

OPTN/SRTR 2017 Annual Data Report: Heart

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Abstract

In 2017, 3273 heart transplants were performed in the United States. New listings continued to increase, and 3769 new adults were listed for heart transplant in 2017. Over the past decade, posttransplant mortality has declined. The number of new pediatric listings increased over the past decade, as did the number of pediatric heart transplants, although some fluctuation has occurred more recently. New listings for pediatric heart transplants increased from 481 in 2007 to 623 in 2017. The number of pediatric heart transplants performed each year increased from 330 in 2007 to 432 in 2017, slightly fewer than in 2016. Short-term and long-term mortality improved. Among pediatric patients who underwent transplant between 2015-2016, 4.8% had died by 6 months and 6.2% by 1 year.

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

1 Introduction

The most significant occurrence in heart transplantation in recent years was approval of the new heart allocation policy in 2016 and its implementation in October 2018. This new algorithm attempts to address broader sharing and risk stratification through development of a 6-status system that combines Zone A and donation service area (DSA) as the first point of allocation for higher urgency statuses. This important new development also increased the data that OPTN will collect, with the goal of providing a dynamic policy that can continue to evolve over time. In addition, mechanical circulatory support technology continues to improve, with newer pumps designed to decrease risk of thrombosis. These improvements, if they result in better patient outcomes, will likely affect future heart allocation policy. In this iteration of the annual data report, we review the significant trends in heart transplantation in 2017.

2 Adult Heart Transplant

2.1 Waitlist Trends

Between 2006 and 2017, the number of new active listings for heart transplant increased 49%, from 2424 to 3623 (Figure HR 1). Despite a decline between 2015 and 2017, the number of candidates actively awaiting heart transplant increased dramatically since 2006, from 1243 to 2727 (Figure HR 2), an increase of 119%, suggesting that transplant rates have not increased at the same rate as listings. The most remarkable demographic trends in heart transplantation include the following: a continued increase in the proportion of heart transplant candidates aged 65 years or older to 18.5% in 2017 (Figure HR 3); an increase in the proportion of racial/ethnic minorities, with black candidates comprising 25.5% of patients awaiting heart transplant (Figure HR 5); and a continued increase in patients with non-ischemic cardiomyopathy (Figure HR 6). The proportion of candidates with extended waiting times decreased. In 2006, 15.9% of candidates waited 5 years or more; this proportion gradually declined to 4.1% in 2017 (Figure HR 7). The proportion of candidates awaiting transplant as status 1A increased to 45.0% in 2017 (Figure HR 8). The proportion of status 1B candidates increased similarly, while the proportion waiting as status 2 declined from 29.8% to 15.7%. The proportion of candidates with ventricular assist devices (VADs) at listing increased from 9.1% in 2006 to 32.6% in 2017 (Figure HR 9). Sex distribution has not changed (Figure HR 4). In 2017, 85.1% of candidates resided in a metropolitan area (Table HR 1). The number of candidates listed for heart-kidney transplant increased from 69 to 208 between 2007 and 2017, and the proportion of heart-lung candidates declined to 1.2% (Table HR 3). The number of patients receiving circulatory support prior to transplant increased from 1610 in 2012 to 2427 in 2017 (Table HR 6). Of these, 47.6% had left VADs (LVADs), which increased by 594 over the 5-year period. The number of patients receiving IV inotropes increased by 224 and the number of those with intra-aortic balloon pumps (IABPs) increased by 115. The number of patients with extracorporeal membrane oxygenation increased notably, from 15 to 32.

Between 2006 and 2017, heart transplant rates fluctuated, but overall remained the same, 77.2 per 100 waitlist-years (Figure HR 14). The decade low of 61.5 per 100 waitlist-years occurred in 2015, and was followed by an increase; this trend was similar

for all age groups, racial/ethnic groups, blood types, and status groups (Figure HR 11, Figure HR 12, Figure HR 13, Figure HR 14). Transplant rates peaked for most groups in 2006 and 2007, and reached a nadir in 2014 and 2015. Transplant rates by age group remained similar, but varied widely by blood type and medical urgency status. By age, 2017 transplant rates were highest for patients aged 65 or older and lowest for those aged 35-49 years, 66.6 per 100 waitlist-years. Between 2006 and 2010, transplant rates were highest for patients aged 18-34 years, but this shifted in 2011. Transplant rates have consistently been highest for candidates with blood type AB (208.8 per 100 waitlist-years) and for those listed as status 1A (277.3 per 100 waitlist-years). In 2017, blood type O candidates underwent transplant at a rate of 52.9 per 100 waitlist-years, nearly half the rate of blood type A and B candidates and 25% of the rate of blood type AB candidates. Candidates with blood type A underwent transplant at a rate of 105.7 per 100 waitlist-years, higher than in previous years, and higher than candidates with blood type B. Transplant rates declined substantially for all status groups between 2006 and 2015, but in 2017 appeared to be increasing again. In 2017, candidates residing in non-metropolitan areas underwent transplant at slightly higher rates than those in metropolitan areas, 80.5 per 100 waitlist-years vs. 76.8 (Figure HR 15). Although trends based on candidate distance from the donor hospital have been similar over the past decade, in 2017 candidates residing 150-250 nautical miles (NM) from the donor hospital underwent transplant at the highest rate, 92.8 per 100 waitlist-years, and those residing 100-150 NM away at the lowest rate, 67.2 per 100 waitlist-years (Figure HR 16).

Multiple factors have contributed to the trends in transplant rates over the past decade, and the variations may have been affected by policy changes and by changes in program practices in response to policy changes and evolving mechanical circulatory support. The median waiting time in 2016-2017 was 7.9 months, an increase from 4.0 months in 2006-2007 (Figure HR 18). Waiting times peaked in 2014-2015, then declined again. In 2016-2017, median waiting time was longest for blood type O candidates, 13.8 months (Figure HR 19), and candidates with body mass index ≥ 31 kg/m², 12.2 months (Figure HR 21). Women waited on average 6.1 months, and men 8.4 months (Figure HR 18). Status 2 candidates had the longest median waiting times, 17.7 months in 2016-2017 (Figure HR 20). Over the past decade, the proportion of candidates undergoing transplant within 1 year of listing declined overall, but appears to be increasing since 2014. Of candidates listed in 2016, 56.3% underwent transplant within 1 year (Figure HR 22). Geographic variability in transplant rates persisted, and in 2017, the proportion of candidates undergoing transplant within 1 year varied from 23.1% to 94.1% depending on DSA (Figure HR 23). Similar variability occurred by state, ranging from 20.0% to 100% (Figure HR 24).

Among candidates listed in 2014, 48.6% underwent transplant during the first year on the waiting list, 33.8% were still waiting, 9.4% were removed from the list, and 8.2% had died (Figure HR 17). At 3 years, 63.1% had undergone transplant, 9.7% were still waiting, 17.4% had been removed from the list, and 9.8% had died. Despite slight increases since 2016 in proportions of patients who were still waiting, who were removed from the list, or who died, most patients undergo transplant within 3 years, and less than 10.0% die on the waiting list. Between 2015 and 2017, fewer patients were removed from the waiting list due to death and more were removed due to undergoing transplant (Table HR 5).

Since 2006-2007, pretransplant mortality declined, from 16.3 to 12 deaths per 100

waitlist-years in 2016-2017 (Figure HR 25). Declines occurred in all age and racial/ethnic groups, with the most notable declines for candidates aged 18-34 years and black and Hispanic candidates (Figure HR 25, Figure HR 26). Pretransplant mortality declined notably for candidates with VADs at listing, from 47.8 to 11.8 deaths per 100 waitlist-years, now making pretransplant mortality nearly identical for candidates with and without VADs at listing (Figure HR 30). Pretransplant mortality rates were highest for candidates listed as status 1A, but declined dramatically since 2005-2006, from 91.9 to 30.4 deaths per 100 waitlist-years (Figure HR 29). Similarly, pretransplant mortality among candidates listed as status 1B declined from 36.3 to 8.1 deaths per 100 waitlist-years. Pretransplant mortality was slightly higher for candidates residing in nonmetropolitan areas than for those in metropolitan areas (Figure HR 31).

Pretransplant mortality varied by DSA from 2.1 to 23.9 deaths per 100 waitlist-years (Figure HR 33). Among candidates removed from the waiting list for reasons other than transplant, 18.4% died within 6 months of removal. The proportion of deaths within 6 months of removal from the waiting list fluctuated over the past decade, peaking at 33.2% in 2013 (Figure HR 34). In 2017, 87 patients died within 6 months of removal from the waiting list. In 2017, 48.5% of candidates listed as status 1A died within 6 months of removal, reflecting the acuity of illness. The percentage of candidates aged 18-34 years who died within 6 months decreased notably, from 21.0% in 2006 to 6.8% in 2017, and the percentage of candidates aged 65 years or older who died within 6 months of removal increased from 20.0% in 2006 to 25.7% in 2017 (Figure HR 35).

2.2 Donor Trends

Deceased donor heart donations continued to increase, with 3272 donors in 2017, the highest number to date, and an increase of 45% since 2006. The majority of these, 51.6%, were from donors aged 18-34 years (Figure HR 37), increasing from 1087 in 2007 to 1687 in 2017 (Figure HR 36). The rate of discards reached a nadir of 0.6% between 2008 and 2011 and has trended upward since, with a slight downtrend in 2016-2017 (Figure HR 40). In 2016-2017, 1.0% of recovered hearts were not transplanted. The discard rate was highest among donors age 50 years or older, 2.7%. In 2016-2017, hearts from Public Health Service high-risk donors were discarded at a lower rate, 0.8%, than hearts from donors not considered high risk, 1.1% (Figure HR 41).

The largest proportion of heart donor deaths, 47.1%, were caused by head trauma, despite head trauma declining in prevalence from 63.3% in 2006. Anoxia continued to increase as a cause of death among heart donors, and was 37.2% in 2017 from 14.0% in 2006 (Figure HR 42). While pediatric organs can be donated to adults, the proportion of pediatric hearts transplanted into an adult is low, varying by state from 0% to 1% in 2017 (Figure HR 39).

2.3 Overall Trends in Heart Transplant

In 2017, 3273 heart transplants were performed, an increase of 64 since 2016; 432 transplants occurred in pediatric recipients and 2841 in adult recipients (Figure HR 43). Over the past decade, adult heart transplants reached a nadir in 2008, and have been increasing since, while pediatric transplants increased until 2015 and have declined by

28 since (Figure HR 43). The number of heart transplants increased in all age groups, but the distribution increased more for recipients aged 65 years or older (Figure HR 44). Transplants increased in all racial/ethnic groups (Figure HR 46). In 2017, 66.4% of adult heart transplants were performed in candidates listed as status 1A, compared with 44.4% in 2007 (Table HR 8). In 2017, 85.0% of recipients resided in a metropolitan area; 60.4% of recipients lived within 50 miles of the transplant program (Table HR 7). In 2017, 49.4% of recipients had LVADs. Although 25.2% of patients underwent transplant within 31 days of listing in 2017, the proportion who underwent transplant after waiting 1 year or more increased over the past decade: 21.7% in 2017 vs. 11.4% in 2007 (Table HR 9). Dual organ transplant remained a small proportion of heart transplants. The proportion of heart-lung transplants declined from 1.5% to 0.9% between 2007 and 2017, heart-kidney transplants increased to 6.5% from 2.8%, and heart-liver transplants increased from 0.5 to 1.0% (Table HR 9).

Use of induction therapy has changed little since 2006. In 2017, 52.4% of adult heart transplant recipients received either IL2-RA or T-cell depleting therapy (Figure HR 49). In 2017, 95.2% of recipients received a tacrolimus-based immunosuppression regimen, while 3.6% received other regimens (Figure HR 50).

Transplant program volume has increased since 2006, with 50% of programs performing at least 20 transplants per year in 2017 (Figure HR 53). In 2006, the median volume was 12 transplants per year. The proportion of transplants performed at higher- and lower-volume programs has shifted since 2006. In 2006, 10.8% of heart transplants were performed at programs with fewer than 10 transplants per year, compared with 3.6% in 2017. In contrast, 15.0% of transplants in 2006 were performed at programs with 60 or more transplants per year, compared with 21.1% in 2017 (Figure HR 54).

2.4 Posttransplant Survival and Morbidity

Overall 1-year survival for patients who underwent heart transplant in 2010-2012 was 90.5%, 3-year survival was 84.1%, and 5-year survival was 79.1% (Figure HR 57). One-year survival in most subgroups was similar, but tended to be lower among recipients aged 65 years or older (Figure HR 55) and black recipients (Figure HR 56). Asian recipients tended to have better survival at all time points. Survival at 1, 3, and 5 years was similar between recipients with VADs and those without circulatory support; however, survival was lower at 1, 3, and 5 years for recipients with IABPs, 88.4%, 80.4%, and 75.0%, respectively. This reduction in survival for patients with IABPs occurred as early as 1 month posttransplant (Figure HR 58). Survival among new transplants and re-transplants was similar, except at 5 years, when survival was slightly better for recipients undergoing re-transplant, 83.1% vs. 79.1% (Figure HR 59). Survival was lower for recipients in non-metropolitan areas than for those in metropolitan areas (Figure HR 61). Finally, while recipients residing 250 miles or farther from the transplant program fared similarly to other recipients early after transplant, at 1, 3, and 5 years, their survival tended to be lower compared with survival of recipients living closer to the transplant program. Five-year survival in this group was 74.2%, lowest of all groups, followed by black recipients and recipients with IABPs (Figure HR 62). Since 2006, patient death after transplant has decreased overall at 6 months and at 1, 3, and 5 years, despite slight increases between 2011 and 2014 (Figure HR 63). The number of heart transplant survivors has increased by approximately 10,000 since 2006. On

June 30, 2017, 32,210 heart transplant recipients were alive with a functioning graft. Most survivors had undergone transplant at age 50 years or older (Figure HR 64).

The incidence of acute rejection in the first year posttransplant was 25.4% for recipients undergoing transplant in 2015-2016 (Figure HR 65). Posttransplant lymphoproliferative disorder (PTLD) remained uncommon, with an overall cumulative incidence of only 1.1% by 5 years posttransplant (Figure HR 67). The incidence was comparatively higher in recipients who were Epstein-Barre virus (EBV) seronegative, 1.1%, 1.9%, and 2.6% at 1, 3, and 5 years, respectively. The most common documented cause of death in the first posttransplant year was infection (Figure HR 68); however, by the second year, cardiovascular/cerebrovascular disease emerged as the leading documented cause of death through year 5 (Figure HR 69). Malignancy was a relatively infrequent cause of death, 1.4% of deaths at 5 years.

3 Pediatric Heart Transplant

3.1 Pediatric Waitlist Trends

In 2017, 623 new pediatric candidates were added to the heart transplant waiting list, with few at inactive status (Figure HR 70). At year-end 2017, 384 candidates listed before their eighteenth birthdays were awaiting heart transplant, 68.0% active (Figure HR 71). Over the past decade, the number of candidates with inactive status at year-end decreased from 164 in 2007 to 123 in 2017. The largest pediatric age group on the waiting list in 2017 was ages 11-17 years (34.4%), followed by ages younger than 1 year (27.0%), 1-5 years (24.8%), and 6-10 years (13.7%) (Figure HR 72). Almost half of heart transplant candidates were white, 21.5% were Hispanic, 21.4% were black, and 4.4% were Asian (Figure HR 73). Considering trends over time, the proportion of waitlist candidates aged younger than 1 year increased from 9.6% on December 31, 2007, to 13.5% on December 31, 2017; the proportion of candidates aged 6-10 years decreased from 23.7% to 16.7% over the same time period (Table HR 11). The proportion of white candidates decreased from 61.4% on December 31, 2007, to 47.7% on December 31, 2017. For candidates waiting on December 31, 2017, congenital defect was the leading cause of heart disease (57.5%), increased from 45.0% in 2007 (Table HR 12). The proportion of status 1B candidates increased from 9.2% in 2007 to 20.7% in 2017. The differences in status 1A and 1B listing percentages are likely due in part to changes to pediatric heart allocation policy implemented in 2016. The percentage of candidates using VADs at the time of listing increased from 2.8% in 2007 to 8.0% in 2017 (Table HR 12). Proportions of heart-only candidates increased from 91.2% at year-end 2007 to 98.9% at year-end 2017 (Table HR 13). Among the 606 candidates removed from the waiting list in 2017 (Table HR 14), 444 (73.3%) were removed due to undergoing transplant, 67 (11.1%) died, 54 (8.9%) were removed due to improved condition, and 28 (4.6%) were considered too sick to undergo transplant (Table HR 15).

Just over 70% of candidates newly listed in 2014 underwent transplant within 3 years, 12.1% died, 11.1% were removed from the list, and 5.1% were still waiting (Figure HR 78). The rate of heart transplants among pediatric waitlist candidates was 114.9 per 100 waitlist-years in 2017 (Figure HR 79). Transplant rates varied by age; rates were highest for candidates aged younger than 1 year, at 192.0 transplants per 100 waitlist-years in 2017, followed by candidates aged 11-17 years, at 119.3 trans-

plants per 100 waitlist-years (Figure HR 79). Pretransplant mortality decreased by half over the past decade; 23.5 deaths per 100 waitlist-years in 2006-2007 to 11.9 deaths per 100 waitlist-years in 2016-2017 (Figure HR 82). By age, pretransplant mortality rates were highest for candidates aged younger than 1 year, at 41.2 deaths per 100 waitlist-years in 2016-2017. Rates were 7.2 deaths per 100 waitlist-years for candidates aged 1-5 years, 5.1 for ages 6-10 years, and 7.6 for ages 11-17 years (Figure HR 82). By medical urgency status, pretransplant mortality was highest for status 1A (40.3 deaths per 100 waitlist-years) and 1B (15.0) candidates, compared with 5.5 for status 2 candidates (Figure HR 85).

3.2 Pediatric Trends in Heart Transplant

Pediatric transplant recipients are defined as those aged 18 years or younger at the time of transplant. The number of pediatric heart transplants performed each year increased from 321 in 2006 to 432 in 2017 (Figure HR 88). In 2017, 27 of 136 total heart transplant programs performed pediatric heart transplants exclusively, 86 performed adult heart transplants, and 23 performed both adult and pediatric heart transplants (Figure HR 89). In 2017, 9.3% of transplants in recipients aged younger than 10 years were performed at programs with volume of five or fewer pediatric transplants in that year (Figure HR 90). Over the past decade, the age and sex of pediatric heart transplant recipients changed little (Table HR 16). The proportion of recipients who were white or black decreased and the proportion who were Hispanic increased (Table HR 16). Congenital defects remained the most common primary cause of disease, affecting 49.4% of recipients who underwent transplant in 2015-2017 (Table HR 17). The proportion of patients who underwent transplant as status 1A increased from 74.8% in 2005-2007 to 82.9% in 2015-2017. VAD use doubled from 12.8% of transplant recipients in 2005-2007 to 25.0% in 2015-2017 (Table HR 17). The proportion of ABO-incompatible transplants in 2015-2017 was 7.5%, increased from 3.1% a decade earlier (Table HR 18).

In 2017, use of T-cell depleting agents for induction continued to increase, to 72.0% of heart transplant recipients; use of interleukin-2 receptor antagonists decreased to 9.4% (Figure HR 91). The initial immunosuppression regimen used most commonly in 2017 was tacrolimus, mycophenolate (MMF), and steroid (54.2%), followed by tacrolimus and MMF in 37.5% (Figure HR 92).

3.3 Pediatric Posttransplant Survival and Morbidity

Among pediatric heart transplant recipients 2015-2016, the rate of acute rejection in the first year was 19.3% overall; the highest rate observed was 21.7% in the 6-10 year age group, and the lowest 17.5% in recipients aged younger than 6 years (Figure HR 96). Among pediatric heart transplant recipients 2013-2017, 60.6% were cytomegalovirus (CMV) negative and 43.8% were EBV negative (Table HR 20). The combination of a CMV-positive donor and CMV-negative recipient occurred in 28.5% of transplants; for EBV, this combination occurred in 27.9% of transplants (Table HR 20).

Recipient death occurred in 4.8% of patients at 6 months posttransplant and in 6.2% at 1 year posttransplant among heart transplants performed in 2015-2016, in 12.0% at 3 years post-transplant for transplants performed in 2013-2014, in 15.2% at 5 years posttransplant for transplants performed in 2011-2012, and in 28.8% at 10

years posttransplant for transplants performed in 2007-2008 (Figure HR 98). Overall, 1-year and 5-year patient survival were 89.8% and 80.1%, respectively, among recipients who underwent transplant in 2005-2012 (Figure HR 99). By age, 5-year patient survival was 75.3% for recipients aged younger than 1 year, 81.5% for ages 1-5 years, 87.7% for ages 6-10 years, and 80.4% for ages 11-17 years (Figure HR 99). The leading identified causes of death in the first 12 months posttransplant were graft failure (1.5%) and cardio/cerebrovascular disease (1.5%) (Figure HR 100). At 5 years posttransplant, the leading causes were cardio/cerebrovascular disease (3.5%) and graft failure (3.5%) (Figure HR 101).

The overall incidence of PTLD was 4.0% at 5 years posttransplant, with 5.5% among EBV-negative recipients and 2.7% among EBV-positive recipients (Figure HR 97).

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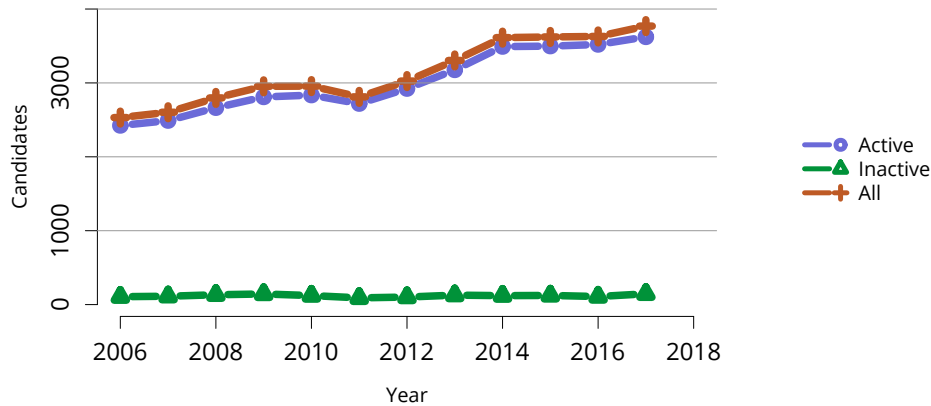


Figure HR 1. New adult candidates added to the heart transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates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

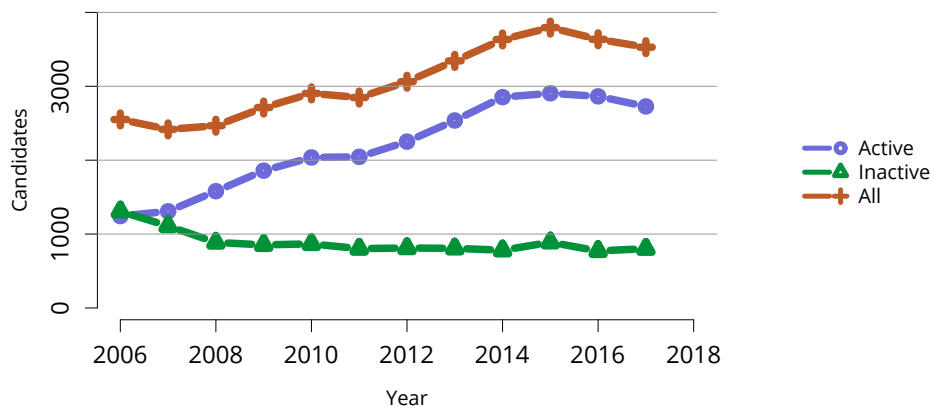


Figure HR 2. Adults listed for heart transplant on December 31 each year. Candidates concurrently listed at multiple centers are counted once. Those with concurrent listings and active at any program are considered active.

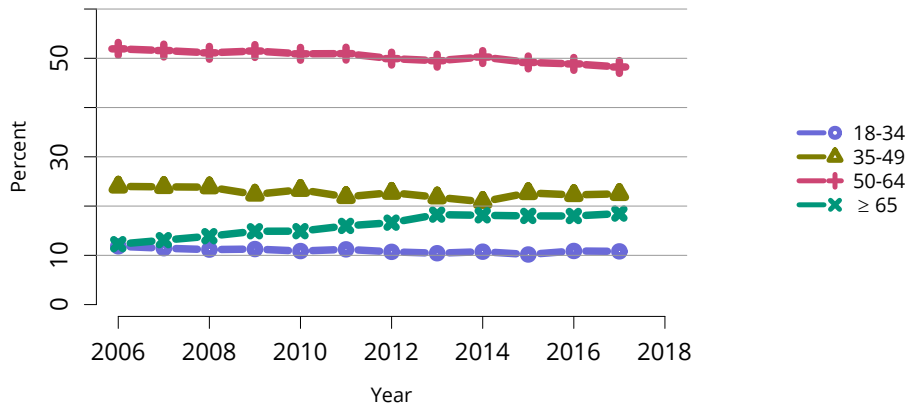


Figure HR 3. Distribution of adults waiting for heart transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Age is determined at the later of listing date or January 1 of the given year. Active and inactive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

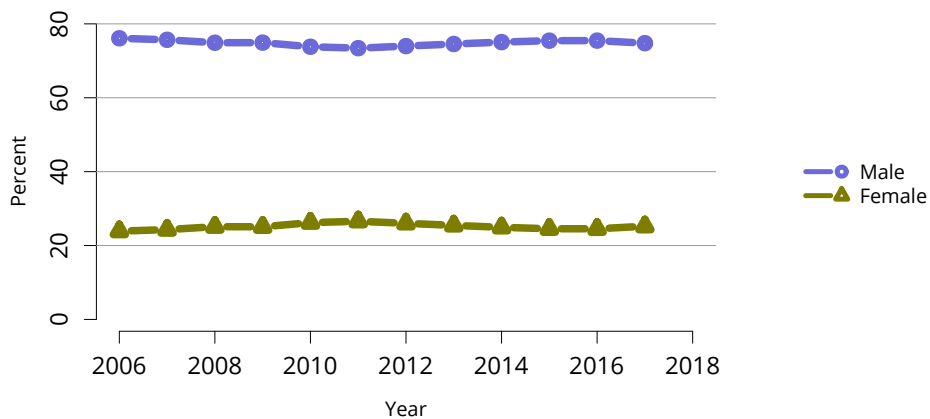


Figure HR 4. Distribution of adults waiting for heart transplant by sex. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included.

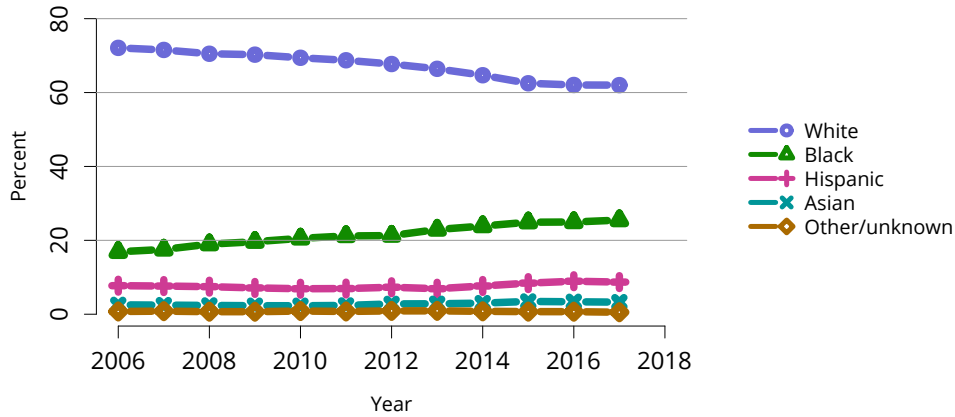


Figure HR 5. Distribution of adults waiting for heart transplant by race. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive candidates are included.

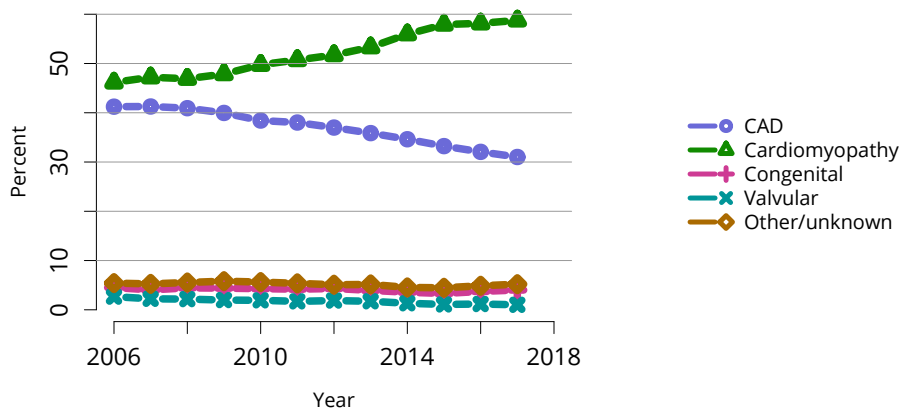


Figure HR 6. Distribution of adults waiting for heart transplant by diagnosis. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included. CAD, coronary artery disease.

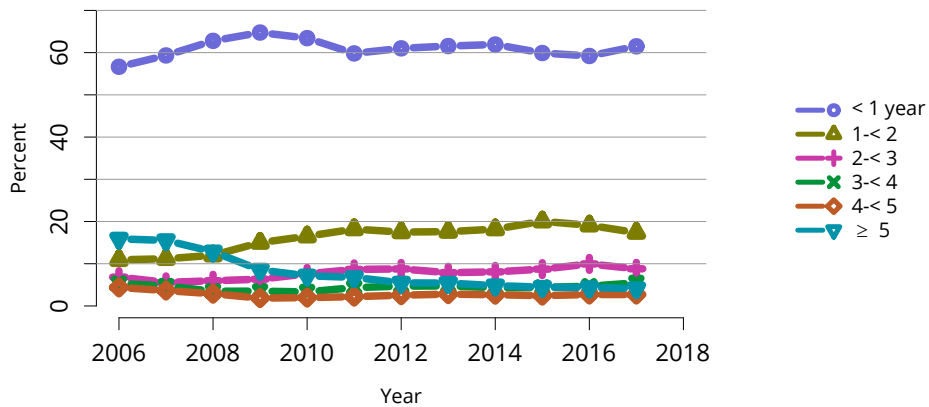


Figure HR 7. Distribution of adults waiting for heart transplant by waiting time. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Time on the waiting list is determined at the earlier of December 31 or removal from the waiting list. Active and inactive candidates are included.

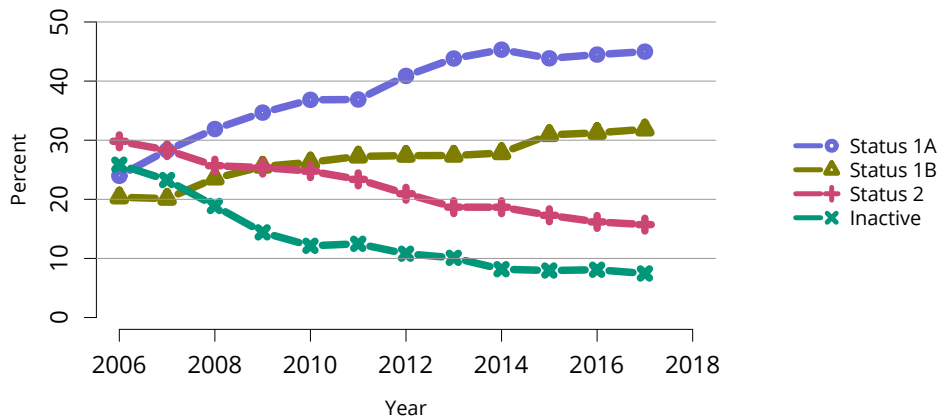


Figure HR 8. Distribution of adults waiting for heart transplant by medical urgency. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Medical urgency status is the most severe during the year. Active and inactive patients are included.

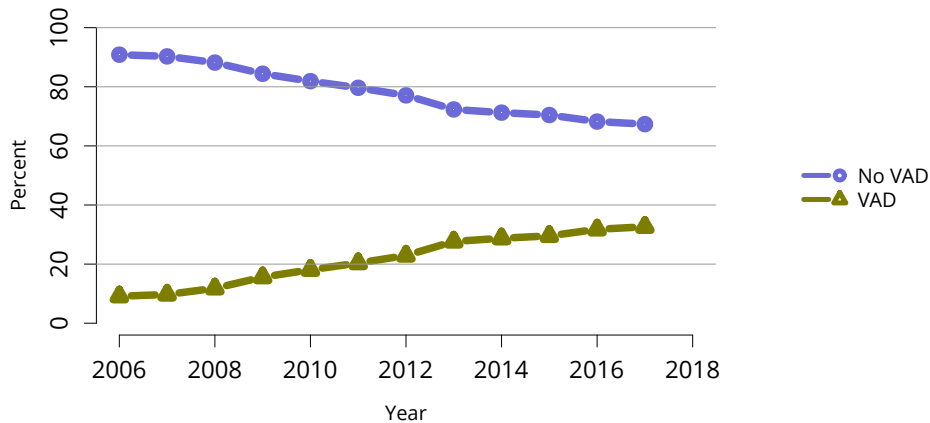


Figure HR 9. Distribution of adults waiting for heart transplant by VAD status at listing. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included. VAD, ventricular assist device.

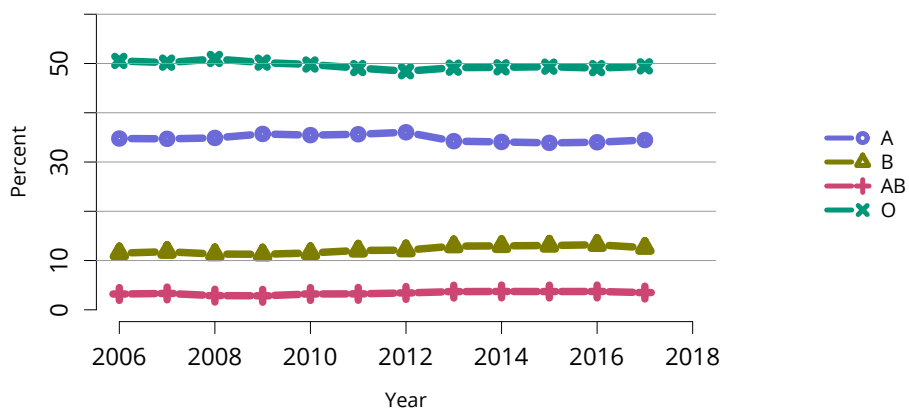


Figure HR 10. Distribution of adults waiting for heart transplant by blood type. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included.

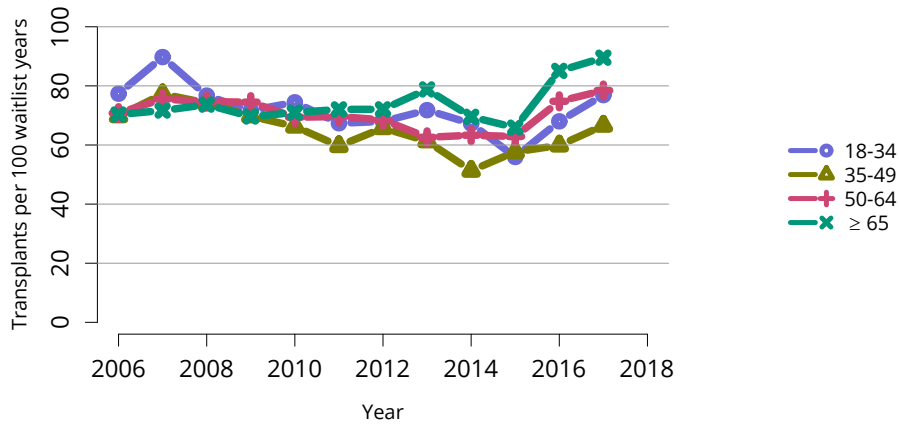


Figure HR 11. Deceased donor heart transplant rates among adult wait-list candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

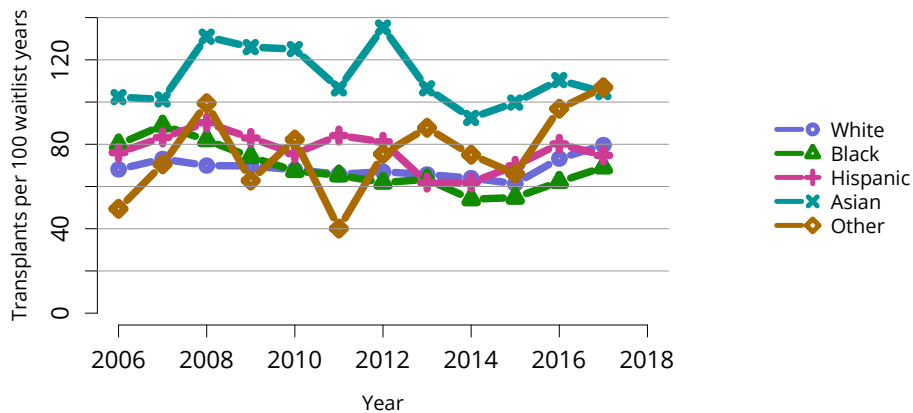


Figure HR 12. Deceased donor heart transplant rates among adult wait-list candidates by race. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

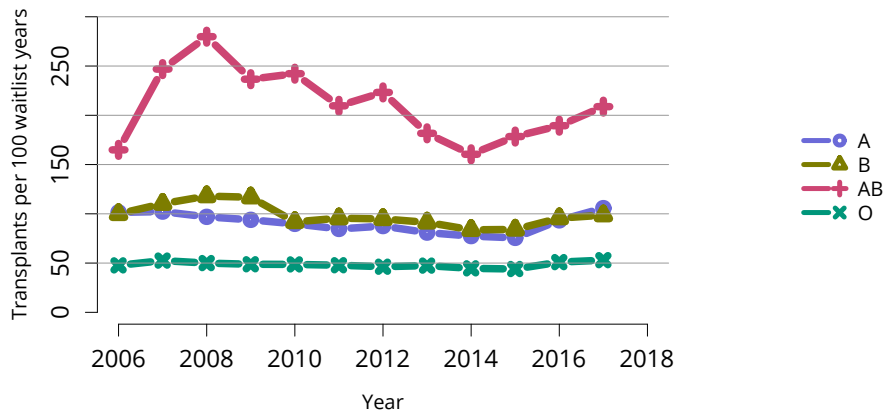


Figure HR 13. Deceased donor heart transplant rates among adult waitlist candidates by blood type. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

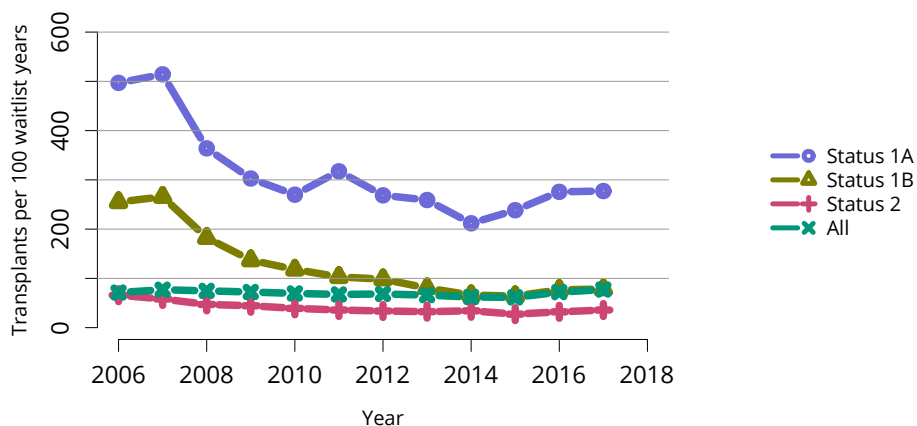


Figure HR 14. Deceased donor heart transplant rates among adult waitlist candidates by medical urgency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Medical urgency is assessed at the time of listing. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

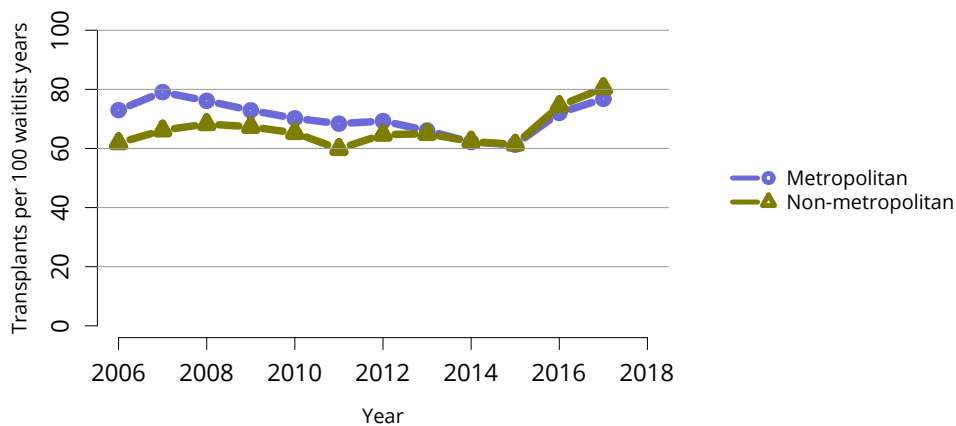


Figure HR 15. Deceased donor heart transplant rates among waitlist candidates by metropolitan vs. non-metropolitan residence. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Urban/rural determination is made using the RUCA (Rural-Urban Commuting Area) designation of the candidate’s permanent zip code. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

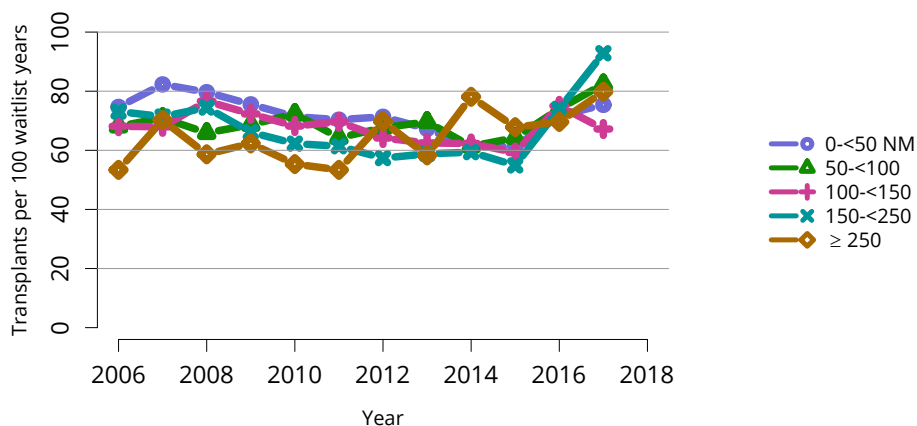


Figure HR 16. Deceased donor heart transplant rates among waitlist candidates by distance from listing center. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Distance is nautical miles (NM) between the zip code centroids of the candidate’s listing center and candidate’s permanent zip code. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

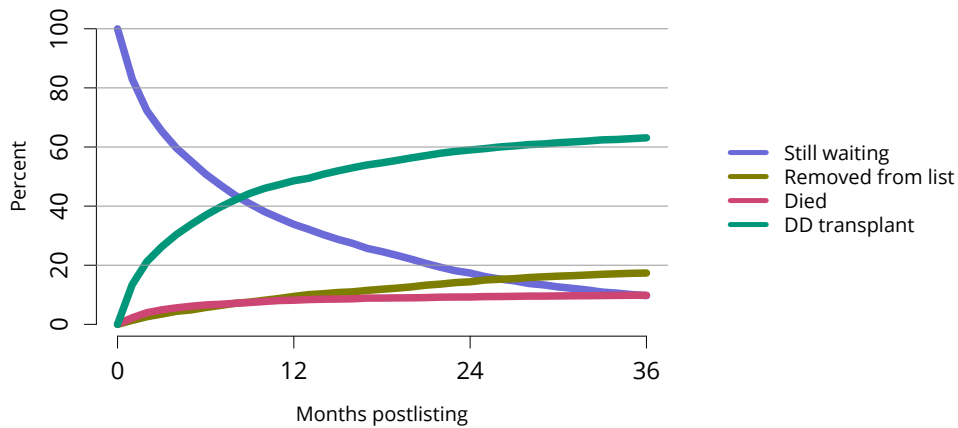


Figure HR 17. Three-year outcomes for adults waiting for heart transplant, new listings in 2014. Adults waiting for heart transplant and first listed in 2014. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. DD, deceased donor.



Figure HR 18. Median months to heart transplant for waitlisted adults by sex. Observations censored on December 31, 2017; 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.

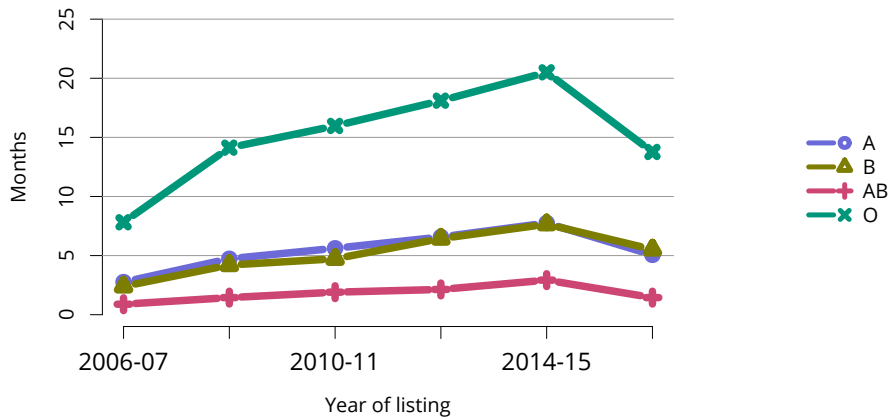


Figure HR 19. Median months to heart transplant for waitlisted adults by blood type. Observations censored on December 31, 2017; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per candidate, not per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.

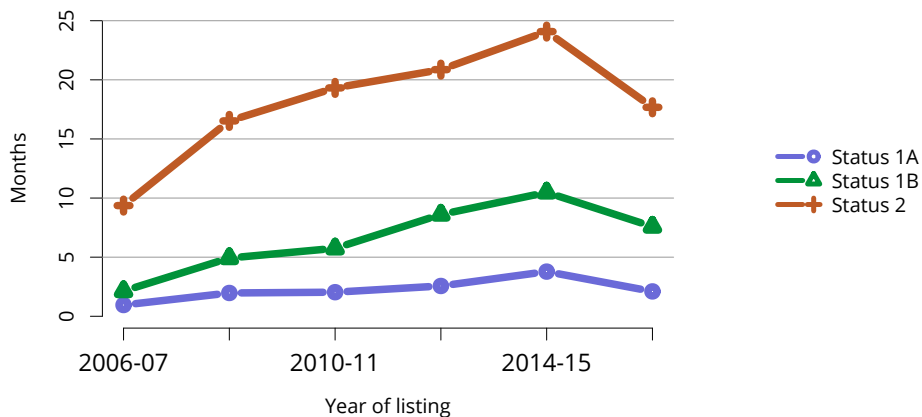


Figure HR 20. Median months to heart transplant for waitlisted adults by medical urgency at listing. Observations censored on December 31, 2017; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per candidate, not per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.

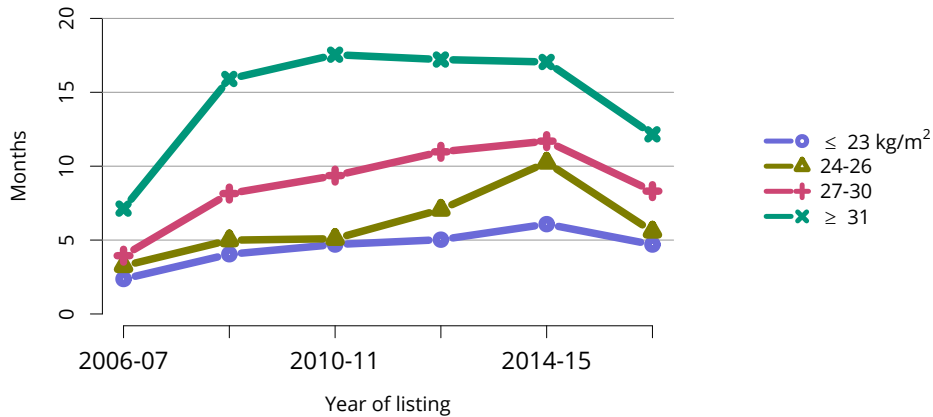


Figure HR 21. Median months to heart transplant for waitlisted adults by BMI at listing. Observations censored on December 31, 2017; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per candidate, not per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.

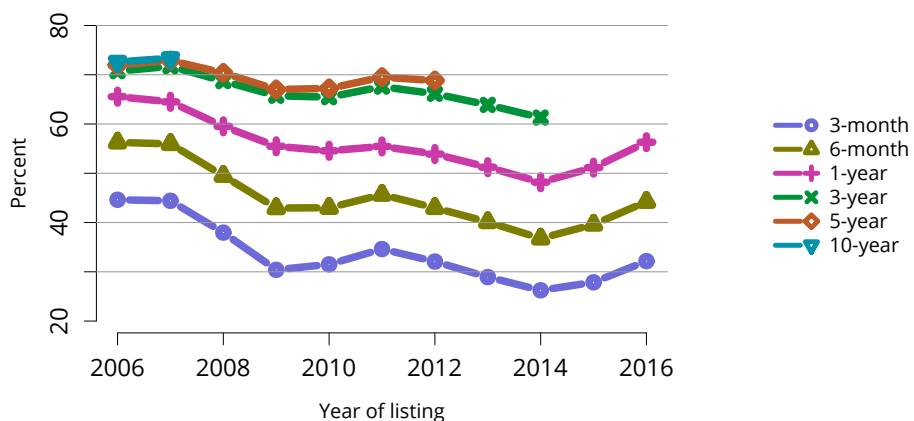


Figure HR 22. Percentage of adults who underwent deceased donor heart transplant within a given time period of listing. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal.

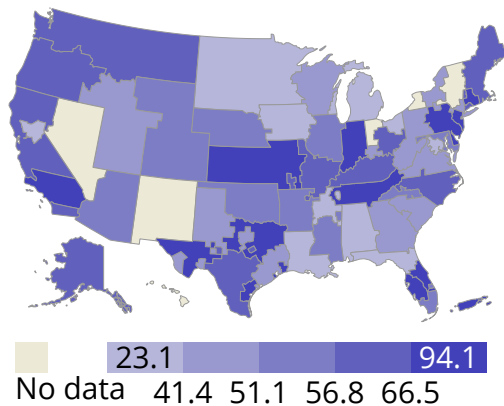


Figure HR 23. Percentage of adults who underwent deceased donor heart transplant within 1 year of listing in 2016 by DSA. Candidates listed concurrently in a single DSA are counted once in that DSA, from the time of earliest listing to the time of latest removal; candidates listed in multiple DSAs are counted separately per DSA.

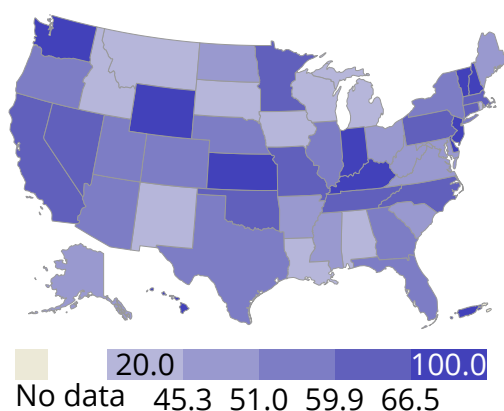


Figure HR 24. Percentage of adults who underwent deceased donor heart transplant within 1 year of listing in 2016 by state. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal.

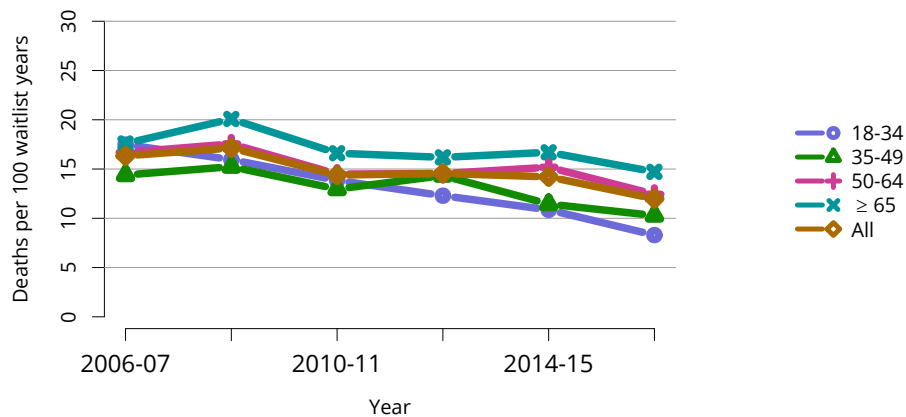


Figure HR 25. Pretransplant mortality rates among adults waitlisted for heart transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Age is determined at the later of listing date or January 1 of the given year.

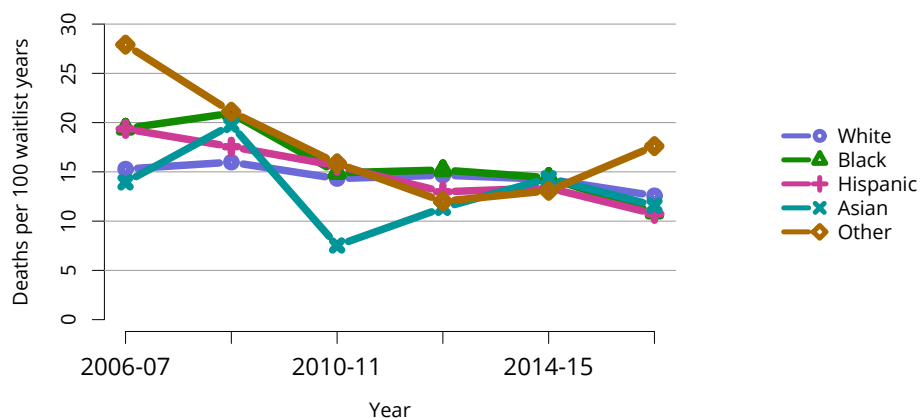


Figure HR 26. Pretransplant mortality rates among adults waitlisted for heart transplant by race. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

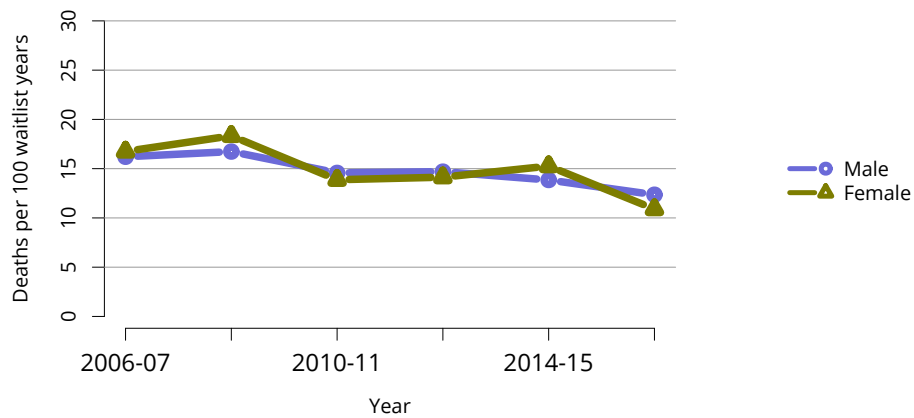


Figure HR 27. Pretransplant mortality rates among adults waitlisted for heart transplant by sex. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

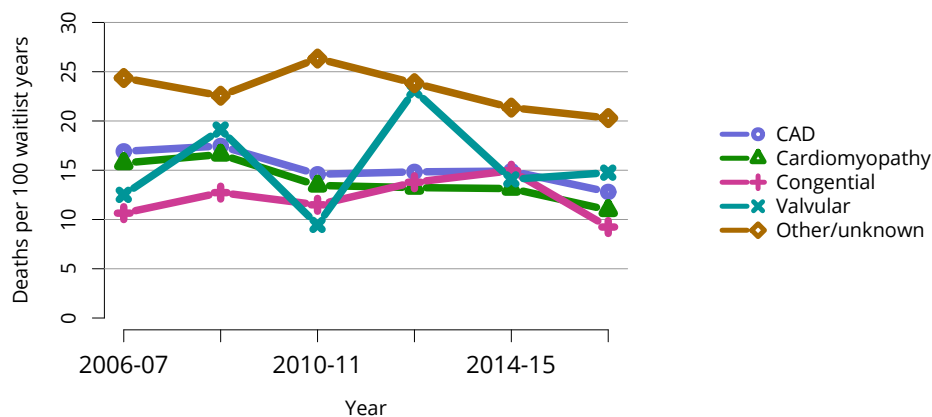


Figure HR 28. Pretransplant mortality rates among adults waitlisted for heart transplant by diagnosis. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. CAD, coronary artery disease.

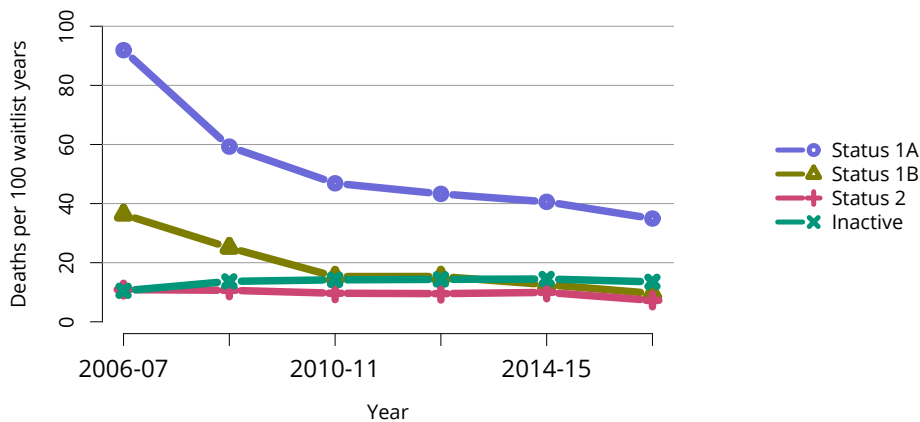


Figure HR 29. Pretransplant mortality rates among adults waitlisted for heart transplant by medical urgency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Medical urgency is determined at the later of listing date and January 1 of the year.

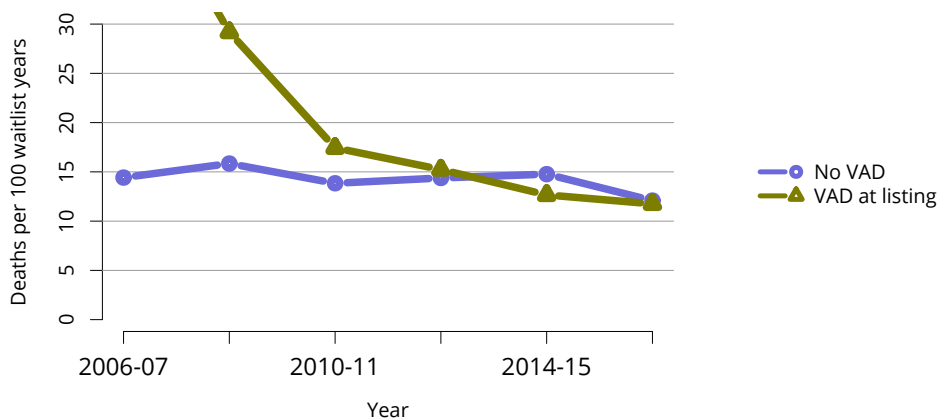


Figure HR 30. Pretransplant mortality rates among adults waitlisted for heart transplant by VAD at listing. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. VAD, ventricular assist device.

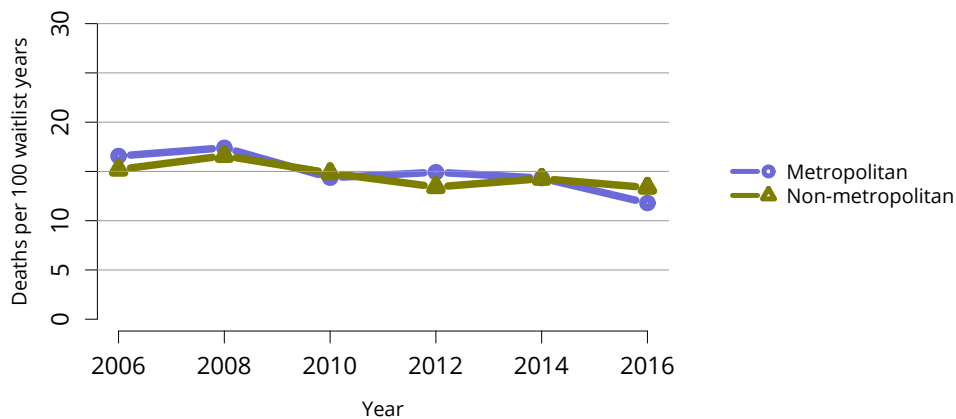


Figure HR 31. Pretransplant mortality rates among adults waitlisted for heart by metropolitan vs. non-metropolitan residence. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Urban/rural determination is made using the RUCA (Rural-Urban Commuting Area) designation of the candidate’s permanent zip code.

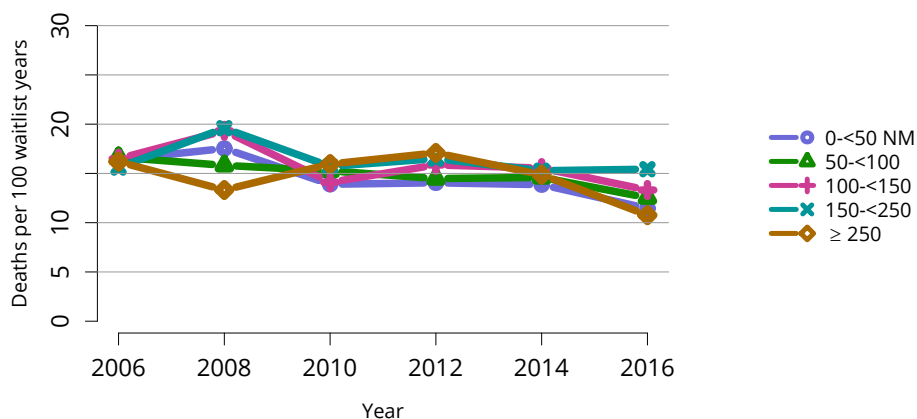


Figure HR 32. Pretransplant mortality rates among adults waitlisted for heart, by distance from listing center. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Distance is nautical miles (NM) between the zip code centroids of the candidate’s listing center and candidate’s permanent zip code.

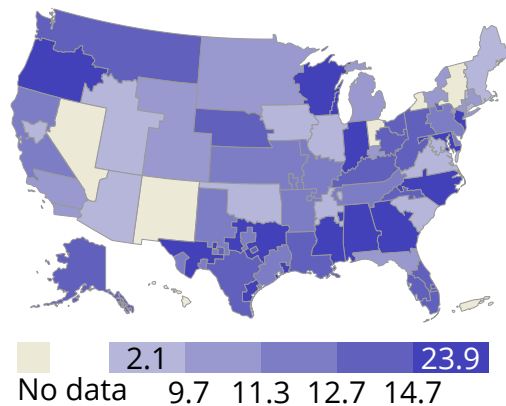


Figure HR 33. Pretransplant mortality rates among adults waitlisted for heart transplant in 2016-2017, by DSA. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the DSA. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.

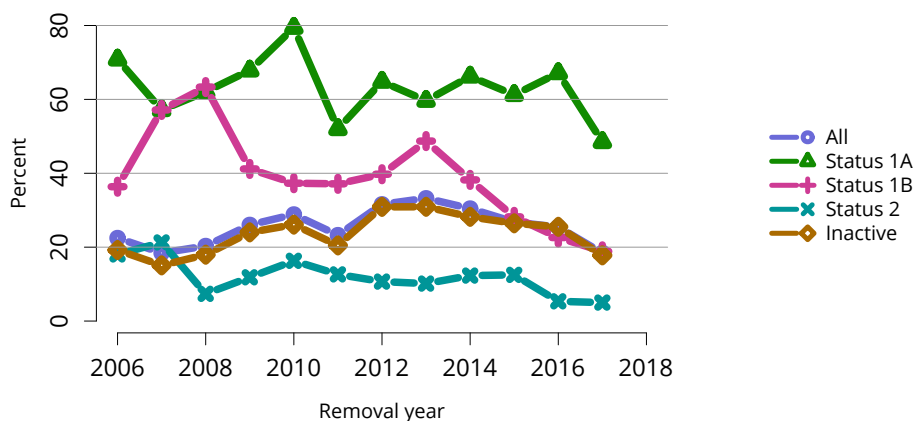


Figure HR 34. Deaths within six months after removal among adult heart waitlist candidates, by status at removal. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

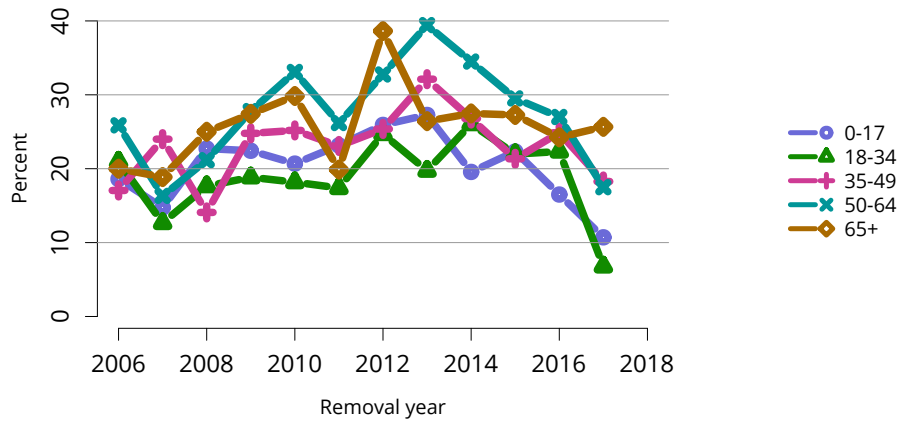


Figure HR 35. Deaths within six months after removal among adult heart waitlist candidates, by age at removal. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

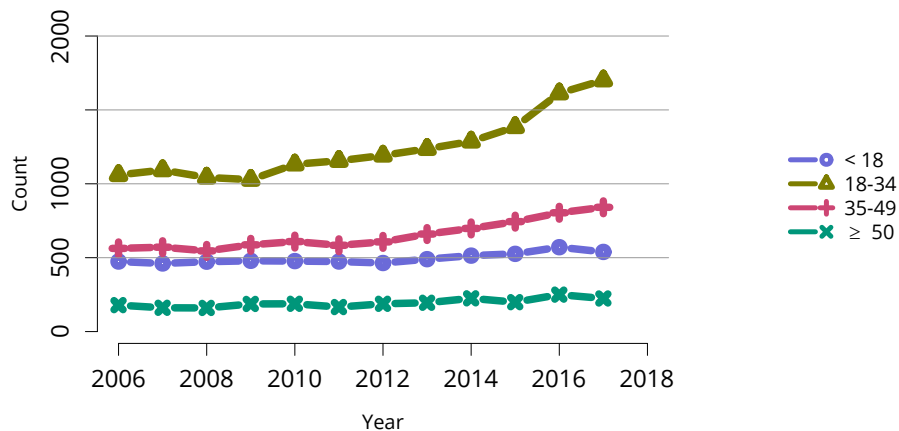


Figure HR 36. Deceased heart donor count by age. Count of deceased donors whose hearts were recovered for transplant, by age at donation.

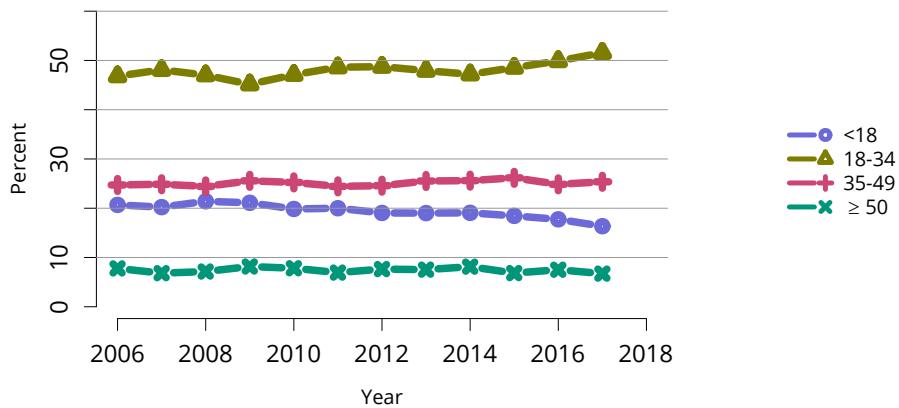


Figure HR 37. Distribution of deceased heart donors by age. Deceased donors whose hearts were recovered for transplant.

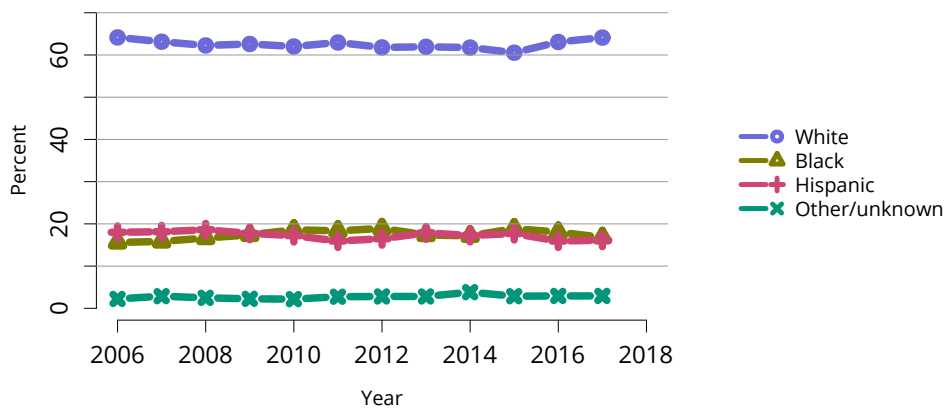


Figure HR 38. Distribution of deceased heart donors by race. Deceased donors whose hearts were recovered for transplant.

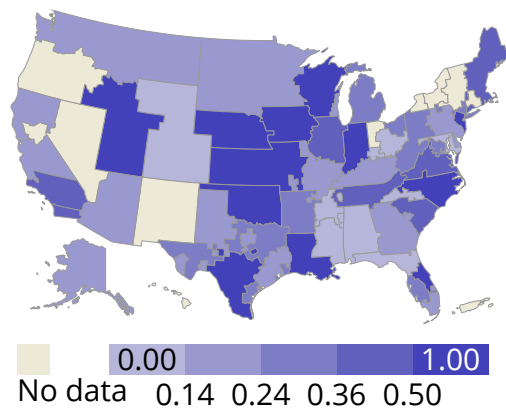


Figure HR 39. Percent of pediatric heart donors allocated to adult recipients. Numerator: pediatric heart and heart-lung donors allocated to adult recipients. Denominator: total pediatric heart and heart-lung donors

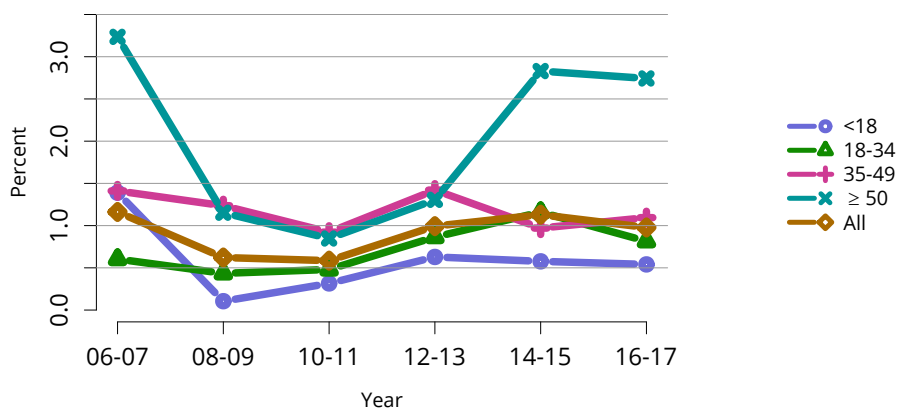


Figure HR 40. Rates of hearts recovered for transplant and not transplanted by donor age. Percentages of hearts not transplanted out of all hearts recovered for transplant.

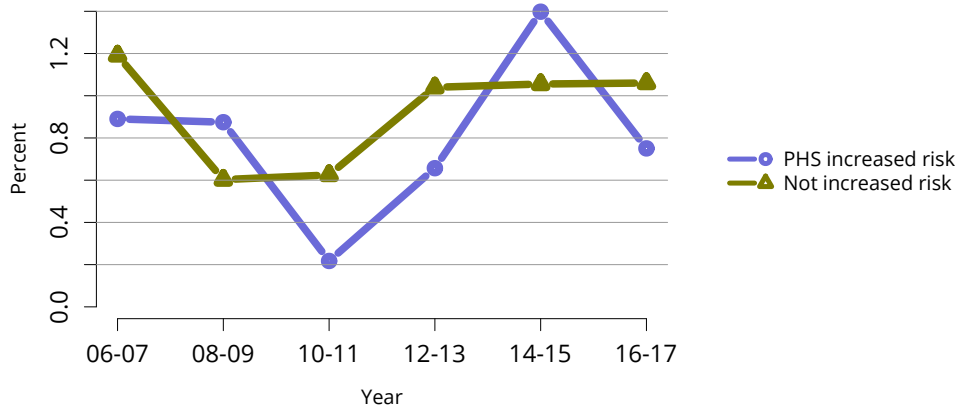


Figure HR 41. Rates of hearts recovered for transplant and not transplanted, by donor risk of disease transmission. "Increased risk" is defined by criteria from the US Public Health Service Guidelines for increased risk for HIV, hepatitis B and hepatitis C transmission.

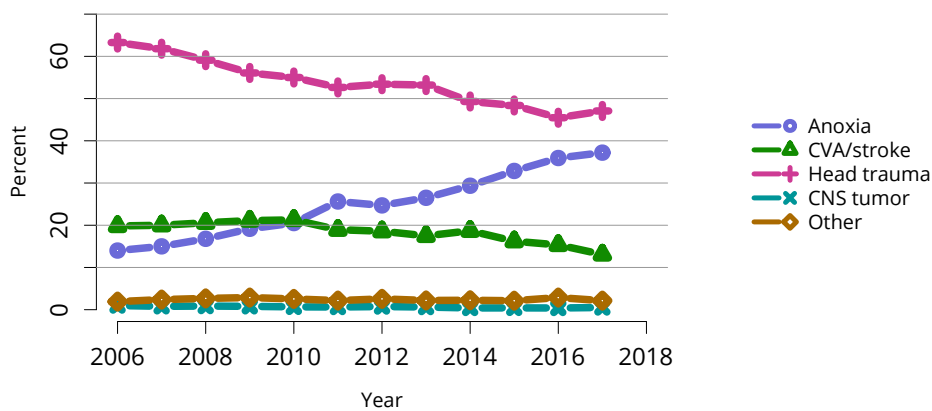


Figure HR 42. Cause of death among deceased heart donors. Deceased donors whose hearts were transplanted. CNS, central nervous system; CVA, cerebrovascular accident.

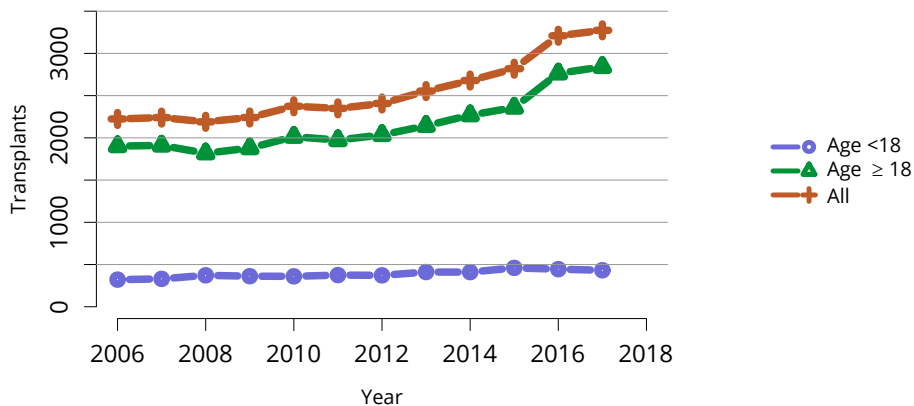


Figure HR 43. Total heart transplants. All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

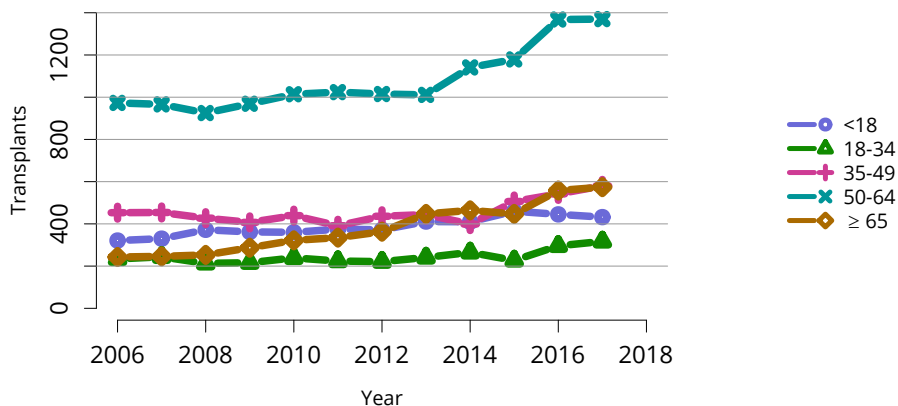


Figure HR 44. Total heart transplants by age. All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

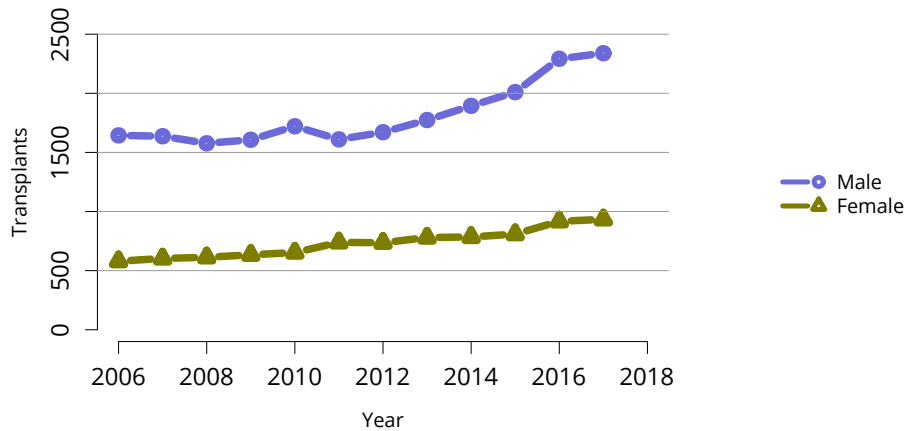


Figure HR 45. Total heart transplants by sex. All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

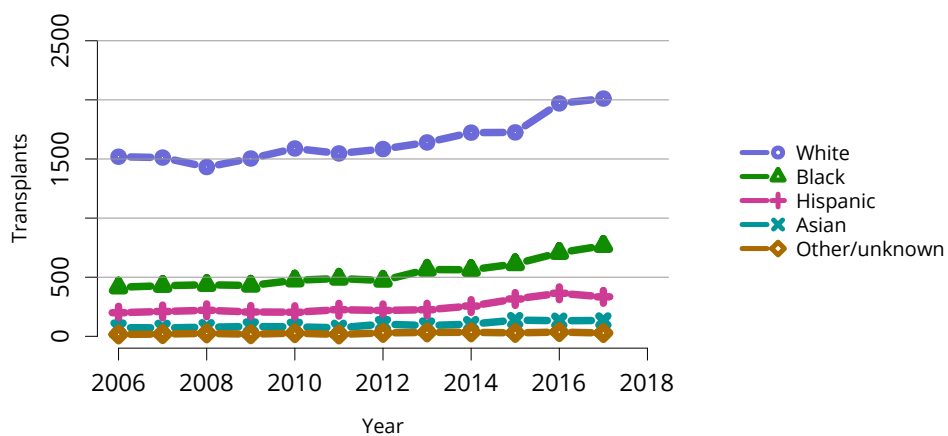


Figure HR 46. Total heart transplants by race. All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

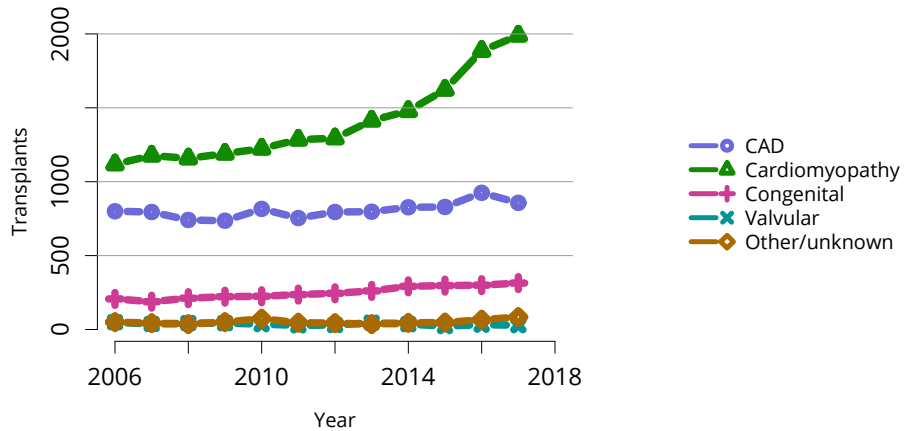


Figure HR 47. Total heart transplants by diagnosis. All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients. CAD, coronary artery disease.

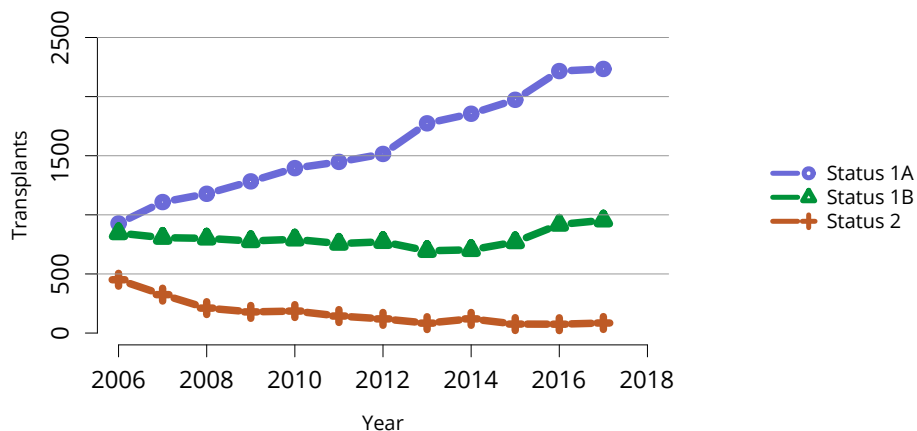


Figure HR 48. Total heart transplants by medical urgency. All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

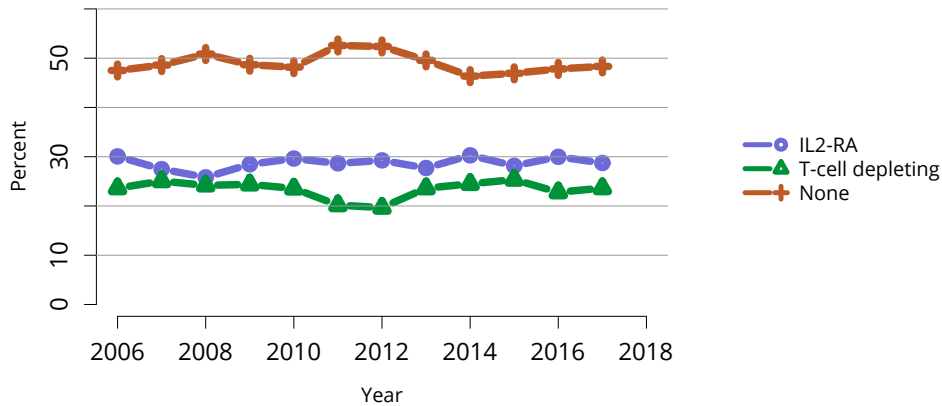


Figure HR 49. Induction agent use in adult heart transplant recipients. Immunosuppression at transplant reported to the OPTN. IL2-RA, interleukin-2 receptor antagonist.

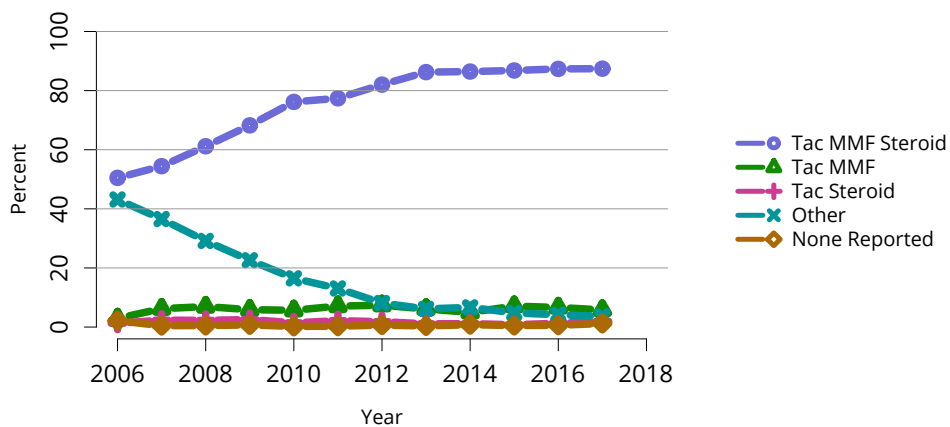


Figure HR 50. Immunosuppression regimen use in adult heart transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. Tac, tacrolimus. MMF, mycophenolate mofetil.

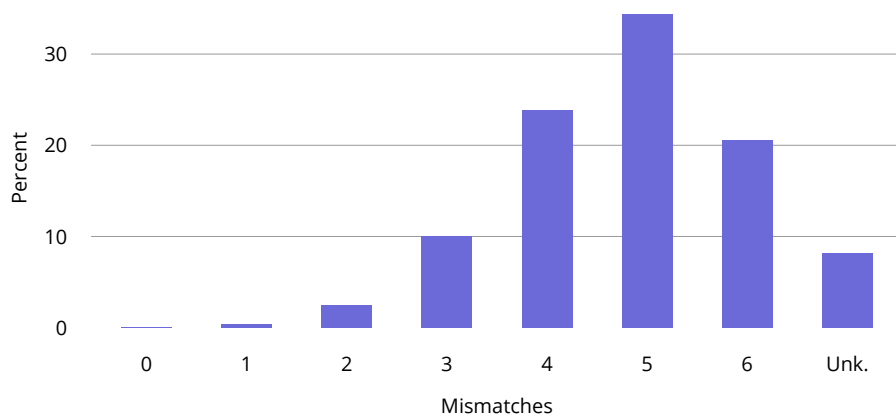


Figure HR 51. Total HLA A, B, and DR mismatches among adult deceased donor heart transplant recipients, 2013-2017. Donor and recipient antigen matching is based on OPTN antigen values and split equivalences policy as of 2016.

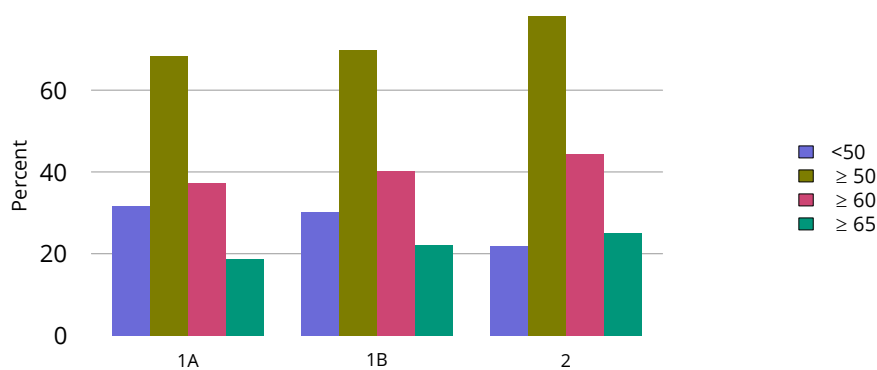


Figure HR 52. Status of adult heart transplant recipients, 2015-2017, by age. Age categories are not exclusive. All recipients aged 65 or older, for example, are also included among those aged 60 or older and 50 or older.

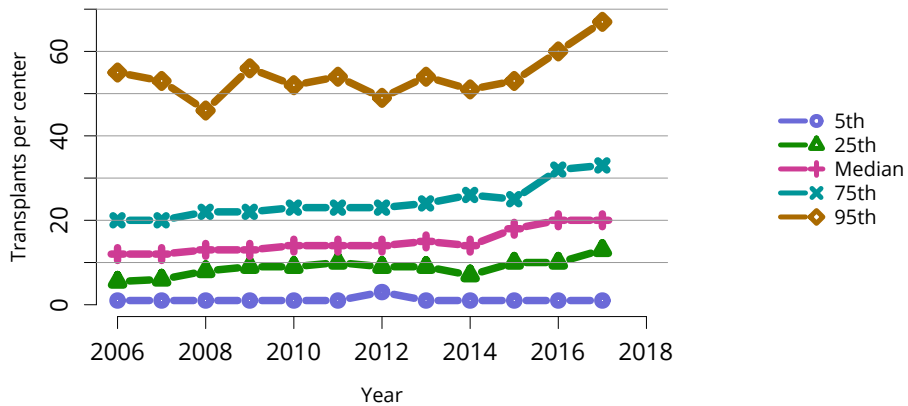


Figure HR 53. Annual adult heart transplant center volumes, by percentile. Annual volume data are limited to recipients aged 18 or older.

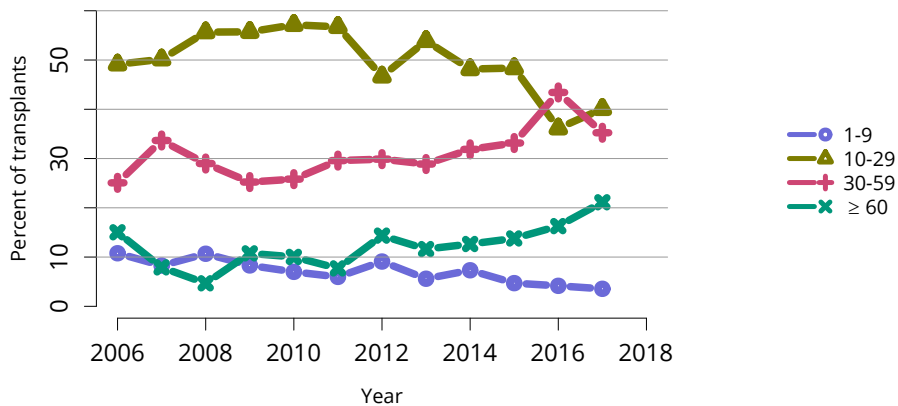


Figure HR 54. Distribution of adult heart transplants by annual center volume. Based on annual volume data among recipients aged 18 or older.

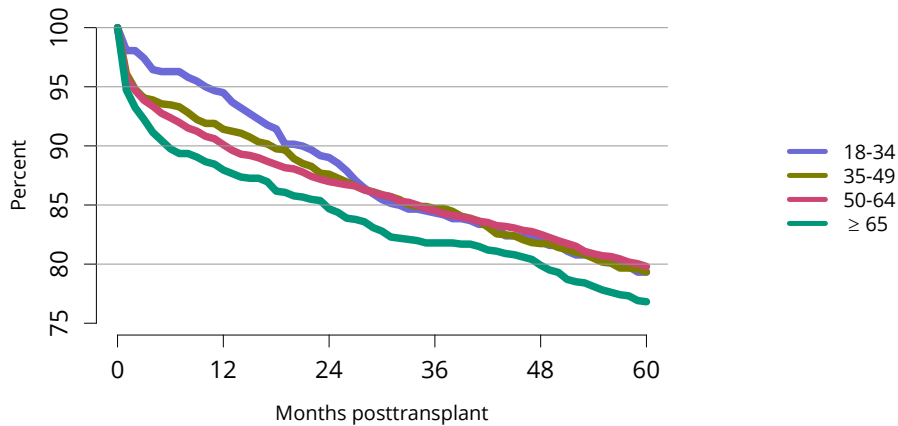


Figure HR 55. Patient survival among adult heart transplant recipients, 2010-2012, by age. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

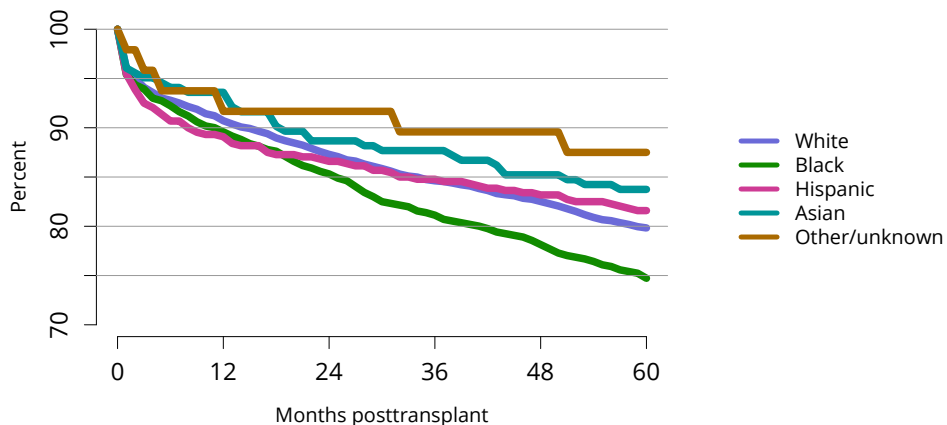


Figure HR 56. Patient survival among adult heart transplant recipients, 2010-2012, by race. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

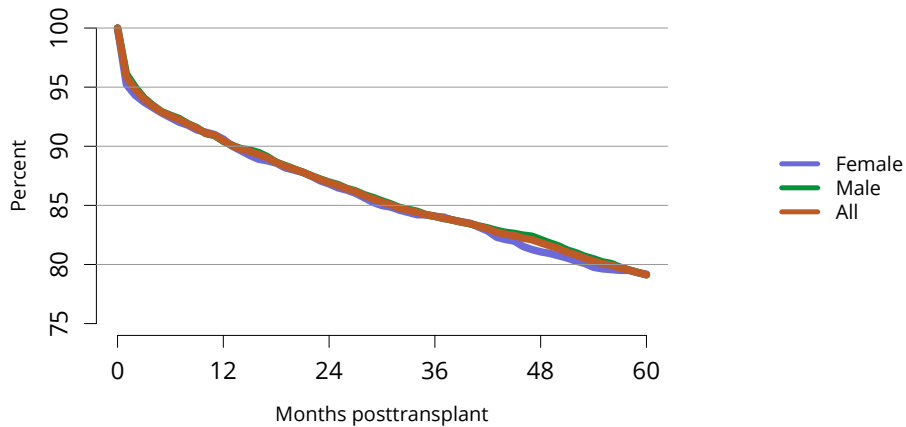


Figure HR 57. Patient survival among adult heart transplant recipients, 2010-2012, by sex. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

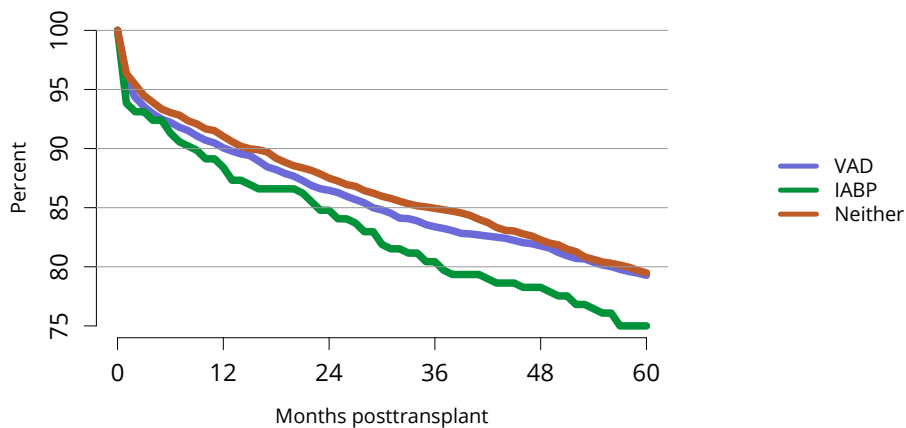


Figure HR 58. Patient survival among adult heart transplant recipients, 2010-2012, by circulatory support. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered. Ventricular assist device (VAD) status at time of transplant. IABP, intra-aortic balloon pump.

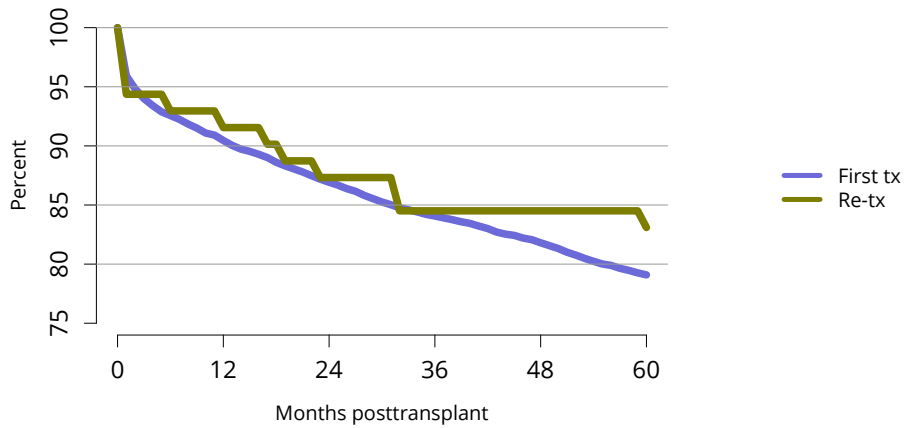


Figure HR 59. Patient survival among adult heart transplant recipients, 2010-2012, by first vs. retransplant. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

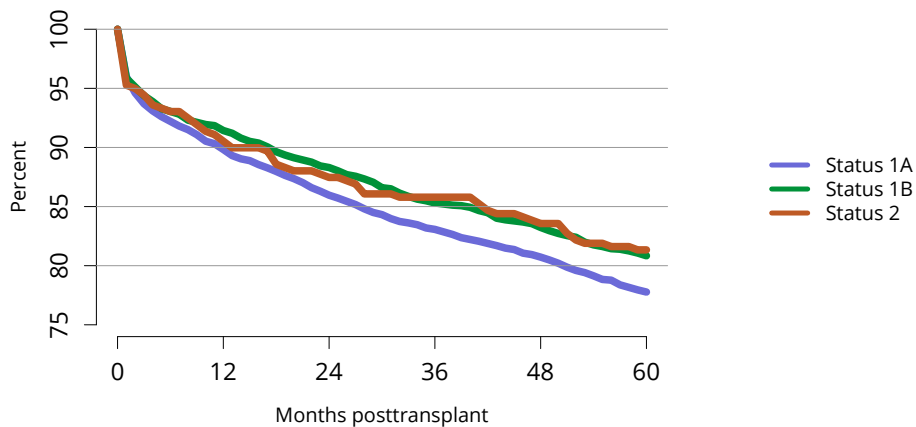


Figure HR 60. Patient survival among adult heart transplant recipients, 2010-2012, by medical urgency. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

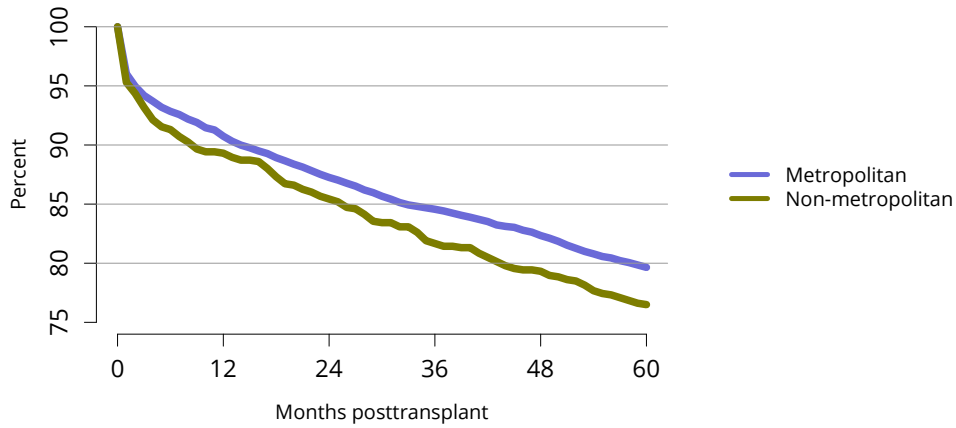


Figure HR 61. Patient survival among adult heart transplant recipients, 2010-2012, by metropolitan vs. non-metropolitan recipient residence. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

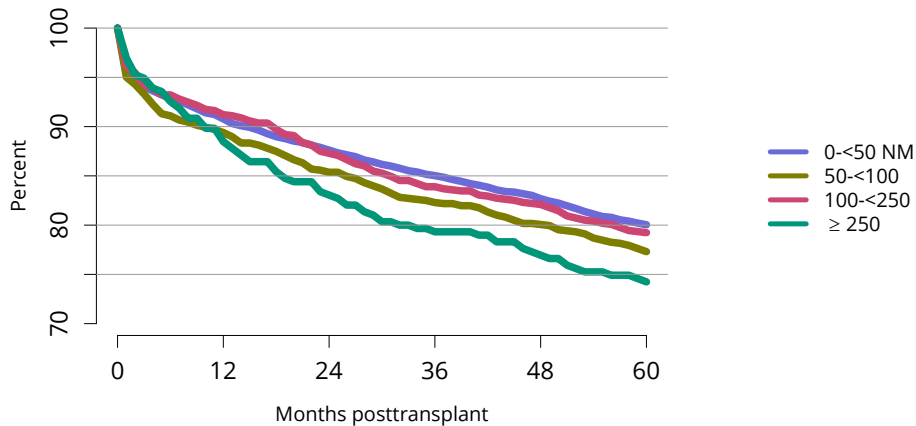


Figure HR 62. Patient survival among adult heart transplant recipients, 2010-2012, by recipients' distance from transplant center. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered. Distance is between the zipcode centroids of the TX center and the recipient's permanent residence, measured in nautical miles (NM).

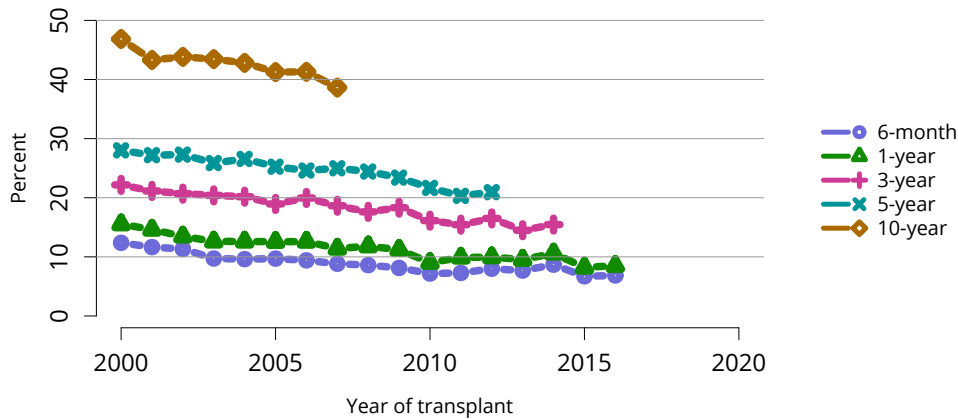


Figure HR 63. Patient death among adult heart transplant recipients. All adult recipients of deceased donor hearts, including multi-organ transplants. Patients are followed until the earlier of death or December 31, 2017. Estimates computed with Cox proportional hazards models adjusted for age, sex, and race.

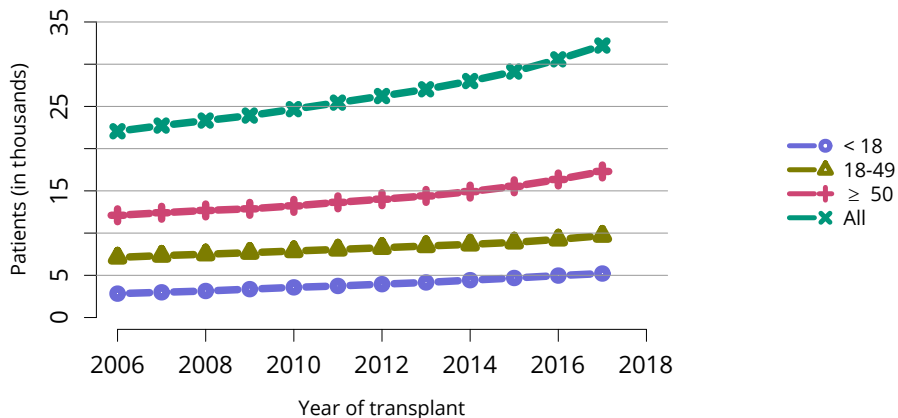


Figure HR 64. Recipients alive with a functioning heart graft on June 30 of the year, by age at transplant. Recipients are assumed to be alive with function unless a death or graft failure is recorded. A recipient may experience a graft failure and be removed from the cohort, undergo retransplant, and re-enter the cohort.

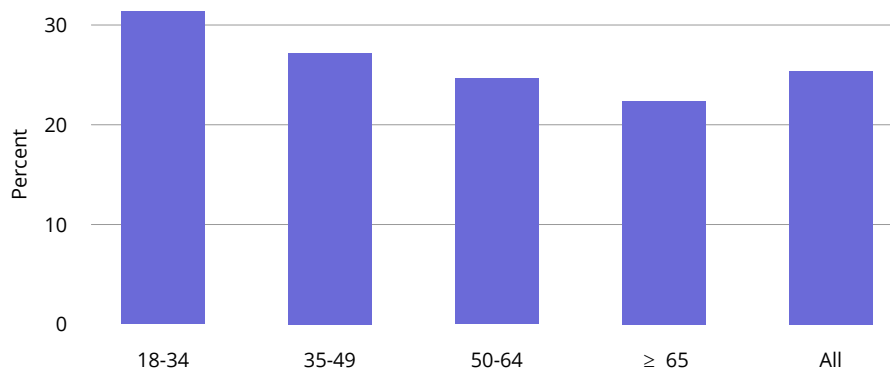


Figure HR 65. Incidence of acute rejection by 1 year posttransplant among adult heart transplant recipients by age, 2015-2016. Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method.

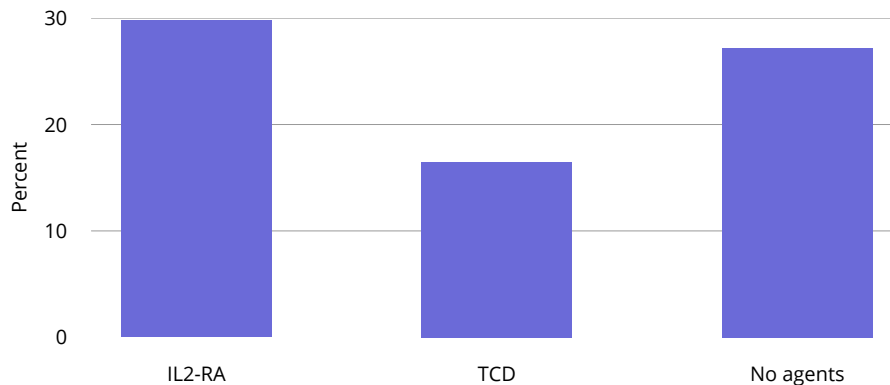


Figure HR 66. Incidence of acute rejection by 1 year posttransplant among adult heart transplant recipients by induction status, 2015-2016. Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method. If a recipient used both IL-2-RA and TCD agents, s/he will contribute to both of those cumulative incidence estimates.

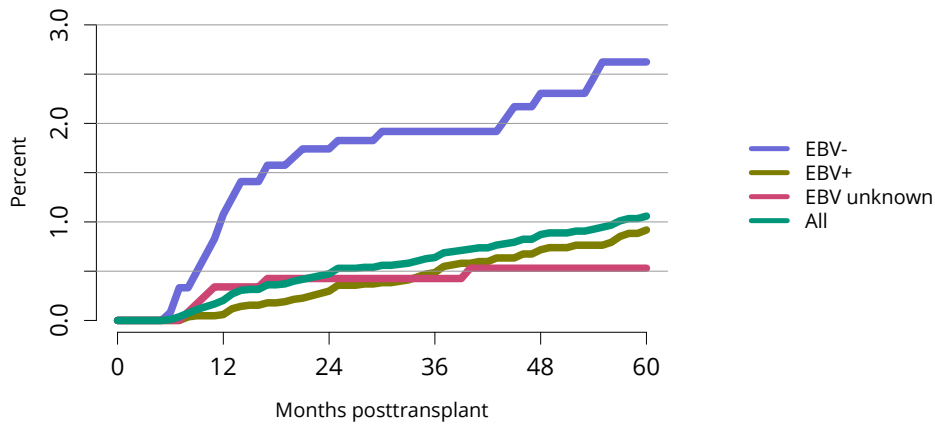


Figure HR 67. Incidence of PTLD among adult heart transplant recipients by recipient EBV status at transplant, 2011-2015. Cumulative incidence is estimated using the Kaplan-Meier competing risk method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up 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.

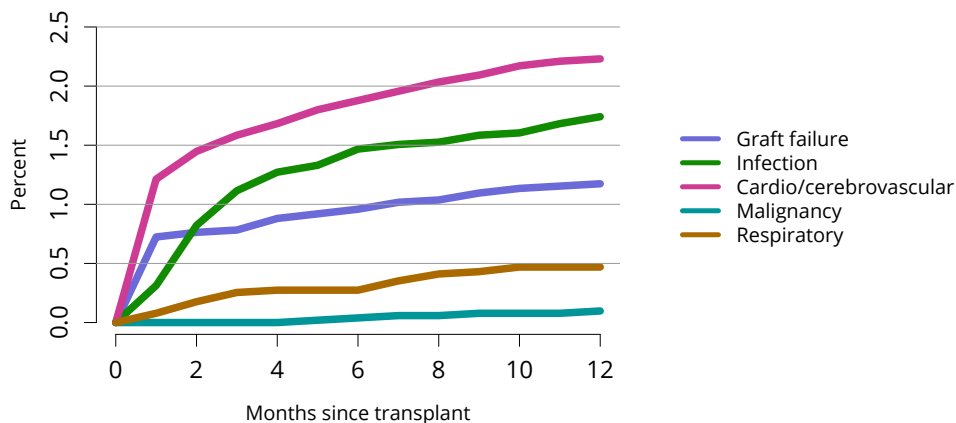


Figure HR 68. One-year cumulative incidence of death by cause among adult heart recipients, 2015-2016. Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

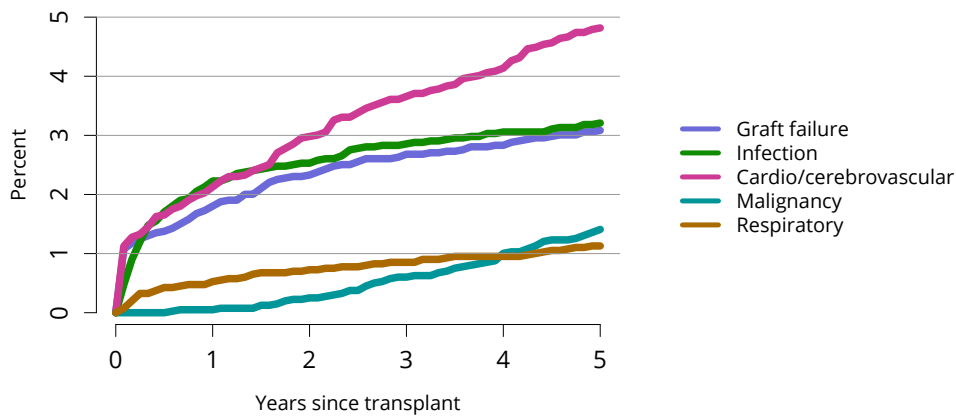


Figure HR 69. Five-year cumulative incidence of death by cause among adult heart recipients, 2011-2012. Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

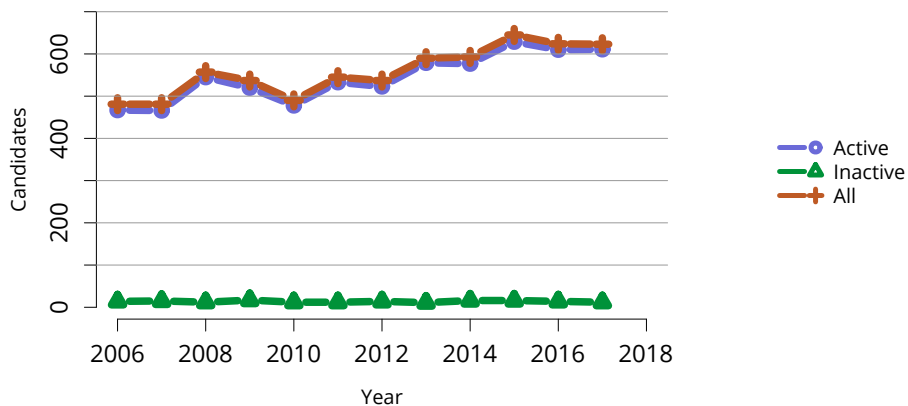


Figure HR 70. New pediatric candidates added to the heart transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates concurrently listed at multiple centers are counted once. Active and inactive patients are included. Age determined at listing.

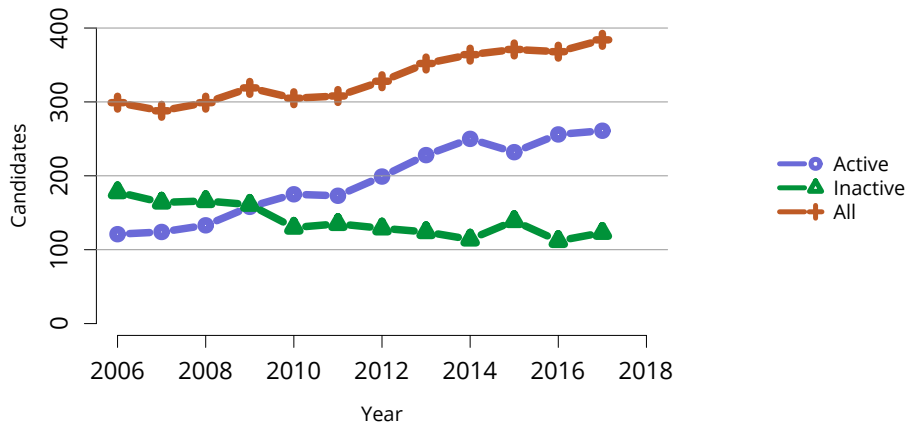


Figure HR 71. Pediatric candidates listed for heart transplant on December 31 each year. Candidates concurrently listed at multiple centers are counted once. Those with concurrent listings and active at any program are considered active.

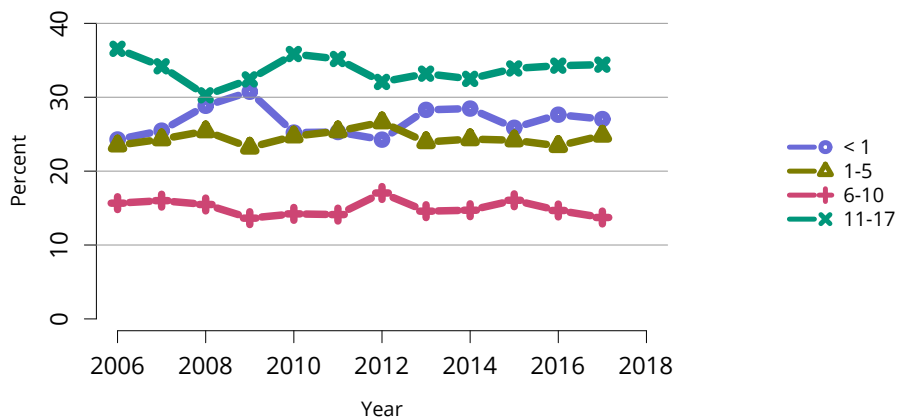


Figure HR 72. Distribution of pediatric candidates waiting for heart transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Age is determined at the later of listing date or January 1 of the given year. Active and inactive candidates are included.

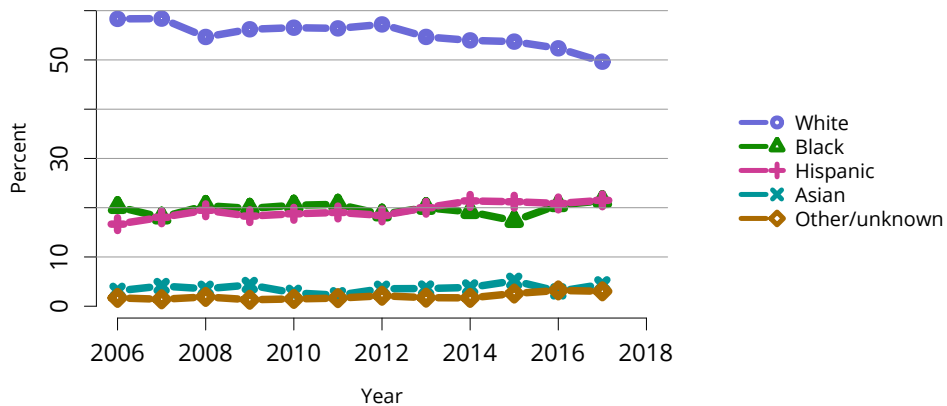


Figure HR 73. Distribution of pediatric candidates waiting for heart transplant by race. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive candidates are included.

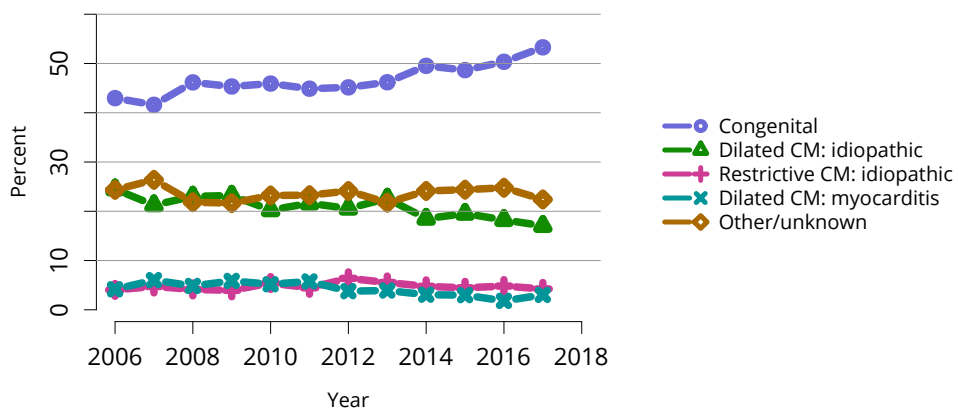


Figure HR 74. Distribution of pediatric candidates waiting for heart transplant by diagnosis. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive candidates are included. CM, cardiomyopathy.

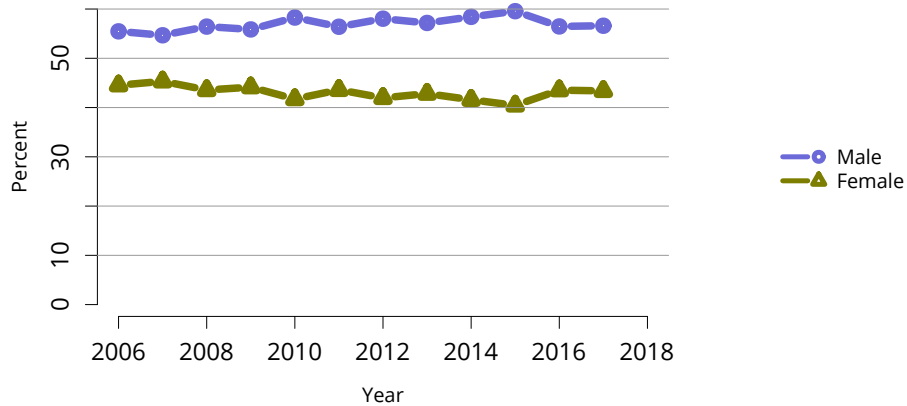


Figure HR 75. Distribution of pediatric candidates waiting for heart transplant by sex. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included.

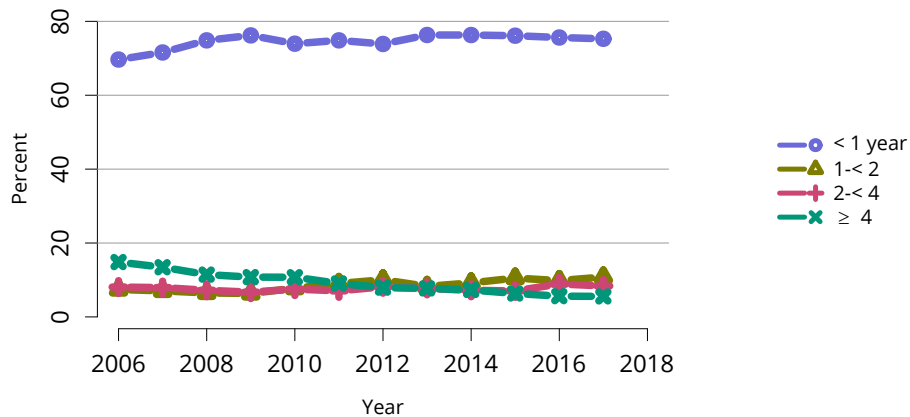


Figure HR 76. Distribution of pediatric candidates waiting for heart transplant by waiting time. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Time on the waiting list is determined at the earlier of December 31 or removal from the waiting list. Active and inactive candidates are included.

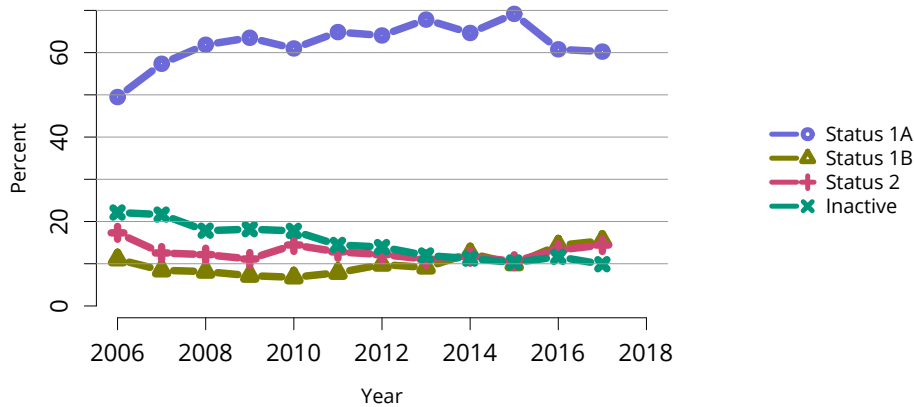


Figure HR 77. Distribution of pediatric candidates waiting for heart transplant by medical urgency. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Medical urgency status is the most severe during the year. Active and inactive patients are included.

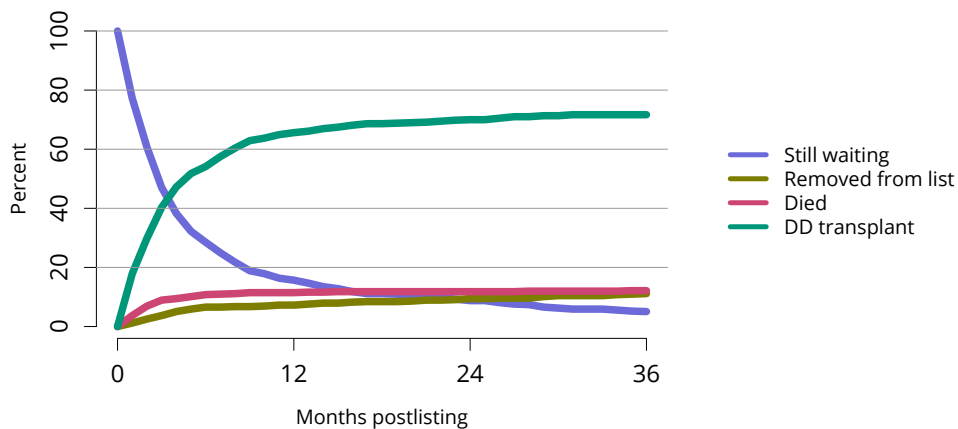


Figure HR 78. Three-year outcomes for newly listed pediatric candidates waiting for heart transplant, 2014. Pediatric candidates who joined the waitlist in 2014. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. DD, deceased donor.

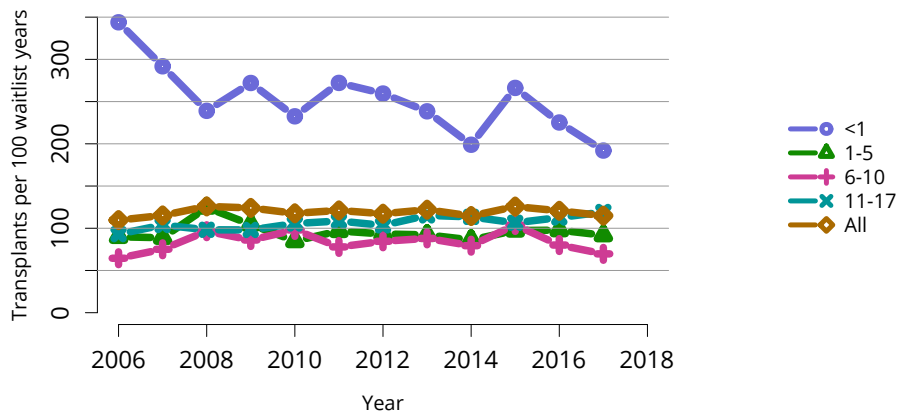


Figure HR 79. Heart transplant rates among pediatric waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

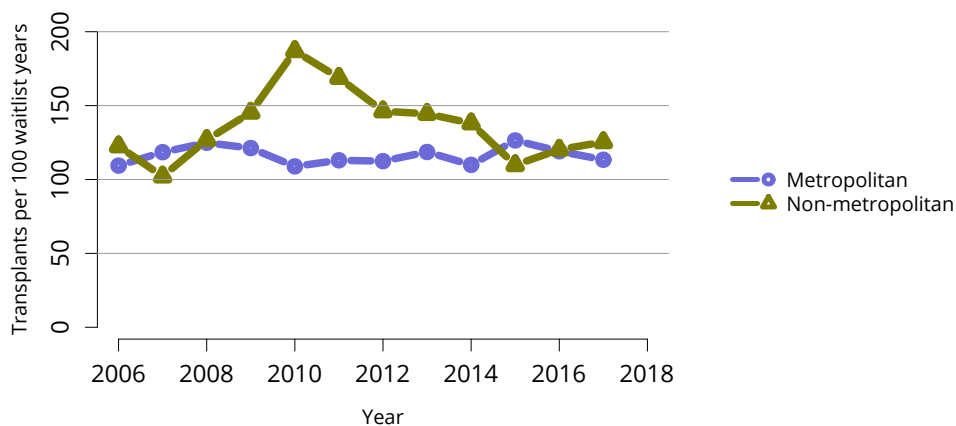


Figure HR 80. Deceased donor heart transplant rates among pediatric waitlist candidates by metropolitan vs. non-metropolitan residence. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

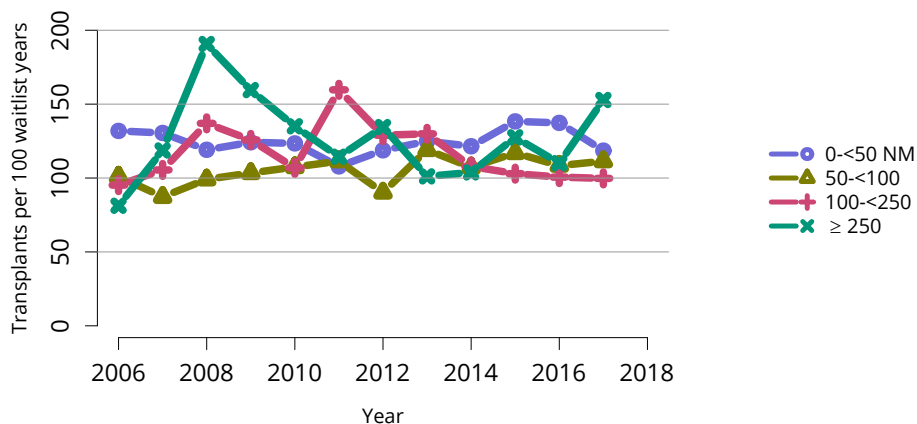


Figure HR 81. Deceased donor heart transplant rates among pediatric waitlist candidates by distance from listing center. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Distance is between the zipcode centroids of the TX center and the recipient’s permanent residence, measured in nautical miles (NM).

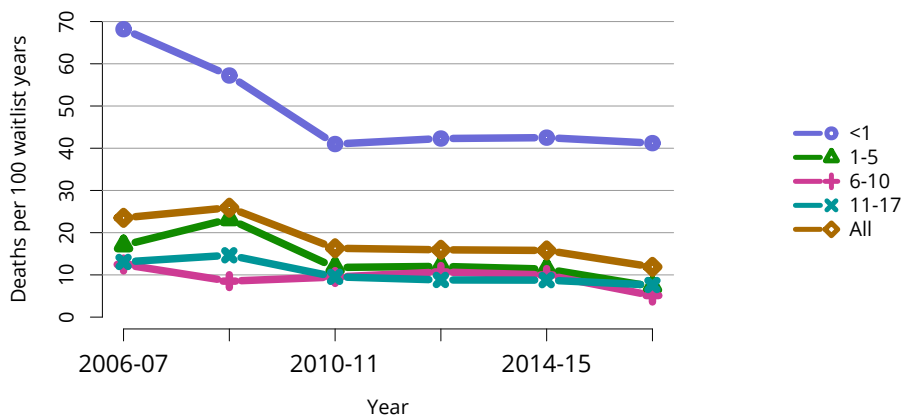


Figure HR 82. Pretransplant mortality rates among pediatrics waitlisted for heart transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

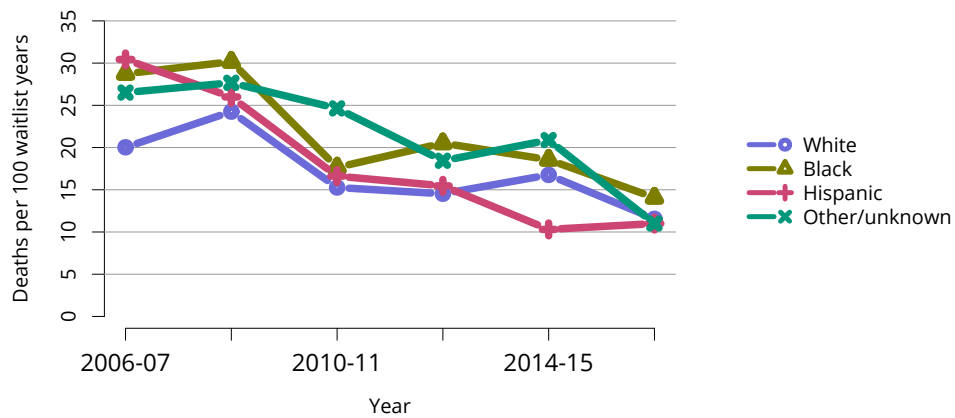


Figure HR 83. Pretransplant mortality rates among pediatric waitlisted for heart transplant by race. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

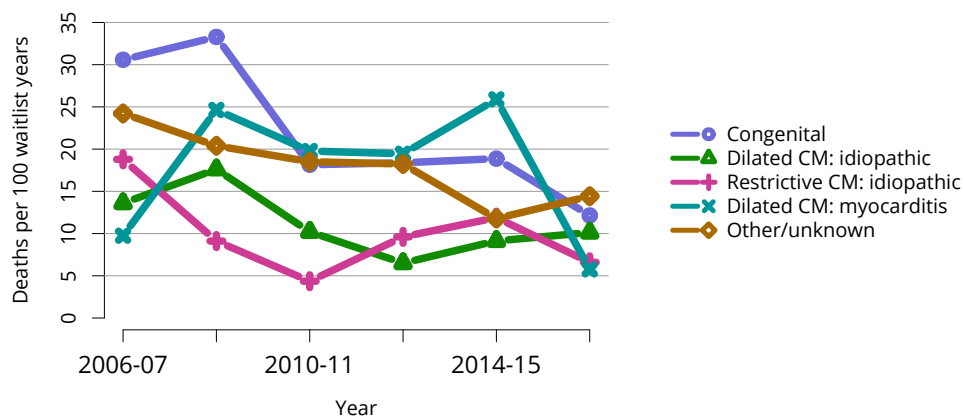


Figure HR 84. Pretransplant mortality rates among pediatric waitlisted for heart transplant by diagnosis. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. CM, cardiomyopathy.

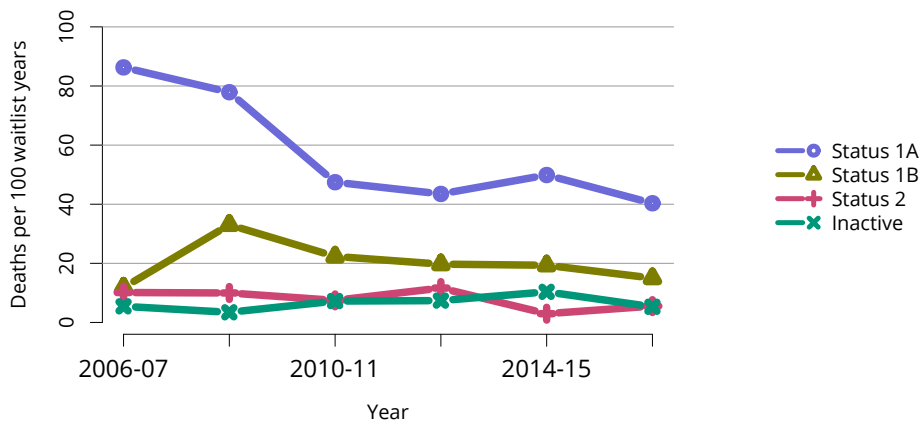


Figure HR 85. Pretransplant mortality rates among pediatric waitlisted for heart transplant by medical urgency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active waiting in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Medical urgency status is determined at the later of listing date and January 1 of the given year.

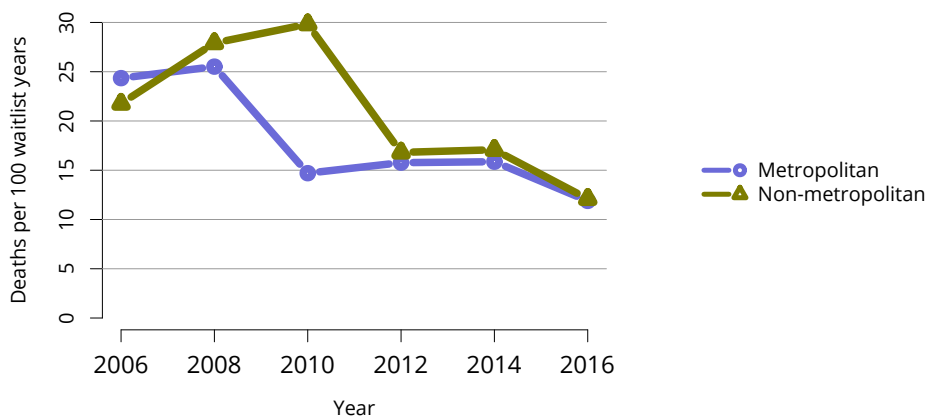


Figure HR 86. Pretransplant mortality rates among pediatric waitlisted for heart transplant by metropolitan vs. non-metropolitan residence. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. CM, cardiomyopathy.

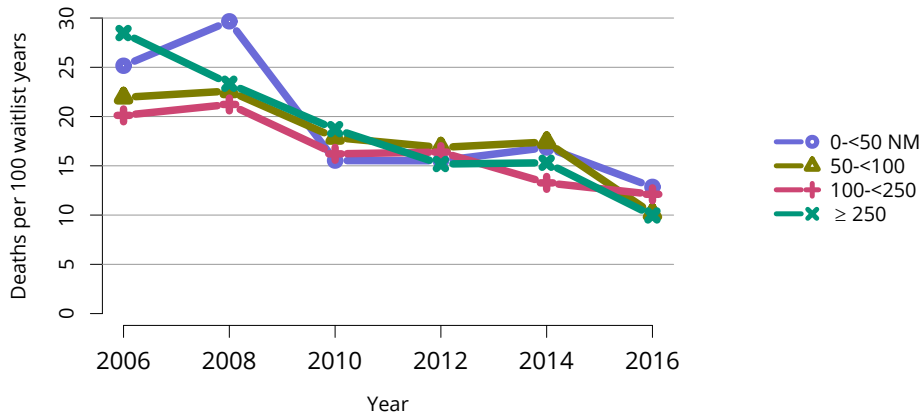


Figure HR 87. Pretransplant mortality rates among pediatric waitlisted for heart transplant by distance from listing center. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active waiting in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Medical urgency status is determined at the later of listing date and January 1 of the given year.

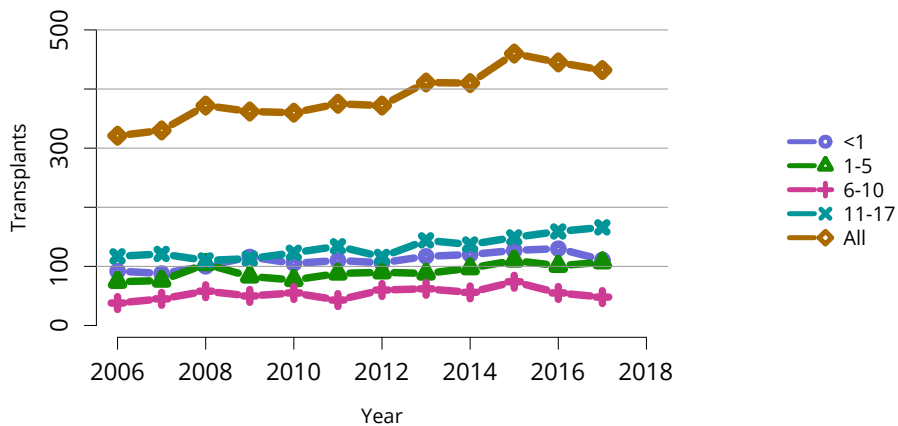


Figure HR 88. Pediatric heart transplants by recipient age. All pediatric heart transplant recipients, including retransplant, and multi-organ recipients.

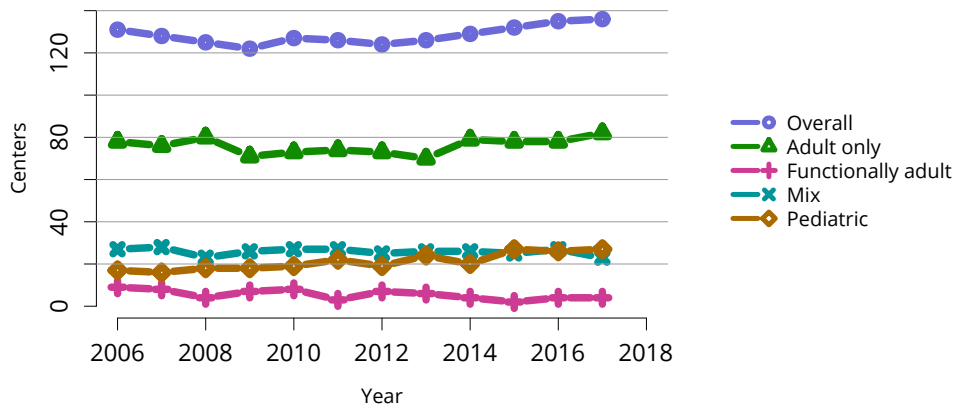


Figure HR 89. Number of centers performing pediatric and adult heart transplants by center's age mix. Adult centers transplanted only recipients aged 18 years or older. Functionally adult centers transplant 80% adults or more, and the remainder were children aged 15-17 years. Mixed included adults and children of any age groups. Child only centers transplanted recipients aged 0-17 years, and small number of adults up to age 21 years.

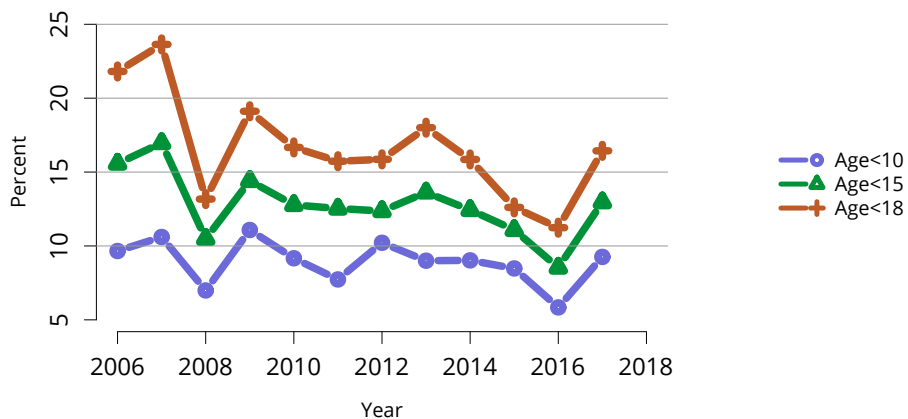


Figure HR 90. Pediatric heart recipients at programs that perform 5 or fewer pediatric transplants annually. Age groups are cumulative.

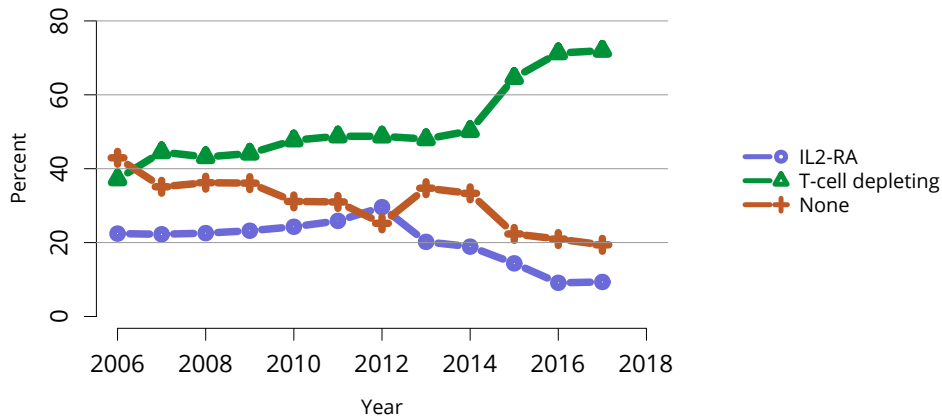


Figure HR 91. Induction agent use in pediatric heart transplant recipients. Immunosuppression at transplant reported to the OPTN. IL2-RA, interleukin-2 receptor antagonist.

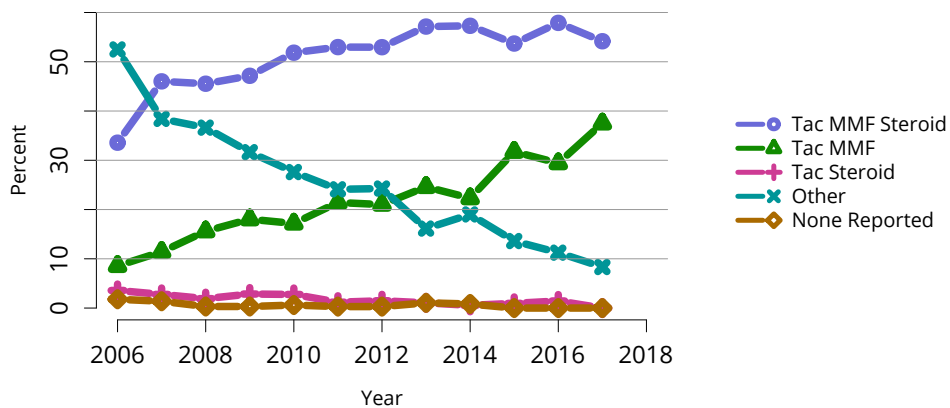


Figure HR 92. Immunosuppression regimen use in pediatric heart transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. Tac, tacrolimus. MMF, mycophenolate mofetil.

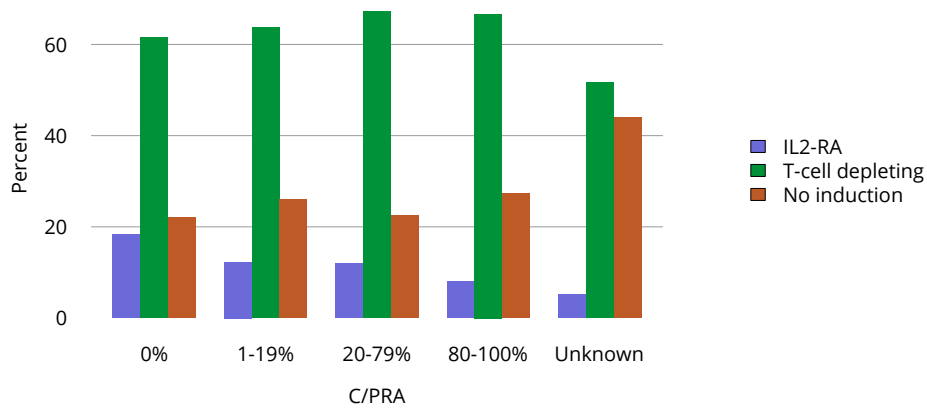


Figure HR 93. Induction use by C/PRA among pediatric heart transplant recipients, 2013-2017. Collection of calculated PRA (CPRA) began March 31, 2015. Prior to that, PRA class I and II values were used. IL2-RA, interleukin-2 receptor antagonist.

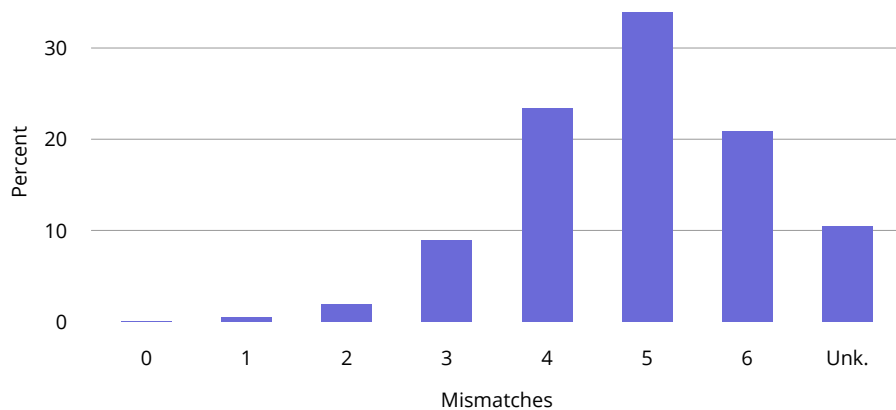


Figure HR 94. Total HLA A, B, and DR mismatches among pediatric deceased donor heart transplant recipients, 2013-2017. Donor and recipient antigen matching is based on OPTN antigen values and split equivalences policy as of 2016.

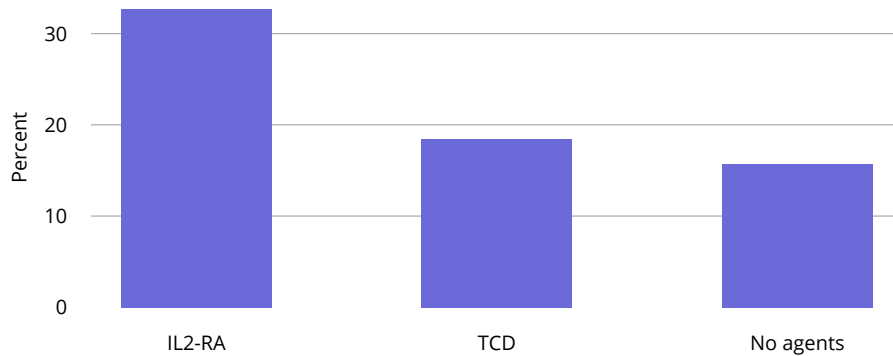


Figure HR 95. Incidence of acute rejection by 1 year posttransplant among pediatric heart transplant recipients by induction status, 2015-2016. Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method. If a recipient used both IL-2-RA and TCD agents, s/he will contribute to both of those cumulative incidence estimates.

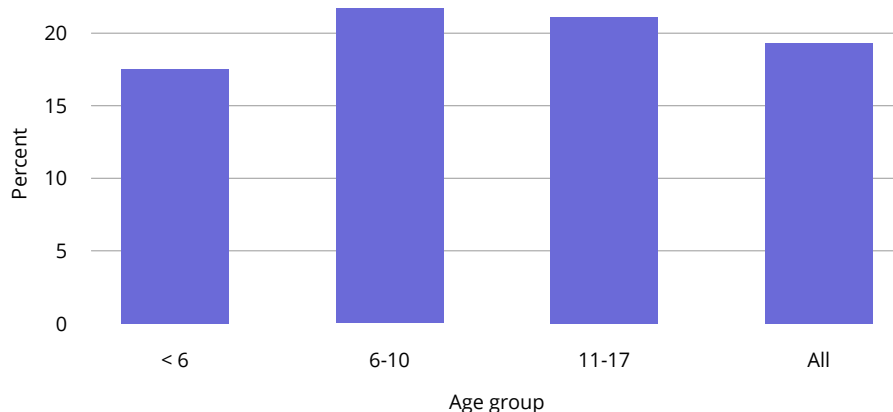


Figure HR 96. Incidence of acute rejection by 1 year posttransplant among pediatric heart transplant recipients by age, 2015-2016. Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration Form or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method.

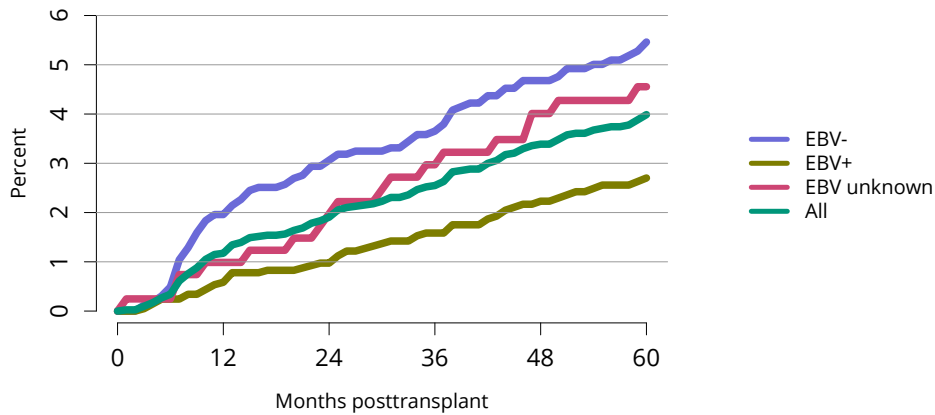


Figure HR 97. Incidence of PTLD among pediatric heart transplant recipients by recipient EBV status at transplant, 2004-2014. Cumulative incidence is estimated using the Kaplan-Meier competing risk method. Posttransplant lymphoproliferative disorder (PTLD) is identified as a reported complication or 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.

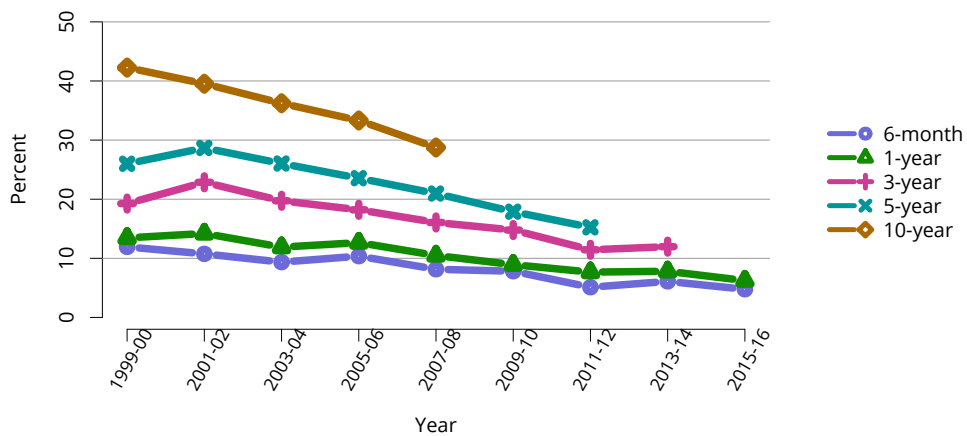


Figure HR 98. Patient death among pediatric heart transplant recipients. All pediatric recipients of deceased donor hearts, including multi-organ transplants. Patients are followed until the earlier of death or December 31, 2017. Estimates computed with Cox proportional hazards models adjusted for age, sex, and race.

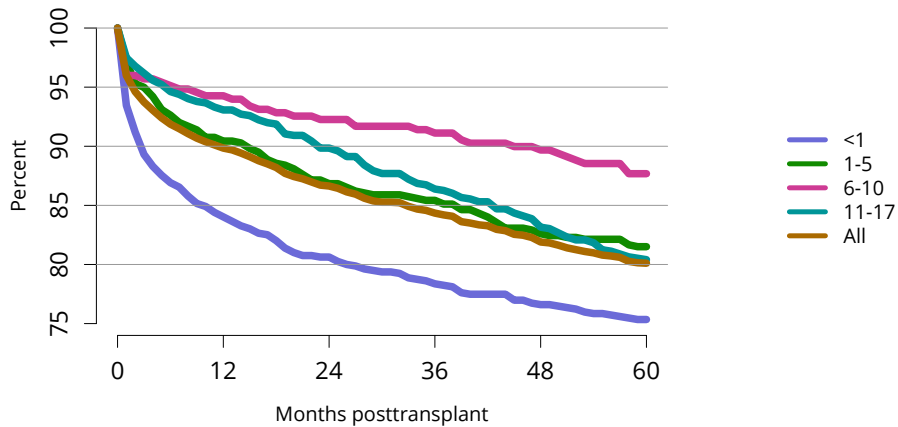


Figure HR 99. Patient survival among pediatric deceased donor heart transplant recipients, 2005-2012, by recipient age. Recipient survival estimated using unadjusted Kaplan-Meier methods.

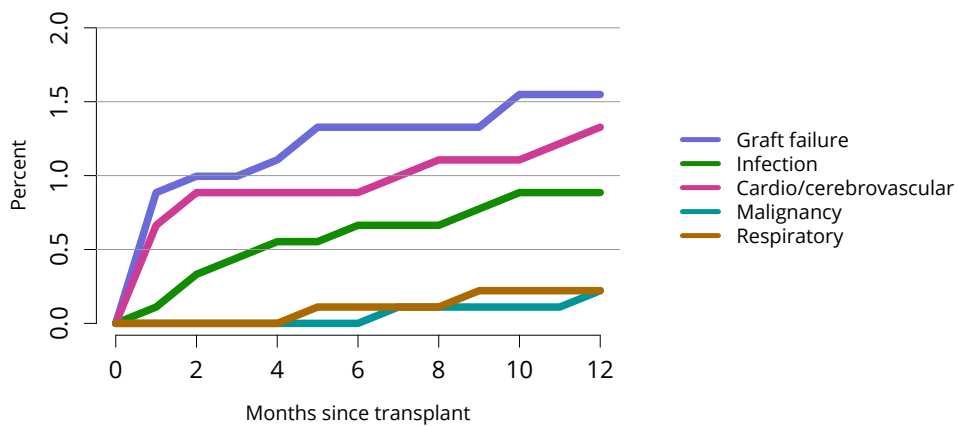


Figure HR 100. One-year cumulative incidence of death by cause among pediatric heart recipients, 2015-2016. Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

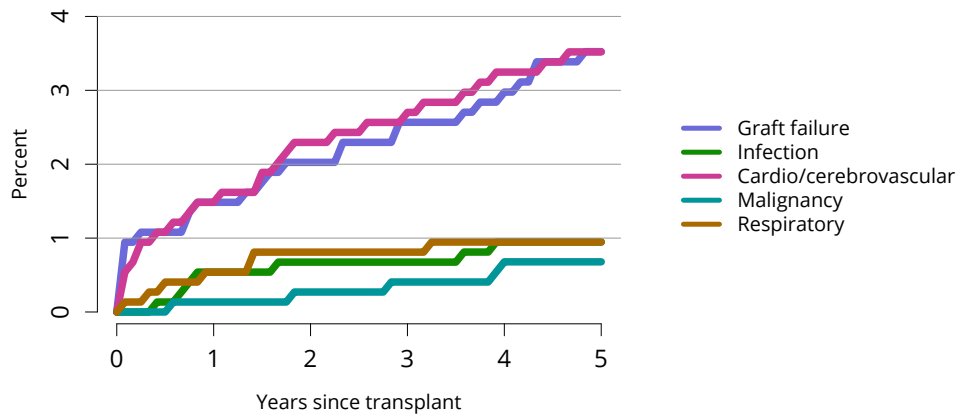


Figure HR 101. Five-year cumulative incidence of death by cause among pediatric heart recipients, 2011-2012. Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

Characteristic	2007		2017	
	N	Percent	N	Percent
Age				
18-34 years	246	10.2%	387	11.0%
35-49 years	542	22.4%	829	23.5%
50-64 years	1276	52.8%	1651	46.8%
≥ 65 years	353	14.6%	662	18.8%
Sex				
Female	595	24.6%	865	24.5%
Male	1822	75.4%	2664	75.5%
Race/ethnicity				
White	1768	73.1%	2146	60.8%
Black	404	16.7%	952	27.0%
Hispanic	177	7.3%	314	8.9%
Asian	49	2.0%	98	2.8%
Other/unknown	19	0.8%	19	0.5%
Geography				
Metropolitan	1943	80.4%	3004	85.1%
Non-metro	474	19.6%	525	14.9%
Distance				
< 50 miles	1382	57.2%	2164	61.3%
50-<100 miles	418	17.3%	569	16.1%
100-<150 miles	239	9.9%	332	9.4%
150-<250 miles	179	7.4%	223	6.3%
≥ 250 miles	173	7.2%	219	6.2%
Unknown	26	1.1%	22	0.6%
All candidates	2417	100.0%	3529	100.0%

Table HR 1 Demographic characteristics of adults on the heart transplant waiting list on December 31, 2007 and December 31, 2017. Candidates waiting for transplant on December 31, 2007, and December 31, 2017, regardless of first listing date; multiple listings are collapsed.

Characteristic	2007		2017	
	N	Percent	N	Percent
Diagnosis				
Coronary artery disease	1012	41.9%	1124	31.9%
Cardiomyopathy	1076	44.5%	2009	56.9%
Congenital disease	135	5.6%	181	5.1%
Valvular disease	57	2.4%	34	1.0%
Other/unknown	137	5.7%	181	5.1%
Blood type				
A	762	31.5%	1059	30.0%
B	228	9.4%	400	11.3%
AB	38	1.6%	69	2.0%
O	1389	57.5%	2001	56.7%
Medical urgency				
Status 1A	90	3.7%	378	10.7%
Status 1B	319	13.2%	1555	44.1%
Status 2	899	37.2%	794	22.5%
Inactive status	1109	45.9%	802	22.7%
VAD at listing	144	6.0%	1191	33.7%
All candidates	2417	100.0%	3529	100.0%

Table HR 2 Clinical characteristics of adults on the heart transplant waiting list on December 31, 2007 and December 31, 2017. Candidates waiting for transplant on December 31, 2007, and December 31, 2017, regardless of first listing date; multiple listings are collapsed. VAD, ventricular assist device.

Characteristic	2007		2017	
	N	Percent	N	Percent
Transplant history				
First	2332	96.5%	3404	96.5%
Retransplant	85	3.5%	125	3.5%
Wait time				
< 1 year	1019	42.2%	1825	51.7%
1-< 2 years	350	14.5%	722	20.5%
2-< 3 years	187	7.7%	393	11.1%
3-< 4 years	155	6.4%	251	7.1%
4-< 5 years	134	5.5%	119	3.4%
≥ 5 years	572	23.7%	219	6.2%
Tx type				
Heart only	2249	93.0%	3243	91.9%
Heart-kidney	69	2.9%	208	5.9%
Heart-lung	82	3.4%	41	1.2%
Other	17	0.7%	37	1.0%
All candidates	2417	100.0%	3529	100.0%

Table HR 3 Listing characteristics of adults on the heart transplant waiting list on December 31, 2007 and December 31, 2017. Candidates waiting for transplant on December 31, 2007, and December 31, 2017, regardless of first listing date; multiple listings are collapsed.

Waiting list state	2015	2016	2017
Patients at start of year	3626	3790	3629
Patients added during year	3622	3629	3769
Patients removed during year	3454	3783	3869
Patients at end of year	3794	3636	3529

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.

Removal reason	2015	2016	2017
Deceased donor transplant	2331	2734	2811
Patient died	395	324	290
Patient refused transplant	24	25	27
Improved, transplant not needed	161	187	176
Too sick for transplant	297	261	290
Other	246	251	273

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	2012		2017	
	N	Percent	N	Percent
Any life support	1610	79.1%	2427	85.4%
Intravenous inotropes	789	38.8%	1013	35.7%
Left ventricular assist device	759	37.3%	1353	47.6%
Intra-aortic balloon pump	121	5.9%	236	8.3%
Right ventricular assist device	53	2.6%	46	1.6%
Ventilator	22	1.1%	22	0.8%
Total artificial heart	21	1.0%	23	0.8%
Extra corporeal membrane oxygenation	15	0.7%	32	1.1%
Prostaglandins	15	0.7%	1	0.0%
Inhaled NO	4	0.2%	5	0.2%

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

Characteristic	2007		2017	
	N	Percent	N	Percent
Age				
18-34 years	244	12.8%	317	11.2%
35-49 years	454	23.8%	580	20.4%
50-64 years	966	50.6%	1370	48.2%
≥ 65 years	246	12.9%	574	20.2%
Sex				
Female	453	23.7%	742	26.1%
Male	1457	76.3%	2099	73.9%
Race/ethnicity				
White	1326	69.4%	1791	63.0%
Black	368	19.3%	676	23.8%
Hispanic	149	7.8%	247	8.7%
Asian	53	2.8%	112	3.9%
Other/unknown	14	0.7%	15	0.5%
Insurance				
Private	1032	54.0%	1337	47.1%
Medicare	521	27.3%	1033	36.4%
Medicaid	267	14.0%	370	13.0%
Other government	66	3.5%	88	3.1%
Unknown	24	1.3%	13	0.5%
Geography				
Metropolitan	1589	83.2%	2414	85.0%
Non-metro	321	16.8%	427	15.0%
Distance				
< 50 miles	1159	60.7%	1717	60.4%
50-<100 miles	318	16.6%	489	17.2%
100-<150 miles	155	8.1%	223	7.8%
150-<250 miles	134	7.0%	231	8.1%
≥ 250 miles	117	6.1%	164	5.8%
Unknown	27	1.4%	17	0.6%
All recipients	1910	100.0%	2841	100.0%

Table HR 7 Demographic characteristics of adult heart transplant recipients, 2007 and 2017. Adult heart transplant recipients, including retransplants.

Characteristic	2007		2017	
	N	Percent	N	Percent
Diagnosis				
Coronary artery disease	790	41.4%	852	30.0%
Cardiomyopathy	996	52.1%	1797	63.3%
Congenital disease	56	2.9%	92	3.2%
Valvular disease	34	1.8%	29	1.0%
Other/unknown	34	1.8%	71	2.5%
Blood type				
A	782	40.9%	1165	41.0%
B	273	14.3%	408	14.4%
AB	105	5.5%	162	5.7%
O	750	39.3%	1106	38.9%
Medical urgency				
Status 1A	848	44.4%	1886	66.4%
Status 1B	762	39.9%	885	31.2%
Status 2	300	15.7%	70	2.5%
On VAD	497	26.0%	1404	49.4%
CPRA				
< 1%	1241	65.0%	1276	44.9%
1-< 20%	290	15.2%	356	12.5%
20-< 80%	194	10.2%	457	16.1%
80-< 98%	41	2.1%	111	3.9%
98-100%	22	1.2%	38	1.3%
Unknown	122	6.4%	603	21.2%
All recipients	1910	100.0%	2841	100.0%

Table HR 8 Clinical characteristics of adult heart transplant recipients, 2007 and 2017. 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	2007		2017	
	N	Percent	N	Percent
Wait time				
< 31 days	731	38.3%	717	25.2%
31-60 days	268	14.0%	349	12.3%
61-90 days	167	8.7%	232	8.2%
3-< 6 months	287	15.0%	474	16.7%
6-< 12 months	239	12.5%	453	15.9%
1-< 2 years	120	6.3%	354	12.5%
≥ 2 years	98	5.1%	262	9.2%
Transplant history				
First	1844	96.5%	2761	97.2%
Retransplant	66	3.5%	80	2.8%
Tx type				
Heart only	1818	95.2%	2601	91.6%
Heart-lung	28	1.5%	25	0.9%
Heart-kidney	53	2.8%	184	6.5%
Heart-liver	10	0.5%	28	1.0%
Other	1	0.1%	3	0.1%
All recipients	1910	100.0%	2841	100.0%

Table HR 9 Transplant characteristics of adult heart transplant recipients, 2007 and 2017. Adult heart transplant recipients, including retransplants.

Donor	Recipient	CMV	EBV	HIV
D-	R-	16.9%	0.7%	96.9%
D-	R+	21.3%	5.4%	0.3%
D-	R unk	0.6%	0.5%	2.3%
D+	R-	23.9%	9.1%	0.0%
D+	R+	36.0%	77.4%	0.0%
D+	R unk	0.8%	6.7%	0.0%
D unk	R-	0.2%	0.0%	0.5%
D unk	R+	0.3%	0.2%	0.0%
D unk	R unk	0.0%	0.0%	0.0%

Table HR 10 Adult heart donor-recipient serology matching, 2013-2017.

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	2007		2017	
	N	Percent	N	Percent
Age				
< 1 year	24	9.6%	47	13.5%
1-5 years	83	33.3%	123	35.3%
6-10 years	59	23.7%	58	16.7%
11-17 years	83	33.3%	120	34.5%
Sex				
Female	114	45.8%	143	41.1%
Male	135	54.2%	205	58.9%
Race/ethnicity				
White	153	61.4%	166	47.7%
Black	38	15.3%	73	21.0%
Hispanic	48	19.3%	81	23.3%
Asian	8	3.2%	17	4.9%
Other/unknown	2	0.8%	11	3.2%
Geography				
Metropolitan	208	83.5%	291	83.6%
Non-metro	41	16.5%	57	16.4%
Distance				
< 50 miles	123	49.4%	175	50.3%
50-<100 miles	48	19.3%	76	21.8%
100-<150 miles	25	10.0%	49	14.1%
150-<250 miles	26	10.4%	25	7.2%
≥ 250 miles	20	8.0%	18	5.2%
Unknown	7	2.8%	5	1.4%
All candidates	249	100.0%	348	100.0%

Table HR 11 Demographic characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2007 and December 31, 2017. 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. Candidates listed as children who turned 18 before the cohort date are excluded.

Characteristic	2007		2017	
	N	Percent	N	Percent
Diagnosis				
Congenital defect	112	45.0%	200	57.5%
Idiopathic dilated CM	56	22.5%	52	14.9%
Familial dilated CM	3	1.2%	8	2.3%
Idiopathic restrictive CM	9	3.6%	18	5.2%
Myocarditis	15	6.0%	7	2.0%
Other/unknown	54	21.7%	63	18.1%
Blood type				
A	66	26.5%	91	26.1%
B	25	10.0%	46	13.2%
AB	5	2.0%	9	2.6%
O	153	61.4%	202	58.0%
Medical urgency				
Status 1A	43	17.3%	82	23.6%
Status 1B	23	9.2%	72	20.7%
Status 2	52	20.9%	92	26.4%
Inactive status	131	52.6%	102	29.3%
VAD at listing	7	2.8%	28	8.0%
All candidates	249	100.0%	348	100.0%

Table HR 12 Clinical characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2007 and December 31, 2017. Candidates aged younger than 18 years waiting for transplant on December 31, 2007, and December 31, 2017, regardless of first listing date; multiple listings are collapsed. Candidates listed as children who turned 18 before the cohort date are excluded. CM, cardiomyopathy; VAD, ventricular assist device.

Characteristic	2007		2017	
	N	Percent	N	Percent
Transplant history				
First	231	92.8%	327	94.0%
Retransplant	18	7.2%	21	6.0%
Wait time				
< 1 year	124	49.8%	220	63.2%
1-< 2 years	35	14.1%	56	16.1%
2-< 3 years	23	9.2%	26	7.5%
3-< 4 years	16	6.4%	21	6.0%
4-< 5 years	8	3.2%	9	2.6%
≥ 5 years	43	17.3%	16	4.6%
Tx type				
Heart only	227	91.2%	344	98.9%
Heart-kidney	3	1.2%	4	1.1%
Heart-lung	18	7.2%	0	0.0%
Other	1	0.4%	0	0.0%
All candidates	249	100.0%	348	100.0%

Table HR 13 Listing characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2007 and December 31, 2017. Candidates aged younger than 18 years waiting for transplant on December 31, 2007, and December 31, 2017, regardless of first listing date; multiple listings are collapsed. Candidates listed as children who turned 18 before the cohort date are excluded.

Waiting list state	2015	2016	2017
Patients at start of year	362	369	367
Patients added during year	645	626	623
Patients removed during year	636	627	606
Patients at end of year	371	368	384

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.

Removal reason	2015	2016	2017
Deceased donor transplant	464	460	444
Patient died	81	61	67
Patient refused transplant	3	2	0
Improved, transplant not needed	48	60	54
Too sick for transplant	23	28	28
Other	17	16	13

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	2005-07		2015-17	
	N	Percent	N	Percent
Age				
< 1 year	261	26.9%	368	27.5%
1-5 years	218	22.5%	318	23.8%
6-10 years	128	13.2%	177	13.2%
11-17 years	363	37.4%	474	35.5%
Sex				
Female	457	47.1%	584	43.7%
Male	513	52.9%	753	56.3%
Race/ethnicity				
White	557	57.4%	693	51.8%
Black	218	22.5%	251	18.8%
Hispanic	135	13.9%	292	21.8%
Asian	44	4.5%	62	4.6%
Other/unknown	16	1.6%	39	2.9%
Insurance				
Private	515	53.1%	540	40.4%
Medicaid	364	37.5%	667	49.9%
Other government	63	6.5%	95	7.1%
Unknown	28	2.9%	35	2.6%
Geography				
Metropolitan	806	83.1%	1115	83.4%
Non-metro	164	16.9%	222	16.6%
Distance				
< 50 miles	506	52.2%	704	52.7%
50-<100 miles	147	15.2%	246	18.4%
100-<150 miles	97	10.0%	138	10.3%
150-<250 miles	95	9.8%	108	8.1%
≥ 250 miles	98	10.1%	110	8.2%
Unknown	27	2.8%	31	2.3%
All recipients	970	100.0%	1337	100.0%

Table HR 16 Demographic characteristics of pediatric heart transplant recipients, 2005-2007 and 2015-2017. Heart transplant recipients, including retransplants.

Characteristic	2005-07		2015-17	
	N	Percent	N	Percent
Diagnosis				
Congenital defect	409	42.2%	661	49.4%
Idiopathic dilated CM	294	30.3%	305	22.8%
Familial dilated CM	32	3.3%	83	6.2%
Idiopathic restrictive CM	60	6.2%	61	4.6%
Myocarditis	31	3.2%	33	2.5%
Other/unknown	144	14.8%	194	14.5%
Blood type				
A	358	36.9%	480	35.9%
B	118	12.2%	190	14.2%
AB	35	3.6%	42	3.1%
O	459	47.3%	625	46.7%
Medical urgency				
Status 1A	726	74.8%	1108	82.9%
Status 1B	129	13.3%	189	14.1%
Status 2	115	11.9%	40	3.0%
On VAD	124	12.8%	334	25.0%
CPRA				
< 1%	547	56.4%	526	39.3%
1-< 20%	157	16.2%	198	14.8%
20-< 80%	96	9.9%	266	19.9%
80-< 98%	31	3.2%	72	5.4%
98-100%	34	3.5%	37	2.8%
Unknown	105	10.8%	238	17.8%
All recipients	970	100.0%	1337	100.0%

Table HR 17 Clinical characteristics of pediatric heart transplant recipients, 2005-2007 and 2015-2017. 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	2005-07		2015-17	
	N	Percent	N	Percent
Wait time				
< 31 days	462	47.6%	383	28.6%
31-60 days	177	18.2%	259	19.4%
61-90 days	99	10.2%	190	14.2%
3-< 6 months	135	13.9%	270	20.2%
6-< 12 months	67	6.9%	139	10.4%
1-< 2 years	24	2.5%	66	4.9%
≥ 2 years	6	0.6%	30	2.2%
ABO				
Compatible/identical	940	96.9%	1237	92.5%
Incompatible	30	3.1%	100	7.5%
Transplant history				
First	893	92.1%	1274	95.3%
Retransplant	77	7.9%	63	4.7%
Tx type				
Heart only	945	97.4%	1323	99.0%
Heart-lung	14	1.4%	5	0.4%
Heart-kidney	8	0.8%	7	0.5%
Heart-liver	2	0.2%	2	0.1%
Other	1	0.1%	0	0.0%
All recipients	970	100.0%	1337	100.0%

Table HR 18 Transplant characteristics of pediatric heart transplant recipients, 2005-2007 and 2015-2017. Heart transplant recipients, including re-transplants.

Support	2012		2017	
	N	Percent	N	Percent
Any life support	267	71.8%	317	73.4%
Intravenous inotropes	199	53.5%	207	47.9%
Left ventricular assist device	77	20.7%	124	28.7%
Ventilator	64	17.2%	72	16.7%
Extra corporeal membrane oxygenation	19	5.1%	19	4.4%
Right ventricular assist device	18	4.8%	18	4.2%
Prostaglandins	7	1.9%	13	3.0%
Total artificial heart	2	0.5%	1	0.2%
Intra-aortic balloon pump	1	0.3%	2	0.5%
Inhaled NO	1	0.3%	6	1.4%

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-	31.3%	15.7%
D-	R+	17.0%	14.6%
D-	R unk	0.8%	1.0%
D+	R-	28.5%	27.9%
D+	R+	20.4%	38.2%
D+	R unk	0.8%	2.2%
D unk	R-	0.8%	0.2%
D unk	R+	0.3%	0.1%

Table HR 20 Pediatric heart donor-recipient serology matching, 2013-2017. 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.