridge to transplant, the number of recipients with LVADs at transplant has markedly increased. While VADs have been effective in stabilizing patients on the waiting list, they have added new complexity to heart allocation policies. Risk stratification among candidates awaiting heart transplant remains a major concern in allocation policy. The number of candidates listed for heart transplant continues to rise, and it is encouraging that the number of heart transplants also continues to rise steadily each year.

Adult Heart Transplant

Waitlist Trends: New Listings, Time to Transplant, and Waitlist Mortality

The number of candidates awaiting heart transplant has increased ([Figure HR 1.1](#)). The number of new active candidates increased by 50.7% between 2004 and 2014. Despite fluctuation in the number of candidates on the list during this time, growth has been steady since 2011. The most notable waitlist trends include the following: the proportion of candidates aged 65 years or older increased from 11.1% in 2004 to 18.1% in 2014 ([Figure HR 1.2](#)); proportions of ethnic minorities continue to increase; black candidates made up 23.9% of heart transplant candidates in 2014 compared with 15.4% in 2004, and the proportion of Asian candidates rose slightly. Cardiomyopathy has clearly replaced coronary artery disease as the major reason for listing for heart transplant, and was indicated as the primary cause of disease for 55.8% of heart transplant candidates. The majority of candidates, 61.9%, waited less than 1 year on the heart transplant waiting list. Twenty-eight percent of waitlist candidates had a VAD at the time of listing. The prevalence of Status 1A candidates increased remarkably over the past decade. Status 1A accounted for 45.3% of candidates in 2014, while the proportion of Status 2 candidates declined by half. The proportion of Status 1B candidates remained stable at 27.8%.

In general, heart transplant rates ([Figure HR 1.3](#)) peaked in 2006 and 2007. A similar peak with a steady decline until

2014 appeared to occur for all subgroups; however, within subgroups, there were notable differences. Candidates aged 35-49 years underwent transplant at a much lower rate, 68.2 per 100 waitlist years, than candidates in the other age groups. The transplant rate among candidates with blood type AB far exceeded rates for candidates with other blood types: 262.4 per 100 waitlist years compared with 101.9 for candidates with blood type A, 110.4 for candidates with blood type B, and only 57.1 for candidates with blood type O. As expected, the heart transplant rate was highest among Status 1A candidates, 400.8 per 100 waitlist years; however, the rate was only 43.8 per 100 waitlist years for Status 1B candidates, the second highest urgency category. Geographic variability in access to donor hearts was marked, and partially reflected by time to transplant. On average, 51.1% of candidates listed in 2013 underwent transplant in less than 1 year; however, the proportion of candidates undergoing transplant within this time frame varied from 21% to 100% depending on the donation service area ([Figure HR 1.4](#)). Among donation service areas with more than 10 candidates, the proportion of candidates undergoing transplant in less than 1 year ranged from 21.1% to 87.7%.

Evaluation of waitlist activity demonstrates a growing number of candidates removed from the list due to undergoing transplant, but also growing numbers of candidates added to the list over the past 3 years. Of candidates removed from the list over the past 3 years, approximately 70% were removed due to undergoing transplant and approximately 11% were removed due to death ([Table HR 1.2](#)). A smaller proportion of patients were removed due to being too sick to undergo transplant. Of candidates listed in 2011, 55.9% underwent transplant during the first year on the waiting list, 30.2% were still waiting, and 7.2% had died ([Figure HR 1.5](#)). At 3 years, 9.2% had died, 12.6% had been removed from the list, 68.6% had undergone transplant, and 9.5% were still waiting.

The median time to heart transplant increased from 6.7 months in 2003-2004 to 10.9 months in 2013-2014 ([Figure HR 1.6](#)). In 2013-2014, candidates with blood type O waited 20.1 months, almost 3 times as long as candidates with other blood types, and similar to the waiting time for candidates listed as Status 2, 20.7 months. Women, candidates with blood type AB, and candidates listed as Status 1A tended to have shorter waiting times. Median time to transplant did not change dramatically for Status 1A candidates, 3.6 months in 2013-2014, but increased for Status 1B candidates to 9.9 months.

Pretransplant mortality declined to 10.7 per 100 waitlist years in 2013-2014, though some groups experienced increases in the most recent era, most notably candidates with valvular disease, to 19.9 per 100 waitlist years, and candidates who were inactive on the waiting list (Figure HR 1.7). The pretransplant mortality rate was lowest for candidates aged 18 to 34 years, 6.4 per 100 waitlist years. The rate declined dramatically for candidates with VADs at the time of listing, from 68.4 per 100 waitlist years in 2003-2004 to 9.9 in 2013-2014, and was similar to the rate for candidates without VADs at listing. This should be interpreted cautiously, however, since candidates who did not have a VAD at listing may have received a VAD after listing. In 2013-2014, pretransplant mortality also declined substantially among Status 1A and 1B candidates to 17.1 per 100 waitlist years for Status 1A and 5.2 for Status 1B. After 2005-2006, there was a large decline in pretransplant mortality among Status 1A candidates, likely reflecting the broader sharing policy implemented in 2006.

Donor Trends

Overall, the deceased heart donor rate was 2.7 per 1000 deaths, but it varied by state, ranging from 1.1 to 5.0 per 1000 deaths (Figure HR 2.2). Forty-seven percent of donors were aged 18 to 34 years (Figure HR 2.1). Rates of hearts recovered for transplant but not transplanted reached a nadir in 2009-2010 and have trended up since (Figure HR 2.3). In 2013-2014, 1.0% of recovered hearts were not transplanted. Head trauma remained the most common cause of death among heart donors, though 2014 was the first year in which deaths due to head trauma represented less than half of all heart donors. Donor deaths due to head trauma declined and deaths due to anoxia increased. In 2014, anoxia was responsible for 29.4% of heart donor deaths (Figure HR 2.4).

Trends in Heart Transplant

In 2014, 2679 heart transplants were performed, an increase of 28.4% since 2003 (Figure HR 3.1). Recipients aged 50 to 64 years made up the greatest proportion of heart transplant recipients. Heart transplants increased in all age groups except 35 to 49 years. In adult recipients, use of life support at the time of transplant increased from 59.4% in 2009 to 64.3% in 2014, driven by the increase in LVAD support (Table HR 3.1). In 2014, 44.9% of recipients ($n = 1018$) had an LVAD at the time of transplant, compared with 33.6% of recipients ($n = 631$) in 2009. Presence of right ventricular assist devices at

the time of transplant declined to only 56 recipients in 2014. In 2014, less than 5% of recipients underwent transplant while on a ventilator, total artificial heart, or extracorporeal membrane oxygenation.

Recipient Characteristics

In 2014, 20.4% of heart recipients were aged 65 years or older, compared with 10.3% in 2004 (Table HR 3.2). The typical recipient was white, male, with blood type A or O. Private payers covered 48.5% of recipients and Medicare/Medicaid 46.8%. Although a waiting time to transplant of less than 31 days was most common (22.9% of candidates in 2014), waiting times between 3 months and 2 years became more prevalent in 2014 compared with 2004. Almost half of heart transplant recipients had a VAD at the time of transplant in 2014, compared with 23.7% a decade earlier. Dual-organ transplants remained uncommon, although heart-kidney and heart-liver transplants increased since 2004. Heart-lung transplant decreased to less than 1% of heart transplants.

Posttransplant Survival and Morbidity

One-year survival for patients who underwent heart transplant from 2007 through 2009 was 88.8%, 3-year survival was 82.1%, and 5-year survival 75.9% (Figure HR 4.1). One-year survival among the subgroups was similar to overall survival but tended to be lower among recipients who were aged 65 years or older, black, or Status 2 at transplant, or who had VADs or intra-aortic balloon pumps at the time of transplant. After the first year posttransplant, however, survival declined more rapidly for recipients aged 18 to 34 years and for black recipients. By 5 years, survival was only 67.4% for recipients age 18 to 34 years and 70.1% for black recipients (Figure HR 4.1). Survival did not differ meaningfully between the medical urgency categories at any time, but tended to be lower for Status 2 recipients. The number of heart transplant survivors continued to increase. On June 30, 2014, 28,110 heart transplant recipients were alive with a functioning graft; most had undergone transplant at age 50 years or older (Figure HR 4.2).

Rejection remained prevalent after heart transplant; overall, the incidence of acute rejection in the first posttransplant year was 23.5% in 2012-2013 (Figure HR 4.3). Although the trend has been stable, rejection declined among recipients aged 65 years or older between 2008-2009 and 2012-2013 to only 19.0%. Rejection remained most prevalent in recipients aged 18 to 34 years. Posttransplant

lymphoproliferative disorder (PTLD) remained uncommon, with a cumulative incidence of only 0.9% by 5 years posttransplant (Figure HR 4.4). Posttransplant survival continued to improve. Among recipients in 2013, 7.6% died within the first 6 months and 9.4% within the first year. Among recipients in 2011, 15.2% died within 3 years; 23.2% of recipients in 2009 died within 5 years and 42.3% of recipients in 2004 died within 10 years (Figure HR 4.5). The leading causes of death in the first year posttransplant were infection, cardiovascular/cerebrovascular disease, and graft failure. By the second year, cardiovascular/cerebrovascular disease was most common (Figure HR 4.6). Though cumulative exposure to immunosuppression and associated risk of malignancy remain a concern in the transplant community, death due to malignancy remained infrequent. By year 5, 1.6% of recipients had died from malignancy (Figure HR 4.6).

Pediatric Heart Transplant

Pediatric Waitlist Trends

In 2014, the number of new pediatric candidates added to the heart transplant waiting list increased to 593, with very few added at inactive status. At year-end 2014, 363 candidates listed before their eighteenth birthdays were awaiting heart transplant, with 68.6% active (Figure HR 5.1). The largest pediatric age group on the waiting list in 2014 was aged 11 to 17 years (32.4%), followed by ages younger than 1 year (28.6%), 1 to 5 years (24.3%), and 6 to 10 years (14.8%) (Figure HR 5.2). Almost 55% of heart transplant candidates were white, 21.1% were Hispanic, 19.2% were black, and 3.8% were Asian. The proportion of waitlist candidates aged 1 to 5 years increased from 24.7% on December 31, 2004, to 30.3% on December 31, 2014 (Table HR 5.1). The proportion of male candidates remained high, 63.9% in 2014. The proportion of Hispanic candidates increased from 14.6% on December 31, 2004, to 24.2% on December 31, 2014. For candidates waiting on December 31, 2014, congenital defect was the leading cause of heart disease (49.3%). The proportion of candidates with idiopathic cardiomyopathy decreased over time, from 25.6% in 2004 to 15.2% in 2014. Almost 60% of candidates (59.5%) waiting for a heart transplant on December 31, 2014, had been waiting for less than 1 year, compared with 43.0% in 2004. Thirty percent of candidates were listed as Status 1A in 2014, compared with only 12.3% in 2004. Increases in Status 1B listings were similar, 16.8% in 2014 compared with 5.7% in

2004. The percentage of candidates using VADs at the time of listing increased from 1.6% in 2004 to 4.4% in 2014. Listings for heart-lung transplant decreased from 11.7% in 2004 to only 1.9% in 2014. Among candidates removed from the waiting list in 2014, 73.1% were removed due to undergoing transplant, 13.1% died, 7.4% were removed due to improved condition, and 5.0% were considered too sick to undergo transplant (Table HR 5.2).

Just over 70% of patients newly listed in 2011 underwent transplant within 3 years, 10.6% died, 13.2% were removed from the list, and 4.6% were still waiting (Figure HR 5.3). The rate of heart transplants among active pediatric waitlist candidates decreased from a peak of almost 300 per 100 waitlist years in 2006 to 170 per 100 waitlist years in 2014, likely attributable to a growing waiting list. Transplant rates varied by age, with the highest rates for candidates aged less than 1 year, at 289 transplants per 100 waitlist years, followed by candidates aged 11 to 17 years, at 178 transplants per 100 waitlist years (Figure HR 5.4). Pretransplant mortality continued to decrease, to 18.6 deaths per 100 waitlist years in 2013-2014 (Figure HR 5.5). The pretransplant mortality rate was highest for candidates aged younger than 1 year, at 44.9 deaths per 100 waitlist years in 2013-2014, approximately 3 times higher than the rate for candidates aged 1 to 5 years. Regarding cause of disease, pretransplant mortality was highest for candidates with congenital defects or dilated myopathy/myocarditis. Pretransplant mortality among candidates with a VAD at the time of listing declined over time, from 48.7 deaths per 100 waitlist years in 2005-2006 to 29.5 in 2013-2014. Pretransplant mortality was highest for Status 1A candidates, at 27.9 deaths per 100 waitlist years, compared with 2.9 and 2.0 for Status 1B and Status 2 candidates, respectively.

Pediatric Transplant

The number of pediatric heart transplants performed each year increased from 293 in 2003 to 410 in 2014 (Figure HR 5.6). Over the past decade, the age, sex, and race of pediatric heart transplant recipients changed little. Congenital defects remained the most common primary cause of disease, affecting 44.3% of recipients who underwent transplant in 2011-2014. The proportion of recipients undergoing retransplant has remained stable over the decade at 5% to 7%. The proportion of ABO-incompatible transplants in 2011-2014 was 3.8%, increased from 1.2% a decade earlier. The proportion of recipients with private insurance

decreased and the proportion with Medicaid coverage increased from 40.1% to 45.9%. The proportion of patients who underwent transplant as Status 1A increased from 68.3% in 2001-2004 to 88.8% in 2011-2014. VAD use increased from only 8.0% of transplant recipients in 2001-2004 to 24.0% in 2011-2014 ([Table HR 5.3](#)).

Pediatric Immunosuppression and Outcomes

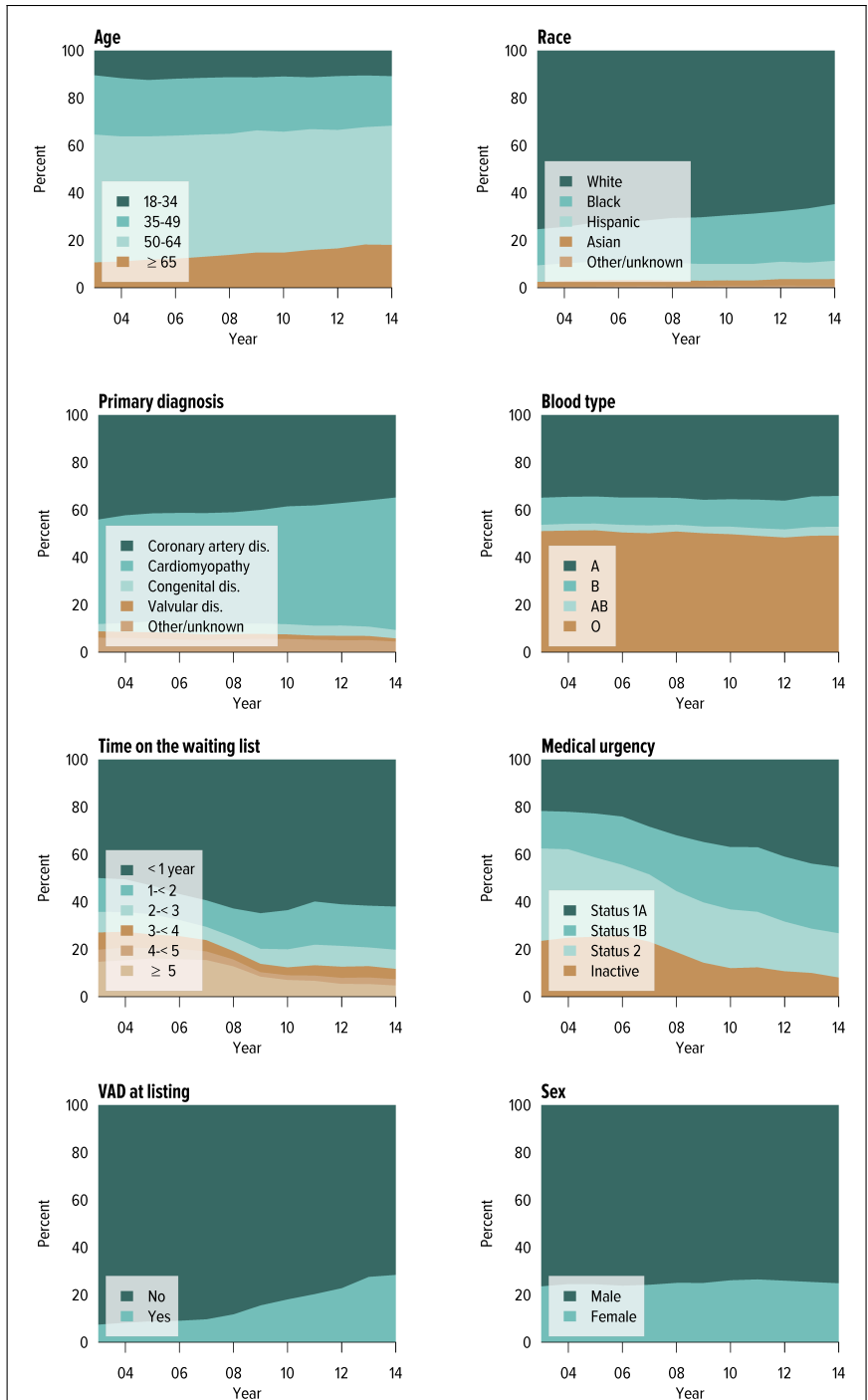
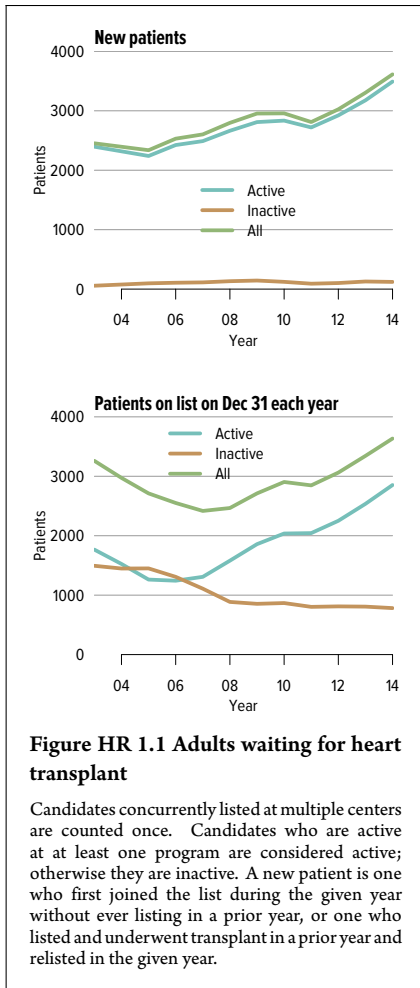
Substantial changes in immunosuppression have occurred in heart transplantation. In 2014, the most common induction therapy was T-cell depleting agents, used in half of heart transplant recipients, followed by interleukin-2 receptor antagonists (IL-2-RA) in 18.7%. No induction therapy was reported in 33.8% of recipients ([Figure HR 5.7](#)). Regarding induction use by PRA, use of T-cell depleting agents increased as PRA increased, with a corresponding decrease in IL-2-RA use and no induction use ([Figure HR 5.8](#)). The initial immunosuppression agents used most commonly in 2014 were tacrolimus (84.8%), mycophenolate (94.5%), and steroids (67.2%). Mammalian target of rapamycin inhibitors were used in only 1.2% of recipients at the time of transplant, but use increased to 7.7% at 1 year posttransplant. Steroid use at 1 year posttransplant was reported in 63.2% of recipients ([Figure HR 5.7](#)).

Among pediatric heart transplant recipients from 2010 to 2014, 57.6% were cytomegalovirus (CMV) negative and

42.5% were Epstein-Barr virus (EBV) negative ([Table HR 5.4](#)). The combination of a CMV-positive donor and CMV-negative recipient occurred in 28.8% of transplants; for EBV, this occurred in 31.1% of transplants.

Recipient death occurred in 5.0% at 6 months and 6.0% at 1 year among heart transplants performed in 2013, 12.2% at 3 years for transplants performed in 2011, 20.8% at 5 years for transplants performed in 2009, and 34.4% at 10 years for transplants performed in 2004 ([Figure HR 5.9](#)). By age, 5-year patient survival was 69.9% for recipients aged younger than 1 year, 77.4% for ages 1 to 5 years, 84.9% for ages 6 to 10 years, and 75.7% for ages 11 to 17 years ([Figure HR 5.10](#)). The incidence of PTLD among EBV-negative recipients was 5.9% at 5 years posttransplant, compared with 2.0% among EBV-positive recipients ([Figure HR 5.11](#)). The overall incidence of first acute rejection in the first posttransplant year decreased from 20.4% of recipients who underwent transplant in 2010-2011 to 17.8% in 2012-2013 ([Figure HR 5.12](#)). By age, the highest incidence of rejection was 25.6% in the group aged 6 to 10 years.

Among patients who underwent transplant in 2008-2012, overall cumulative incidence of death at 1, 3, and 5 years was 9.2%, 14.7%, and 18.3%, respectively ([Figure HR 5.13](#)). The leading identified causes of death were graft failure and cardio/cerebrovascular disease, with almost identical rates at 1 year and 5 years posttransplant ([Figure HR 5.13](#)).



		2004		2014	
		N	%	N	%
Age	18-34	328	11.0	359	9.9
	35-49	702	23.6	824	22.7
	50-64	1,553	52.2	1,773	48.8
	≥65	390	13.1	679	18.7
Sex	Female	717	24.1	829	22.8
	Male	2,256	75.9	2,806	77.2
Race	White	2,214	74.5	2,313	63.6
	Black	448	15.1	930	25.6
	Hispanic	224	7.5	270	7.4
	Asian	70	2.4	98	2.7
	Other/unknown	17	0.6	24	0.7
Citizenship	US citizen	2,933	98.7	3,508	96.5
	Non-citizen resident	27	0.9	12	0.3
	Non-citizen non-resident	9	0.3	6	0.2
	Other/unknown	4	0.1	109	3.0
Primary diagnosis	Coronary artery disease	1,237	41.6	1,234	33.9
	Cardiomyopathy	1,345	45.2	2,072	57.0
	Congenital disease	140	4.7	139	3.8
	Valvular disease	72	2.4	34	0.9
	Other/unknown	179	6.0	156	4.3
Heart transplant history	First transplant	2,889	97.2	3,525	97.0
	Retransplant	84	2.8	110	3.0
Blood type	A	924	31.1	1,132	31.1
	B	295	9.9	420	11.6
	AB	51	1.7	92	2.5
	O	1,703	57.3	1,991	54.8
Waiting time	< 1 year	1,028	34.6	1,942	53.4
	1-< 2 years	486	16.3	786	21.6
	2-< 3 years	329	11.1	360	9.9
	3-< 4 years	246	8.3	204	5.6
	4-< 5 years	224	7.5	119	3.3
	≥ 5 years	660	22.2	224	6.2
Medical urgency	1A	60	2.0	379	10.4
	1B	328	11.0	1,574	43.3
	2	1,137	38.2	900	24.8
	Inactive	1,448	48.7	782	21.5
VAD at listing		147	4.9	1,054	29.0
Multi-organ	Heart only	2,775	93.3	3,403	93.6
	Heart-kidney	54	1.8	165	4.5
	Heart-lung	135	4.5	39	1.1
	Other	9	0.3	28	0.8
All candidates		2,973	100.0	3,635	100.0

Table HR 1.1 Characteristics of adults on the heart transplant waiting list on December 31, 2004 and December 31, 2014

Candidates waiting for transplant on December 31, 2004, and December 31, 2014, regardless of first listing date; active/inactive status is on this date, and multiple listings are not counted. VAD, ventricular assist device.

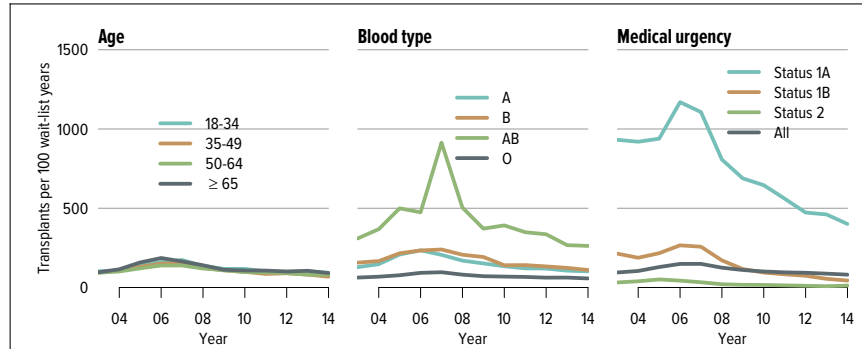


Figure HR 1.3 Heart transplant rates among active adult waitlist candidates

Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active waiting in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. Rates by medical urgency are computed in a time-dependent manner.

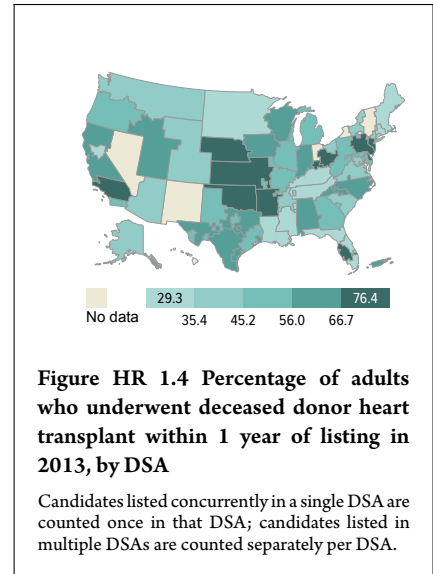


Figure HR 1.4 Percentage of adults who underwent deceased donor heart transplant within 1 year of listing in 2013, by DSA

Candidates listed concurrently in a single DSA are counted once in that DSA; candidates listed in multiple DSAs are counted separately per DSA.

	2012	2013	2014
Patients at start of year	2,843	3,057	3,339
Patients added during year	3,025	3,304	3,613
Patients removed during year	2,806	3,018	3,317
Patients at end of year	3,062	3,343	3,635
Removal reason			
Deceased donor transplant	2,000	2,114	2,236
Patient died	312	340	368
Patient refused transplant	21	14	22
Improved, transplant not needed	145	146	202
Too sick for transplant	191	223	269
Other	137	181	220

Table HR 1.2 Heart transplant waitlist activity among adults

Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. Candidates who are listed, undergo transplant, and are re-listed are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multi-organ transplants are included.

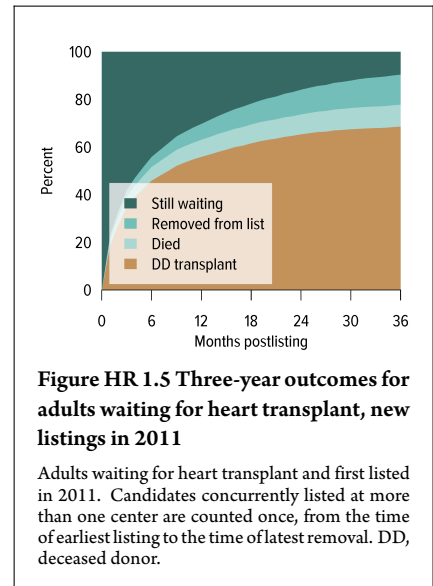


Figure HR 1.5 Three-year outcomes for adults waiting for heart transplant, new listings in 2011

Adults waiting for heart transplant and first listed in 2011. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. DD, deceased donor.

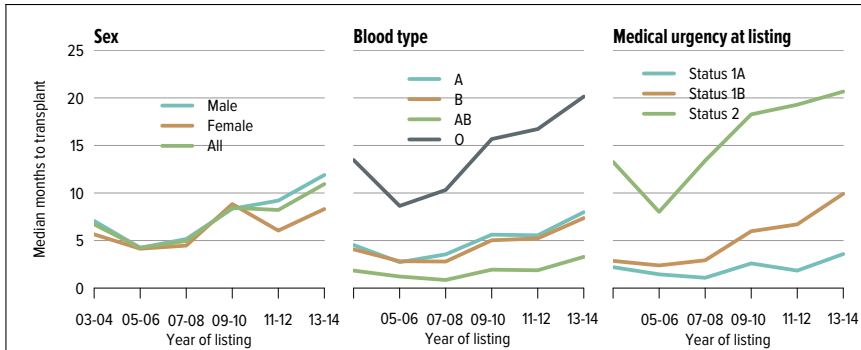


Figure HR 1.6 Median months to heart transplant for waitlisted adults

Observations censored on December 31, 2014. Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per candidate, not per listing. Only the first transplant is counted. VAD, ventricular assist device.

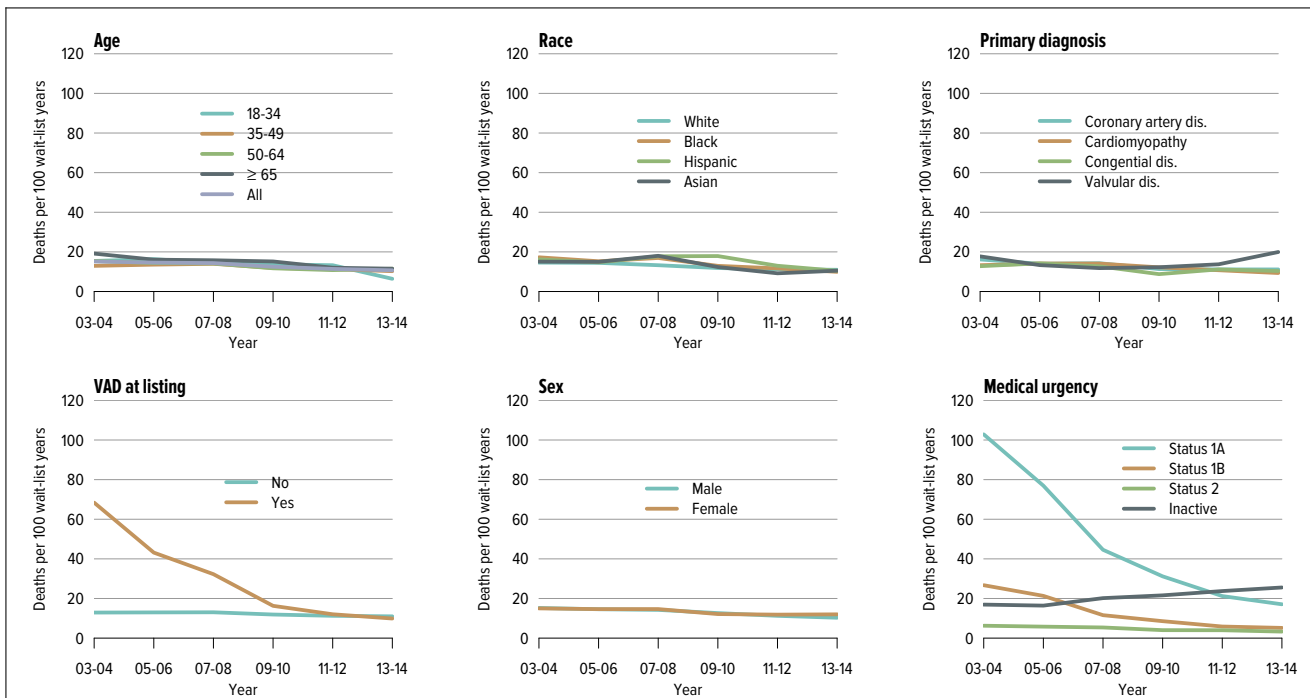
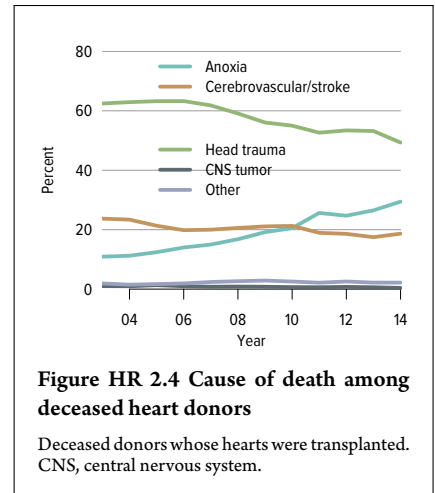
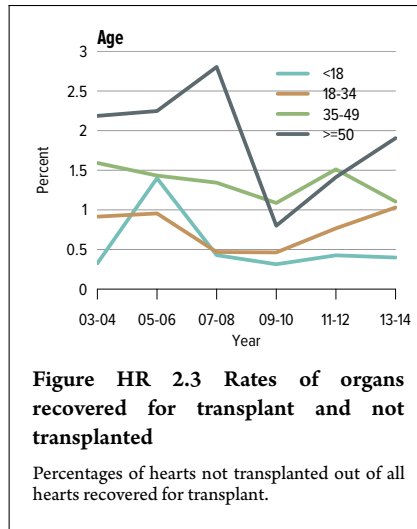
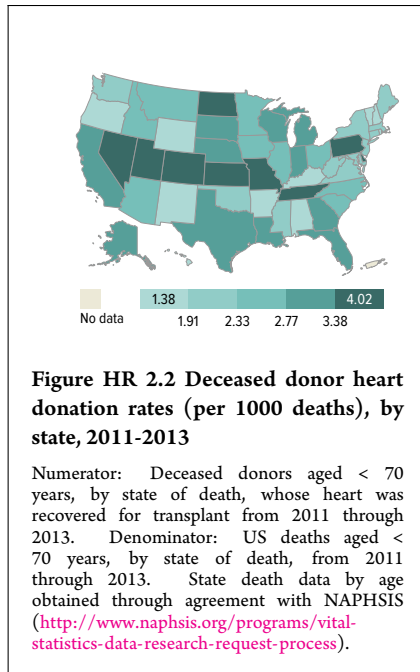
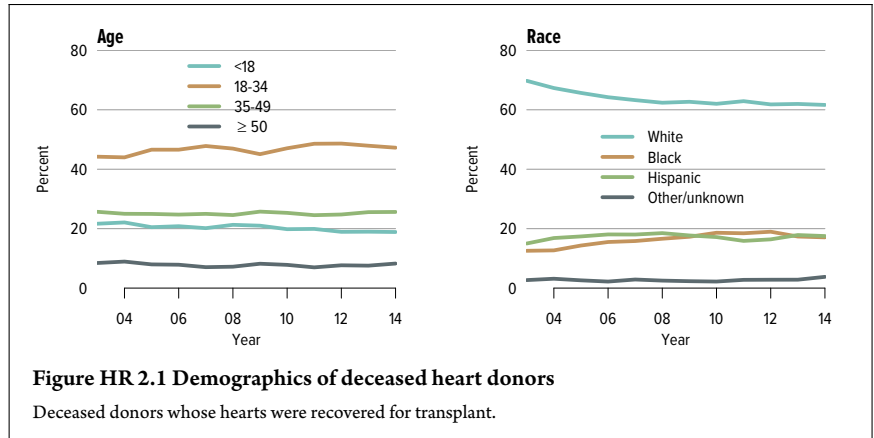


Figure HR 1.7 Pretransplant mortality rates among adults waitlisted for heart transplant

Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. Age is determined at the later of listing date or January 1 of the given year. Rates by medical urgency status are computed in a time-dependent manner. VAD, ventricular assist device.



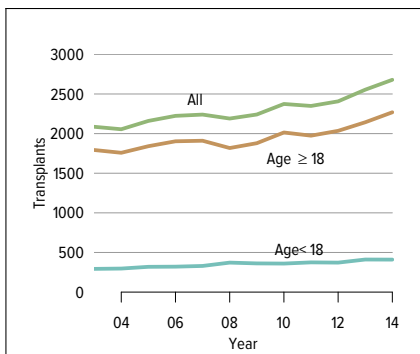


Figure HR 3.1 Total heart transplants

All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

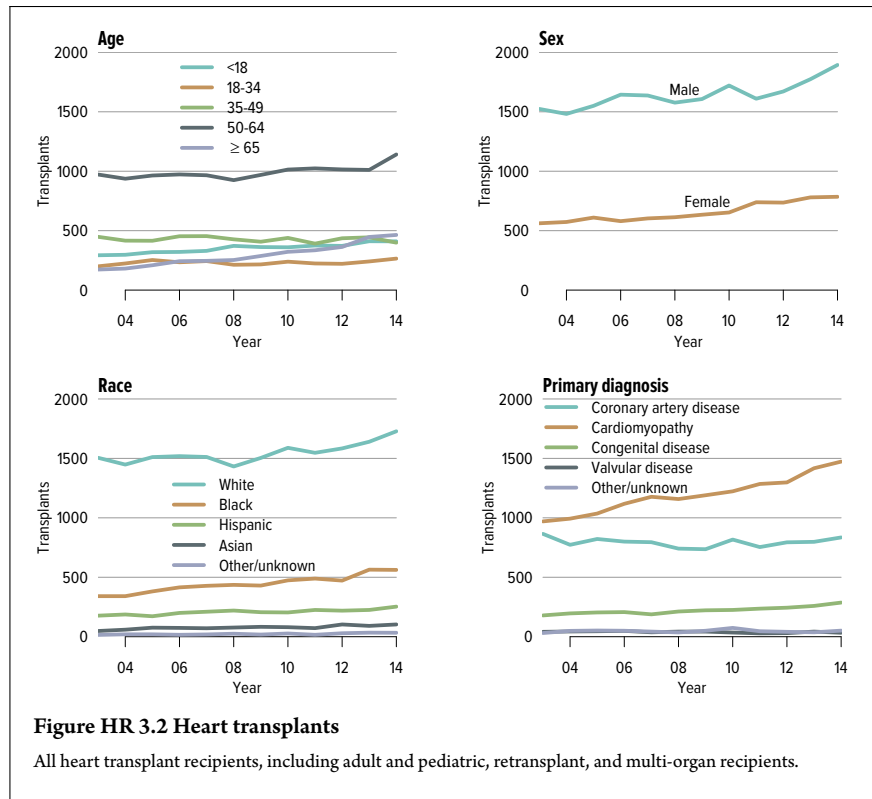


Figure HR 3.2 Heart transplants

All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

Support	2009		2014	
	N	%	N	%
Any life support	1,117	59.4	1,460	64.3
Intravenous inotropes	784	41.7	706	31.1
Left ventricular assist device	631	33.6	1,018	44.9
Intra-aortic balloon pump	76	4.0	126	5.6
Right ventricular assist device	70	3.7	56	2.5
Ventilator	64	3.4	23	1.0
Total artificial heart	21	1.1	34	1.5
Extra corporeal membrane oxygenation	18	1.0	28	1.2
Inhaled NO	7	0.4	1	0.0
Prostaglandins	0	0.0	10	0.4

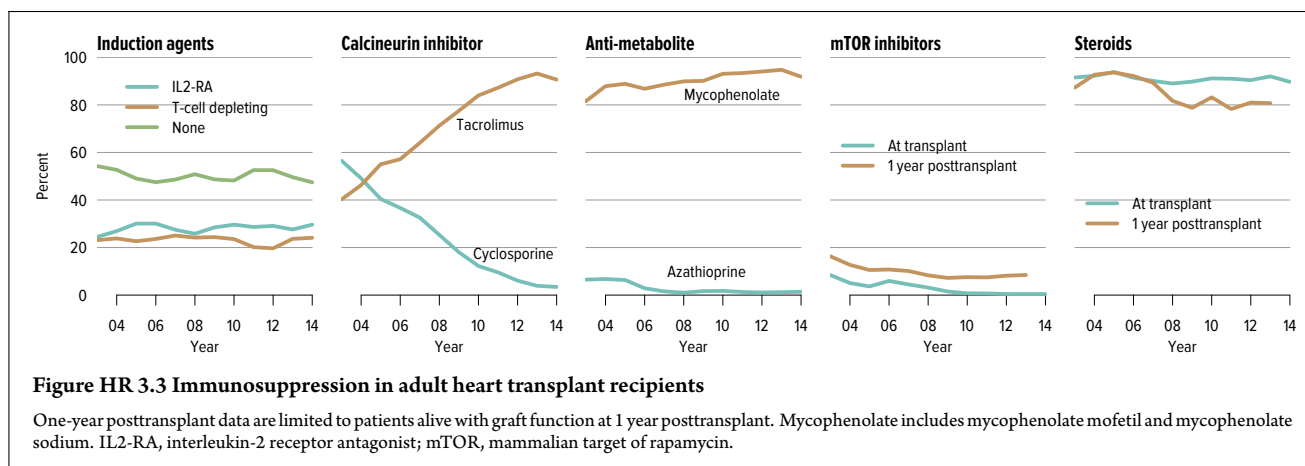
Table HR 3.1 Adult heart recipients on circulatory support before transplant

Patients may have more than one type of circulatory support.

		2004		2014	
		N	%	N	%
Age	18-34	224	12.7	265	11.7
	35-49	416	23.7	399	17.6
	50-64	937	53.3	1,141	50.3
	≥65	181	10.3	464	20.4
Sex	Female	441	25.1	599	26.4
	Male	1,317	74.9	1,670	73.6
Race	White	1,299	73.9	1,505	66.3
	Black	264	15.0	482	21.2
	Hispanic	136	7.7	175	7.7
	Asian	46	2.6	86	3.8
	Other/unknown	13	0.7	21	0.9
Primary diagnosis	Coronary artery disease	770	43.8	832	36.7
	Cardiomyopathy	838	47.7	1,265	55.8
	Congenital disease	63	3.6	96	4.2
	Valvular disease	44	2.5	33	1.5
	Other/unknown	43	2.4	43	1.9
Heart transplant history	First transplant	1,703	96.9	2,193	96.7
	Retransplant	55	3.1	76	3.3
Blood type	A	711	40.4	902	39.8
	B	262	14.9	340	15.0
	AB	89	5.1	136	6.0
	O	696	39.6	891	39.3
Insurance	Private	990	56.3	1,100	48.5
	Medicare	463	26.3	801	35.3
	Medicaid	241	13.7	260	11.5
	Other government	46	2.6	49	2.2
	Other/unknown	18	1.0	59	2.6
Waiting time	< 31 days	501	28.5	520	22.9
	31-60 days	252	14.3	285	12.6
	61-90 days	172	9.8	167	7.4
	3-< 6 months	287	16.3	415	18.3
	6-< 12 months	252	14.3	422	18.6
	1-< 2 years	172	9.8	295	13.0
	2-< 3 years	54	3.1	88	3.9
	≥ 3 years	68	3.9	77	3.4
Medical urgency	Status 1A	625	35.6	1,500	66.1
	Status 1B	630	35.8	662	29.2
	Status 2	503	28.6	107	4.7
VAD status	No VAD	1,341	76.3	1,171	51.6
	VAD	417	23.7	1,098	48.4
Multi-organ transplant	Heart only	1,671	95.1	2,130	93.9
	Heart-lung	32	1.8	17	0.7
	Heart-kidney	44	2.5	103	4.5
	Heart-liver	9	0.5	18	0.8
	Other	2	0.1	1	0.0
HLA mismatches	0	2	0.1	4	0.2
	1	14	0.8	11	0.5
	2	54	3.1	58	2.6
	3	168	9.6	206	9.1
	4	421	23.9	572	25.2
	5	540	30.7	740	32.6
	6	310	17.6	451	19.9
	Unknown	249	14.2	227	10.0
PRA	< 1%	1,153	65.6	1,414	62.3
	1-< 20%	294	16.7	368	16.2
	20-< 80%	127	7.2	285	12.6
	80-< 98%	14	0.8	65	2.9
	98-100%	13	0.7	17	0.7
	Unknown	157	8.9	120	5.3
All recipients		1,758	100.0	2,269	100.0

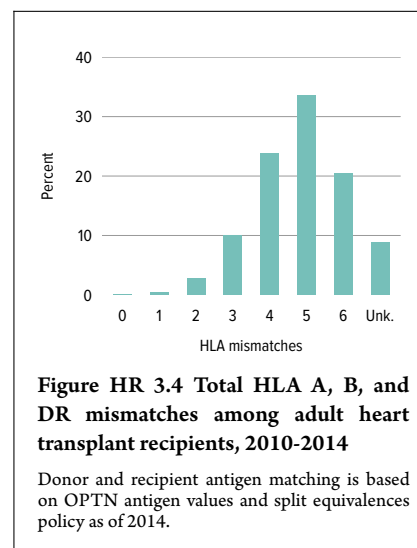
Table HR 3.2 Characteristics of adult heart transplant recipients, 2004 and 2014

Adult heart transplant recipients, including retransplants. Ventricular assist device (VAD) information is from the OPTN Transplant Recipient Registration Form and includes left VAD, right VAD, total artificial heart, and left + right VAD.



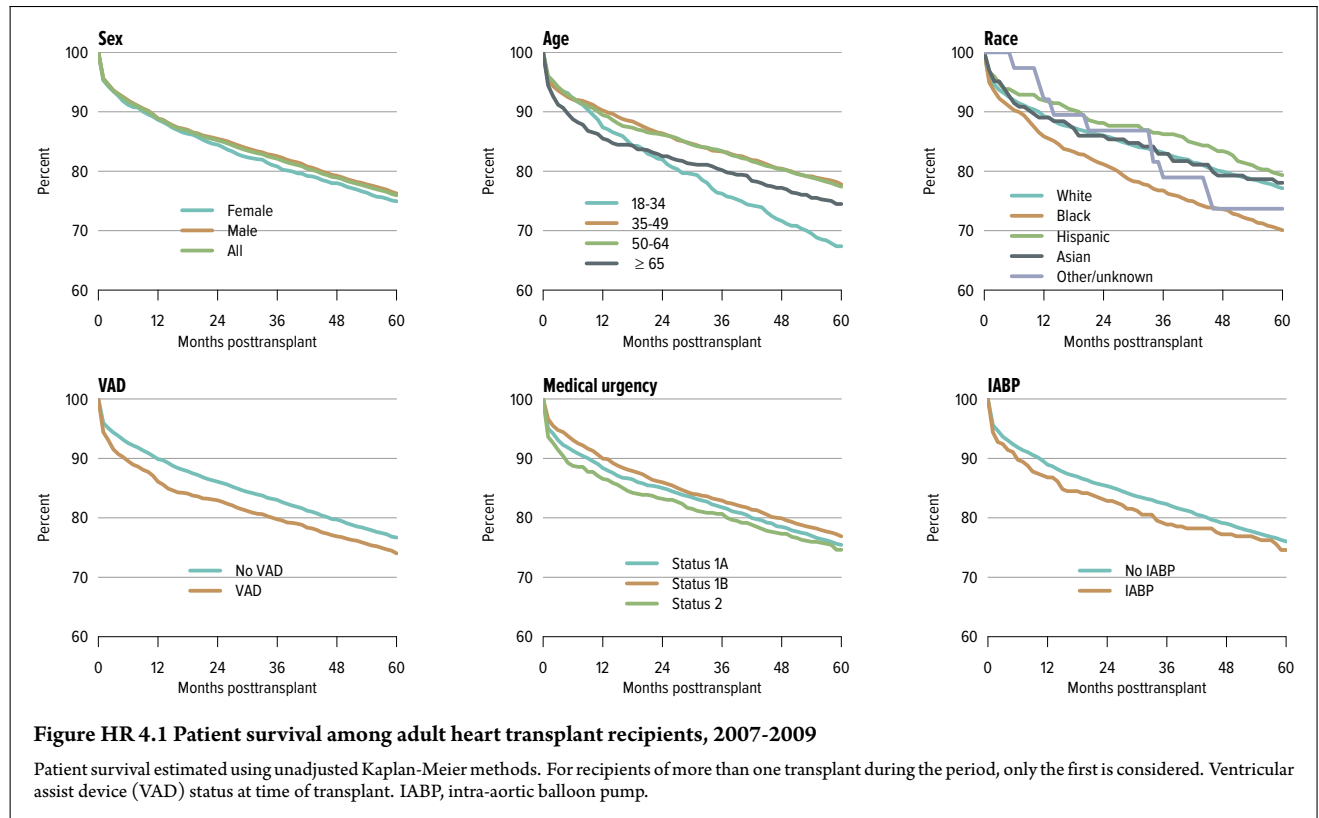
Medication	% in 1st yr posttransplant	Medication	% in 2nd yr posttransplant
Prednisone	58.1	Tacrolimus	38.6
Mycophenolate	55.6	Mycophenolate	37.5
Tacrolimus	49.7	Prednisone	28.7
Sulfamethoxazole-Trimethoprim	49.0	Pravastatin Sodium	27.6
Valganciclovir	41.0	Amoxicillin	19.0
Pravastatin Sodium	36.7	Sulfamethoxazole-Trimethoprim	18.4
Furosemide	30.9	Hydrocodone	17.8
Hydrocodone	27.5	Omeprazole	16.6
Oxycodone	27.0	Amlodipine Besylate	15.8
Nystatin	26.0	Lisinopril	15.4
Amlodipine Besylate	25.4	Magnesium Oxide	15.0
Magnesium Oxide	24.7	Oxycodone	15.0
Omeprazole	24.1	Azithromycin	13.0
Lisinopril	22.6	Furosemide	12.5
Potassium Chloride	22.6	Levothyroxine Sodium	11.6

Table HR 3.3 Top 15 medications filled by adult heart transplant recipients, 2010
 Adult heart transplant recipients, 2010, who were matched to the IMS Health pharmacy claims database and had at least one medication filled during year 1 or year 2 posttransplant. Immunosuppression data may differ from data reported to OPTN due to different patient subsets and data sources.



Donor	Recipient -			Recipient +			Recipient unk.		
	D-	D+	D unk.	D-	D+	D unk.	D-	D+	D unk.
CMV	15.1	23.2	0.1	22.0	36.2	0.2	1.2	2.0	0.0
EBV	0.7	11.3	0.0	3.9	69.7	0.2	0.7	13.4	0.0
HIV	94.6	0.0	0.2	0.2	0	0	5.0	0.0	0.0

Table HR 3.4 Adult heart donor-recipient serology matching, 2010-2014
 Donor serology is reported on the OPTN Donor Registration Form and recipient serology on the OPTN Transplant Recipient Registration Form. Any evidence for a positive serology is treated as positive for that serology. If all fields are unknown, incomplete, or pending, the person is categorized as unknown for that serology; otherwise, serology is assumed negative. CMV, cytomegalovirus; EBV, Epstein-Barr virus.



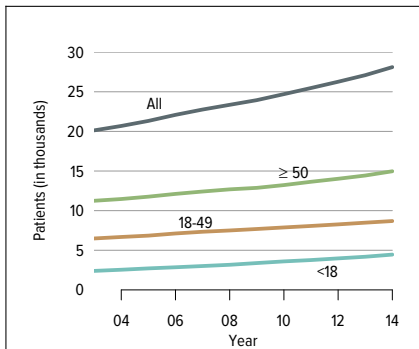


Figure HR 4.2 Recipients alive with a functioning heart graft on June 30 of the year, by age at transplant

Recipients are assumed to be alive with function unless a death or graft failure is recorded. A recipient may experience a graft failure and be removed from the cohort, undergo retransplant, and re-enter the cohort.

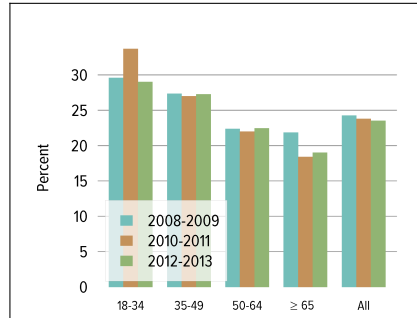


Figure HR 4.3 Incidence of acute rejection in year 1 posttransplant among adult heart transplant recipients, by age

Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method.

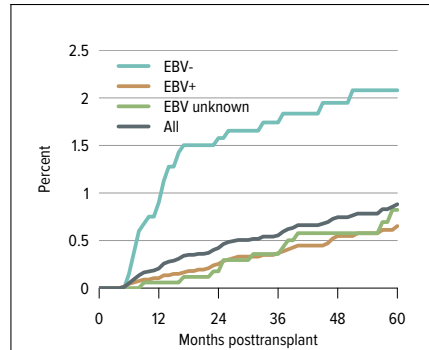


Figure HR 4.4 Incidence of PTLD among adult heart transplant recipients, by recipient EBV status at transplant, 2008-2012

Cumulative incidence is estimated using the Kaplan-Meier competing risk method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.

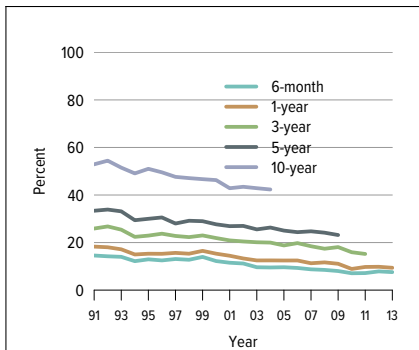


Figure HR 4.5 Patient death among adult heart transplant recipients

All adult recipients of deceased donor hearts, including multi-organ transplants. Patients are followed until the earliest of retransplant, death, or December 31, 2014. Estimates computed with Cox proportional hazards models adjusted for age, sex, and race.

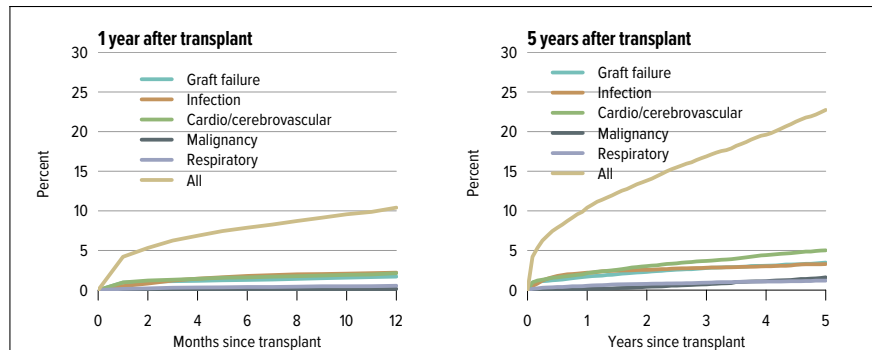


Figure HR 4.6 Cumulative incidence of death by cause among adult heart recipients, 2008-2012

Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

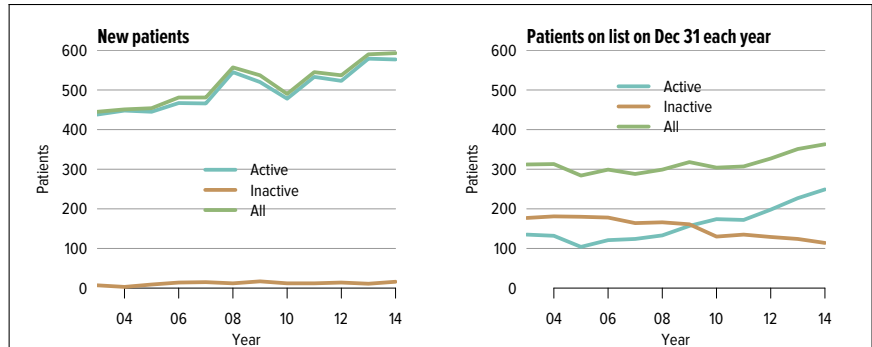


Figure HR 5.1 Pediatric candidates waiting for heart transplant

Candidates concurrently listed at multiple centers are counted once. Candidates who are active at at least one program are considered active; otherwise they are inactive. A new patient is one who first joined the list during the given year without ever listing in a prior year, or one who listed and underwent transplant in a prior year and relisted in the given year. Patients on the list on December 31 were pediatric at listing.

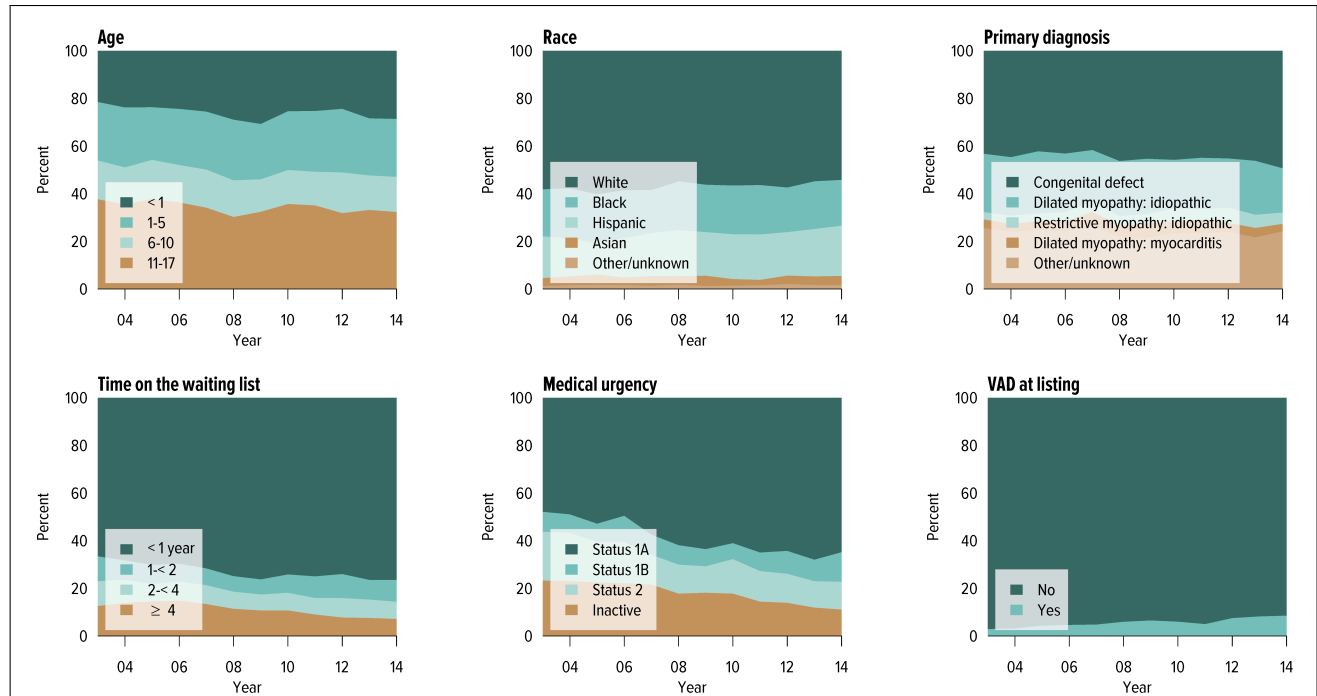


Figure HR 5.2 Distribution of pediatric candidates waiting for heart transplant

Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Age is determined at the later of listing date or January 1 of the given year. Time on the waiting list is determined at the earlier of December 31 or removal from the waiting list. Medical urgency status is the most severe during the year. Ventricular assist device (VAD) information is from the time of listing. Active and inactive patients are included.

		2004		2014	
		N	%	N	%
Age	<1	41	13.0	43	11.8
	1-5	78	24.7	110	30.3
	6-10	62	19.6	68	18.7
	11-17	86	27.2	106	29.2
	≥18	49	15.5	36	9.9
Sex	Female	142	44.9	131	36.1
	Male	174	55.1	232	63.9
Race	White	206	65.2	197	54.3
	Black	49	15.5	60	16.5
	Hispanic	46	14.6	88	24.2
	Asian	11	3.5	15	4.1
	Other/unknown	4	1.3	3	0.8
Citizenship	US citizen	308	97.5	351	96.7
	Non-citizen resident	2	0.6	0	0.0
	Non-citizen non-resident	3	0.9	2	0.6
	Other/unknown	3	0.9	10	2.8
Primary diagnosis	Congenital defect	132	41.8	179	49.3
	Dilated myopathy: idiopathic	81	25.6	55	15.2
	Dilated myopathy: familial	3	0.9	8	2.2
	Restrictive myopathy: idiopathic	11	3.5	17	4.7
	Dilated myopathy: myocarditis	13	4.1	9	2.5
	Other/unknown	76	24.1	95	26.2
Heart transplant history	First transplant	298	94.3	331	91.2
	Retransplant	18	5.7	32	8.8
Blood type	A	93	29.4	117	32.2
	B	29	9.2	40	11.0
	AB	6	1.9	12	3.3
	O	188	59.5	194	53.4
Waiting time	<1 year	136	43.0	216	59.5
	1-<2 years	35	11.1	52	14.3
	2-<3 years	30	9.5	28	7.7
	3-<4 years	20	6.3	17	4.7
	4-<5 years	19	6.0	14	3.9
	≥5 years	76	24.1	36	9.9
Medical urgency	1A	39	12.3	109	30.0
	1B	18	5.7	61	16.8
	2	77	24.4	79	21.8
	Inactive	182	57.6	114	31.4
VAD at listing		5	1.6	16	4.4
Multi-organ	Heart only	270	85.4	351	96.7
	Heart-kidney	6	1.9	4	1.1
	Heart-lung	37	11.7	7	1.9
	Other	3	0.9	1	0.3
All candidates		316	100.0	363	100.0

Table HR 5.1 Characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2004 and December 31, 2014

Candidates aged younger than 18 years at listing waiting for transplant on December 31, 2004, and December 31, 2014, regardless of first listing date; active/inactive status is on this date, and multiple listings are not counted. In 2014, 9.9% were adults on December 31. VAD, ventricular assist device.

	2012	2013	2014
Patients at start of year	306	328	349
Patients added during year	538	591	593
Patients removed during year	516	568	579
Patients at end of year	328	351	363
Removal reason			
Deceased donor transplant	380	418	423
Patient died	63	53	76
Patient refused transplant	0	2	1
Improved, transplant not needed	44	47	43
Too sick for transplant	22	30	29
Other	7	18	7

Table HR 5.2 Heart transplant waitlist activity among pediatric candidates

Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. Candidates who are listed, undergo transplant, and are re-listed are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multi-organ transplants are included.

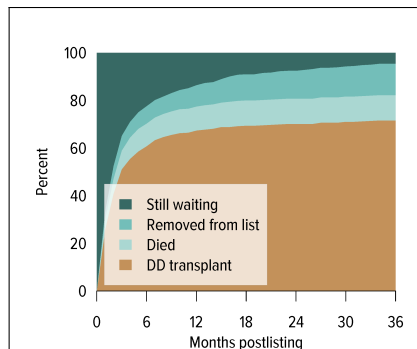


Figure HR 5.3 Three-year outcomes for pediatric candidates waiting for heart transplant, new listings in 2011

Candidates waiting for any heart transplant and first listed in 2011. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. DD, deceased donor.

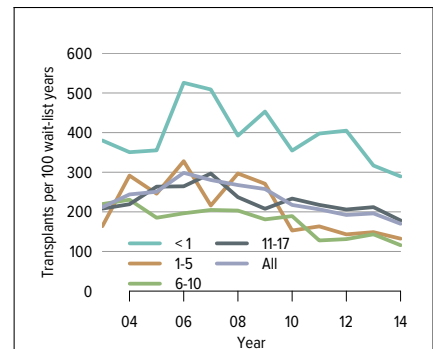
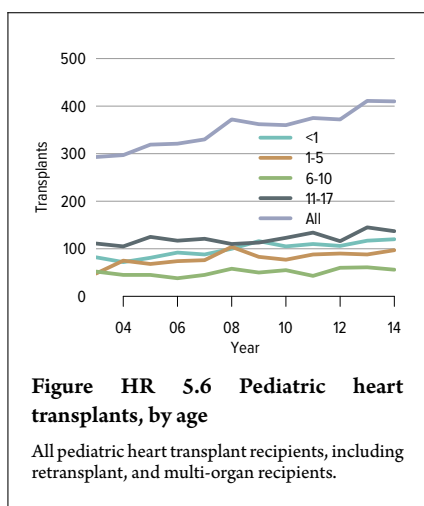
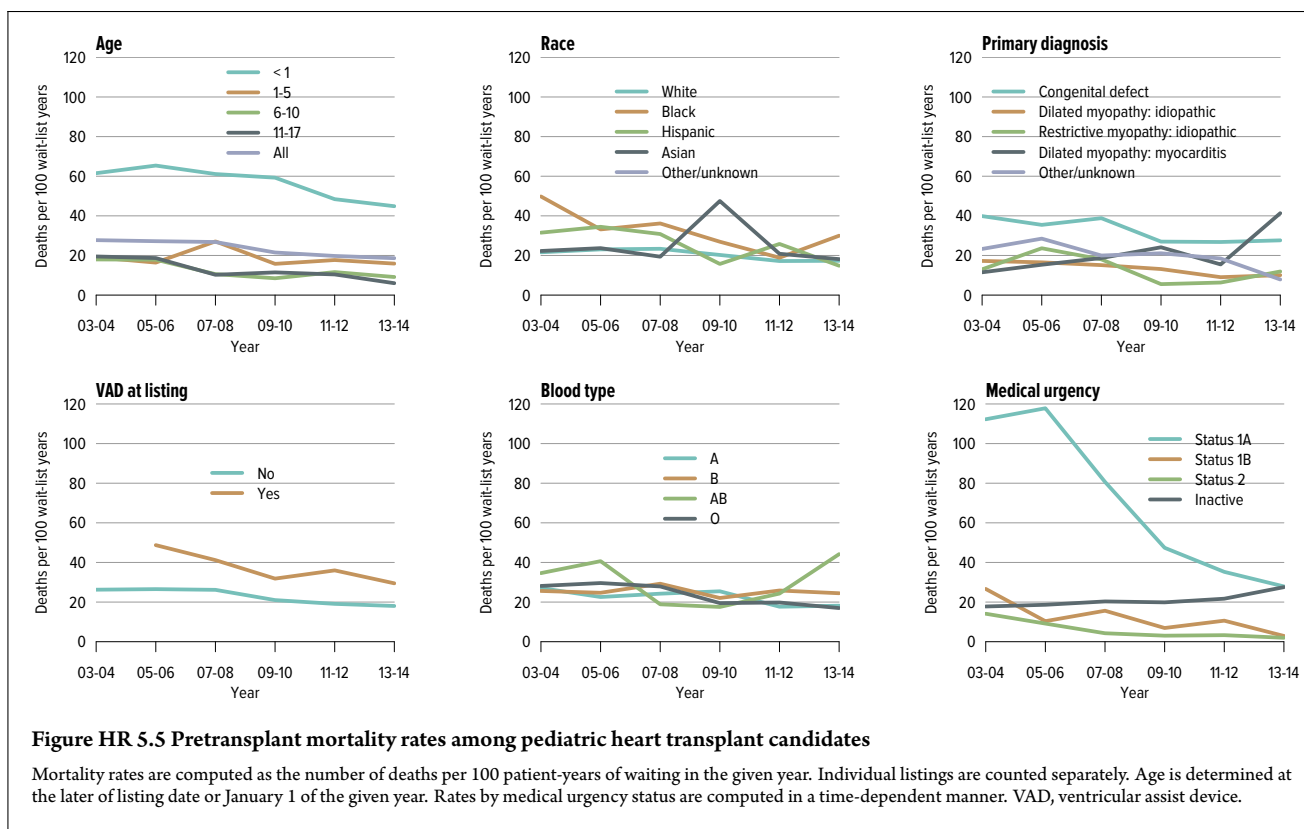


Figure HR 5.4 Heart transplant rates among active pediatric waitlist candidates

Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active waiting in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.

pediatric transplant



		2001-2004		2011-2014	
		N	%	N	%
Age	< 1	290	24.9	453	28.9
	1-5	285	24.5	363	23.2
	6-10	166	14.3	220	14.0
	11-17	422	36.3	532	33.9
Sex	Female	545	46.9	737	47.0
	Male	618	53.1	831	53.0
Race	White	654	56.2	855	54.5
	Black	223	19.2	330	21.0
	Hispanic	216	18.6	284	18.1
	Asian	51	4.4	62	4.0
	Other/unknown	19	1.6	37	2.4
Primary diagnosis	Congenital defect	514	44.2	694	44.3
	Dilated myopathy: idiopathic	372	32.0	445	28.4
	Dilated myopathy: familial	39	3.4	72	4.6
	Restrictive myopathy: idiopathic	69	5.9	79	5.0
	Dilated myopathy: myocarditis	30	2.6	71	4.5
	Other/unknown	139	12.0	207	13.2
Heart transplant history	First transplant	1,081	92.9	1,483	94.6
	Retransplant	82	7.1	85	5.4
Blood type	A	493	42.4	583	37.2
	B	133	11.4	208	13.3
	AB	42	3.6	64	4.1
	O	495	42.6	713	45.5
ABO compatibility	Compatible/identical	1,149	98.8	1,508	96.2
	Incompatible	14	1.2	60	3.8
Insurance	Private	610	52.5	699	44.6
	Medicaid	466	40.1	720	45.9
	Other government	51	4.4	115	7.3
	Other/unknown	36	3.1	34	2.2
Waiting time	< 31 days	516	44.4	495	31.6
	31-60 days	221	19.0	298	19.0
	61-90 days	127	10.9	214	13.6
	3-< 6 months	150	12.9	284	18.1
	6-< 12 months	81	7.0	182	11.6
	1-< 2 years	43	3.7	64	4.1
	2-< 3 years	15	1.3	19	1.2
	≥ 3 years	10	0.9	12	0.8
Medical urgency	Status 1A	794	68.3	1,393	88.8
	Status 1B	145	12.5	121	7.7
	Status 2	224	19.3	54	3.4
VAD status	No VAD	1,070	92.0	1,192	76.0
	VAD	93	8.0	376	24.0
Multi-organ transplant	Heart only	1,133	97.4	1,544	98.5
	Heart-lung	24	2.1	17	1.1
	Heart-kidney	6	0.5	4	0.3
	Heart-liver	0	0.0	3	0.2
PRA	< 1%	708	60.9	883	56.3
	1-< 20%	133	11.4	244	15.6
	20-< 80%	77	6.6	232	14.8
	80-< 98%	27	2.3	53	3.4
	98-100%	15	1.3	24	1.5
	Unknown	203	17.5	132	8.4
All recipients		1,163	100.0	1,568	100.0

Table HR 5.3 Characteristics of pediatric heart transplant recipients, 2001-2004 and 2011-2014

Heart transplant recipients, including retransplants. VAD, ventricular assist device.

pediatric transplant

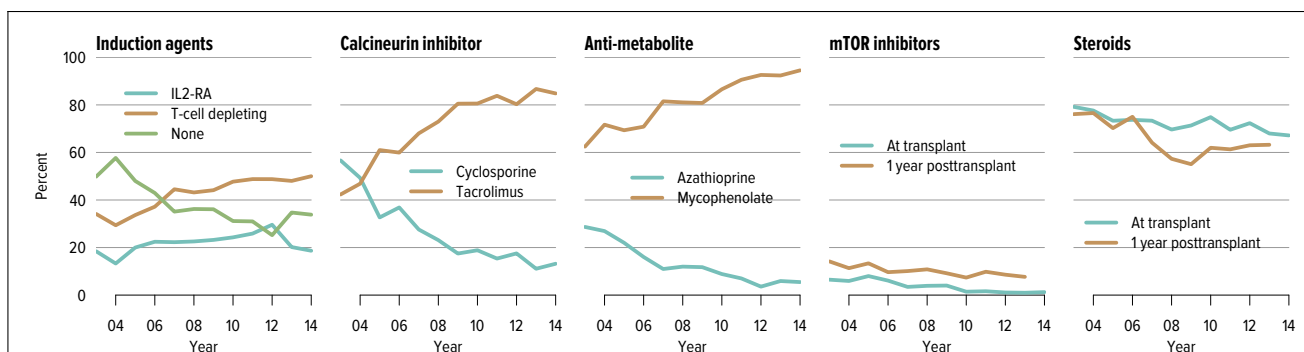


Figure HR 5.7 Immunosuppression in pediatric heart transplant recipients

One-year posttransplant data are limited to patients alive with graft function at 1 year posttransplant. Mycophenolate includes mycophenolate mofetil and mycophenolate sodium. IL2-RA, interleukin-2 receptor antagonist; mTor, mammalian target of rapamycin.

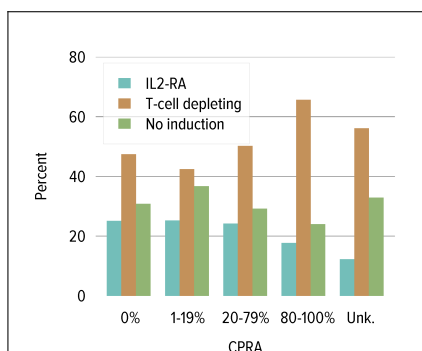


Figure HR 5.8 Induction use by PRA among pediatric heart transplant recipients, 2010-2014

IL2-RA, interleukin-2 receptor antagonist.

Donor	Recipient -			Recipient +			Recipient unk.		
	D-	D+	D unk.	D-	D+	D unk.	D-	D+	D unk.
CMV	28.1	28.8	0.6	17.9	21.9	0.3	1.0	1.3	0.0
EBV	11.1	31.1	0.3	12.7	39.0	0.1	1.7	4.1	0.0

Table HR 5.4 Pediatric heart donor-recipient serology matching, 2010-2014

Donor serology is reported on the OPTN Donor Registration Form and recipient serology on the OPTN Transplant Recipient Registration Form. Any evidence for a positive serology is treated as positive for that serology. If all fields are unknown, incomplete, or pending, the person is categorized as unknown for that serology; otherwise, serology is assumed negative. CMV, cytomegalovirus; EBV, Epstein-Barr virus.

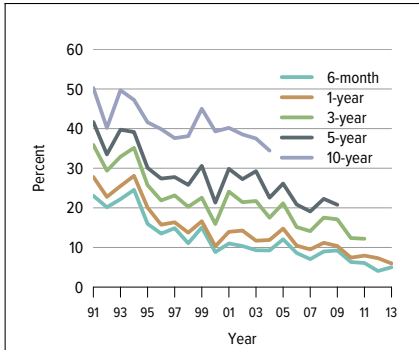


Figure HR 5.9 Patient death among pediatric heart transplant recipients

All pediatric recipients of deceased donor hearts, including multi-organ transplants. Patients are followed until the earlier of death or December 31, 2014. Estimates computed with Cox proportional hazards models reporting, adjusted for age, sex, and race.

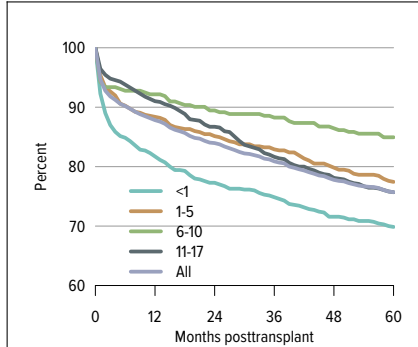


Figure HR 5.10 Patient survival among pediatric heart transplant recipients, by age, 2002-2009

Recipient survival estimated using unadjusted Kaplan-Meier methods.

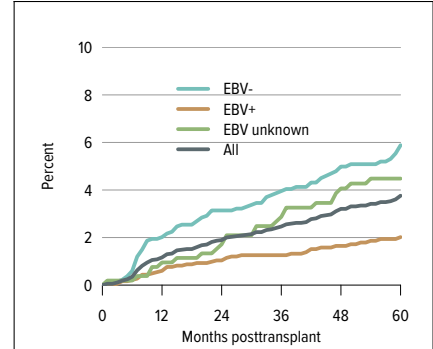


Figure HR 5.11 Incidence of PTL D among pediatric heart transplant recipients, by recipient EBV status at transplant, 2002-2012

Cumulative incidence is estimated using the Kaplan-Meier competing risk method. Posttransplant lymphoproliferative disorder (PTLD) is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or on the Posttransplant Malignancy Form as polymorphic PTL D, monomorphic PTL D, or Hodgkin disease. Only the earliest date of PTL D diagnosis is considered. EBV, Epstein-Barr virus.

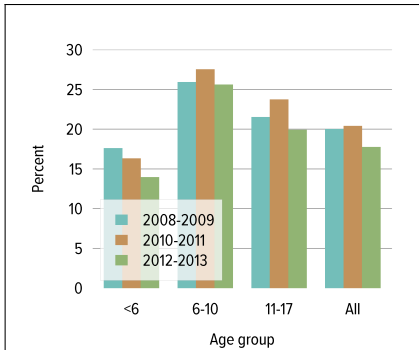


Figure HR 5.12 Incidence of acute rejection in year 1 posttransplant among pediatric heart transplant recipients, by age

Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration Form or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method.

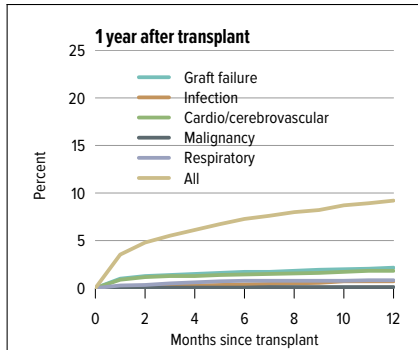
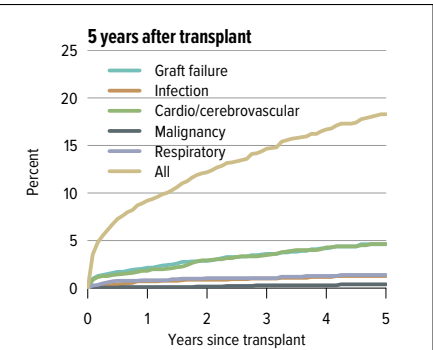


Figure HR 5.13 Cumulative incidence of death by cause among pediatric heart recipients, 2008-2012

Primary cause of death is as reported on the OPTN Transplant Follow-up Form. Other causes of death include hemorrhage, trauma, noncompliance, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.



transplant center maps

Figure HR.6.1 Centers performing adult transplants or listing active adult heart candidates, within DSAs, 2012-2014

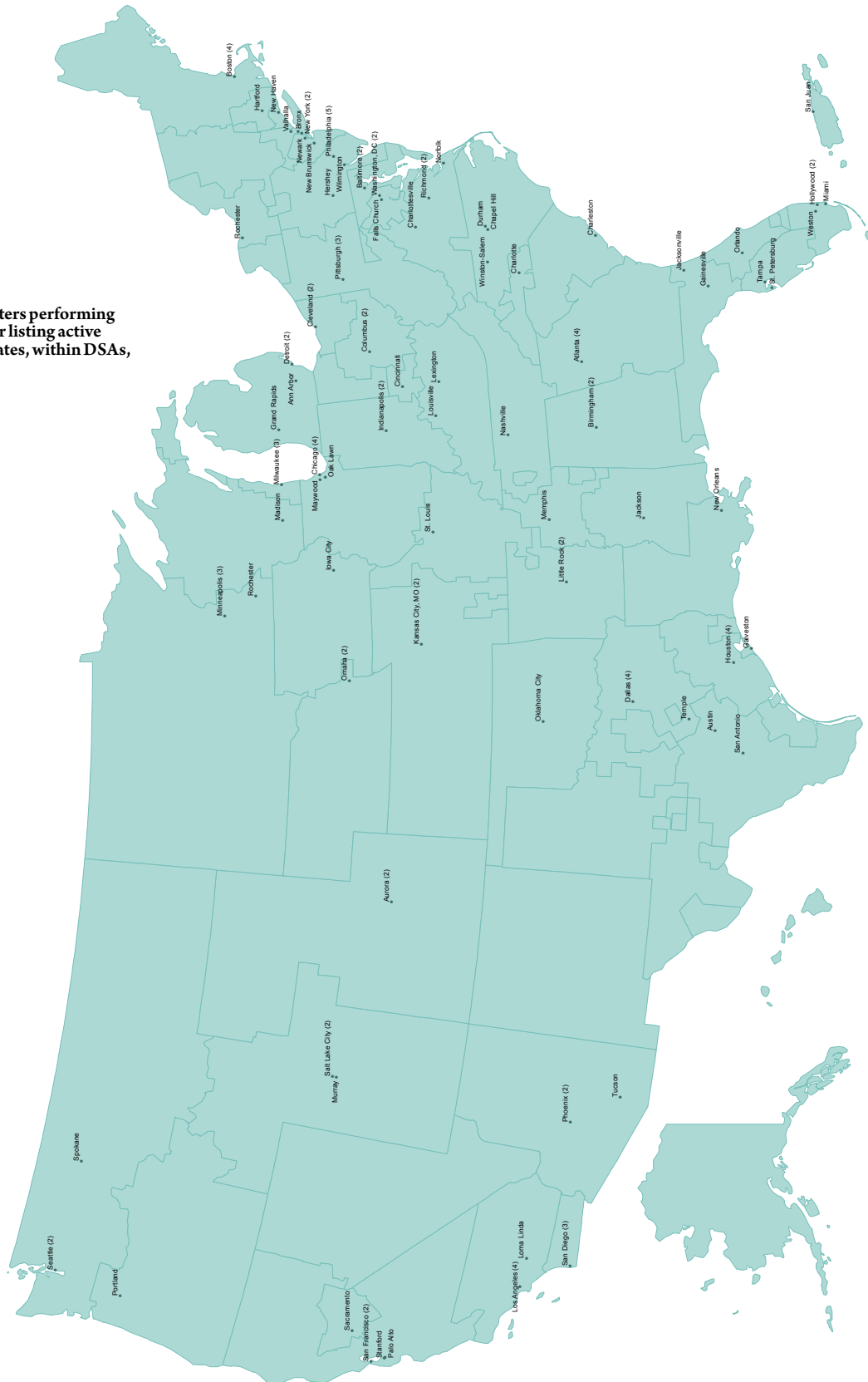
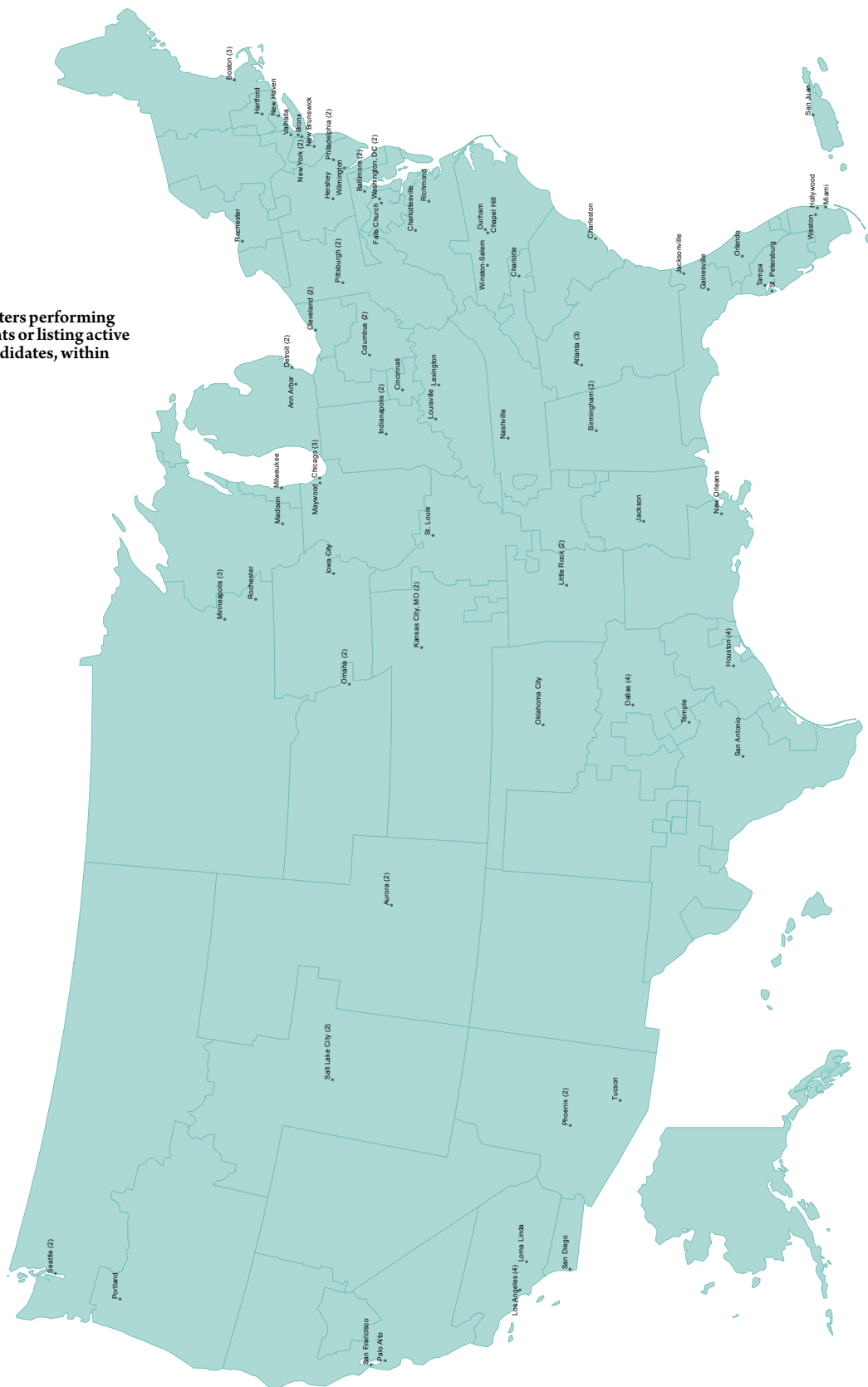


Figure HR.6.2 Centers performing pediatric transplants or listing active pediatric heart candidates, within DSAs, 2012-2014



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[Table HR 3.2](#) Characteristics of adult heart transplant recipients, 2004 and 2014
[Table HR 3.3](#) Top 15 medications filled by adult heart transplant recipients, 2010
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pediatric transplant

- [Table HR 5.1](#) Characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2004 and December 31, 2014
[Table HR 5.2](#) Heart transplant waitlist activity among pediatric candidates
[Table HR 5.3](#) Characteristics of pediatric heart transplant recipients, 2001-2004 and 2011-2014
[Table HR 5.4](#) Pediatric heart donor-recipient serology matching, 2010-2014