

# OPTN/SRTR 2016 Annual Data Report: Heart

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## Abstract

In 2016, 3209 heart transplants were performed in the United States. New, active listings increased 57% since 2005. The number of adult heart transplant survivors continued to increase, and in 2016, 30,622 recipients were living with heart transplants. Patient mortality following transplant has declined. The number of pediatric candidates and transplants performed also increased. New listings for pediatric heart transplants increased from 454 in 2005 to 624 in 2016. The number of pediatric heart transplants performed each year increased from 319 in 2005 to 445 in 2016. Among pediatric patients who underwent transplant in 2015, death occurred in 5.9% at 6 months and 7.2% at 1 year.

**Keywords:** End-stage heart failure, heart transplant, transplant outcomes, ventricular assist device.

## 1 Introduction

Since the first heart transplant was performed in the US in 1968, heart transplantation has transitioned from a high-risk experimental procedure to a lifesaving surgery that affords good outcomes and longevity for patients with end-stage heart failure. Survival after heart transplant continues to improve. In addition, patients are surviving long enough to undergo transplant in large part due to mechanical circulatory support. Ventricular assist devices (VADs) have evolved substantially and are currently designed to improve function and longevity. The improved devices and their acceptance as safe bridges to transplant correspond to an increase in the number of candidates listed with mechanical circulatory support. Over one-half of adult heart transplant recipients in 2016 had a VAD at the time of transplant. The proportion of patients undergoing transplant as status 1A and with a VAD has increased substantially. In 2016, the OPTN Board of Directors approved revisions to the heart allocation policy that were designed to more equitably stratify patients and to account for various management strategies. These modifications to the policy will be implemented in 2018. In this report, we discuss the most significant trends in heart transplantation over the past decade.

## 2 Adult Heart Transplant

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

Between 2005 and 2016, the number of new active listings for heart transplant increased 57%, from 2240 to 3521 (Figure HR 1). The number of candidates actively awaiting heart transplant increased dramatically over the same period, from 1262 to 2862 (Figure HR 2), an increase of 127%, suggesting that transplant rates have not increased at the same rate as listings. The most remarkable demographic trends in heart transplant include the following: a steady increase in the proportion of heart transplant candidates aged 65 years or older, from 11.9% in 2005 to 18.0% in 2016, with a slight decrease in all other age groups (Figure HR 3); an increase in the proportion of black candidates from 16.4% to 24.9% (Figure HR 4); a decline in the proportion of candidates with coronary artery disease as the etiology for transplant from 41.4% to 32.0%, and an increase in cardiomyopathy from 45.5% to 58.1% (Figure HR 5). The proportion of candidates with extended waiting times decreased. In 2005, 16.2% of candidates waited 5 or more years; this proportion gradually declined to 4.3% in 2016 (Figure HR 6). The proportion of candidates awaiting transplant as status 1A doubled to 44.5% in 2016 (Figure HR 7). The proportion of status 1B candidates increased similarly, while those waiting at status 2 declined from 33.4% to 16.2%. The proportion of candidates with VADs at listing more than tripled in this time period, from 8.9% to 31.7% (Figure HR 8). Notably, sex distribution did not change (Figure HR 9).

Between 2005 and 2016, overall heart transplant rates declined 27.8% from 129.0 to 93.1 per 100 waitlist years (Figure HR 13). Similar reductions occurred for all age groups, blood types, and status groups (Figure HR 11, Figure HR 12, Figure HR 13). Transplant rates peaked for all groups in 2006 and 2007, and reached a nadir in 2014 and 2015. The highest transplant rates were consistently for candidates aged 65 years or older (113.1 per 100 waitlist years), in blood group AB (302.5 per 100 waitlist years), and at status 1A (488.1 per 100 waitlist years). Transplant rates by age group were

similar, but varied widely by blood type and medical urgency status. Blood type O candidates underwent transplant at a rate of 64.7 per 100 waitlist years in 2016, nearly half the rate of blood type A and B candidates and 20% of the rate of blood type AB candidates. By status group, transplant rates for status 1B and status 2 candidates declined substantially, from 216.4 to 48.6 per 100 waitlist years, and from 51.0 to 7.4 per 100 waitlist years, respectively.

Concurrent events that may have affected this trend include the OPTN policy allowing patients with LVADs to be listed as status 1A for 30 days; the OPTN broader sharing policy, which changed the heart allocation sequence to prioritize zone A status 1A and 1B candidates over local status 2 candidates, approved by the OPTN Board of Directors in 2002 and 2006, respectively; and the 2008 Food and Drug Administration approval of the HeartMate II LVAD as a bridge to transplant. The broader sharing policy may have resulted in more higher-urgency candidates undergoing transplant. LVADs offer stability on the waiting list, which may have resulted in increased selectivity in choosing organs. The median waiting time in 2015-2016 was 9.4 months, an increase from 4.2 months in 2005-2006 (Figure HR 15). Waiting times peaked in 2013-2014, then declined again. In 2015-2016, median waiting time was longest for blood type O candidates, 17.2 months (Figure HR 16), and 13.6 months for candidates with body mass index  $\geq 31$  kg/m<sup>2</sup> (Figure HR 18). Women waited on average 7.5 months, and men 10.0 months (Figure HR 15). Status 2 candidates had the longest median waiting times, 23.6 months in 2013-2014; fewer than half of status 2 candidates underwent transplant in 2015-2016, and median waiting time was not observed (Figure HR 17). Geographic variability in access to donor hearts remained. Overall, 51.1% of candidates listed in 2015 underwent transplant within 1 year (Figure HR 19); however, the proportion of candidates undergoing transplant within this time frame varied from 15.4% to 100% depending on the donation service area (DSA) (Figure HR 20). Among the 52 DSAs with more than 10 candidates, the proportion of candidates undergoing transplant in less than 1 year ranged from 18.8% to 69.8%.

Among candidates listed in 2013, 51.9% underwent transplant during the first year on the waiting list, 32.7% were still waiting, 8.1% were removed from the list, and 7.2% had died (Figure HR 14). At 3 years, 9.5% had died, 15.6% had been removed from the list, 65.6% had undergone transplant, and 9.4% were still waiting. Thus, within 3 years, most patients undergo transplant and less than 10% die on the waiting list.

Since 2005, pretransplant mortality on the waiting list steadily declined, from 14.6 to 9.7 deaths per 100 waitlist years in 2015-2016. Declines occurred in all age groups and racial/ethnic groups except Asians, whose mortality declined to 9.2 deaths per 100 waitlist years in 2011-2012 and increased to 13.0 deaths per 100 waitlist years in 2015-2016 (Figure HR 21, Figure HR 22). Pretransplant mortality declined notably for candidates with VADs at listing, from 43.2 to 8.0 deaths per 100 waitlist years, lower than the pretransplant mortality among candidates without VADs (10.4 deaths per 100 waitlist years) (Figure HR 26). Pretransplant mortality declined precipitously among status 1A and 1B candidates, from 76.9 deaths per 100 waitlist years in 2005-2006 to 17.3 in 2015-2016, and from 21.3 deaths per 100 waitlist years to 3.4, respectively (Figure HR 25). Of note, pretransplant mortality for status 2 candidates was similar to that for status 1B candidates, 3.1 and 3.4 deaths per 100 waitlist years in 2015-2016, respectively. Inactive candidates made up one of the few subgroups with fairly consistent increases in pretransplant mortality over the past 10 years, 25.3 deaths per 100 waitlist years in 2015-2016, compared with 16.4 in 2005-2006. Among candidates

with known indications for transplant, pretransplant mortality was highest for those with valvular heart disease (Figure HR 24).

Wide variation in pretransplant mortality by DSA persisted, ranging from 3.4 to 19.9 deaths per 100 waitlist years (Figure HR 27). Deaths within 6 months of removal from the waiting list fluctuated over the past decade, peaking at 33.4% in 2013 and declining to 21.8% in 2016 (Figure HR 28). Mortality within 6 months of removal from the waiting list remained highest for candidates listed as status 1A.

## 2.2 Donor Trends

The overall deceased heart donation rate was 2.9 per 1000 deaths, but it varied by state, ranging from 0.37 to 6.16 per 1000 deaths (Figure HR 31). Almost half of donors, 49.8%, were aged 18 to 34 years (Figure HR 29) and 63.1% were white (Figure HR 30). Rates of hearts recovered for transplant but not transplanted reached a nadir in 2009-2010 and have trended upward since (Figure HR 32). In 2015-2016, 1.0% of recovered hearts were not transplanted. The increase is most notable for donors aged 50 years or older.

Head trauma remained the most common cause of death among heart donors, although the proportion declined substantially since 2005, from 63.2% of deceased donors to 45.5% in 2016. Donation after deaths due to anoxia tripled since 2005, to 36.0% of heart donors in 2016 (Figure HR 33).

## 2.3 Overall Trends in Heart Transplant

In 2016, 3209 heart transplants were performed; 445 were in pediatric recipients and 2764 in adult recipients (Figure HR 34). Overall, heart transplants increased in all age groups, but recipients aged 65 years or older represent a growing proportion, from 9.7% in 2005 to 17.4% in 2016 (Figure HR 35). The proportion of recipients who underwent transplant as status 1A increased from 39.5% in 2005 to 69.1% in 2016. In 2005, 26.3% of recipients were status 2, but only 2.3% in 2016; 75 underwent transplant as status 2 (Figure HR 39). In 2016, most heart transplant recipients were aged 50-64 years (Figure HR 35). The typical recipient remained white, male, with blood type A or O, although increasing proportions of recipients are non-white.

In 2016, 52.2% of recipients received induction therapy (Figure HR 40). In 2005, 40.4% of recipients were receiving cyclosporine at the time of transplant; this declined to 2.3% in 2016, and was largely replaced by tacrolimus, used by 93.1% of recipients (Figure HR 41).

Transplant program volume has grown since 2005; the median transplant volume increased from 12 transplants per year in 2005 to 21 in 2016. Although numbers of transplants performed have generally increased, 25% of programs still perform 10 per year or fewer. Most programs perform between 11 and 64 transplants per year (Figure HR 47). In 2016, 41.1% of transplants were performed at programs in the 25th-75th volume percentile and 41.6% at programs in the 75th-95th percentile (Figure HR 48).

## 2.4 Posttransplant Survival and Morbidity

Overall one-year survival for patients who underwent heart transplant in 2009-2011 was 90.1%, 3-year survival was 83.5%, and 5-year survival 78.3% (Figure HR 51). One-

year survival among most subgroups was similar, but tended to be lower among recipients aged 65 years or older (Figure HR 49) and black recipients (Figure HR 50). Conversely, 1-year survival was higher for recipients aged 18-34 years (94.4%) and Asians (92.1%). By 5 years, survival was 76.6% for recipients aged 65 years or older and 73.8% for black recipients. Notably, although similar to recipients with ventricular assist devices at 1 and 3 years, survival for recipients with intra-aortic balloon pumps declined after year 3 to 75.3% at year 5 (Figure HR 52). Survival did not differ meaningfully between the medical urgency categories at any time, but tended to be lower for status 1A recipients at years 3 and 5 (Figure HR 54). Survival after heart transplant continued to improve. Since 2005, patient death after transplant decreased overall at 6 months and at 1, 3, and 5 years, despite slight increases in 6-month and 1- and 3-year mortality between 2011 and 2014 (Figure HR 55). The number of heart transplant survivors has increased since 2005. On June 30, 2016, 30,622 heart transplant recipients were alive with a functioning graft; most had undergone transplant at age 50 years or older (Figure HR 56).

The incidence of acute rejection in the first year posttransplant decreased from 23.8% among recipients who underwent transplant 2010-2011 to 23.3% among recipients who underwent transplant in 2014-2015 (Figure HR 57). Acute rejections in recipients aged 65 years or older increased slightly since 2010-2011. Posttransplant lymphoproliferative disorder (PTLD) remained uncommon, with an overall cumulative incidence of only 1.1% by 5 years posttransplant (Figure HR 58). The most common documented cause of death in the first posttransplant year was infection (Figure HR 59). By the second year, cardiovascular/cerebrovascular disease was the leading documented cause of death through year 5 (Figure HR 60). Malignancy was relatively infrequent as a cause of death, 1.6% of deaths at 5 years.

### 3 Pediatric Heart Transplant

#### 3.1 Pediatric Waitlist Trends

In 2016, 624 new pediatric candidates were added to the heart transplant waiting list, with few at inactive status (Figure HR 61). At year-end 2016, 367 candidates listed before their eighteenth birthdays were awaiting heart transplant, 69.8% active (Figure HR 62). Over the past decade, the number of candidates listed as inactive status decreased from 178 in 2006 to 111 in 2016. The largest pediatric age group on the waiting list in 2016 was 11-17 years (34.2%), followed by ages younger than 1 year (27.7%), 1-5 years (23.4%), and 6-10 years (14.7%) (Figure HR 63). Over half of heart transplant candidates were white, 20.7% were Hispanic, 20.6% were black, and 3.0% were Asian (Figure HR 64). Considering trends over time, the proportion of waitlist candidates aged younger than 1 year increased from 12.4% on December 31, 2006, to 16.2% on December 31, 2016 (Table HR 11). The proportion of male candidates remained high, 55.7%. The proportion of white candidates decreased from 60.2% on December 31, 2006, to 51.4% on December 31, 2016. For candidates waiting on December 31, 2016, congenital defect was the leading cause of heart disease (55.4%), up from 39.4% in 2006 (Table HR 12). The proportion of status 1A candidates at any time during the year increased from 49.5% in 2006 to 69.2% in 2015, then decreased to 60.8% in 2016 (Figure HR 67). The proportion of status 1B candidates increased from 9.8% in 2015 to 14.3% in 2016. The differences in status 1A and 1B listing percent-



ages from 2015 to 2016 are likely due to changes to pediatric heart allocation policy implemented in March 2016. The percentage of candidates using VADs at the time of listing increased from 3.2% in 2006 to 6.1% in 2016 (Table HR 12). Proportions of heart-only candidates increased from 91.2% at year-end 2006 to 99.4% at year-end 2016, and candidates for heart-lung and heart-kidney transplants decreased to less than 1% (Table HR 13). Among the 627 candidates removed from the waiting list in 2016, 460 (73.4%) were removed due to undergoing transplant, 60 (9.6%) died, 59 (9.4%) were removed due to improved condition, and 29 (4.6%) were considered too sick to undergo transplant (Table HR 15).

Just over 70% of candidates newly listed in 2013 underwent transplant within 3 years, 10.7% died, 13.7% were removed from the list, and 4.6% were still waiting (Figure HR 68). The rate of heart transplants among active pediatric waitlist candidates decreased from a peak of almost 300 per 100 waitlist years in 2006 to 183 per 100 waitlist years in 2016 (Figure HR 69). Transplant rates varied by age, with the highest rates for candidates aged younger than 1 year, at 309 transplants per 100 waitlist years in 2016, followed by candidates aged 11-17 years, at 189 transplants per 100 waitlist years (Figure HR 69). Pretransplant mortality slowly declined from 27.1 deaths per 100 waitlist years in 2005-2006 to 19.1 in 2015-2016 (Figure HR 70). The pretransplant mortality rate was highest for candidates aged younger than 1 year, at 56.8 deaths per 100 waitlist years in 2015-2016, an increase from its nadir of 44.9 in 2013-2014; pretransplant mortality was 14.6 deaths per 100 waitlist years for candidates aged 1-5 years, 14.1 for ages 6-10 years, and 8.2 for ages 11-17 years (Figure HR 70). By race, pretransplant mortality was highest in 2015-2016 for white candidates at 23.4 deaths per 100 waitlist years, followed by black and Hispanic candidates at 17.6 and 9.4, respectively (Figure HR 71). Regarding cause of disease, pretransplant mortality was highest for candidates with dilated myopathy/myocarditis or congenital defects (Figure HR 72). By status, pretransplant mortality was highest for status 1A candidates (33.0 deaths per 100 waitlist years) and inactive candidates (27.8), compared with 3.0 and 1.8 for status 1B and status 2 candidates, respectively (Figure HR 73).

### 3.2 Pediatric Transplant

Pediatric transplant recipients are those aged 18 years or younger at the time of transplant; the category excludes candidates listed before their 18th birthdays who underwent transplanted afterward. The number of pediatric heart transplants performed each year increased from 319 in 2005 to 445 in 2016 (Figure HR 74). In 2016, 26 of 135 total heart transplant programs performed pediatric heart transplants exclusively, 78 performed adult heart transplants, and 27 performed both adult and pediatric heart transplants (Fig HR 75). In 2016, 8.5% of transplants in recipients aged younger than 15 years were performed at programs with volume of 5 or fewer pediatric transplants in that year (Fig HR 76). Over the past decade, the age, sex, and race of pediatric heart transplant recipients changed little (Table HR 16). Congenital defects remained the most common primary cause of disease, affecting 48.1% of recipients who underwent transplant in 2014-2016 (Table HR 17). The proportion of ABO-incompatible transplants in 2014-2016 was 5.4%, increased from 2.7% a decade earlier (Table HR 18). The proportion of patients who underwent transplant as status 1A increased from 71.6% in 2004-2006 to 84.8% in 2014-2016. VAD use doubled from 10.5% of transplant recipients in 2004-2006 to 23.7% in 2014-2016 (Table HR 17).

### 3.3 Pediatric Immunosuppression and Outcomes

In 2016, the most common induction therapy was T-cell depleting agents, used in 70.2% of heart transplant recipients, followed by interleukin-2 receptor antagonists (IL-2-RA) in 9.3%. No induction therapy was reported in 21.8% of recipients (Figure HR 77). T-cell depleting agents were generally used more frequently for the most sensitized patients, while IL-2-RA was used less frequently for sensitized patients (Figure HR 82). The initial immunosuppression agents used most commonly in 2016 were tacrolimus (93.2%, Figure HR 78), mycophenolate (93.4%, Figure HR 79), and steroids (63.0%, Figure HR 81). In 2014, mammalian target of rapamycin inhibitors were used in only 1.8% of recipients at the time of transplant, but use increased to 11.2% at 1 year posttransplant (Figure HR 80). Among patients who underwent transplant in 2015, steroid use was 60.2% at transplant and 60.0% at 1 year posttransplant (Figure HR 81).

Among pediatric heart transplant recipients 2014-2015, the rate of acute rejection in the first year was 20.2% overall with the highest rate observed, 24.0%, in the 6-10 year age group; rates of rejection were 20.9% for ages 11-17 years and 18.7% for ages younger than 6 years (Figure HR 84). Among pediatric heart transplant recipients 2012-2016, 34.7% were cytomegalovirus (CMV) negative and 44.5% were Epstein-Barr virus (EBV) negative (Table HR 20). The combination of a CMV-positive donor and CMV-negative recipient occurred in 17.0% of transplants; for EBV, this occurred in 29.0% of transplants (Table HR 20).

Recipient death occurred in 6.5% at 6 months and in 8.4% at 1 year among heart transplants performed in 2014-2015, in 10.2% at 3 years for transplants performed in 2012-2013, in 16.2% at 5 years for transplants performed in 2010-2011, and in 34.1% at 10 years for transplants performed in 2004-2005 (Figure HR 86). Overall, 1-year and 5-year patient survival was 89.3% and 78.7%, respectively, among recipients who underwent transplant in 2004-2011 (Figure HR 87). By age, 5-year patient survival was 73.7% for recipients aged younger than 1 year, 79.9% for ages 1-5 years, 87.5% for ages 6-10 years, and 78.9% for ages 11-17 years (Figure HR 87). The leading identified causes of death in the first 5 years posttransplant were cardio/cerebrovascular disease (4.6%) and graft failure (3.3%) (Figure HR 89).

The incidence of PTLD among EBV-negative recipients was 5.2% at 5 years post-transplant, compared with 2.6% among EBV-positive recipients (Figure HR 85).

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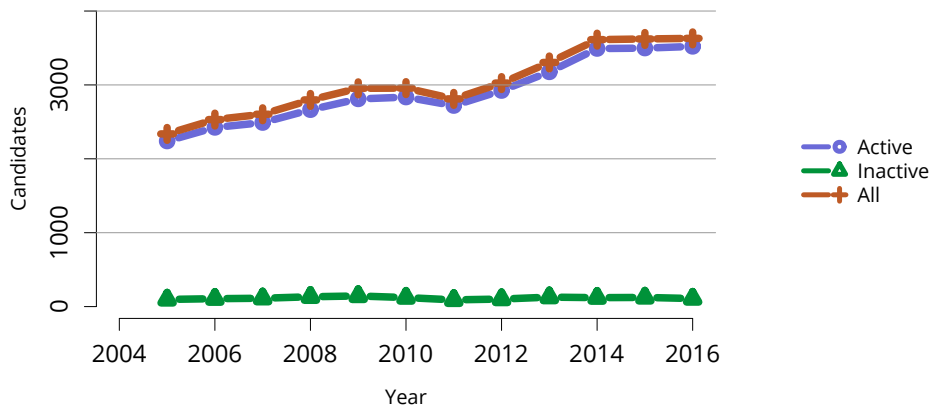
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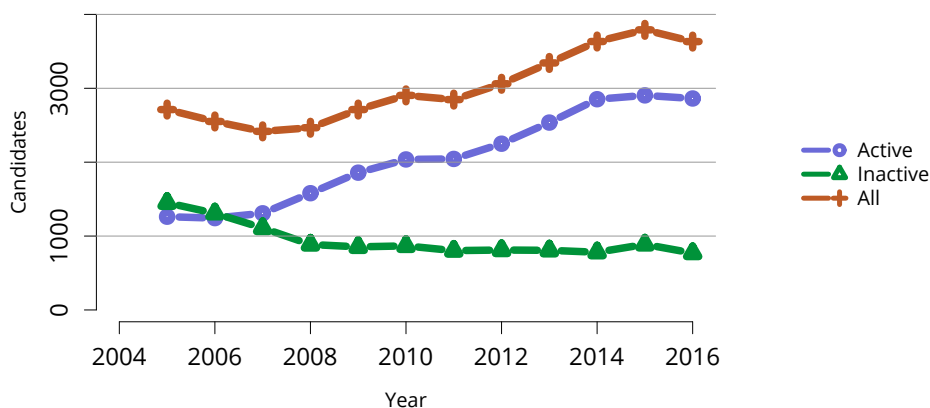
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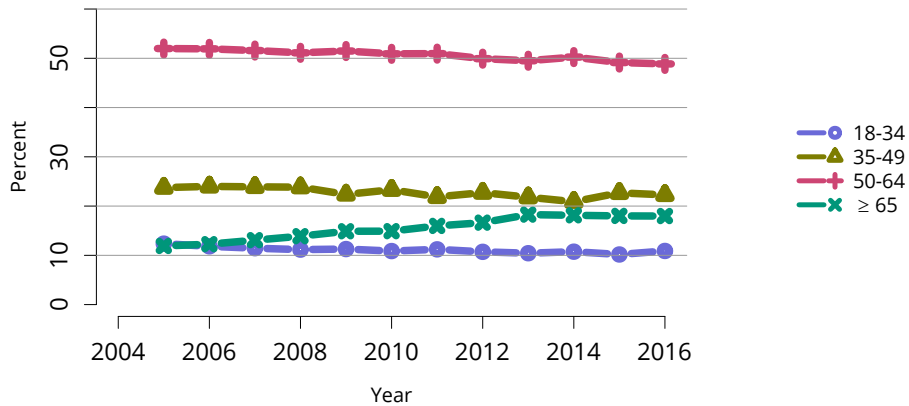




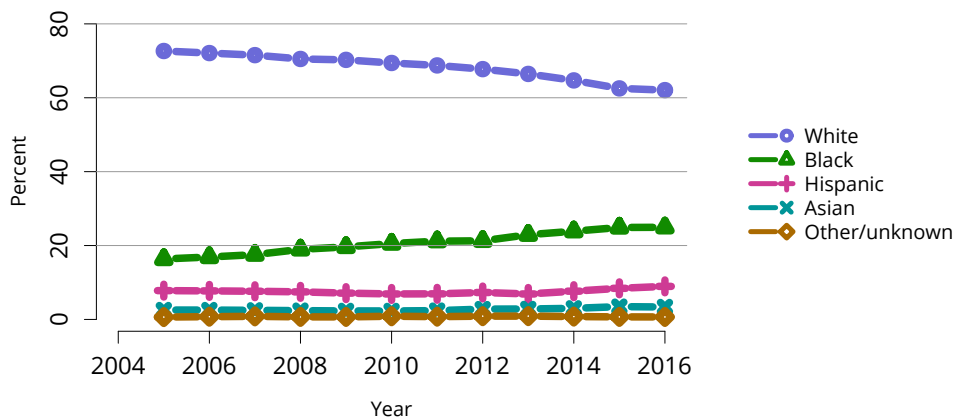
**Figure HR 1. New adult candidates added to the heart transplant waiting list.** A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates concurrently listed at multiple centers are counted once. Active and inactive patients are included.



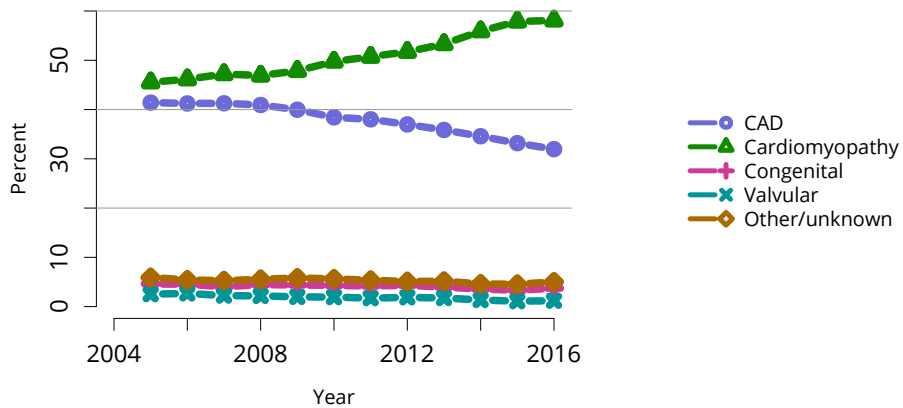
**Figure HR 2. Adults listed for heart transplant on December 31 each year.** Candidates concurrently listed at multiple centers are counted once. Those with concurrent listings and active at any program are considered active.



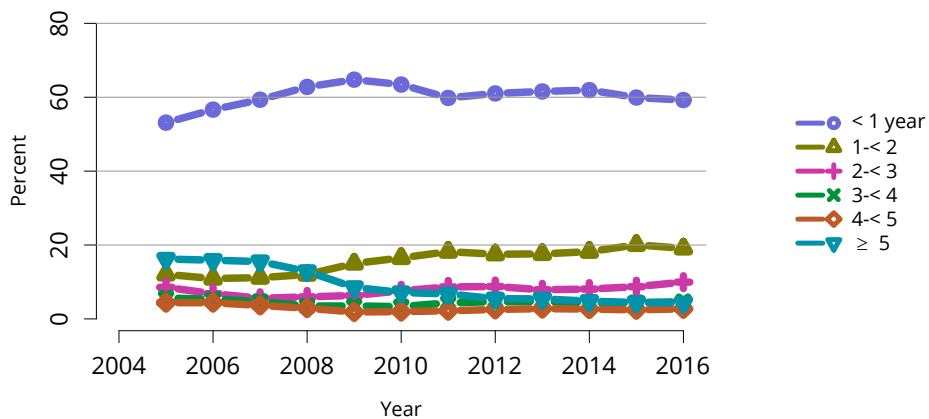
**Figure HR 3. Distribution of adults waiting for heart transplant by age.** Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Age is determined at the later of listing date or January 1 of the given year. Active and inactive candidates are included.



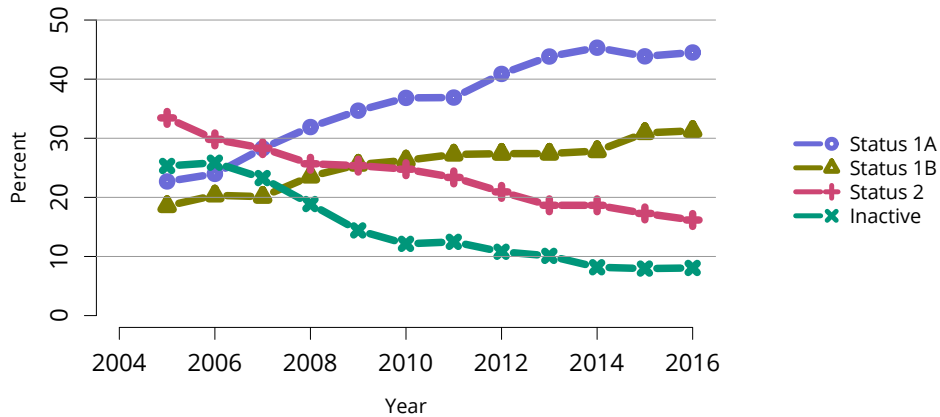
**Figure HR 4. Distribution of adults waiting for heart transplant by race.** Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive candidates are included.



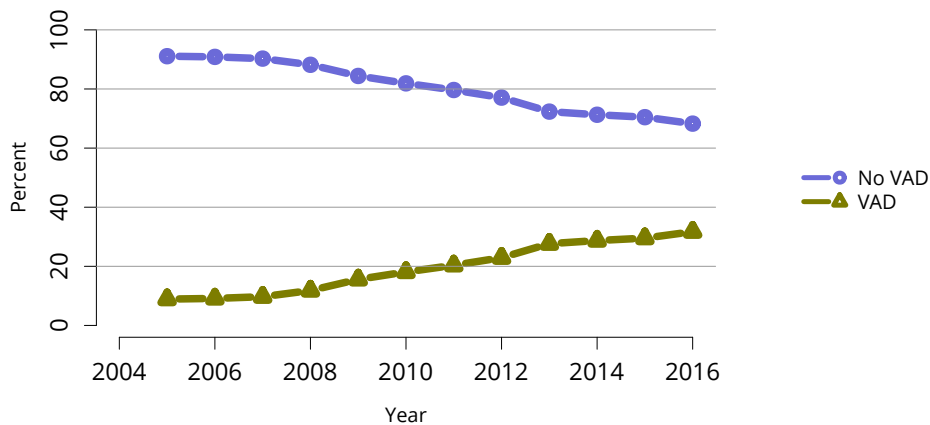
**Figure HR 5. Distribution of adults waiting for heart transplant by diagnosis.** Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included. CAD, coronary artery disease.



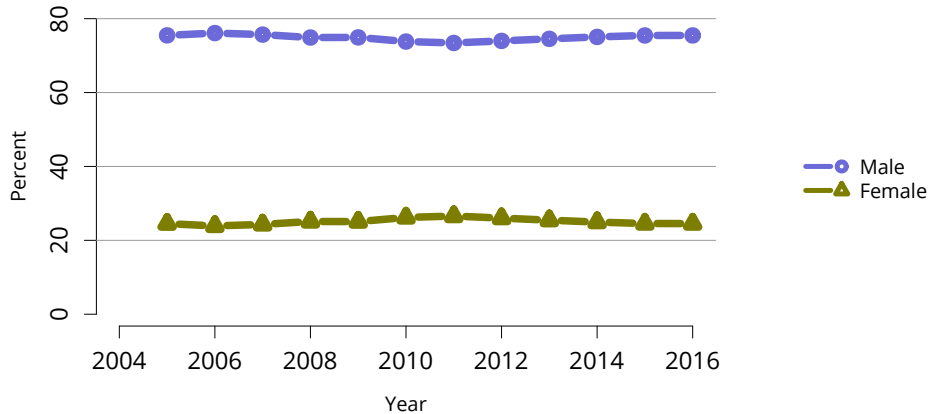
**Figure HR 6. Distribution of adults waiting for heart transplant by waiting time.** Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Time on the waiting list is determined at the earlier of December 31 or removal from the waiting list. Active and inactive candidates are included.



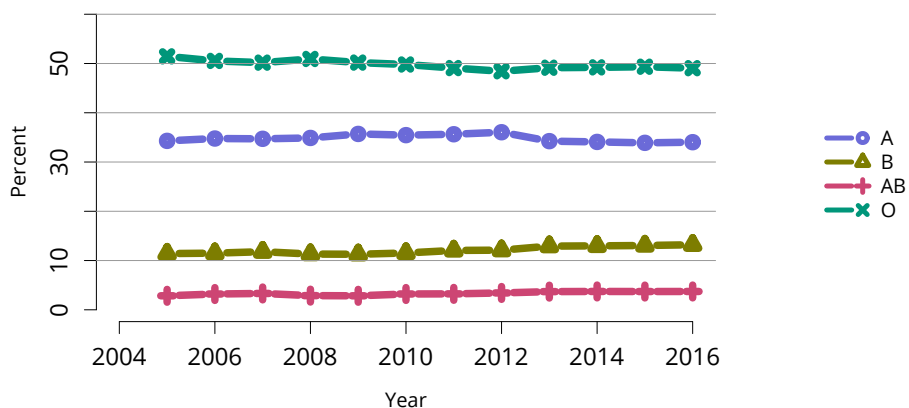
**Figure HR 7. Distribution of adults waiting for heart transplant by medical urgency.** Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Medical urgency status is the most severe during the year. Active and inactive patients are included.



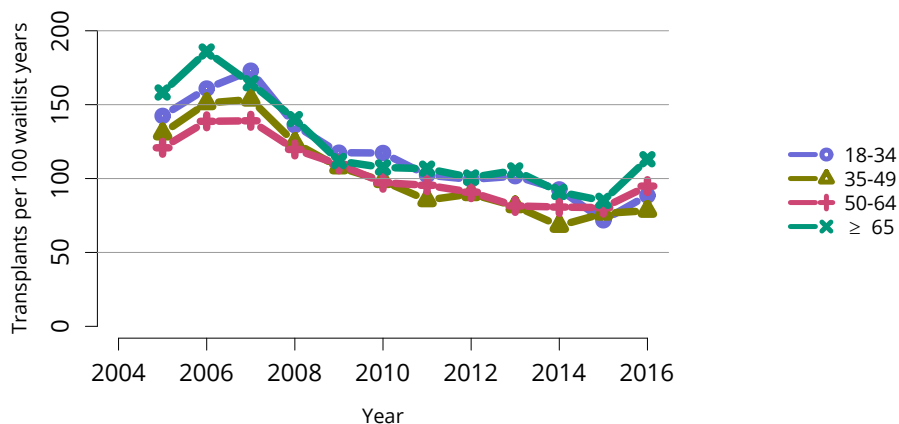
**Figure HR 8. Distribution of adults waiting for heart transplant by VAD status at listing.** Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included. VAD, ventricular assist device.



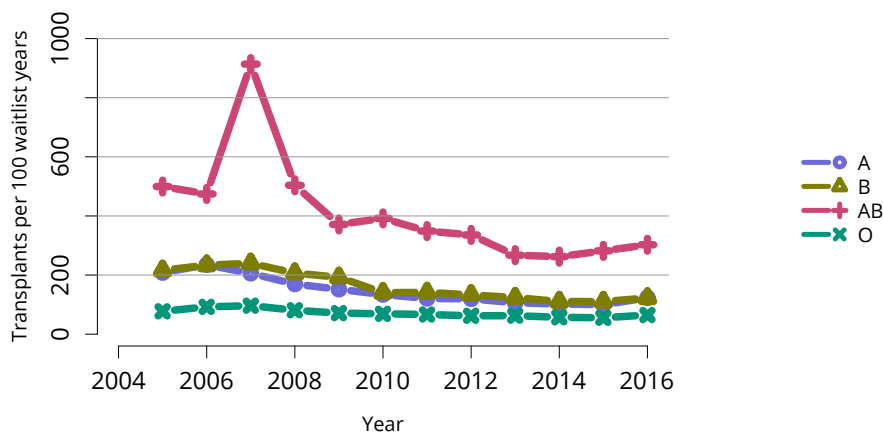
**Figure HR 9. Distribution of adults waiting for heart transplant by sex.** Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included.



**Figure HR 10. Distribution of adults waiting for heart transplant by blood type.** Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included.

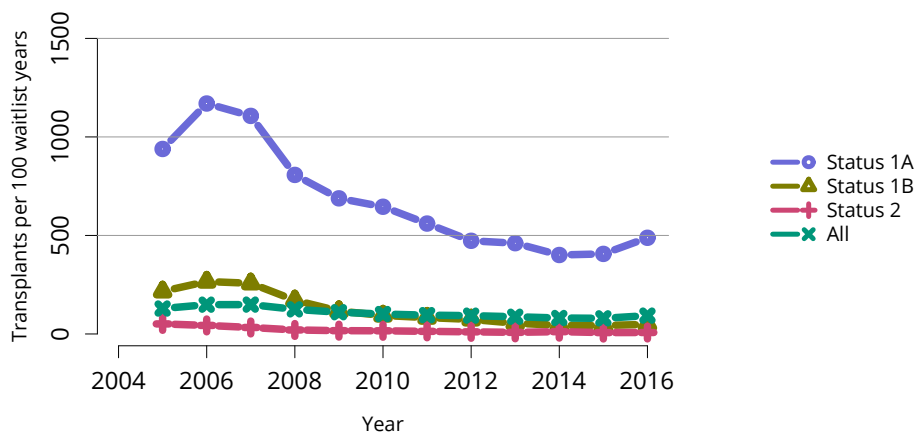


**Figure HR 11. Deceased donor heart transplant rates among active adult waitlist candidates by age.** Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active wait time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Rates with less than 10 patient-years of exposure are not shown.

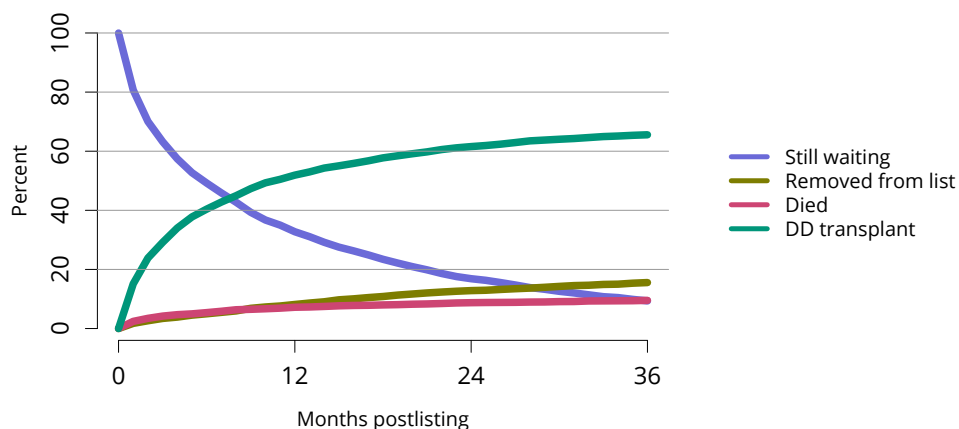


**Figure HR 12. Deceased donor heart transplant rates among active adult waitlist candidates by blood type.** Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active wait time in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.

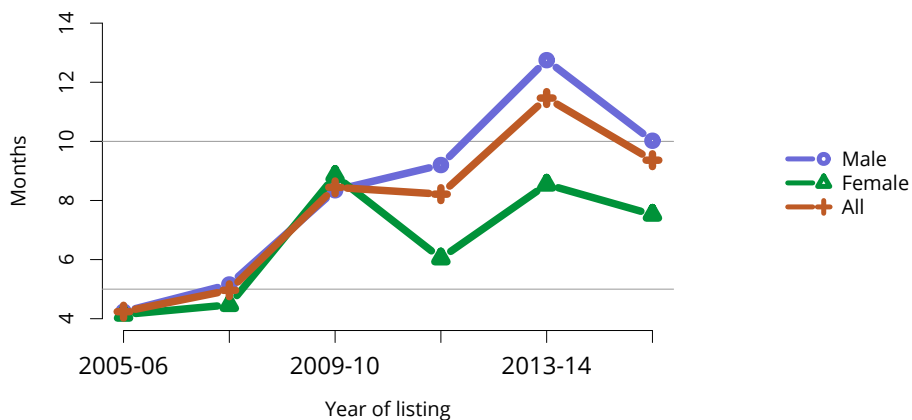




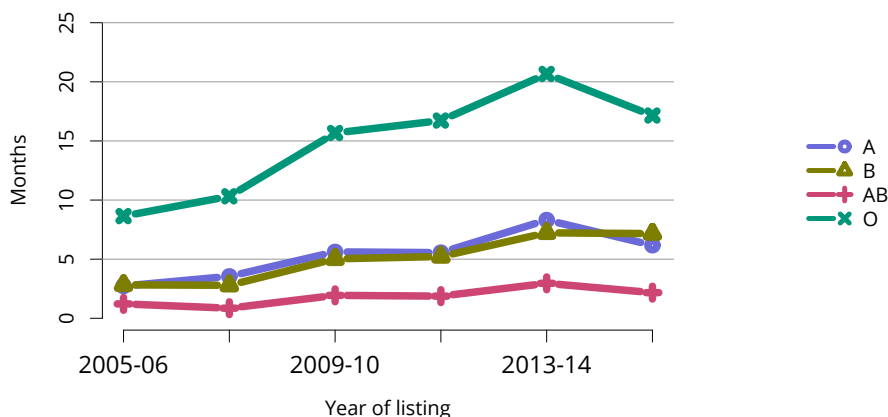
**Figure HR 13. Deceased donor heart transplant rates among active adult waitlist candidates by medical urgency.** Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active wait time in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.



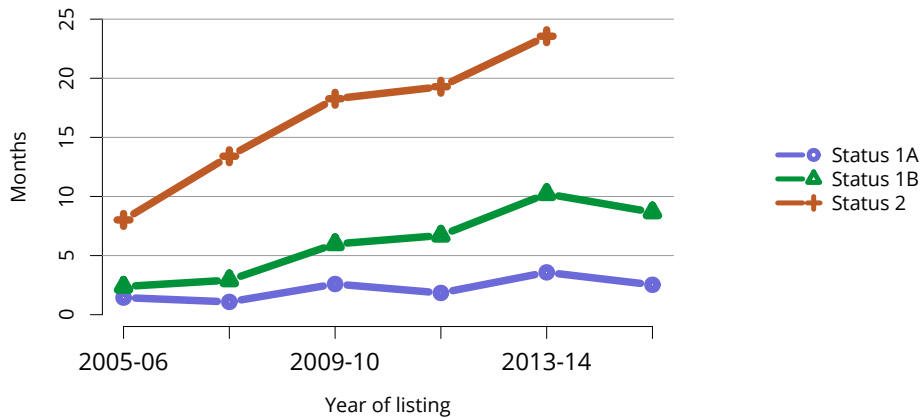
**Figure HR 14. Three-year outcomes for adults waiting for heart transplant, new listings in 2013.** Adults waiting for heart transplant and first listed in 2013. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. DD, deceased donor.



**Figure HR 15. Median months to heart transplant for waitlisted adults by sex.** Observations censored on December 31, 2016; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per candidate, not per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.



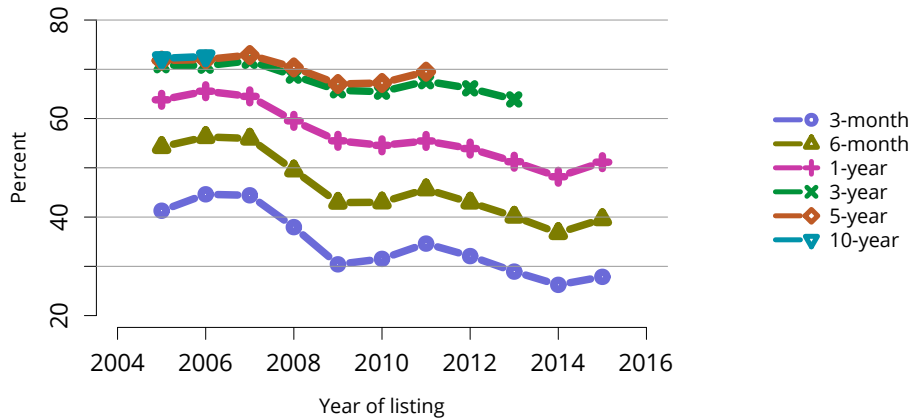
**Figure HR 16. Median months to heart transplant for waitlisted adults by blood type.** Observations censored on December 31, 2016; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per candidate, not per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.



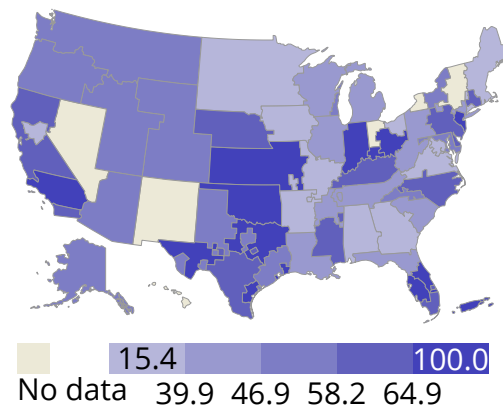
**Figure HR 17. Median months to heart transplant for waitlisted adults by medical urgency at listing.** Observations censored on December 31, 2016; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per candidate, not per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.



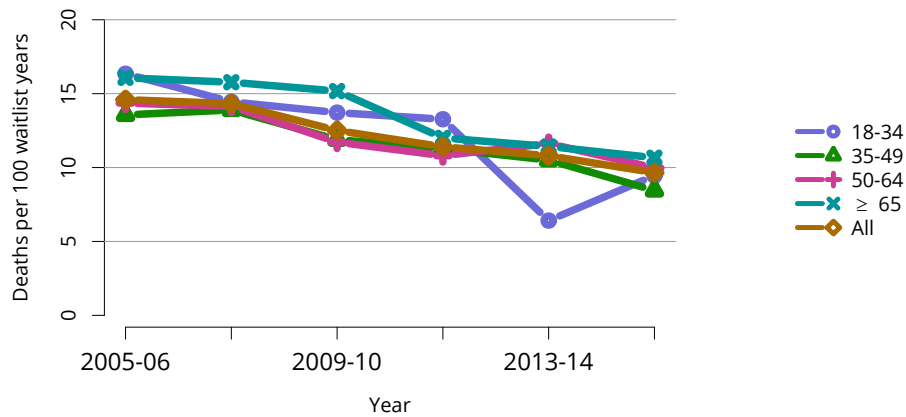
**Figure HR 18. Median months to heart transplant for waitlisted adults by BMI at listing.** Observations censored on December 31, 2016; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per candidate, not per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.



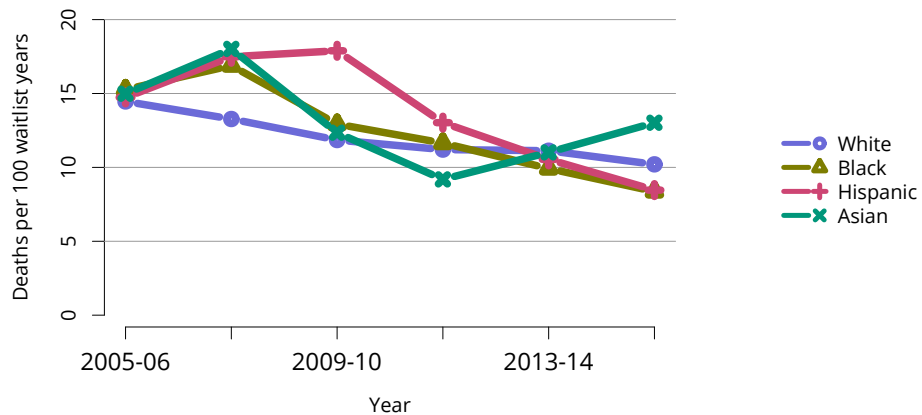
**Figure HR 19. Percentage of adults who underwent deceased donor heart transplant within a given time period of listing.** Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal.



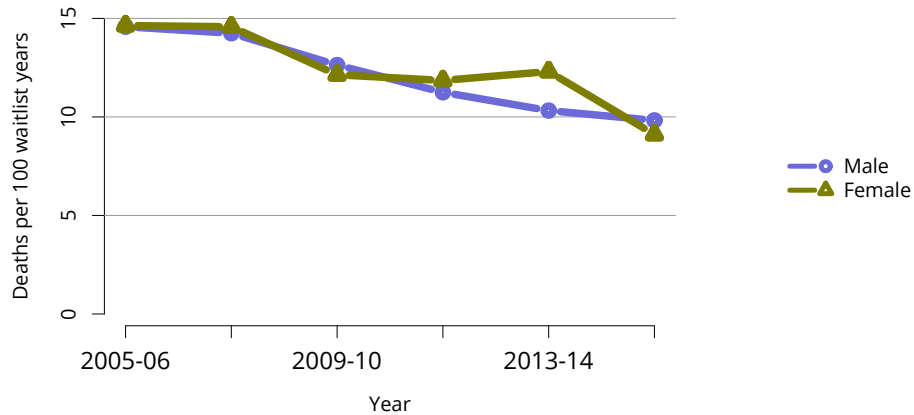
**Figure HR 20. Percentage of adults who underwent deceased donor heart transplant within 1 year of listing in 2015 by DSA.** Candidates listed concurrently in a single DSA are counted once in that DSA, from the time of earliest listing to the time of latest removal; candidates listed in multiple DSAs are counted separately per DSA.



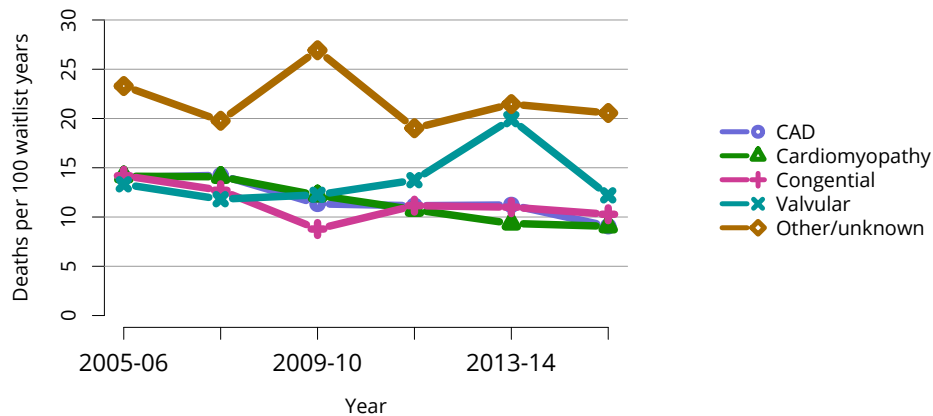
**Figure HR 21. Pretransplant mortality rates among adults waitlisted for heart transplant by age.** Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. Age is determined at the later of listing date or January 1 of the given year.



**Figure HR 22. Pretransplant mortality rates among adults waitlisted for heart transplant by race.** 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.

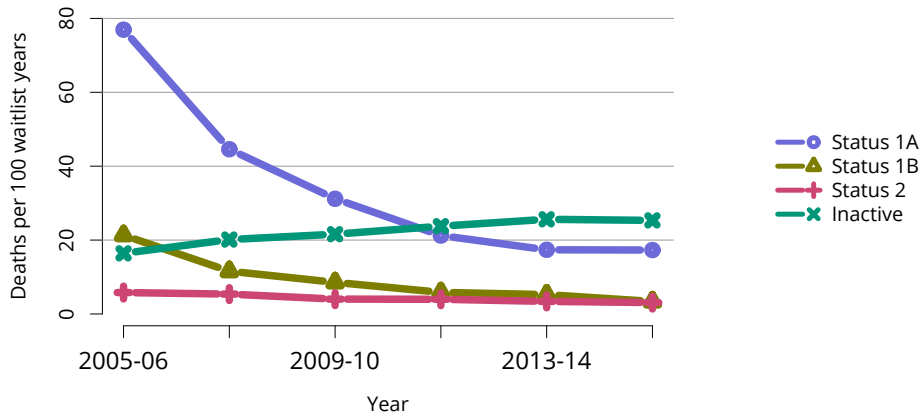


**Figure HR 23. Pretransplant mortality rates among adults waitlisted for heart transplant by sex.** Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.

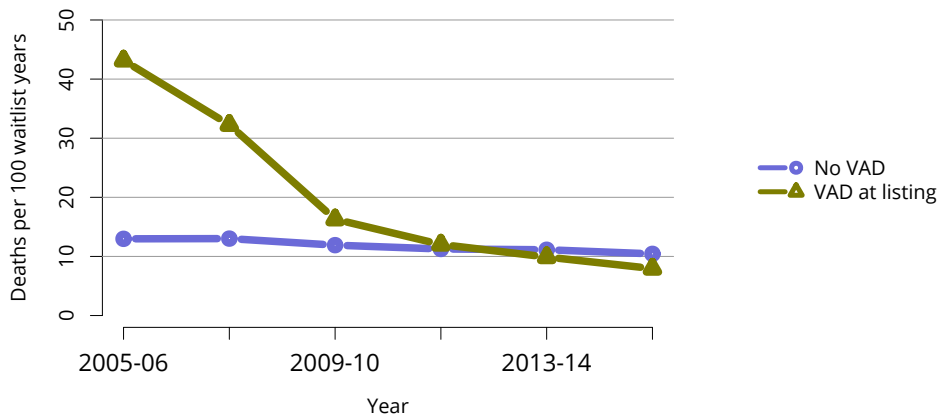


**Figure HR 24. Pretransplant mortality rates among adults waitlisted for heart transplant by diagnosis.** Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. CAD, coronary artery disease.

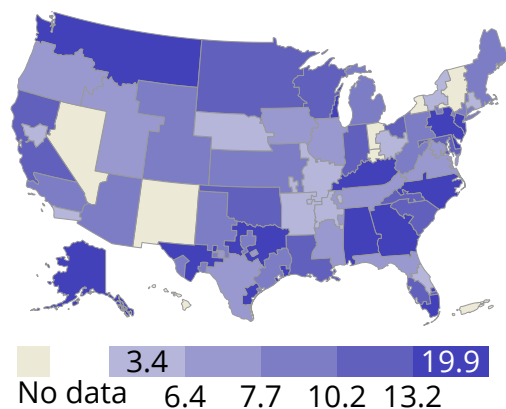




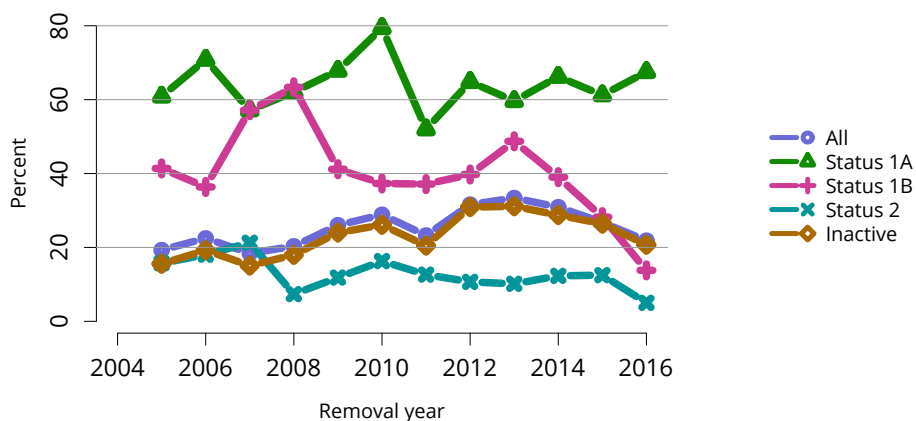
**Figure HR 25. Pretransplant mortality rates among adults waitlisted for heart transplant by medical urgency.** Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.



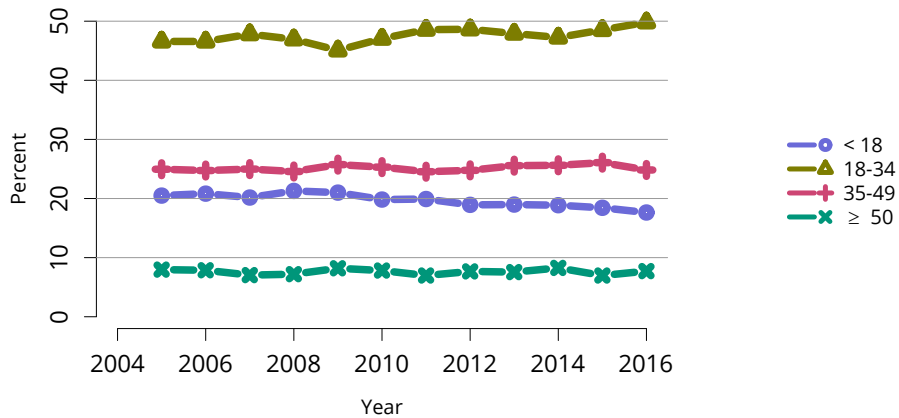
**Figure HR 26. Pretransplant mortality rates among adults waitlisted for heart transplant by VAD at listing.** Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. VAD, ventricular assist device.



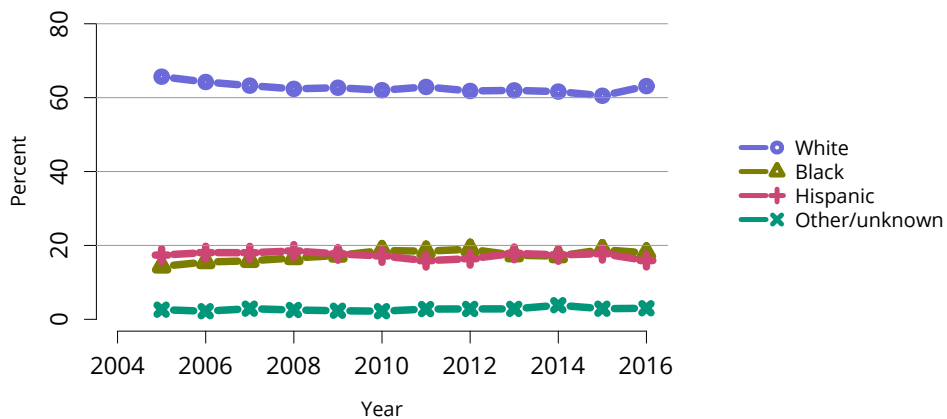
**Figure HR 27. Pretransplant mortality rates among adults waitlisted for heart transplant in 2015-2016, by DSA.** Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Patients censored at waitlist removal. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.



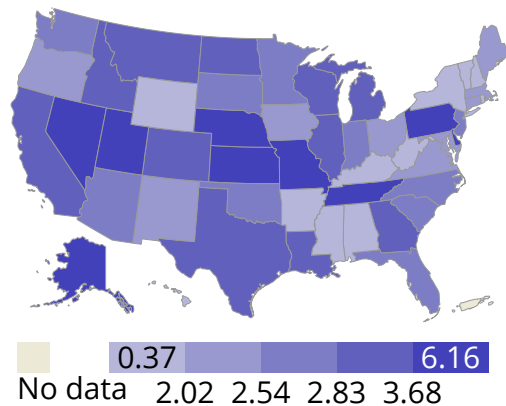
**Figure HR 28. Deaths within six months after removal among adult heart waitlist candidates.** Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.



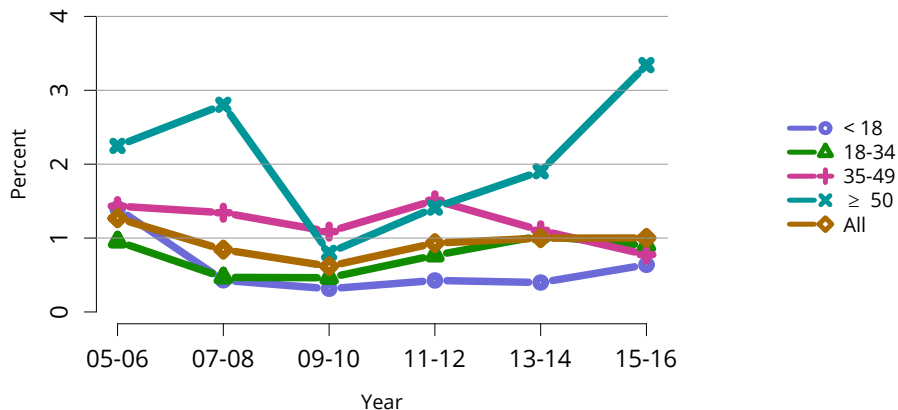
**Figure HR 29. Deceased heart donors by age.** Deceased donors whose hearts were recovered for transplant.



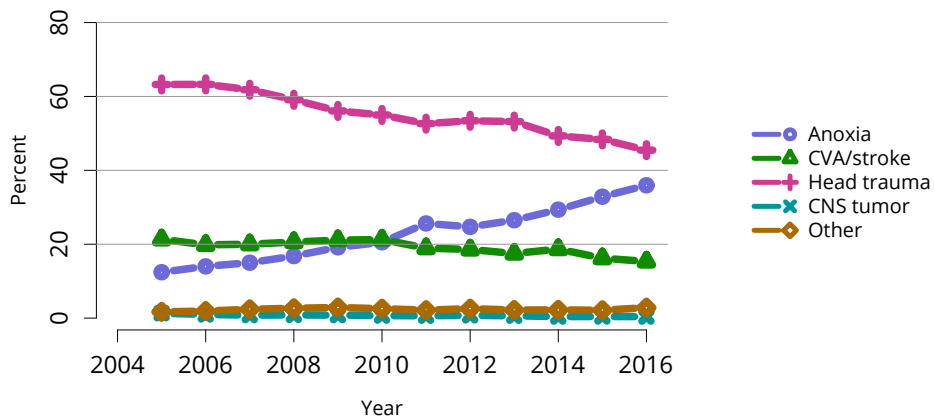
**Figure HR 30. Deceased heart donors by race.** Deceased donors whose hearts were recovered for transplant.



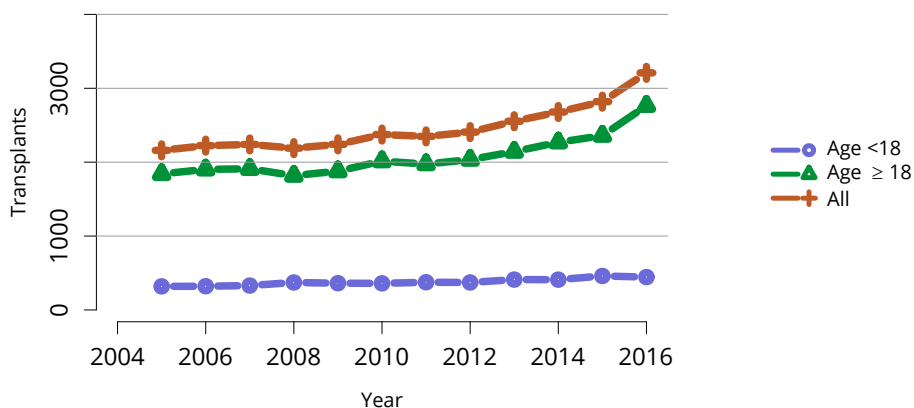
**Figure HR 31. Deceased donor heart donation rates (per 1000 deaths) by state, 2013-2015.** Numerator: Deceased donors aged < 70 years, by state of death, whose heart was recovered for transplant from 2013 through 2015. Denominator: US deaths aged < 70 years, by state of death, from 2013 through 2015. State death data by age obtained through agreement with NAPHSIS (<https://www.naphsis.org/research-requests>).



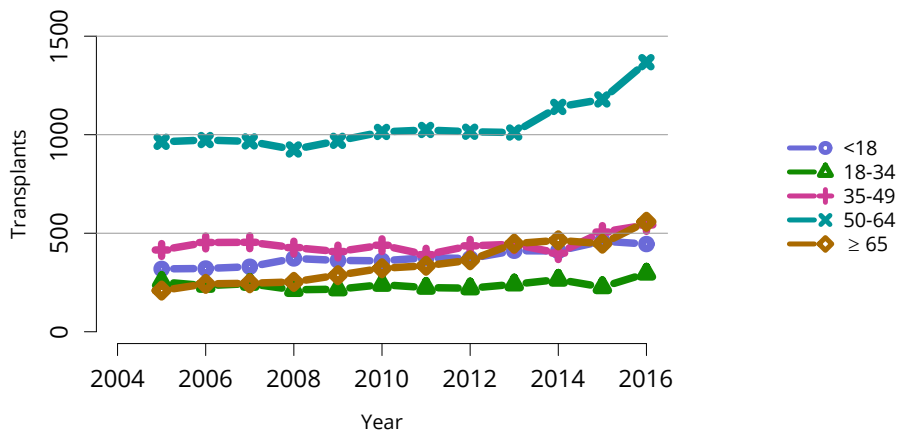
**Figure HR 32. Rates of hearts recovered for transplant and not transplanted by age.** Percentages of hearts not transplanted out of all hearts recovered for transplant.



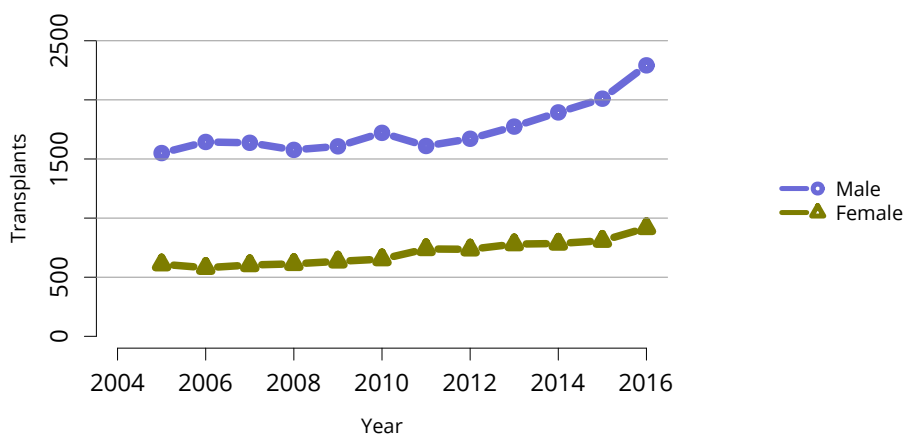
**Figure HR 33. Cause of death among deceased heart donors.** Deceased donors whose hearts were transplanted. CNS, central nervous system; CVA, cerebrovascular accident.



**Figure HR 34. Total heart transplants.** All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

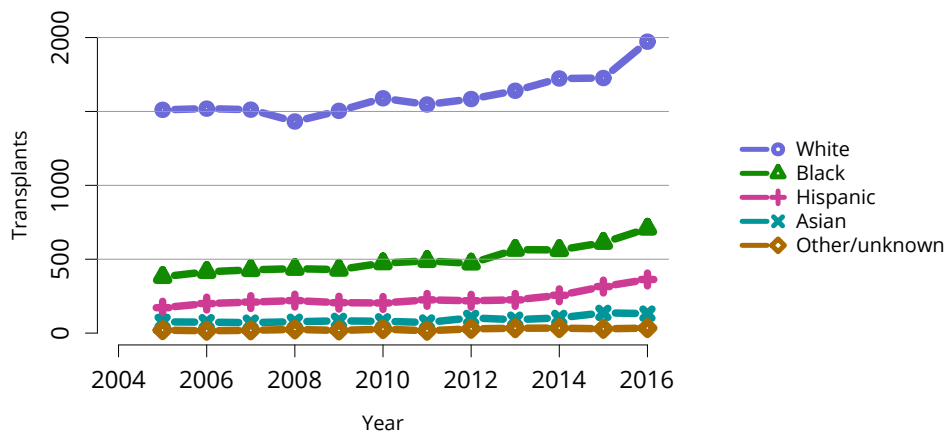


**Figure HR 35. Total heart transplants by age.** All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

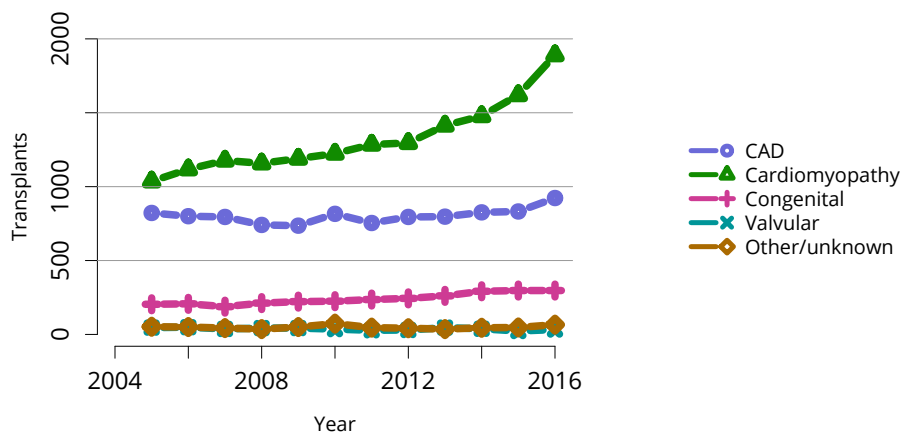


**Figure HR 36. Total heart transplants by sex.** All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

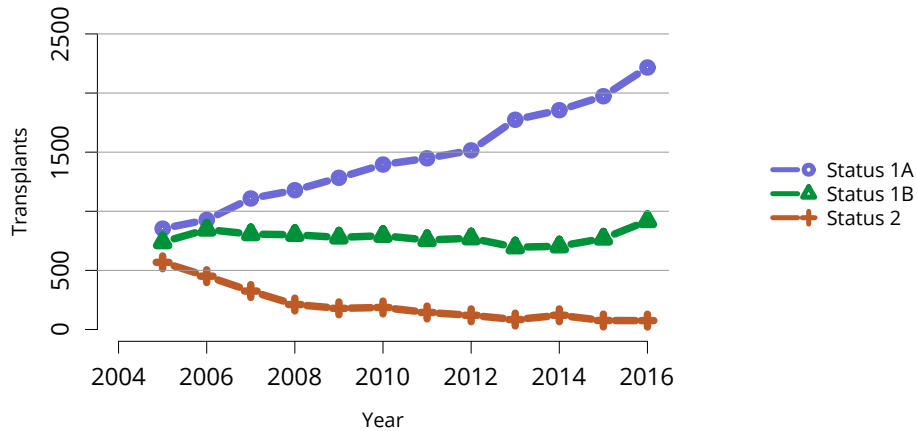




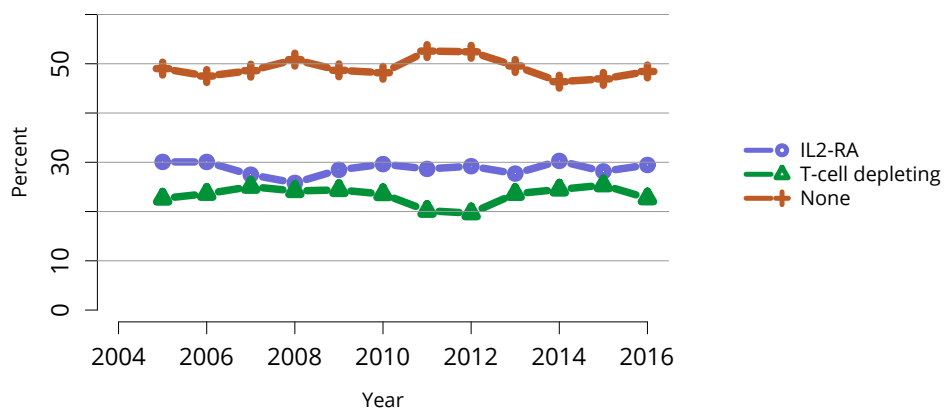
**Figure HR 37. Total heart transplants by race.** All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.



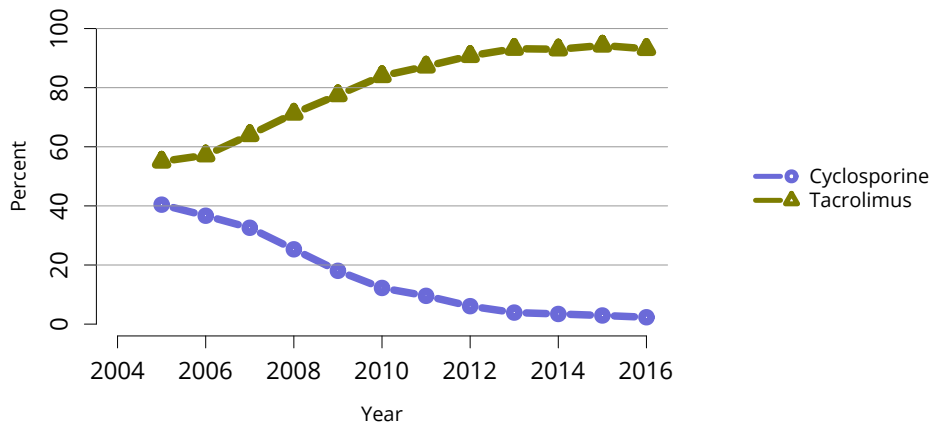
**Figure HR 38. Total heart transplants by diagnosis.** All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients. CAD, coronary artery disease.



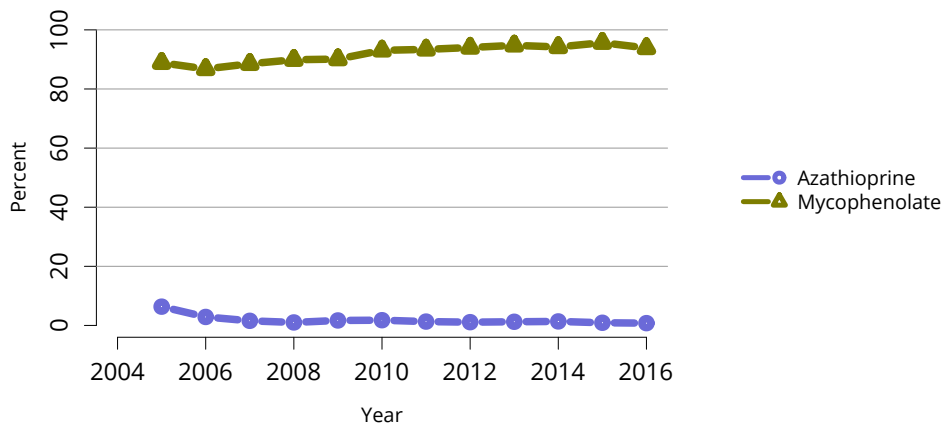
**Figure HR 39. Total heart transplants by medical urgency.** All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.



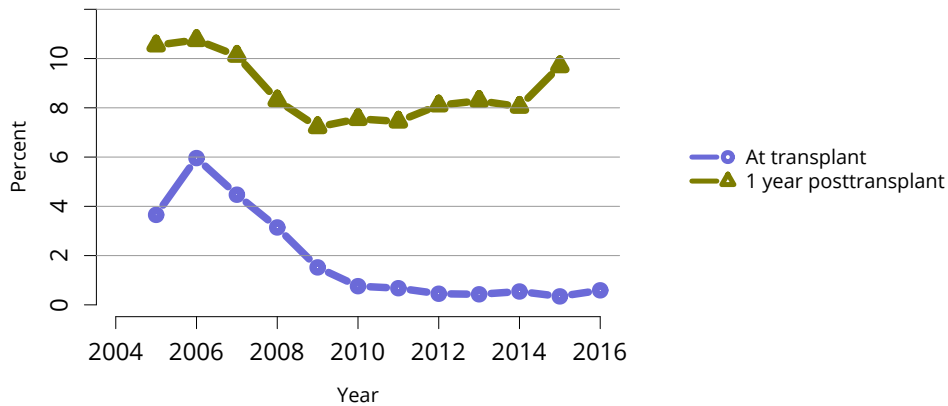
**Figure HR 40. Induction agent use in adult heart transplant recipients.** Immunosuppression at transplant reported to the OPTN. IL2-RA, interleukin-2 receptor antagonist.



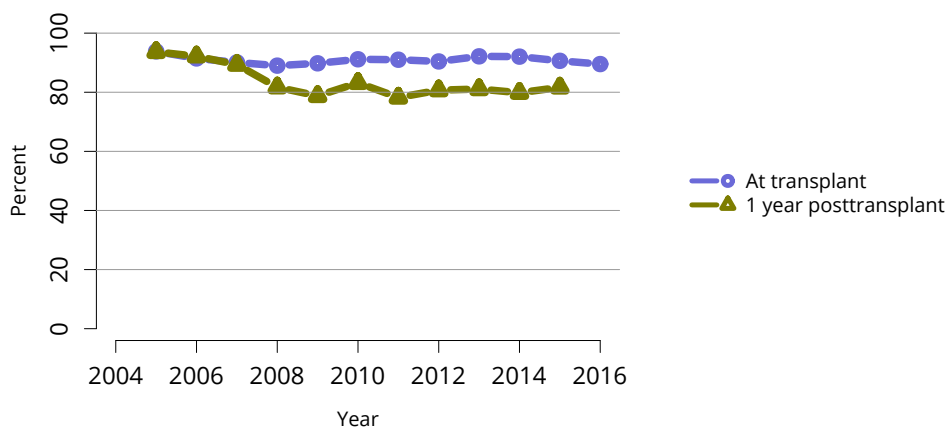
**Figure HR 41. Calcineurin inhibitor use in adult heart transplant recipients.** Immunosuppression at transplant reported to the OPTN.



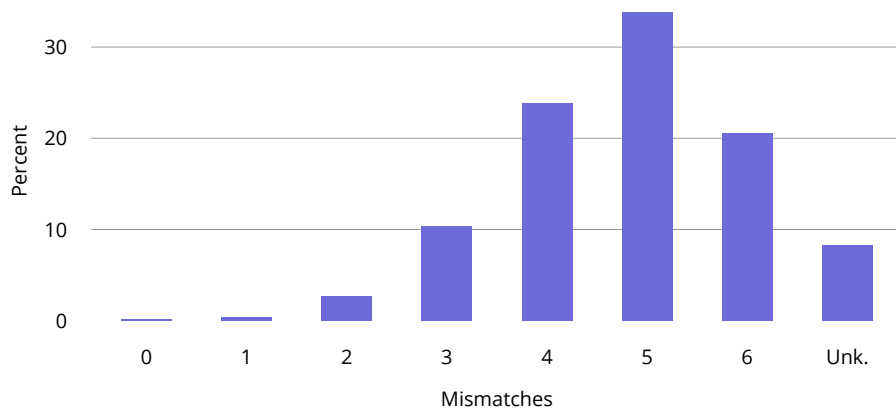
**Figure HR 42. Anti-metabolite use in adult heart transplant recipients.** Immunosuppression at transplant reported to the OPTN. Mycophenolate includes mycophenolate mofetil and mycophenolate sodium.



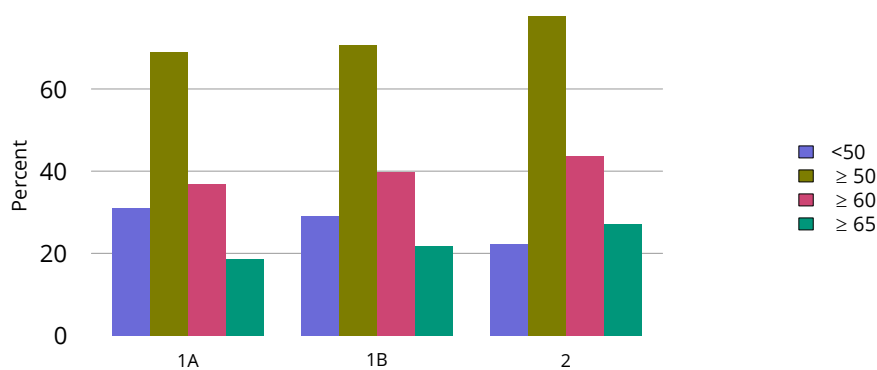
**Figure HR 43. mTOR inhibitor use in adult heart transplant recipients.** Immunosuppression at transplant reported to the OPTN. One-year posttransplant data are limited to patients alive with graft function at 1 year posttransplant. mTOR, mammalian target of rapamycin.



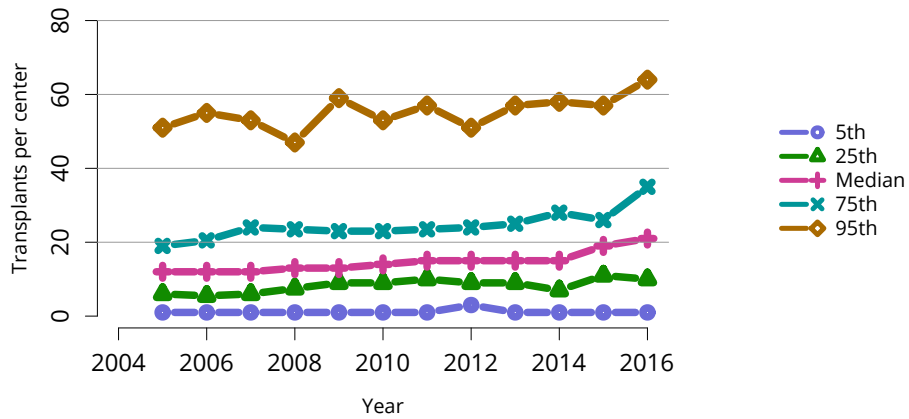
**Figure HR 44. Steroid use in adult heart transplant recipients.** Immunosuppression at transplant reported to the OPTN. One-year posttransplant data are limited to patients alive with graft function at 1 year posttransplant.



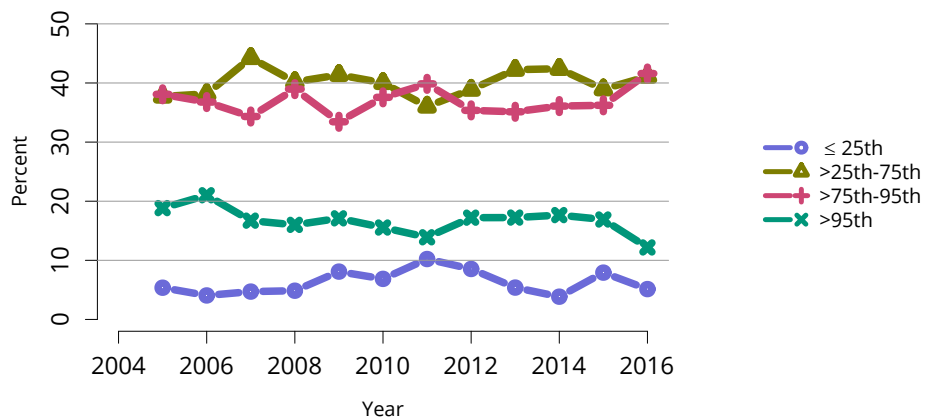
**Figure HR 45. Total HLA A, B, and DR mismatches among adult deceased donor heart transplant recipients, 2012-2016.** Donor and recipient antigen matching is based on OPTN antigen values and split equivalences policy as of 2016.



**Figure HR 46. Status of adult heart transplant recipients, 2014-2016, by age.** Age categories are not exclusive. All recipients aged 65 or older, for example, are also included among those aged 60 or older and 50 or older.

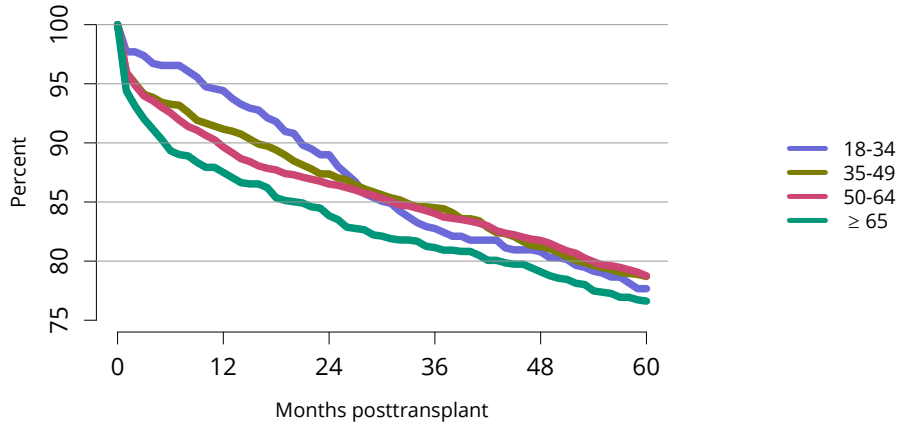


**Figure HR 47. Annual adult heart transplant center volumes, by percentile.** Annual volume data are limited to recipients aged 18 or older.

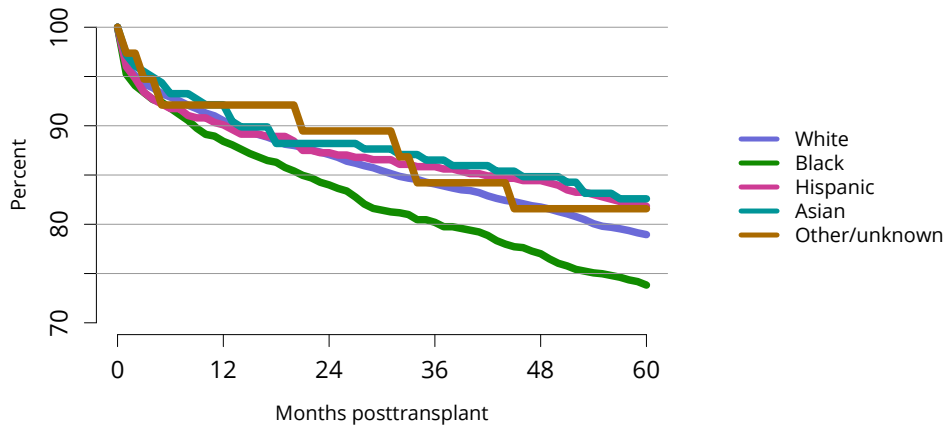


**Figure HR 48. Distribution of adult heart transplants by percentile of center volume.** Percentiles are based on annual volume data among recipients aged 18 or older.

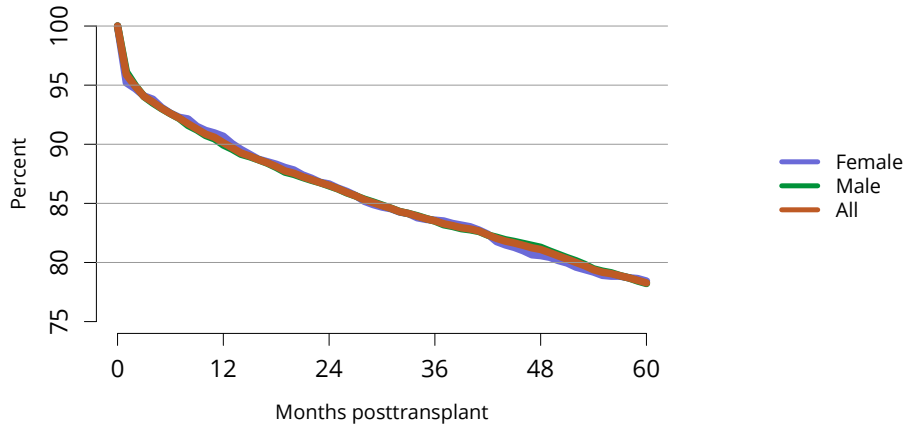




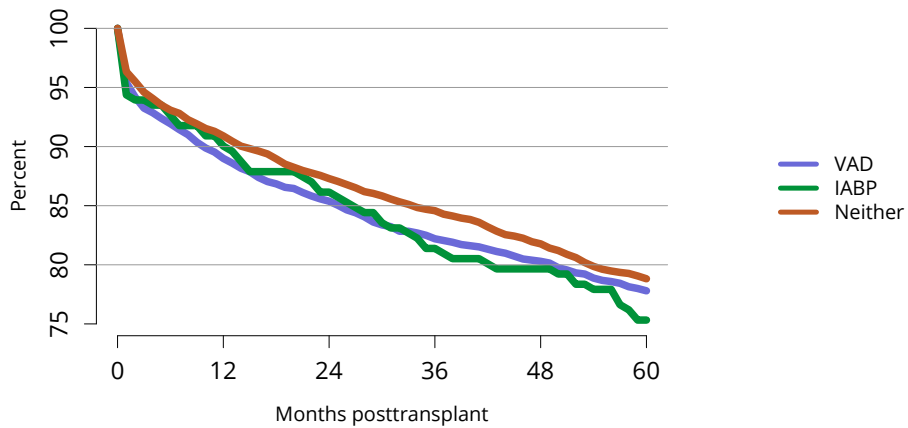
**Figure HR 49. Patient survival among adult heart transplant recipients, 2009-2011, by age.** Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.



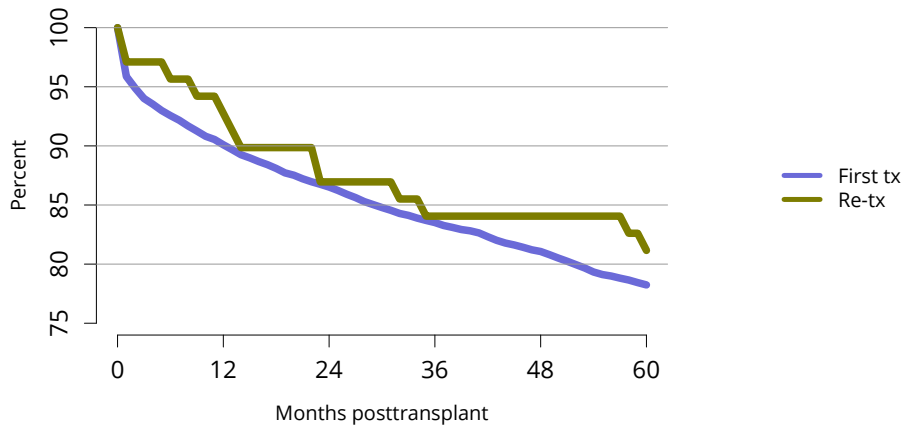
**Figure HR 50. Patient survival among adult heart transplant recipients, 2009-2011, by race.** Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.



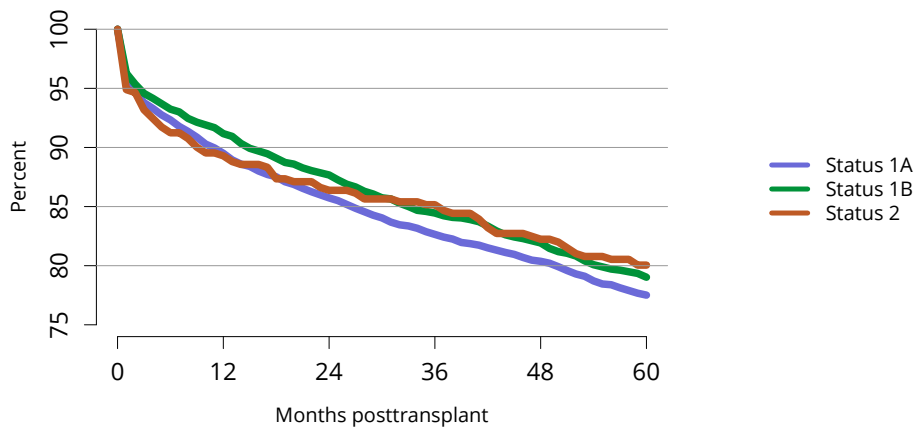
**Figure HR 51. Patient survival among adult heart transplant recipients, 2009-2011, by sex.** Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.



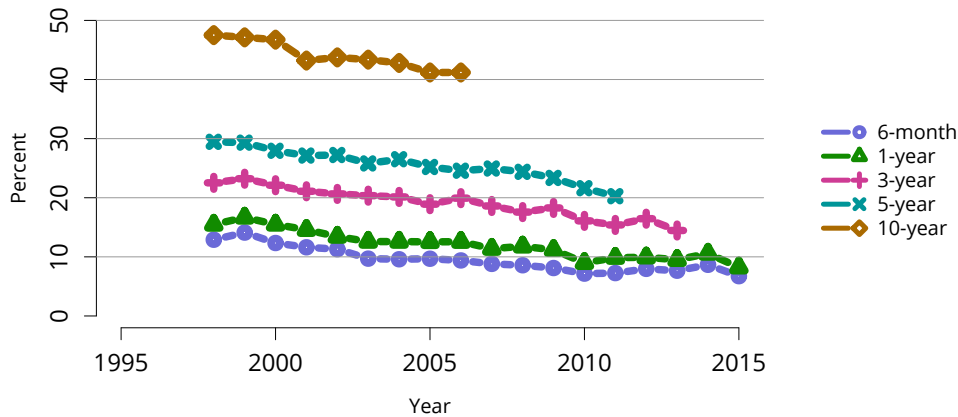
**Figure HR 52. Patient survival among adult heart transplant recipients, 2009-2011, by circulatory support.** Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered. Ventricular assist device (VAD) status at time of transplant. IABP, intra-aortic balloon pump.



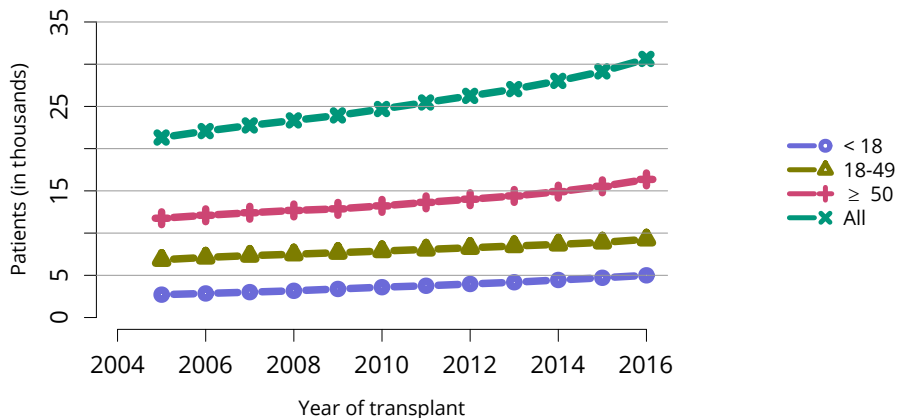
**Figure HR 53. Patient survival among adult heart transplant recipients, 2009-2011, by first vs. retransplant.** Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.



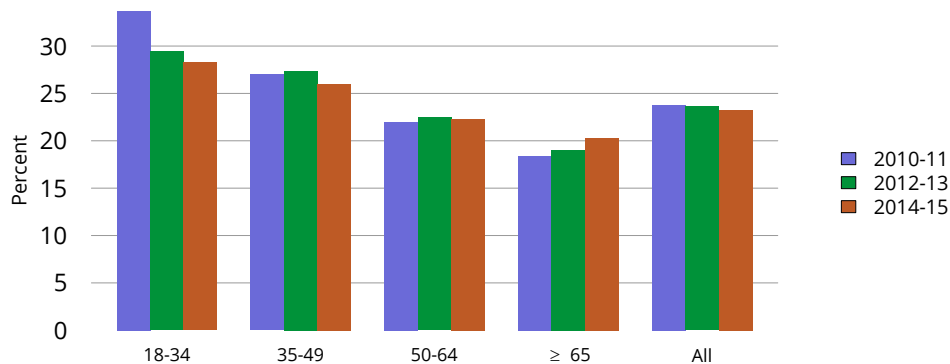
**Figure HR 54. Patient survival among adult heart transplant recipients, 2009-2011, by medical urgency.** Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.



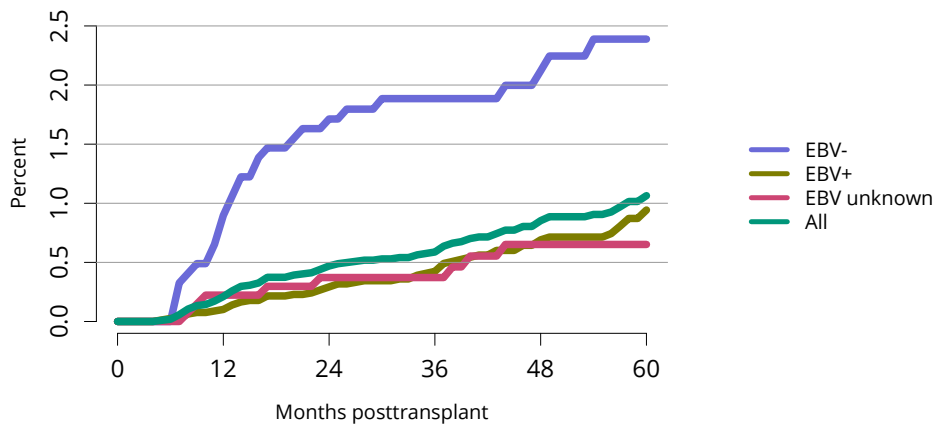
**Figure HR 55. Patient death among adult heart transplant recipients.** All adult recipients of deceased donor hearts, including multi-organ transplants. Patients are followed until the earlier of death or December 31, 2016. Estimates computed with Cox proportional hazards models adjusted for age, sex, and race.



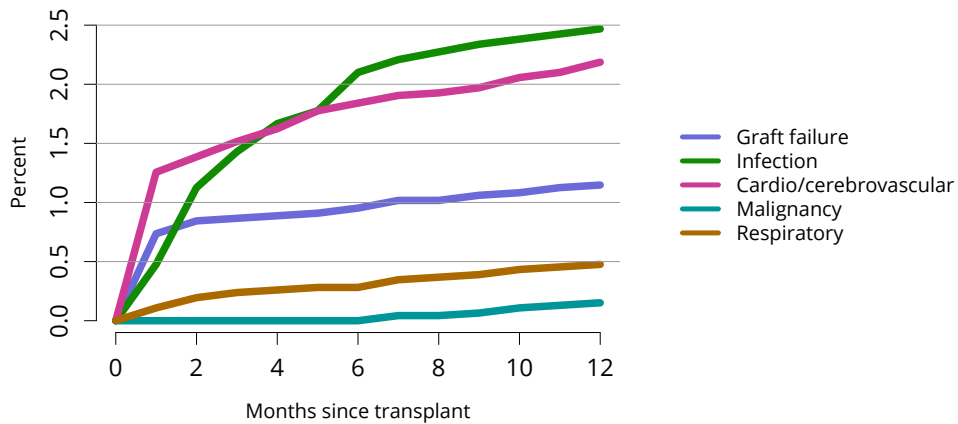
**Figure HR 56. Recipients alive with a functioning heart graft on June 30 of the year, by age at transplant.** Recipients are assumed to be alive with function unless a death or graft failure is recorded. A recipient may experience a graft failure and be removed from the cohort, undergo retransplant, and re-enter the cohort.



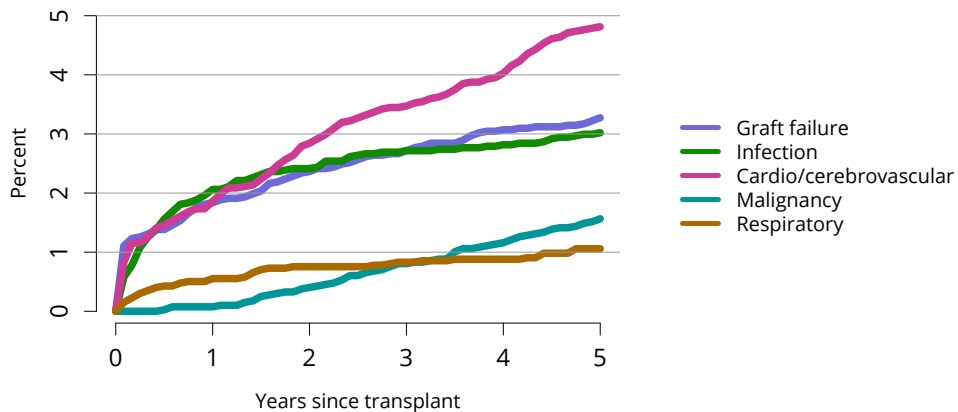
**Figure HR 57. Incidence of acute rejection by 1 year posttransplant among adult heart transplant recipients by age.** Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method.



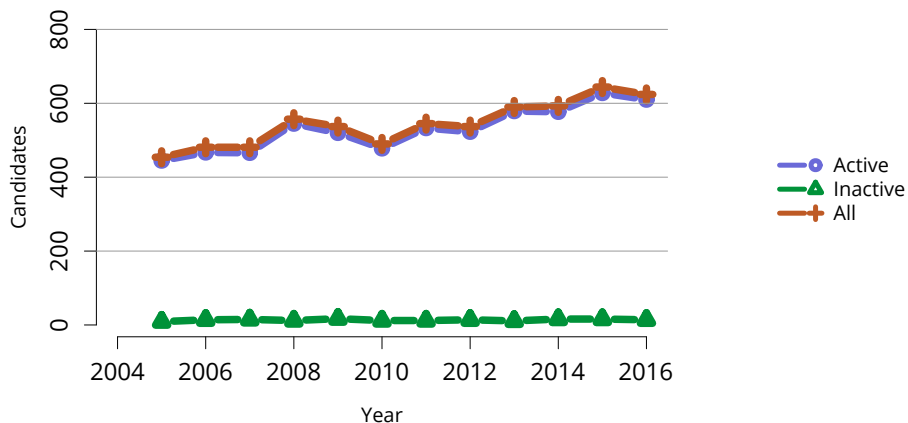
**Figure HR 58. Incidence of PTLD among adult heart transplant recipients by recipient EBV status at transplant, 2010-2014.** Cumulative incidence is estimated using the Kaplan-Meier competing risk method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient 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.



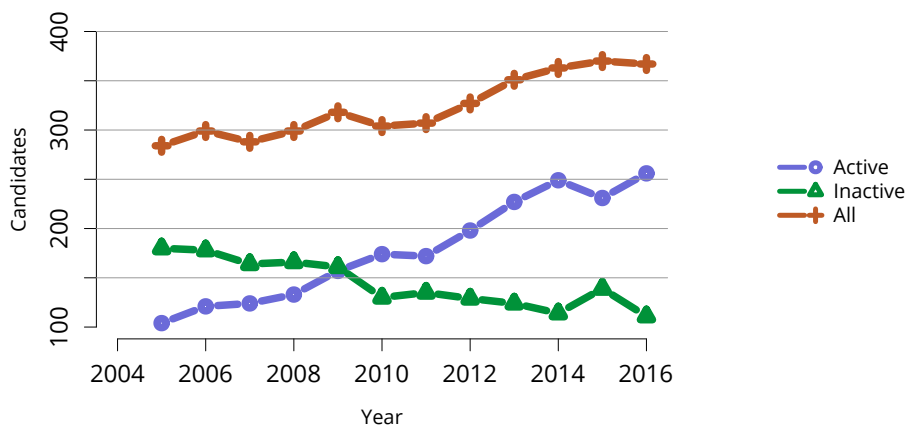
**Figure HR 59. One-year cumulative incidence of death by cause among adult heart recipients, 2014-2015.** Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.



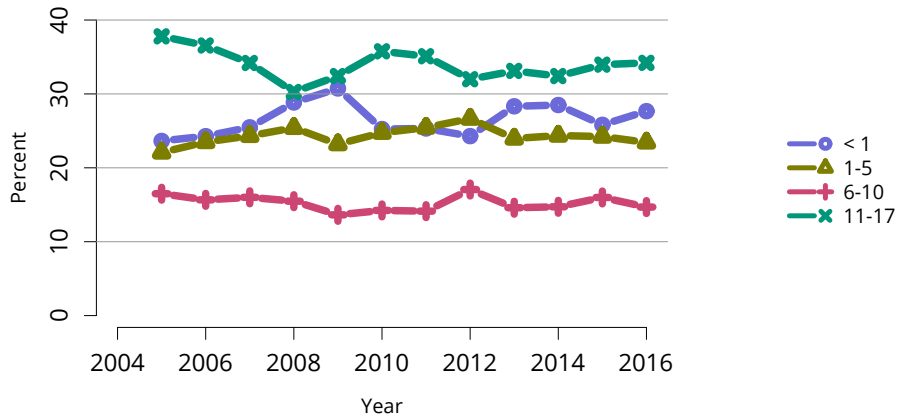
**Figure HR 60. Five-year cumulative incidence of death by cause among adult heart recipients, 2010-2011.** Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.



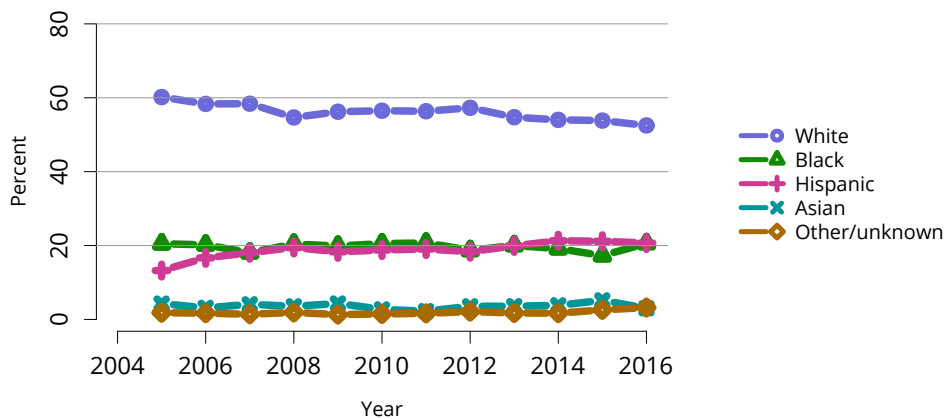
**Figure HR 61. New pediatric candidates added to the heart transplant waiting list.** A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates concurrently listed at multiple centers are counted once. Active and inactive patients are included. Age determined at listing.



**Figure HR 62. Pediatric candidates listed for heart transplant on December 31 each year.** Candidates concurrently listed at multiple centers are counted once. Those with concurrent listings and active at any program are considered active.

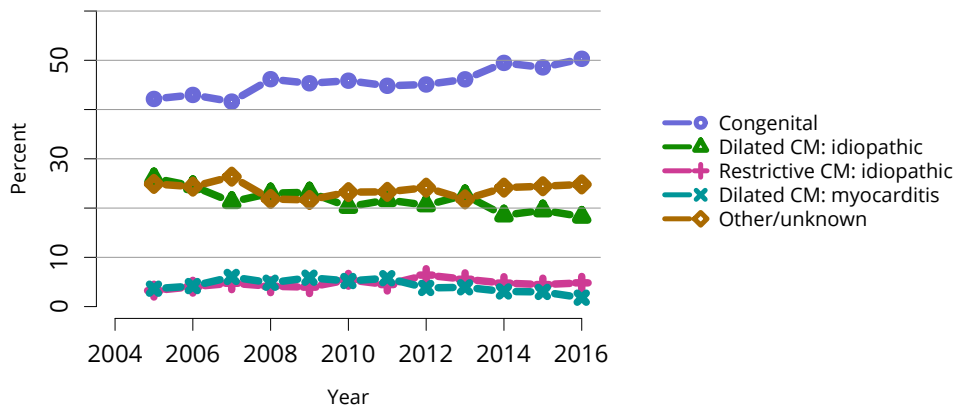


**Figure HR 63. Distribution of pediatric candidates waiting for heart transplant by age.** Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Age is determined at the later of listing date or January 1 of the given year. Active and inactive candidates are included.

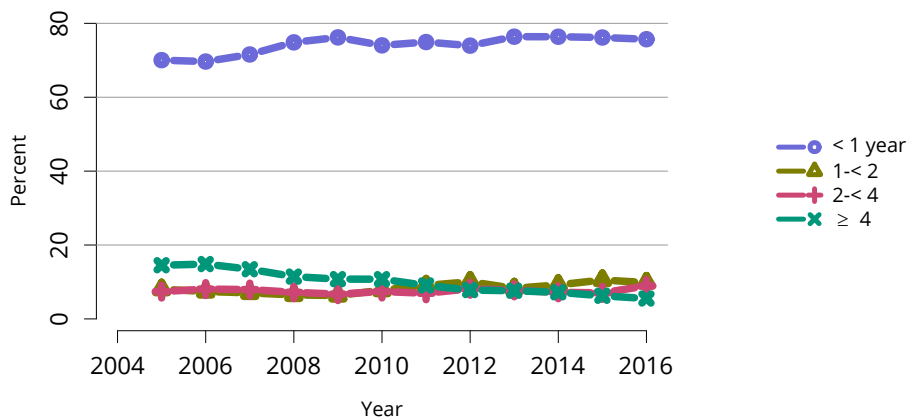


**Figure HR 64. Distribution of pediatric candidates waiting for heart transplant by race.** Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive candidates are included.

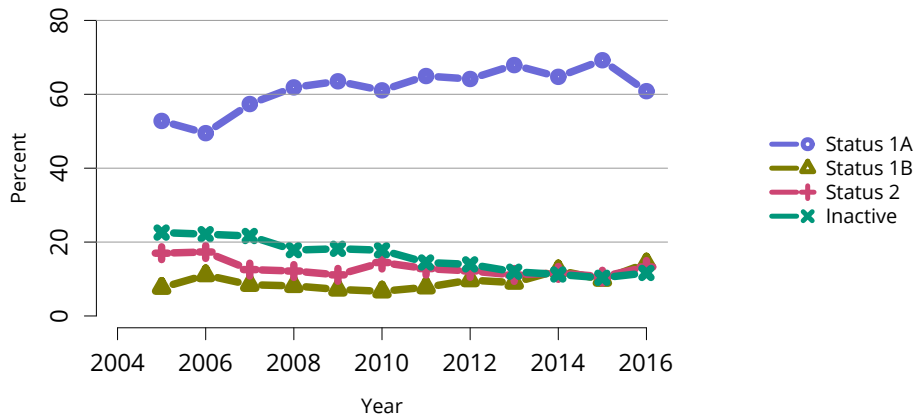




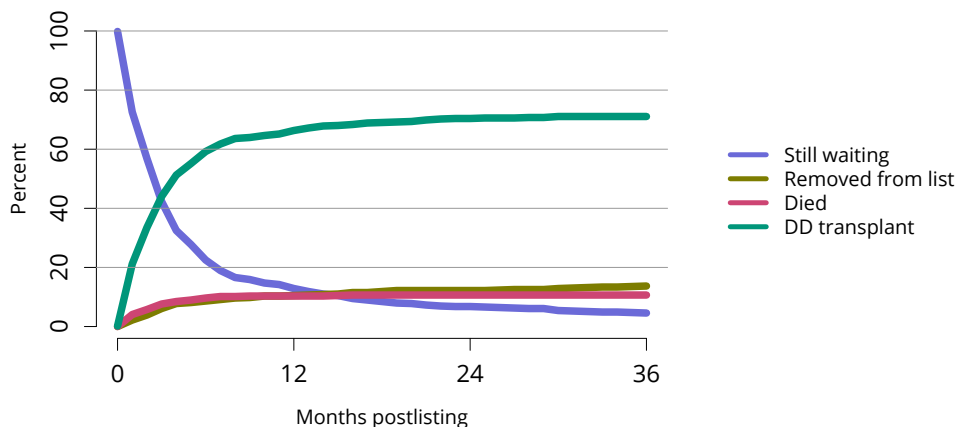
**Figure HR 65. Distribution of pediatric candidates waiting for heart transplant by diagnosis.** Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive candidates are included. CM, cardiomyopathy.



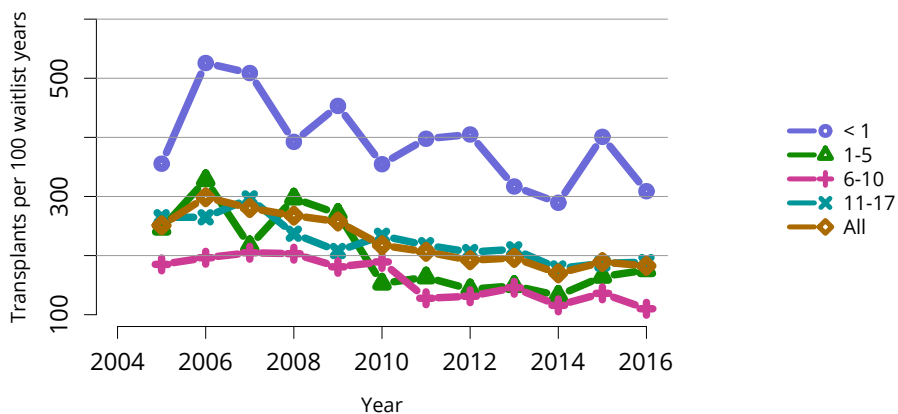
**Figure HR 66. Distribution of pediatric candidates waiting for heart transplant by waiting time.** Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Time on the waiting list is determined at the earlier of December 31 or removal from the waiting list. Active and inactive candidates are included.



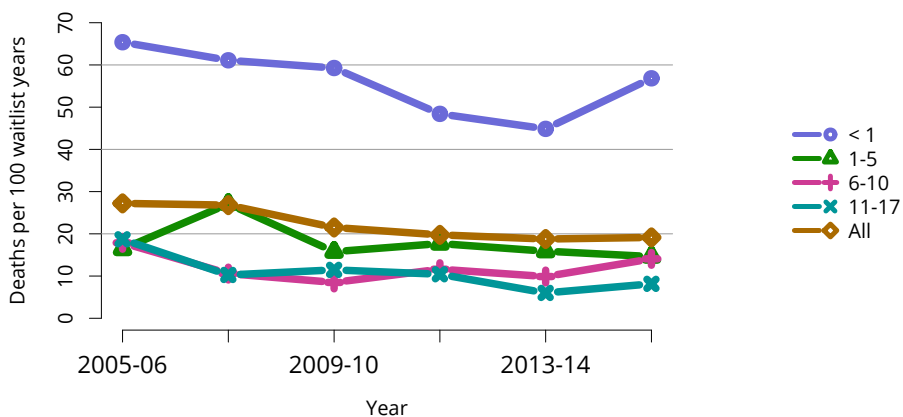
**Figure HR 67. Distribution of pediatric candidates waiting for heart transplant by medical urgency.** Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Medical urgency status is the most severe during the year. Active and inactive patients are included.



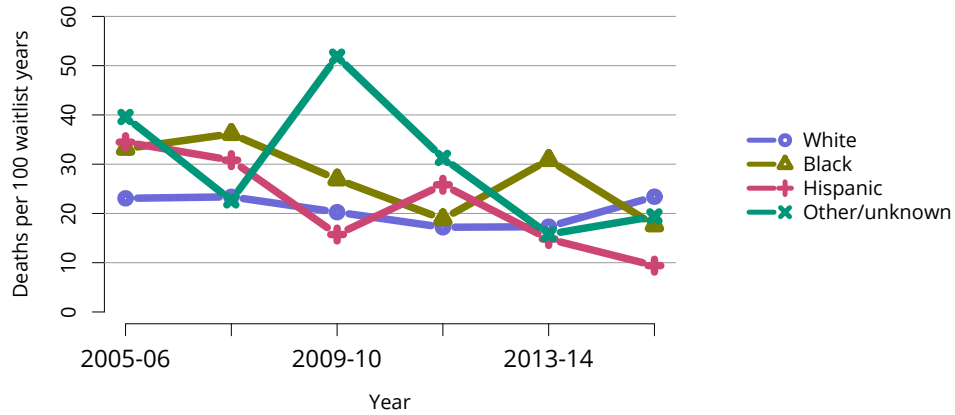
**Figure HR 68. Three-year outcomes for newly listed pediatric candidates waiting for heart transplant, 2013.** Pediatric candidates who joined the waitlist in 2013. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. DD, deceased donor.



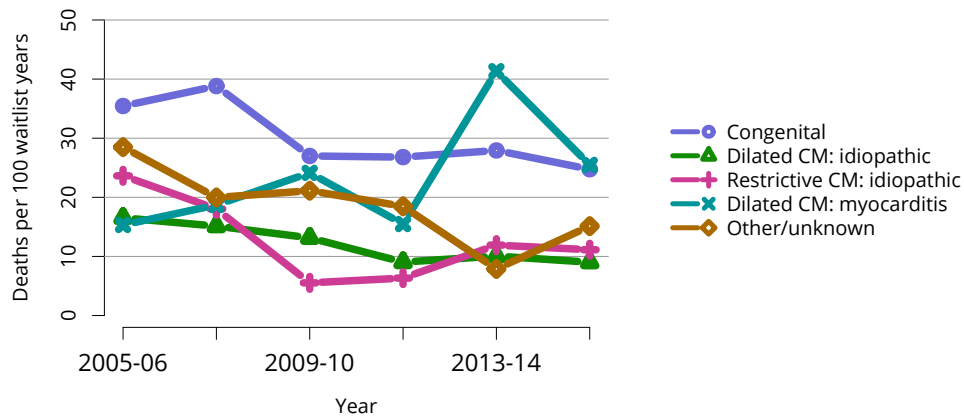
**Figure HR 69. Heart transplant rates among active pediatric waitlist candidates by age.** Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active waiting in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Rates with less than 10 patient-years of exposure are not shown.



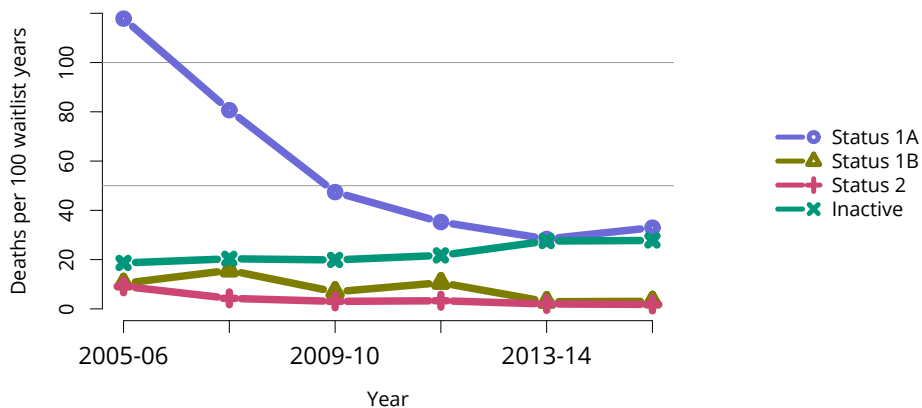
**Figure HR 70. Pretransplant mortality rates among pediatrics waitlisted for heart transplant by age.** Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Rates with less than 10 patient-years of exposure are not shown.



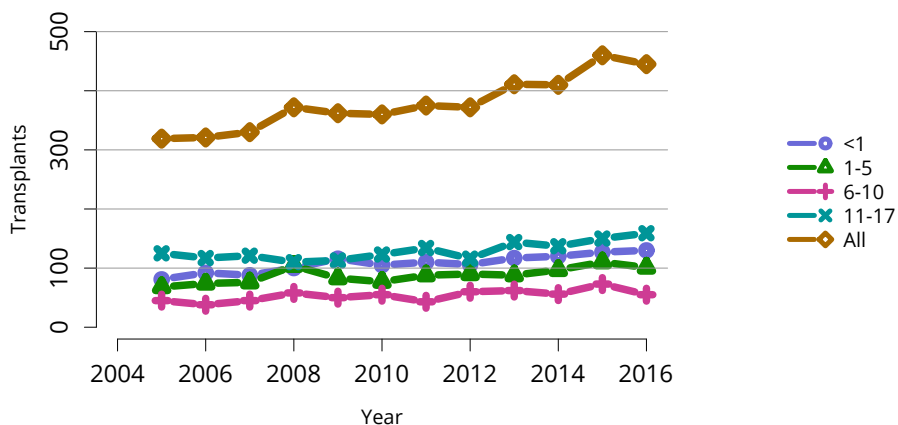
**Figure HR 71. Pretransplant mortality rates among pediatric heart transplant waitlisted for heart transplant by race.** Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.



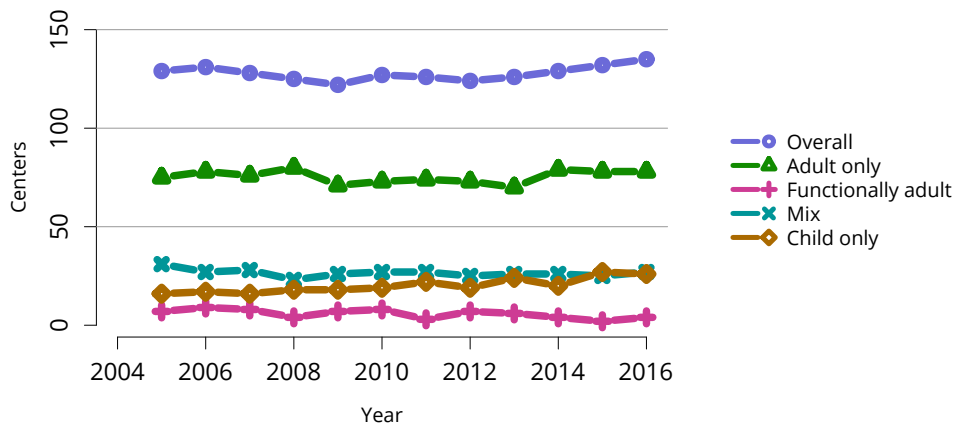
**Figure HR 72. Pretransplant mortality rates among pediatric heart transplant waitlisted for heart transplant by diagnosis.** Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. CM, cardiomyopathy.



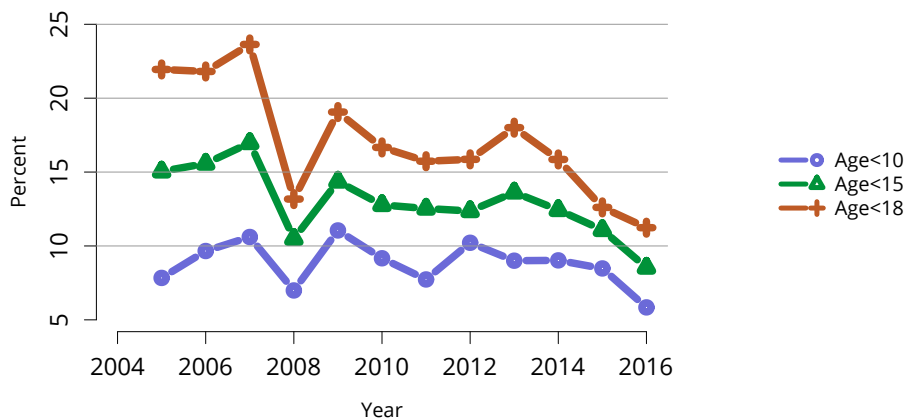
**Figure HR 73. Pretransplant mortality rates among pediatric heart transplant waitlisted for heart transplant by medical urgency.** Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.



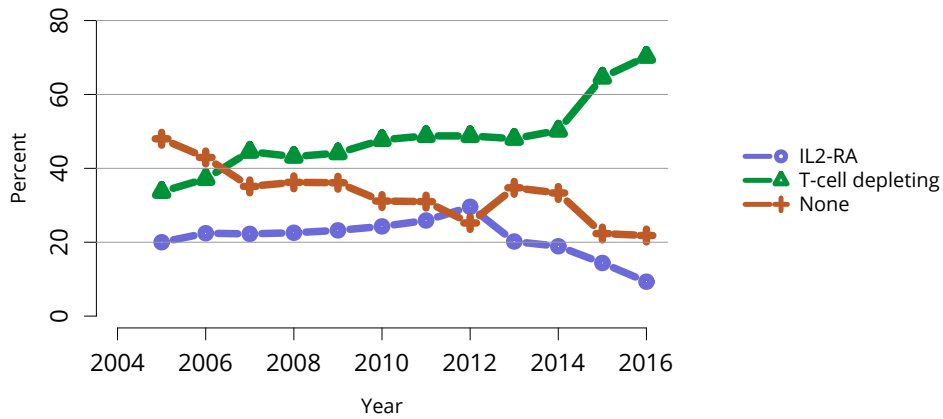
**Figure HR 74. Pediatric heart transplants by age.** All pediatric heart transplant recipients, including retransplant, and multi-organ recipients.



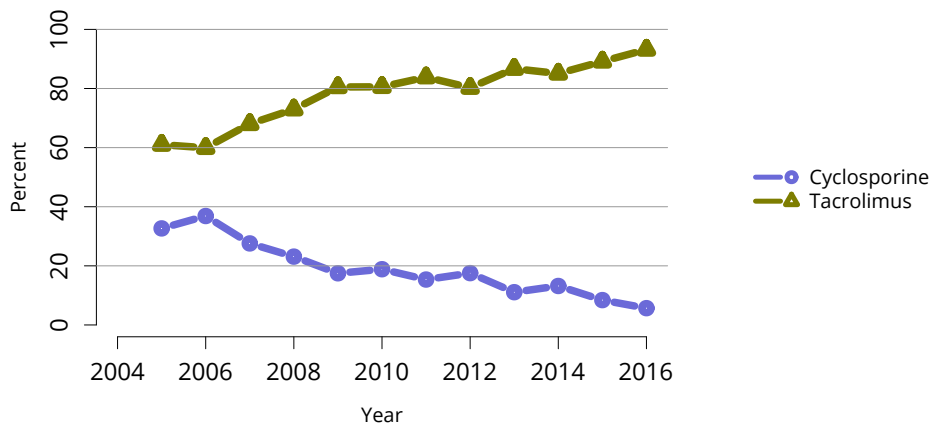
**Figure HR 75. Number of centers performing pediatric and adult heart transplants by center's age mix.** Adult centers transplanted only recipients aged 18 years or older. Functionally adult centers transplant 80% adults or more, and the remainder were children aged 15-17 years. Mixed included adults and children of any age groups. Child only centers transplanted recipients aged 0-17 years, and small number of adults up to age 21 years.



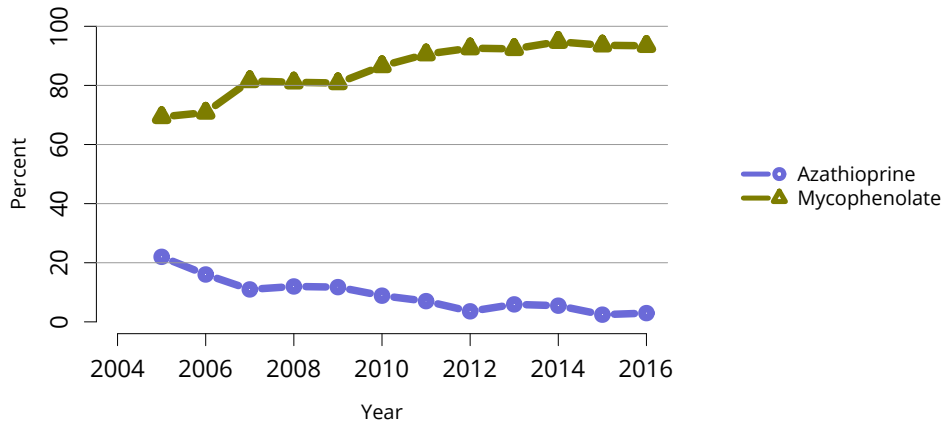
**Figure HR 76. Pediatric heart recipients at programs that perform 5 or fewer pediatric transplants annually.** Age groups are cumulative.



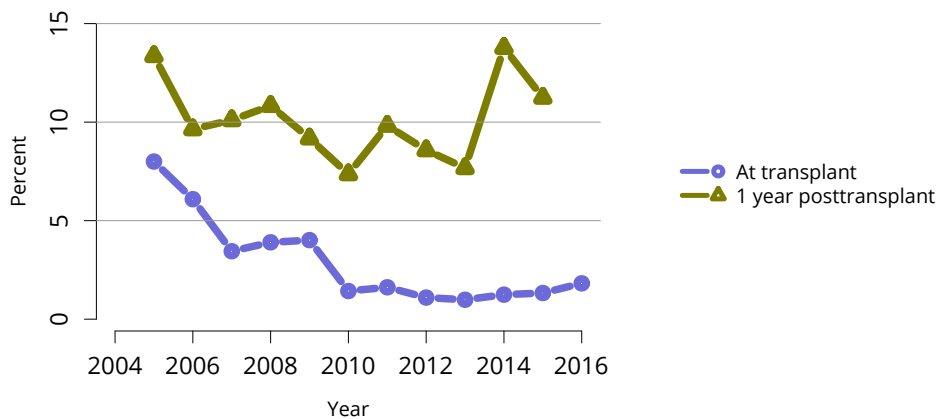
**Figure HR 77. Induction agent use in pediatric heart transplant recipients.** Immunosuppression at transplant reported to the OPTN. IL2-RA, interleukin-2 receptor antagonist.



**Figure HR 78. Calcineurin inhibitor use in pediatric heart transplant recipients.** Immunosuppression at transplant reported to the OPTN.

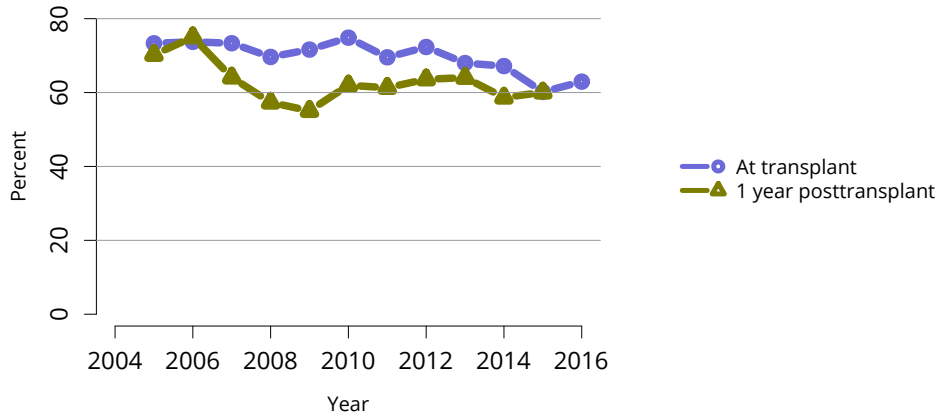


**Figure HR 79. Anti-metabolite use in pediatric heart transplant recipients.** Immunosuppression at transplant reported to the OPTN. Mycophenolate includes mycophenolate mofetil and mycophenolate sodium.

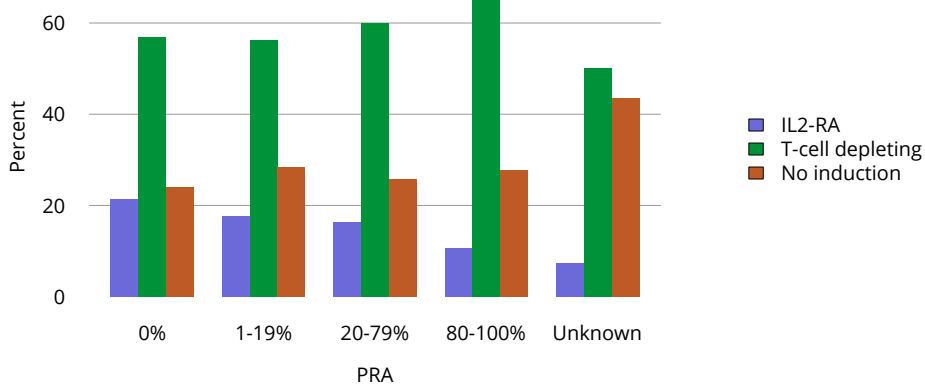


**Figure HR 80. mTOR inhibitor use in pediatric heart transplant recipients.** Immunosuppression at transplant reported to the OPTN. One-year posttransplant data are limited to patients alive with graft function at 1 year posttransplant. mTOR, mammalian target of rapamycin.

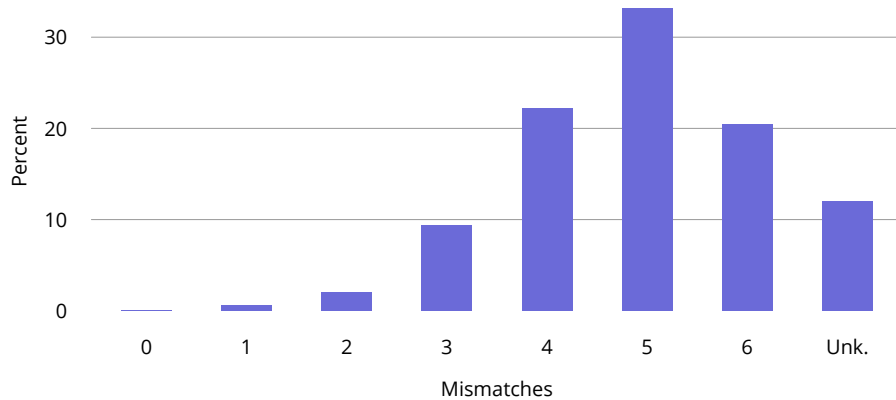




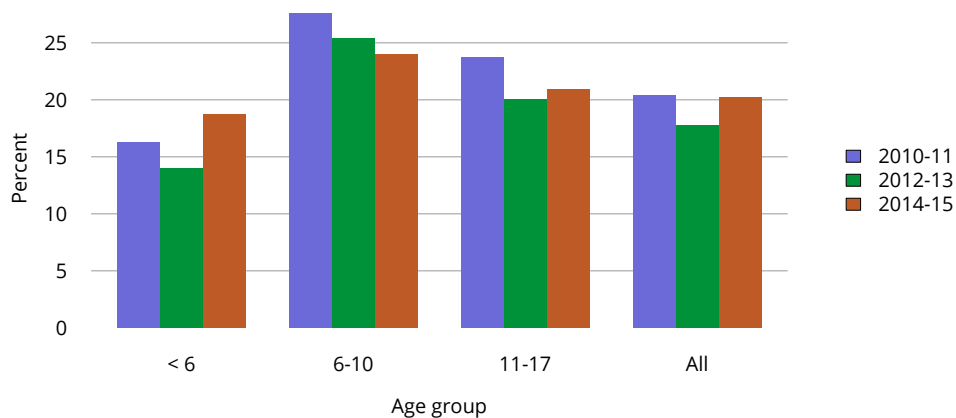
**Figure HR 81. Steroid use in pediatric heart transplant recipients.** Immunosuppression at transplant reported to the OPTN. One-year posttransplant data are limited to patients alive with graft function at 1 year posttransplant.



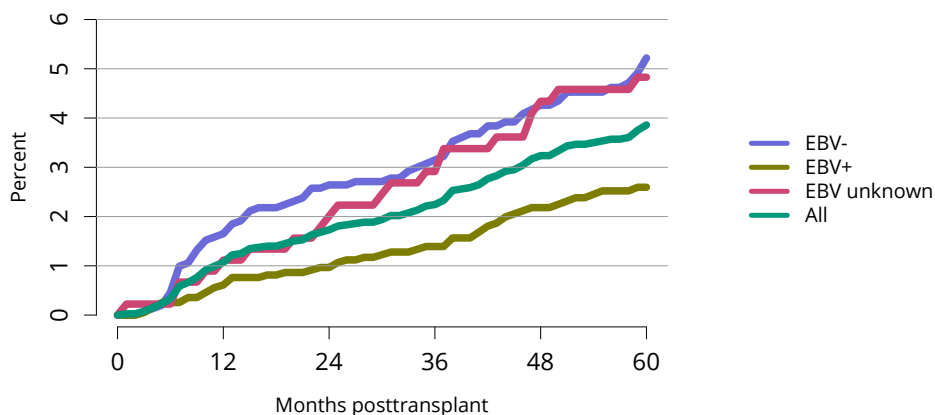
**Figure HR 82. Induction use by C/PRA among pediatric heart transplant recipients, 2012-2016.** Collection of calculated PRA (CPRA) began March 31, 2015. Prior to that, PRA class I and II values were used. IL2-RA, interleukin-2 receptor antagonist.



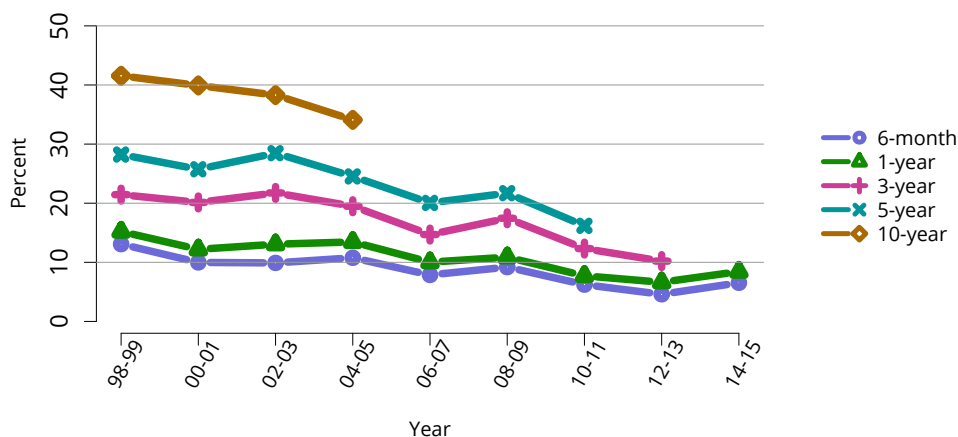
**Figure HR 83. Total HLA A, B, and DR mismatches among pediatric deceased donor heart transplant recipients, 2012-2016.** Donor and recipient antigen matching is based on OPTN antigen values and split equivalences policy as of 2016.



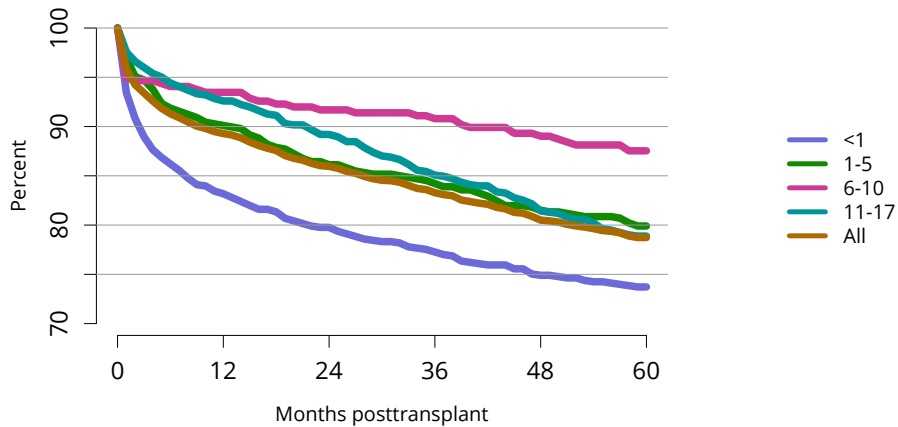
**Figure HR 84. Incidence of acute rejection by 1 year posttransplant among pediatric heart transplant recipients by age.** Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration Form or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method.



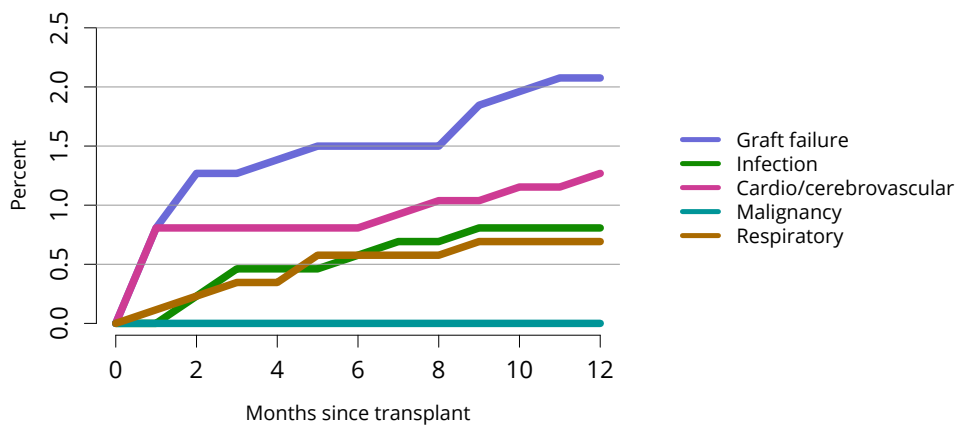
**Figure HR 85. Incidence of PTLD among pediatric heart transplant recipients by recipient EBV status at transplant, 2004-2014.** Cumulative incidence is estimated using the Kaplan-Meier competing risk method. Posttransplant lymphoproliferative disorder (PTLD) is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or on the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus.



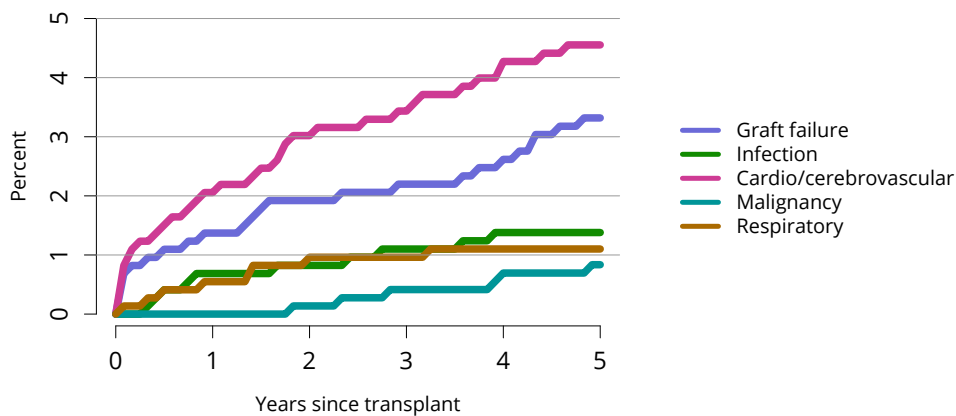
**Figure HR 86. Patient death among pediatric heart transplant recipients.** All pediatric recipients of deceased donor hearts, including multi-organ transplants. Patients are followed until the earlier of death or December 31, 2016. Estimates computed with Cox proportional hazards models adjusted for age, sex, and race.



**Figure HR 87. Patient survival among pediatric deceased donor heart transplant recipients, 2004-2011, by age.** Recipient survival estimated using unadjusted Kaplan-Meier methods.



**Figure HR 88. One-year cumulative incidence of death by cause among pediatric heart recipients, 2014-2015.** Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.



**Figure HR 89. Five-year cumulative incidence of death by cause among pediatric heart recipients, 2010-2011.** Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

Characteristic	2006		2016	
	N	Percent	N	Percent
Age				
18-34 years	265	10.4%	398	11.0%
35-49 years	602	23.6%	863	23.8%
50-64 years	1335	52.3%	1715	47.2%
≥ 65 years	349	13.7%	656	18.1%
Sex				
Female	617	24.2%	858	23.6%
Male	1934	75.8%	2774	76.4%
Race/ethnicity				
White	1885	73.9%	2227	61.3%
Black	410	16.1%	964	26.5%
Hispanic	182	7.1%	320	8.8%
Asian	54	2.1%	102	2.8%
Other/unknown	20	0.8%	19	0.5%
All candidates	2551	100.0%	3632	100.0%

**Table HR 1 Demographic characteristics of adults on the heart transplant waiting list on December 31, 2006 and December 31, 2016.** Candidates waiting for transplant on December 31, 2006, and December 31, 2016, regardless of first listing date; multiple listings are collapsed.

Characteristic	2006		2016	
	N	Percent	N	Percent
Diagnosis				
Coronary artery disease	1063	41.7%	1148	31.6%
Cardiomyopathy	1147	45.0%	2094	57.7%
Congenital disease	135	5.3%	175	4.8%
Valvular disease	70	2.7%	36	1.0%
Other/unknown	136	5.3%	179	4.9%
Blood type				
A	741	29.0%	1095	30.1%
B	257	10.1%	420	11.6%
AB	57	2.2%	86	2.4%
O	1496	58.6%	2031	55.9%
Medical urgency				
Status 1A	66	2.6%	391	10.8%
Status 1B	266	10.4%	1626	44.8%
Status 2	911	35.7%	845	23.3%
Inactive status	1308	51.3%	770	21.2%
VAD at listing	145	5.7%	1166	32.1%
All candidates	2551	100.0%	3632	100.0%

**Table HR 2 Clinical characteristics of adults on the heart transplant waiting list on December 31, 2006 and December 31, 2016.** Candidates waiting for transplant on December 31, 2006, and December 31, 2016, regardless of first listing date; multiple listings are collapsed. VAD, ventricular assist device.

Characteristic	2006		2016	
	N	Percent	N	Percent
Transplant history				
First	2478	97.1%	3515	96.8%
Retransplant	73	2.9%	117	3.2%
Wait time				
< 1 year	919	36.0%	1826	50.3%
1-< 2 years	347	13.6%	785	21.6%
2-< 3 years	247	9.7%	449	12.4%
3-< 4 years	212	8.3%	225	6.2%
4-< 5 years	171	6.7%	126	3.5%
≥ 5 years	655	25.7%	221	6.1%
Tx type				
Heart only	2378	93.2%	3362	92.6%
Heart-kidney	58	2.3%	191	5.3%
Heart-lung	104	4.1%	47	1.3%
Other	11	0.4%	32	0.9%
All candidates	2551	100.0%	3632	100.0%

**Table HR 3 Listing characteristics of adults on the heart transplant waiting list on December 31, 2006 and December 31, 2016.** Candidates waiting for transplant on December 31, 2006, and December 31, 2016, regardless of first listing date; multiple listings are collapsed.

<b>Waiting list state</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>
Patients at start of year	3339	3625	3787
Patients added during year	3613	3622	3630
Patients removed during year	3319	3456	3785
Patients at end of year	3633	3791	3632

**Table HR 4 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 relisted 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.



<b>Removal reason</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>
Deceased donor transplant	2228	2331	2734
Patient died	377	393	322
Patient refused transplant	22	24	25
Improved, transplant not needed	201	162	187
Too sick for transplant	271	299	264
Other	220	247	252

**Table HR 5 Removal reason among adult heart transplant candidates.** Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Support	2011		2016	
	N	Percent	N	Percent
Any life support	1553	78.7%	2372	85.8%
Intravenous inotropes	757	38.3%	974	35.2%
Left ventricular assist device	729	36.9%	1347	48.7%
Intra-aortic balloon pump	96	4.9%	211	7.6%
Right ventricular assist device	68	3.4%	39	1.4%
Ventilator	53	2.7%	36	1.3%
Total artificial heart	31	1.6%	38	1.4%
Extra corporeal membrane oxygenation	14	0.7%	33	1.2%
Prostaglandins	10	0.5%	0	0.0%
Inhaled NO	4	0.2%	3	0.1%

**Table HR 6 Adult heart recipients on circulatory support before transplant.** Patients may have more than one type of circulatory support.

Characteristic	2006		2016	
	N	Percent	N	Percent
Age				
18-34 years	234	12.3%	296	10.7%
35-49 years	453	23.8%	542	19.6%
50-64 years	973	51.1%	1368	49.5%
≥65 years	243	12.8%	558	20.2%
Sex				
Female	432	22.7%	722	26.1%
Male	1471	77.3%	2042	73.9%
Race/ethnicity				
White	1333	70.0%	1744	63.1%
Black	340	17.9%	620	22.4%
Hispanic	156	8.2%	261	9.4%
Asian	63	3.3%	120	4.3%
Other/unknown	11	0.6%	19	0.7%
Insurance				
Private	1056	55.5%	1205	43.6%
Medicare	536	28.2%	1082	39.1%
Medicaid	227	11.9%	325	11.8%
Other government	55	2.9%	96	3.5%
Unknown	29	1.5%	56	2.0%
All recipients	1903	100.0%	2764	100.0%

**Table HR 7 Demographic characteristics of adult heart transplant recipients, 2006 and 2016.** Adult heart transplant recipients, including retransplants.

Characteristic	2006		2016	
	N	Percent	N	Percent
Diagnosis				
Coronary artery disease	796	41.8%	917	33.2%
Cardiomyopathy	951	50.0%	1680	60.8%
Congenital disease	70	3.7%	79	2.9%
Valvular disease	48	2.5%	33	1.2%
Other/unknown	38	2.0%	55	2.0%
Blood type				
A	813	42.7%	1094	39.6%
B	265	13.9%	427	15.4%
AB	83	4.4%	158	5.7%
O	742	39.0%	1085	39.3%
Medical urgency				
Status 1A	705	37.0%	1863	67.4%
Status 1B	799	42.0%	837	30.3%
Status 2	399	21.0%	64	2.3%
On VAD	457	24.0%	1438	52.0%
CPRA				
< 1%	1171	61.5%	1335	48.3%
1-< 20%	341	17.9%	329	11.9%
20-< 80%	195	10.2%	475	17.2%
80-< 98%	52	2.7%	88	3.2%
98-100%	30	1.6%	48	1.7%
Unknown	114	6.0%	489	17.7%
All recipients	1903	100.0%	2764	100.0%

**Table HR 8 Clinical characteristics of adult heart transplant recipients, 2006 and 2016.** 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. Collection of calculated PRA (CPRA) began March 31, 2015. Prior to that, PRA class I and II values were used.

Characteristic	2006		2016	
	N	Percent	N	Percent
Wait time				
< 31 days	676	35.5%	649	23.5%
31-60 days	302	15.9%	339	12.3%
61-90 days	196	10.3%	214	7.7%
3-< 6 months	300	15.8%	463	16.8%
6-< 12 months	219	11.5%	447	16.2%
1-< 2 years	125	6.6%	390	14.1%
≥ 2 years	85	4.5%	262	9.5%
Transplant history				
First	1837	96.5%	2691	97.4%
Retransplant	66	3.5%	73	2.6%
Tx type				
Heart only	1835	96.4%	2589	93.7%
Heart-lung	24	1.3%	17	0.6%
Heart-kidney	39	2.0%	139	5.0%
Heart-liver	4	0.2%	18	0.7%
Other	1	0.1%	1	0.0%
All recipients	1903	100.0%	2764	100.0%

**Table HR 9 Transplant characteristics of adult heart transplant recipients, 2006 and 2016.** Adult heart transplant recipients, including retransplants.

<b>Donor</b>	<b>Recipient</b>	<b>CMV</b>	<b>EBV</b>	<b>HIV</b>
D-	R-	9.1%	0.7%	95.6%
D-	R+	12.7%	5.0%	0.3%
D-	R unk	16.6%	0.6%	3.1%
D+	R-	13.5%	9.8%	0.0%
D+	R+	21.3%	75.3%	0.0%
D+	R unk	26.4%	8.4%	0.0%
D unk	R-	0.1%	0.0%	1.1%
D unk	R+	0.1%	0.2%	0.0%
D unk	R unk	0.3%	0.0%	0.0%

**Table HR 10 Adult heart donor-recipient serology matching, 2012-2016.**

Donor serology is reported on the OPTN Donor Registration Form and recipient serology on the OPTN Transplant Recipient Registration Form. There may be multiple fields per serology. 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; HIV, human immunodeficiency virus.

Characteristic	2006		2016	
	N	Percent	N	Percent
Age				
< 1 year	31	12.4%	53	16.2%
1-5 years	74	29.5%	102	31.2%
6-10 years	67	26.7%	69	21.1%
11-17 years	79	31.5%	103	31.5%
Sex				
Female	114	45.4%	145	44.3%
Male	137	54.6%	182	55.7%
Race/ethnicity				
White	151	60.2%	168	51.4%
Black	44	17.5%	68	20.8%
Hispanic	43	17.1%	66	20.2%
Asian	10	4.0%	14	4.3%
Other/unknown	3	1.2%	11	3.4%
All candidates	251	100.0%	327	100.0%

**Table HR 11 Demographic characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2006, December 31, 2011, and December 31, 2016.** Candidates aged younger than 18 years waiting for transplant on December 31 of given year, regardless of first listing date; multiple listings are collapsed. Age calculated at snapshot.

Characteristic	2006		2016	
	N	Percent	N	Percent
Diagnosis				
Congenital defect	99	39.4%	181	55.4%
Idiopathic dilated CM	62	24.7%	51	15.6%
Familial dilated CM	2	0.8%	7	2.1%
Idiopathic restrictive CM	14	5.6%	19	5.8%
Myocarditis	14	5.6%	4	1.2%
Other/unknown	60	23.9%	65	19.9%
Blood type				
A	76	30.3%	82	25.1%
B	17	6.8%	54	16.5%
AB	7	2.8%	6	1.8%
O	151	60.2%	185	56.6%
Medical urgency				
Status 1A	33	13.1%	76	23.2%
Status 1B	27	10.8%	67	20.5%
Status 2	52	20.7%	93	28.4%
Inactive status	139	55.4%	91	27.8%
VAD at listing	8	3.2%	20	6.1%
All candidates	251	100.0%	327	100.0%

**Table HR 12 Clinical characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2006, December 31, 2011, and December 31, 2016.** Candidates aged younger than 18 years waiting for transplant on December 31, 2006, and December 31, 2016, regardless of first listing date; multiple listings are collapsed. CM, cardiomyopathy; VAD, ventricular assist device.



Characteristic	2006		2016	
	N	Percent	N	Percent
Transplant history				
First	230	91.6%	307	93.9%
Retransplant	21	8.4%	20	6.1%
Wait time				
< 1 year	124	49.4%	203	62.1%
1-< 2 years	31	12.4%	53	16.2%
2-< 3 years	25	10.0%	33	10.1%
3-< 4 years	10	4.0%	14	4.3%
4-< 5 years	14	5.6%	13	4.0%
≥ 5 years	47	18.7%	11	3.4%
Tx type				
Heart only	229	91.2%	325	99.4%
Heart-kidney	3	1.2%	1	0.3%
Heart-lung	18	7.2%	1	0.3%
Other	1	0.4%	0	0.0%
All candidates	251	100.0%	327	100.0%

**Table HR 13 Listing characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2006, December 31, 2011, and December 31, 2016.** Candidates aged younger than 18 years waiting for transplant on December 31, 2006, and December 31, 2016, regardless of first listing date; multiple listings are collapsed.

<b>Waiting list state</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>
Patients at start of year	349	361	368
Patients added during year	593	644	626
Patients removed during year	579	635	627
Patients at end of year	363	370	367

**Table HR 14 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 relisted 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.

<b>Removal reason</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>
Deceased donor transplant	422	463	460
Patient died	77	81	60
Patient refused transplant	1	3	2
Improved, transplant not needed	43	48	59
Too sick for transplant	29	23	29
Other	7	17	17

**Table HR 15 Removal reason among pediatric heart transplant candidates.** Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Characteristic	2004-06		2014-16	
	N	Percent	N	Percent
Age				
< 1 year	245	26.1%	377	28.7%
1-5 years	217	23.2%	308	23.4%
6-10 years	128	13.7%	184	14.0%
11-17 years	347	37.0%	446	33.9%
Sex				
Female	439	46.9%	578	44.0%
Male	498	53.1%	737	56.0%
Race/ethnicity				
White	520	55.5%	694	52.8%
Black	235	25.1%	241	18.3%
Hispanic	125	13.3%	285	21.7%
Asian	39	4.2%	57	4.3%
Other/unknown	18	1.9%	38	2.9%
Insurance				
Private	480	51.2%	552	42.0%
Medicaid	384	41.0%	625	47.5%
Other government	51	5.4%	100	7.6%
Unknown	22	2.3%	38	2.9%
All recipients	937	100.0%	1315	100.0%

**Table HR 16 Demographic characteristics of pediatric heart transplant recipients, 2004-2006 and 2014-2016.** Heart transplant recipients, including retransplants.

Characteristic	2004-06		2014-16	
	N	Percent	N	Percent
Diagnosis				
Congenital defect	410	43.8%	632	48.1%
Idiopathic dilated CM	286	30.5%	322	24.5%
Familial dilated CM	33	3.5%	70	5.3%
Idiopathic restrictive CM	51	5.4%	67	5.1%
Myocarditis	25	2.7%	36	2.7%
Other/unknown	132	14.1%	188	14.3%
Blood type				
A	349	37.2%	485	36.9%
B	116	12.4%	183	13.9%
AB	39	4.2%	48	3.7%
O	433	46.2%	599	45.6%
Medical urgency				
Status 1A	671	71.6%	1115	84.8%
Status 1B	116	12.4%	162	12.3%
Status 2	150	16.0%	38	2.9%
On VAD	98	10.5%	312	23.7%
CPRA				
< 1%	496	52.9%	556	42.3%
1-< 20%	154	16.4%	219	16.7%
20-< 80%	94	10.0%	279	21.2%
80-< 98%	30	3.2%	68	5.2%
98-100%	35	3.7%	28	2.1%
Unknown	128	13.7%	165	12.5%
All recipients	937	100.0%	1315	100.0%

**Table HR 17 Clinical characteristics of pediatric heart transplant recipients, 2004-2006 and 2014-2016.** Heart transplant recipients, including re-transplants. Collection of calculated PRA (CPRA) began March 31, 2015. Prior to that, measured PRA values were used. CM, cardiomyopathy; VAD, ventricular assist device.

Characteristic	2004-06		2014-16	
	N	Percent	N	Percent
Wait time				
< 31 days	428	45.7%	362	27.5%
31-60 days	184	19.6%	256	19.5%
61-90 days	98	10.5%	187	14.2%
3-< 6 months	133	14.2%	270	20.5%
6-< 12 months	56	6.0%	143	10.9%
1-< 2 years	23	2.5%	61	4.6%
≥ 2 years	15	1.6%	36	2.7%
ABO				
Compatible/identical	912	97.3%	1244	94.6%
Incompatible	25	2.7%	71	5.4%
Transplant history				
First	871	93.0%	1251	95.1%
Retransplant	66	7.0%	64	4.9%
Tx type				
Heart only	910	97.1%	1300	98.9%
Heart-lung	17	1.8%	10	0.8%
Heart-kidney	7	0.7%	4	0.3%
Heart-liver	2	0.2%	1	0.1%
Other	1	0.1%	0	0.0%
All recipients	937	100.0%	1315	100.0%

**Table HR 18 Transplant characteristics of pediatric heart transplant recipients, 2004-2006 and 2014-2016.** Heart transplant recipients, including re-transplants.

<b>Support</b>	<b>2011</b>		<b>2016</b>	
	<b>N</b>	<b>Percent</b>	<b>N</b>	<b>Percent</b>
Any life support	263	70.1%	339	76.2%
Intravenous inotropes	210	56.0%	235	52.8%
Ventilator	68	18.1%	74	16.6%
Left ventricular assist device	67	17.9%	100	22.5%
Right ventricular assist device	22	5.9%	14	3.1%
Extra corporeal membrane oxygenation	20	5.3%	17	3.8%
Prostaglandins	5	1.3%	18	4.0%
Intra-aortic balloon pump	1	0.3%	1	0.2%
Inhaled NO	1	0.3%	6	1.3%

**Table HR 19 Pediatric heart recipients on circulatory support before transplant.** Patients may have more than one type of circulatory support.

Donor	Recipient	CMV	EBV
D-	R-	17.3%	15.1%
D-	R+	10.7%	14.6%
D-	R unk	21.1%	1.0%
D+	R-	17.0%	29.0%
D+	R+	12.7%	37.4%
D+	R unk	20.4%	2.5%
D unk	R-	0.4%	0.4%
D unk	R+	0.0%	0.1%
D unk	R unk	0.4%	0.0%

**Table HR 20 Pediatric heart donor-recipient serology matching, 2012-2016.** Donor serology is reported on the OPTN Donor Registration Form and recipient serology on the OPTN Transplant Recipient Registration Form. There may be multiple fields per serology. 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.