OPTN/SRTR 2019 Annual Data Report: Heart

M. Colvin[1,2], J. M. Smith[1,3], Y. Ahn[1], M. A. Skeans[1],
E. Messick[4], R. Goff[4], K Bradbrook[4], J. Foutz[4],
A. K. Israni[1,5,6], J. J. Snyder[1,5], B. L. Kasiske[1,6]

[1] Scientific Registry of Transplant Recipients, Hennepin Healthcare Research Institute, Minneapolis, MN

[2] Department of Cardiology, University of Michigan, Ann Arbor, MI

[3] Department of Pediatrics, University of Washington, Seattle, WA

[4] Organ Procurement and Transplantation Network, United Network for Organ Sharing, Richmond, VA

[5] Department of Epidemiology and Community Health, University of Minnesota, Minneapolis, MN

[6] Department of Medicine, Hennepin Healthcare, University of Minnesota, Minneapolis, MN

Abstract

The new adult heart allocation policy was approved in 2016 and implemented in October 2018. This year's Annual Data Report provides early insight into the effects of this policy. In 2019, new listings continued to increase, with 4086 new candidates. Also in 2019, 3597 heart transplants were performed, an increase of 157 (4.6%) from 2018; 509 transplants occurred in children and 3088 in adults. Short- and long-term posttransplant mortality rates improved. Overall, Mortality rates for adult recipients were 6.4% at 6 months and 7.9% at 1 year for transplants in 2018, 14.4% at 3 years for transplants in 2016, and 20.1% at 5 years for transplants in 2014. Mortality rates for pediatric recipients were 6.3% at 6 months and 8.2% at 1 year for transplants in 2018, 10.3% at 3 years for transplants in 2016, and 17.8% at 5 years for transplants in 2014.
Keywords: End-stage heart failure, heart transplant, transplant outcomes, ventricular assist device.

1 Introduction

The new adult heart allocation policy was approved in 2016 and implemented in October 2018 to better stratify heart transplant candidates and broaden sharing for higher-urgency statuses to reduce waiting list mortality. While it is too early to discern the impact of the new policy, the more granular data being collected as part of the new system are anticipated to allow improved analyses of outcomes and risk factors, which will contribute to a more dynamic policy. The current Annual Data Report provides an early glimpse into the trends of heart transplant candidates and recipients under the new allocation system.

2 Adult Heart Transplant

2.1 Waiting List Trends

From 2008 to 2019, the number of new listings for heart transplant increased by 42.5%, from 2867 to 4086 (Figure HR 1). The number of candidates awaiting heart transplant increased by 42.6% over 2008 to 2019, from 5304 to 7562 (Figure HR 2). Some notable demographic trends in heart transplant since 2008 include stable proportions of women and men (Figure HR 4), lower proportions of whites (70.4% in 2008 to 60.4% in 2019), higher proportions of blacks, (19.1% to 26.0%) and Hispanics (7.4% to 9.7%) (Figure HR 5), a slight increase in patients with congenital heart disease, and a substantial decrease in patients with coronary artery disease (Figure HR 6). The proportion of candidates diagnosed as having cardiomyopathy continued to increase. Cardiomyopathy is the most common diagnosis among candidates, comprising 59.7% in 2019.

In 2019, 78.4% of candidates had been on the waiting list for less than 1 year, similar to 2009. In 2009, 14.6% of candidates had been on the waiting list for 2 years or longer; this proportion gradually declined to 12.0% in 2019, the lowest in the past decade (Figure HR 7). The proportion of status 1A candidates awaiting transplant continued to increase, while the proportion of status 1B candidates gradually increased, then declined slightly in 2018 (Figure HR 8). Note that new status groups in use as of October 2018 were converted to former status 1A, 1B, and two equivalents for the 2018 data point. New status groups 1-3 were converted to old status 1A, new status 4 to old status 1B, and new status 5 and 6 to old status 2. The proportion of candidates with ventricular assist devices (VADs) at listing increased from 13.5% in 2009 to 37.1% in 2019 (Table HR 2). Sex distribution did not change appreciably: in 2019, women comprised 26.1% of heart transplant candidates (Figure HR 4). As of December 31, 2019, 85.1% of candidates resided in a metropolitan area; 61.5% lived within 50 miles of the transplant center, compared with 57.2% in 2009 (Table HR 1). Numbers of candidates with a previous heart transplant declined from 4.1% in 2009 to 2.8% in 2019 (Table HR 3). At year-end 2019, 253 candidates were listed for heart-kidney transplant, a substantial increase since 2009. The number of heart-lung candidates remained stable over this

period, with 74 candidates waiting in 2019 (Table HR 3).

From 2017 to 2019, the number of patients removed from the transplant list increased, but fewer were removed due to improvement or being too ill for transplant (Table HR 5). Compared with 2017, 103 fewer patients died on the waiting list in 2019.

The distribution of candidates by status on December 31, 2019, is shown in Table HR 2. At the end of 2019, 4 patients (0.1%) were listed as status 1, and 48 (1.4%) were status 2. Fewer patients were listed in the highest-urgency categories under the new allocation system, with 50.5% listed as status 4. The number of patients receiving any life support before transplant increased slightly, from 2431 in 2017 to 2519 in 2019, although they represented a smaller proportion of candidates in 2019 than in 2017 (Table HR 7). Of these, 1034 (33.5%) had left-VADs (LVADs), a decrease of 324 over the 2-year period. There was a shift toward intra-aortic balloon pump (IABP) and extracorporeal membrane oxygenation (ECMO), and there was a substantial increase in ventilator support before transplant between 2017 and 2019. In 2019, candidates on IABP comprised nearly one-third of all candidates on life support (Table HR 7).

Since 2015, overall deceased-donor heart transplant rates have increased, to a decade high of 89.5 per 100 waitlist years in 2019 (Figure HR 12). This trend was similar for all age-groups; however, the increase was greatest in candidates 65 and older, with 74.3 per 100 waitlist years in 2015 to 132.2 in 2019 (Figure HR 13). For most groups, transplant rates since 2008 reached a nadir in 2014 and 2015 and have increased since. Transplant rates for Asians exceed that for other ethnic groups (Figure HR 14).

Transplant rates have consistently been highest for candidates with blood type AB (276.6 per 100 waitlist years in 2019), those listed as status 1A under the previous allocation system in 2018 (302.2 per 100), and those now listed as status 1 (1649.0 per 100) (Figure HR 16, Figure HR 18, Figure HR 19). In 2019, blood type O candidates underwent transplant at a rate of 59.7 per 100 waitlist years, less than half the rate of blood type A and B candidates. Despite these differences, transplant rates for all blood types have increased since 2015 (Figure HR 16). From 2008 to 2012, candidates residing in metropolitan areas had higher transplant rates than those in non-metropolitan areas; however, since then, the rates have been more closely aligned. In 2019, the transplant rate was 89.6 per 100 waitlist years for those residing in metropolitan areas and 86.6 per 100 in non-metropolitan areas (Figure HR 21).

The median wait time in 2018-2019 was 5.1 months, the lowest in the past decade. Women typically had a shorter median wait than men and in 2018-2019 underwent transplant at a median of 3.5 months, compared with men (5.9 months) (Figure HR 23). The median wait for candidates with blood type O declined substantially over the past 5 years, from 21.6 months in 2014-2015 to 11.7 months in 2018-2019; however, the median wait for blood type O still far exceeded that of all other blood types (Figure HR 24). Candidates with a body mass index (BMI) of 35 kg/m^2 or greater also had longer median waits than

other candidates. In 2008-2009, the median wait for candidates with BMI $\geq$35 kg/m^2 was 32.7 months, which declined to 9.7 months in 2018-2019. Candidates with BMI <18.5 kg/m^2 had the shortest median wait (1.8 months) (Figure HR 26). The proportion of candidates who underwent transplant within 1 year of listing has varied but has increased since 2014. In 2018, 56.8% of candidates underwent transplant within 1 year of listing (Figure HR 27). When stratified by donation service area (DSA), the proportion of candidates undergoing transplant within 1 year of listing in 2018 was 23.1% to 85.5% (Figure HR 28). Similar variability occurred by state (22.2% to 100%) (Figure HR 29).

Pretransplant mortality declined from 17.4 deaths per 100 waitlist years in 2008 to 8.3 per 100 in 2019 (Figure HR 30). Pretransplant mortality declined for all groups starting in 2009. It was lowest for candidates aged 18-34 years (6.7 per 100 waitlist years) and 35-49 (6.8 per 100) and those listed as status 4 (6.1 per 100) or 6 (6.1 per 100) (Figure HR 31, Figure HR 36). Deaths before transplant declined by more than 50% for all age-groups from 2008 to 2019 (Figure HR 31) and declined substantially over the past decade for black, Hispanic, and Asian candidates. Asians had the largest decline in pretransplant mortality rate, from 28.7 deaths per 100 waitlist years in 2008 to 10.4 deaths per 100 in 2019. Pretransplant mortality was lowest for Hispanics (6.5 deaths per 100) in 2019 (Figure HR 32). Aside from occasional fluctuations, pretransplant mortality rates have been similar between men and women, at 8.15 deaths per 100 waitlist years and 8.36 per 100 in 2019, respectively (Figure HR 33).

Despite a large decline in pretransplant mortality among all statuses under the previous system, patients in the highest-urgency categories still die far more often than those with other statuses. In 2017-2018, candidates listed as status 1A had a pretransplant mortality rate of 29.3 deaths per 100 waitlist years, while status 1B and 2 candidates were similar, at 8.3 deaths per 100 and 7.1 per 100, respectively (Figure HR 35). In 2019, status 1 candidates under the new system had a pretransplant mortality rate of 113.5 deaths per waitlist years, followed by status 2 (42.4 per 100), 5 (33.9 per 100), and 3 (17.2 per 100), respectively (Figure HR 36). It is not possible to compare the pretransplant mortality rates between the new and old systems because of the change in both criteria and practice. From 2006 to 2008, policy changes regarding broader sharing and US Food and Drug Administration approval of LVADs resulted in a change in practice. The large decline in pretransplant mortality likely reflects the combined effect of those changes.

In 2019, 20.6% of candidates died within 6 months of removal from the waiting list (whose removal reasons were any reasons other than transplant or death), more than in the previous 2 years (Figure HR 40). After a peak in 2013, deaths after removal from the list declined despite the increase in 2019.

2.2   Donor Trends

The number of deceased-donor hearts continued to increase, with 3635 in 2019, the highest number to date and an increase of 63.6% since 2008 (Figure

HR 43). While the number of donors increased in all age-groups since 2008, the greatest increase remained in donors 30-39 years, from 381 in 2008 to 966 in 2019 (Figure HR 44); the highest proportion of donors, 34.8%, was in donors 18-29 years (Figure HR 45). About 70% of donors are men (Figure HR 46). There is little variation by race; most donors are white, which reflects population demographics (Figure HR 47). The proportion of pediatric hearts allocated to adults varied by DSA and in 2015-2019 was 0 to 71.4 (Figure HR 48).

The discard rate (ie, proportion of recovered hearts not transplanted) has fluctuated over the past decade and in 2019 was 0.85% (Figure HR 49). The discard rate for donors aged 55 and older has declined and in 2019 was 2.06, compared with 1.24 in those 40-54 years. Hearts from donors <18 years were least likely to be discarded, at a rate of 0.35 (Figure HR 50). Women's hearts tended to be discarded more often than men's, although this has varied (Figure HR 51). Discard rates for Asian donor hearts have fluctuated, but there has been no noticeable race-based trend (Figure HR 52).

In 2019, anoxia slightly exceeded head trauma as the most common cause of death among heart donors (42.8% vs 41.1%) (Figure HR 57).

2.3   Trends in Adult Heart Transplant

The number of heart transplants performed in the United States has steadily risen, and in 2019 was 3597 (Figure HR 58). There has been an increase in all age groups; however, recipients 65 and older had the greatest relative increase over the past decade, with 596 transplants in 2019, and 85.1% increase since 2010 (Figure HR 59). The median per-center transplant volume has increased since 2014, from 14 to 23 in 2019 (Figure HR 67). As median volumes increase, the proportion of transplants performed at low-volume centers has declined and the proportion performed at median to high volume centers has increased. In 2019, centers with volumes of 1-9 transplants performed only 2.8% of all procedures, while centers performing 30 or more transplants per year accounted for 63.0% of all heart transplants (Figure HR 68).

The proportion of patients on any type of life support, including inotropic support, declined from 85.6% in 2017 to 81.6% in 2019, although the absolute number increased. There is a growing shift in the use of temporary circulatory support compared with previous years. Notably, LVAD at transplant has declined from 47.8% to 33.5%, while IABP use increased from 8.3% to 29.7%, and ECMO increased from 1.2% to 6.0%. Ventilator use has also increased, from 0.8% to 2.5% (Table HR 7). The typical heart transplant recipient in 2019 was a man (71.6%), white (62.3%), 50-64 years old (47.3%), had private insurance (48.6%), resided in a metropolitan area (85.3%), had cardiomyopathy (62.5%) and blood type A (40.4%), and was status 2 at transplant (47.2%) (Table HR 8, Table HR 9). Between 2009 and 2019, proportions of women and blacks have increased from 24.4% to 28.4% and from 19.3 to 23.1%, respectively (Table HR 8).

2.4 Adult Post-transplant Survival and Morbidity

Adult death rates after heart transplant continued to decline; of those who underwent transplant in 2018, 6.4% died by 6 months, and 7.9% died by 1 year. Death rates at all time points have improved over the past decade (Figure HR 69). In patients who underwent transplant from 2012 to 2014, early survival was similar among all age-groups; however, in recipients 65 and older, 1-year survival rates declined compared with younger age groups. The one-year survival rate in recipients aged 35-49 was 90.4%. One-year survival was greatest in recipients aged 18-34, at 90.9%. At 2 years, survival was highest in recipients aged 50-64 (87.6%) and remained so up to year 5, at 80.2%. Recipients aged 18-35 had the lowest 5-year survival rate, at 77.3% (Figure HR 70). Recipients categorized as "other" race had the best 1-year survival rate (93.9%), followed by Asians (92.7%) (Figure HR 71). By year 5, blacks fared substantially worse (75.9%), followed by whites (80.0%). Recipients with congenital heart disease had the lowest 1- and 5-year survival rate (82.2% and 74.2%), while those with valvular heart diseases fared best (84.5%) at 5 years (Figure HR 72). Men and women had comparable survival at all time points (Figure HR 73). Survival in recipients with VADs was 88.4% at 1 year, compared with 90.9% in those without VADs, a trend that appeared within 30 days and continued through 5 years (Figure HR 74). Status 1B recipients fared better than those of other statuses (previous system) (Figure HR 75). The number of survivors after heart transplant continues to increase. On June 30, 2019, 35,713 recipients were alive with a functioning graft, versus 23,315 in 2008 (Figure HR 77). Acute rejection occurred in 25.1% of recipients by 1 year and was most common in adults aged 18-49 (Figure HR 78). Of adult recipients undergoing transplant from 2013 to 2017, PTLD occurred in 0.87% by year 5 and was most common (3.0%) in EBV-negative recipients (Figure HR 80).

3 Pediatric Heart Transplant

3.1 Pediatric Waitlist Trends

In 2019, 694 new pediatric candidates were added to the heart transplant waiting list (Figure HR 81). In 2019, a total of 1087 candidates aged 17 years or younger were awaiting heart transplant (Figure HR 82). The largest pediatric age groups on the waiting list in 2019 were 12-17 years (30.1%) and younger than 1 year (30.0%), followed by 1-5 years (23.3%), and 6-11 years (16.7%) (Figure HR 83). Just over half of pediatric heart transplant candidates were white, 19.6% were black, 19.3% were Hispanic, and 3.3% were Asian (Figure HR 84). The proportion of pediatric heart transplant candidates with congenital defects increased from 46.4% in 2008 to 55.7% in 2019 (Figure HR 85). Considering trends over time, ages and races of waitlisted candidates remained relatively unchanged (Table HR 11). For candidates waiting on December 31, 2019, congenital defect was the leading cause of heart disease at 62.4%, increased from 49.2% in 2009 (Table HR 12). Regarding medical urgency, almost half

(46.6%) of pediatric heart transplant candidates were listed as status 1A (Figure HR 88). The proportions listed as status 1B and status 2 increased in 2016 and later, likely reflecting changes to pediatric heart allocation policy implemented in 2016. A smaller proportion of candidates were listed for heart-lung transplant in 2019, 1.6% compared with 4.1 % in 2009 (Table HR 13). Among the 672 candidates removed from the waiting list in 2019, 519 (77.2%) were removed due to undergoing transplant, 55 (8.2%) died, 43 (6.4%) were removed due to improved condition, and 28 (4.2%) were considered too sick to undergo transplant (Table HR 14, Table HR 15).

In 2019, the majority (74.0%) of pediatric heart transplant candidates on the waiting list had been waiting for less than 90 days (Figure HR 87). Just over 70% of pediatric candidates newly listed in 2016 underwent transplant within 3 years, 11.4% died, 14.3% were removed from the list, and 3.8% were still waiting (Figure HR 89). The rate of heart transplant among pediatric waitlist candidates remained relatively stable over the past decade and was 128.5 per 100 waitlist years in 2019 (Figure HR 90). Transplant rates varied by age; 2019 rates were highest for candidates aged 12-17 years at 153.1 transplants per 100 waitlist year, and followed by those aged younger than 1 year at 151.5 transplants per 100 waitlist years. The next are by those aged 6-11 years at 111.2 transplants per 100 waitlist years, and those aged 1-5 years at 94.6 transplants per 100 waitlist years (Figure HR 91). Pretransplant mortality decreased from 33.4 deaths per 100 waitlist years in 2008 to 13.9 in 2019 (Figure HR 94), with notable decreases for candidates aged younger than 1 year (Figure HR 95). Pretransplant mortality rates in 2019 varied by age, and were highest for candidates aged younger than 1 year at 21.0 deaths per 100 waitlist years, followed by 18.9 for ages 1-5 years, 8.4 for ages 12-17 years, and 5.9 for ages 6-11 years (Figure HR 95). By medical urgency status, pretransplant mortality was highest for status 1A (34.4 deaths per 100 waitlist years) and 1B (13.1) candidates, compared with 2.1 for status 2 candidates (Figure HR 98).

3.2   Pediatric Trends in Heart Transplant

Pediatric transplant recipients are defined as those aged less than 18 years at the time of transplant. The number of pediatric heart transplants performed each year continued to increase, to 509 in 2019 (Figure HR 100): 181 (35.6%) in recipients aged 11-17 years, 133 (26.1%) in recipients aged < 1 year, 115 (22.6%) in recipients aged 1-5 years, and 80 (15.7%) in recipients aged 6-10 years (Figure HR 101). In 2019, 25 of 137 total heart transplant programs performed pediatric heart transplants exclusively, 77 performed adult heart transplants exclusively, and 35 performed both adult and pediatric heart transplants (Figure HR 102). In 2019, 7.5% of transplants in recipients aged younger than 10 years, 12.0% in recipients aged younger than 15 years, and 15.9% in recipients aged younger than 18 years were performed at programs with volume of five or fewer pediatric transplants in that year (Figure HR 103). Over the past decade, the age, sex, and race/ethnicity of pediatric heart transplant

recipients changed little (Table HR 16). Congenital defects remained the most common primary cause of disease, affecting 51.3% of recipients who underwent transplant in 2017-2019 (Table HR 17). The proportion who underwent transplant at status 1A declined slightly, from 82.2% in 2007-2009 to 80.3% in 2017-2019, while the proportion at status 1B increased from 10.5% to 16.2%, and the proportion at status 2 declined from 7.2% to 3.5%. VAD use at the time of transplant increased from 15.7% of transplant recipients in 2007-2009 to 32.4% in 2017-2019 (Table HR 17). The proportion of ABO-incompatible transplants in 2017-2019 increased to 10.5% from 4.0% a decade earlier (Table HR 18).

Over the past decade, induction therapy use increased to 83.7% of pediatric heart transplant recipients in 2019 (Figure HR 104). The initial immunosuppression regimens used most commonly in 2019 were tacrolimus, MMF, and steroids (53.2%), and tacrolimus and MMF (40.1%) (Figure HR 105).

3.3 Pediatric Posttransplant Survival and Morbidity

Among 2017-2018 pediatric heart transplant recipients, the rate of acute rejection in the first year was 21.2% overall; the highest rates were 23.7% in recipients aged 11-17 years, and 20.0% in recipients aged 6-10 years and younger than 6 years (Figure HR 107).

Recipient death occurred in 6.3% of patients at 6 months posttransplant and in 8.2% at 1 year among pediatric heart transplants performed in 2018, in 10.3% of patients at 3 years for transplants performed in 2016, in 17.8% of patients at 5 years for transplants performed in 2014, and in 28.7% of patients at 10 years for transplants performed in 2009 (Figure HR 109). Overall, 1-year and 5-year patient survival were 92.0% and 84.1%, respectively, among recipients who underwent transplant in 2012-2014 (Figure HR 110). By age, 5-year patient survival was 81.3% for recipients aged younger than 1 year, 85.1% for ages 1-5 years, 84.8% for ages 6-10 years, and 85.4% for ages 11-17 years (Figure HR 111).

Among pediatric heart transplant recipients 2017-2019, the combination of a CMV-positive donor and CMV-negative recipient occurred in 28.3% of transplants; for EBV, this combination occurred in 28.6% of transplants (Table HR 20). The overall incidence of PTLD was 4.5% at 5 years posttransplant; incidence was 5.7% among EBV-negative recipients and 3.5% among EBV-positive recipients (Figure HR 108).
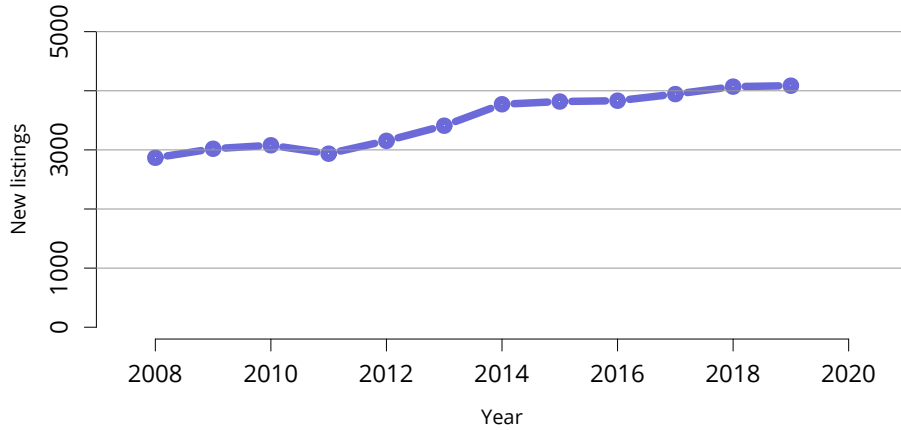
Figure HR 1. New candidates added to the heart transplant waiting list.
A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Active and inactive patients are included.
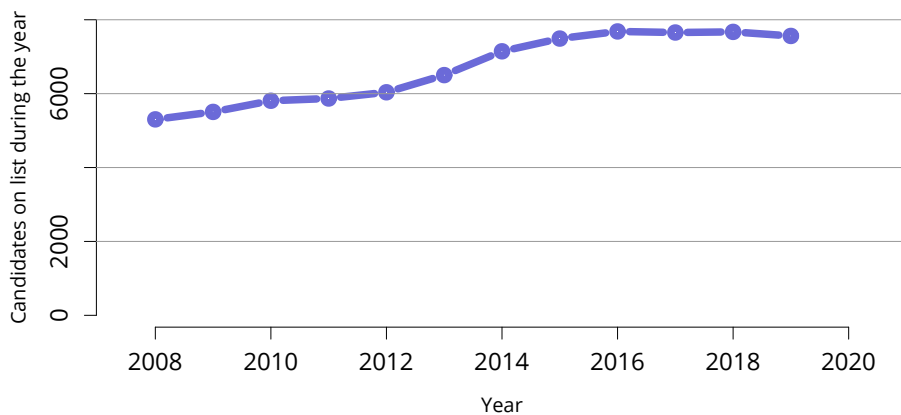

Figure HR 2. All adult candidates on the heart transplant waiting list.
Adult candidates on the list at any time during the year. Candidates listed at more than one center are counted once per listing.
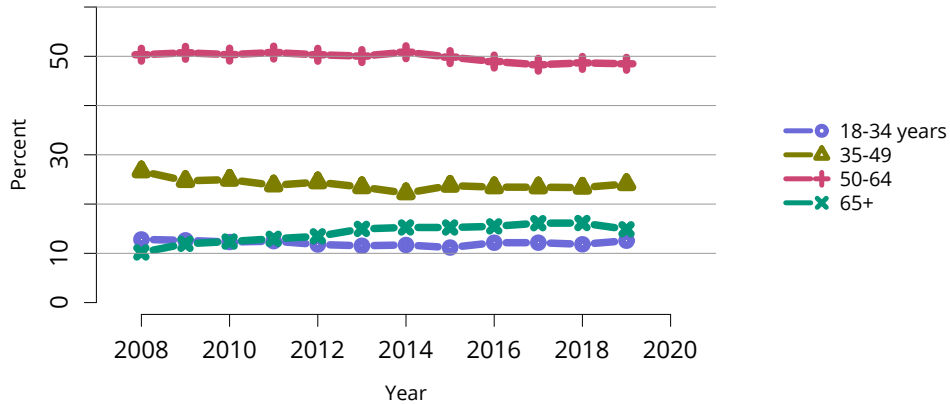
Figure HR 3. Distribution of adults waiting for heart transplant by age.
Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Age is determined at the later of listing date or January 1 of the given year. Active and inactive candidates are included.
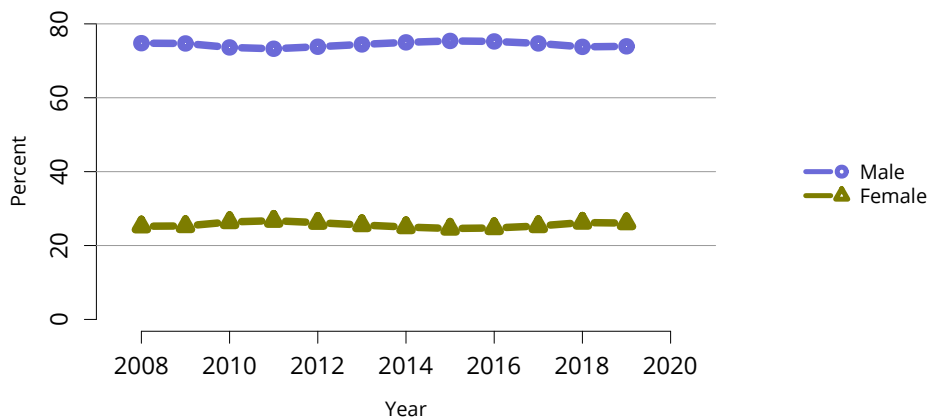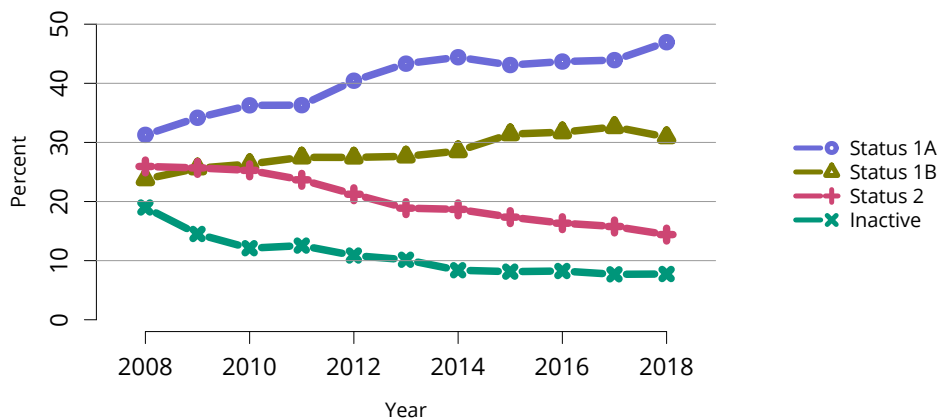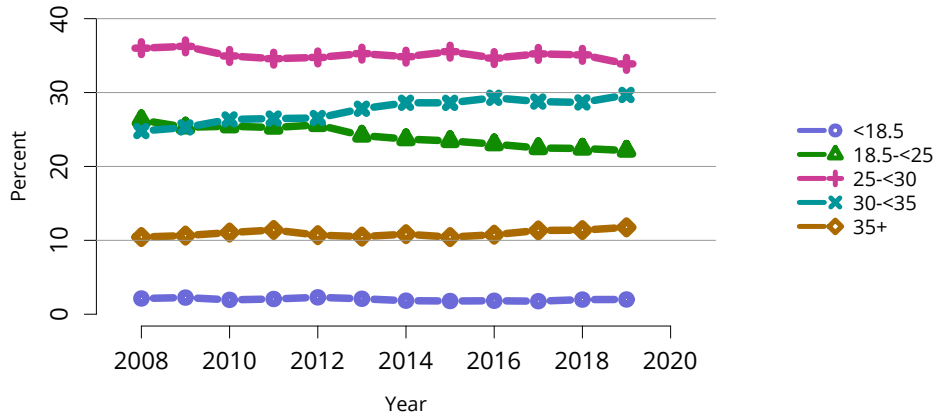

Figure HR 4. Distribution of adults waiting for heart transplant by sex.
Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.
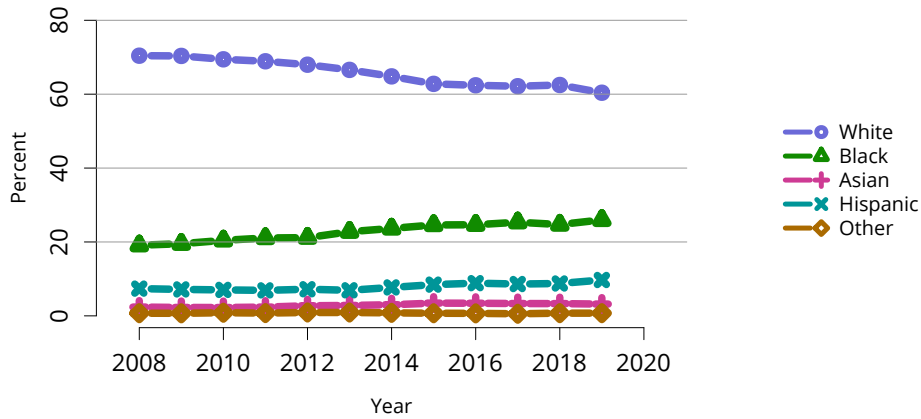
Figure HR 5. Distribution of adults waiting for heart transplant by race.
Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.
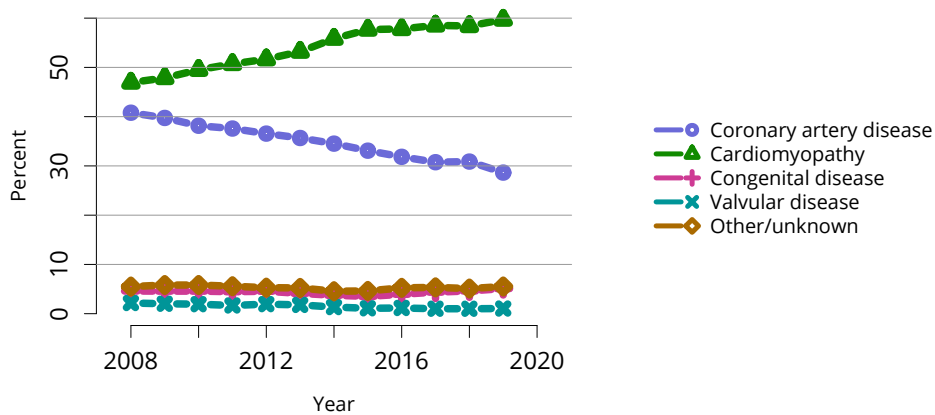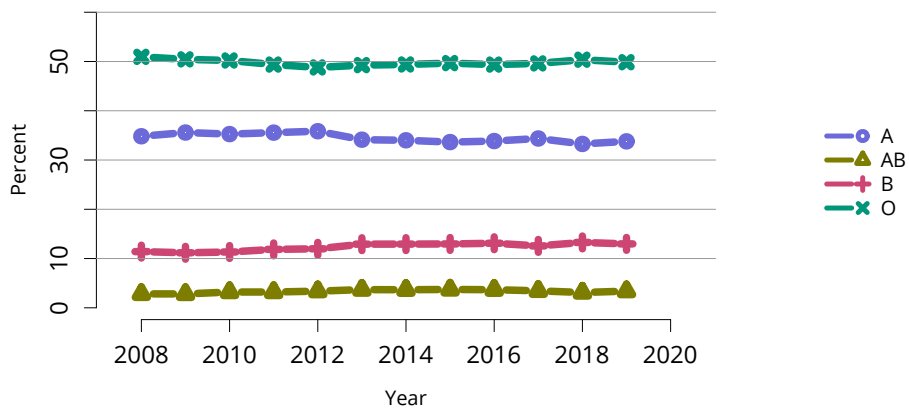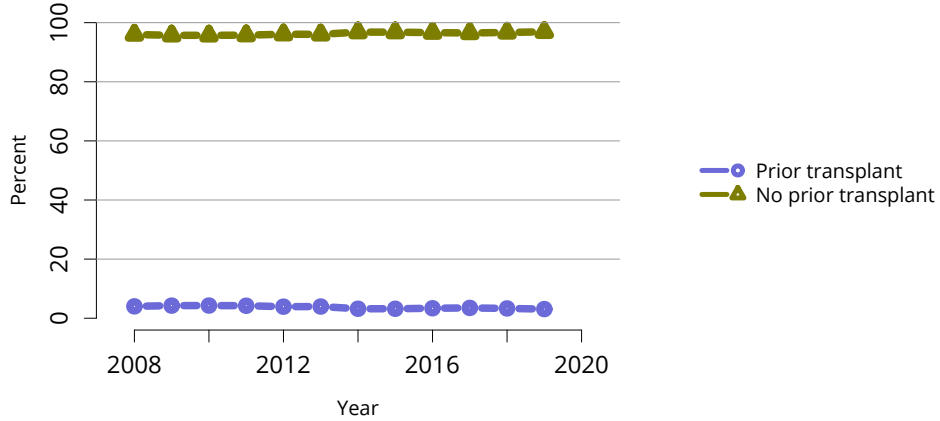

Figure HR 6. Distribution of adults waiting for heart transplant by diagnosis. Candidates waiting for transplant at any time in the given year. Active and inactive patients are included.
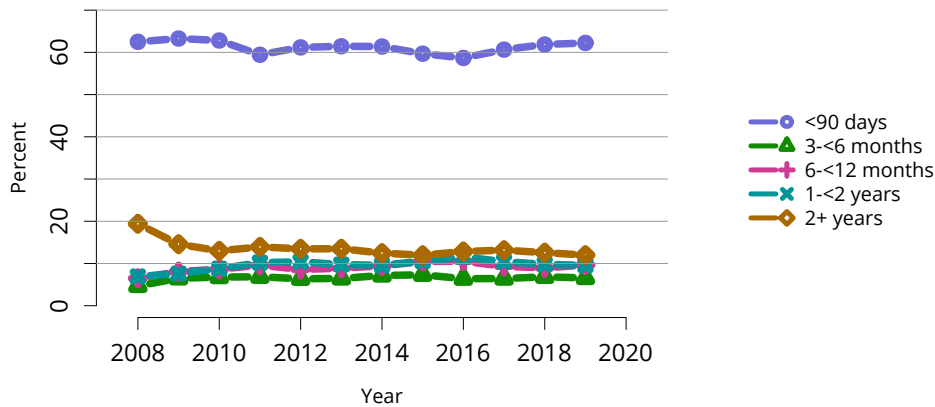
Figure HR 7. Distribution of adults waiting for heart transplant by waiting time. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Time on the waiting list is determined at the later of listing date or January 1 of the given year. Active and inactive candidates are included.

Figure HR 8. Distribution of adults waiting for heart transplant by old medical urgency, 2008-2018. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. The graph only goes through 2018, as the OPTN heart allocation policy changed the status groups in October, 2018. New status codes in use as of October 18, 2018 were converted to their old status equivalents for the 2018 data point.

Figure HR 9. Distribution of adults waiting for heart transplant by BMI. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

Figure HR 10. Distribution of adults waiting for heart transplant by blood type. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

Figure HR 11. Distribution of adults waiting for heart transplant by prior transplant status. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.
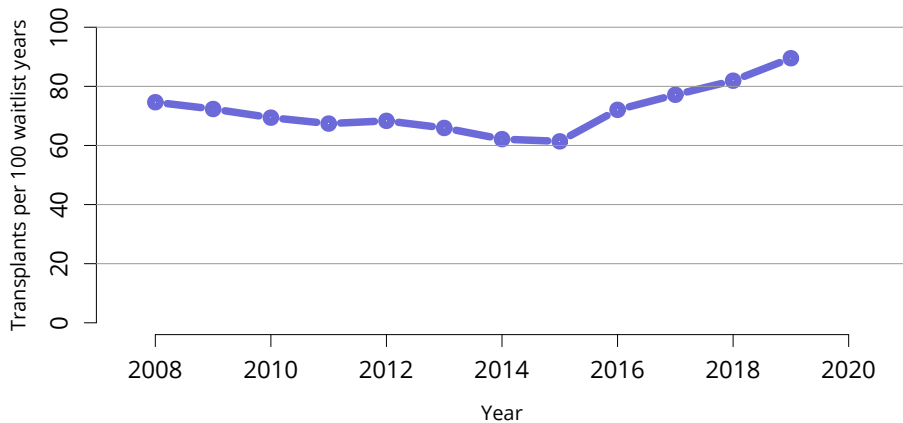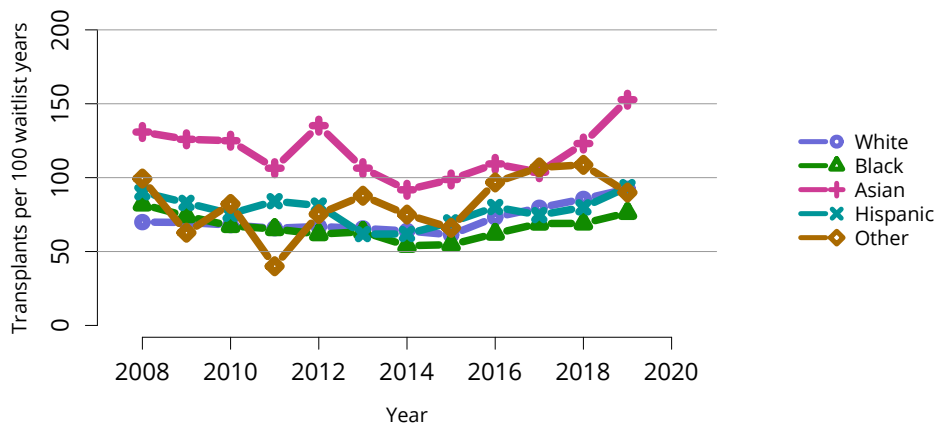

Figure HR 12. Overall deceased donor heart transplant rates among adult waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately.
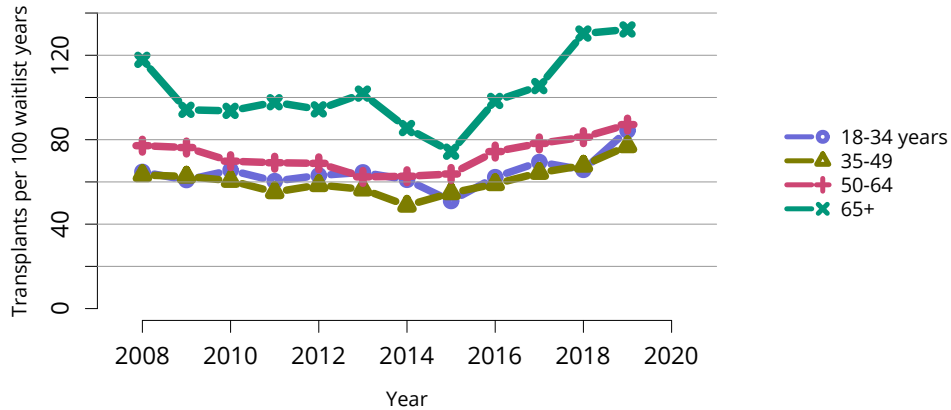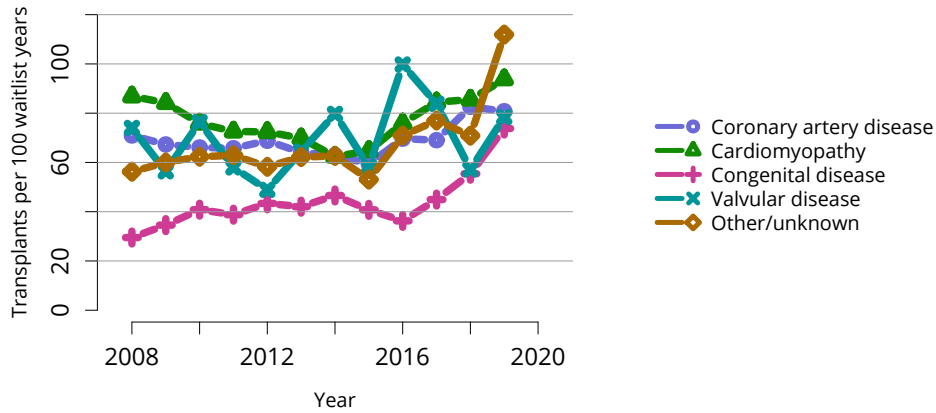
Figure HR 13. Deceased donor heart transplant rates among adult waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year.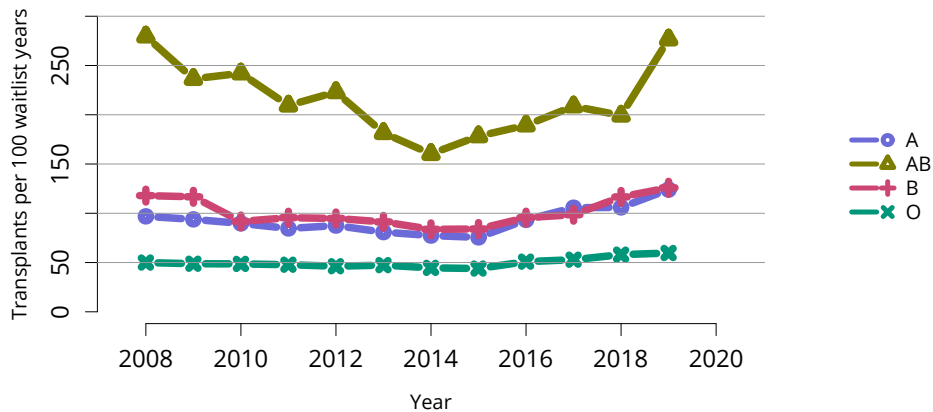 Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.

Figure HR 14. Deceased donor heart transplant rates among adult waitlist 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.
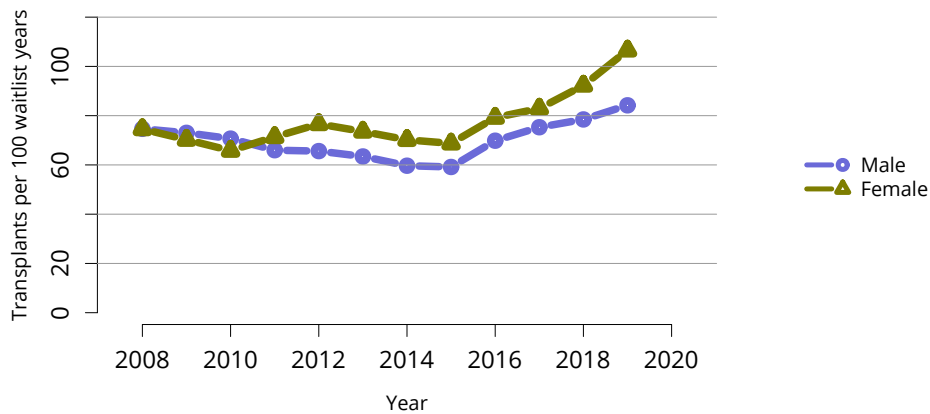
Figure HR 15. Deceased donor heart transplant rates among adult wait-list candidates by diagnosis. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately.

Figure HR 16. Deceased donor heart transplant rates among adult wait-list 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.

Figure HR 17. Deceased donor heart transplant rates among adult waitlist candidates by sex. 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.
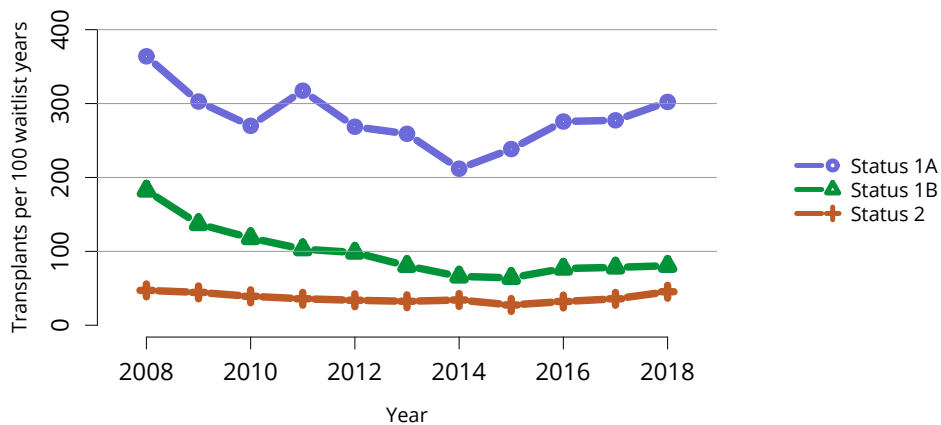

Figure HR 18. Deceased donor heart transplant rates among adult waitlist candidates by former medical urgency groups (Status 1A, 1B, 2), through 2018. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. The graph only goes through 2018, as the OPTN heart allocation policy changed the status groups in October, 2018. Status groups for candidates in late 2018 were converted to old groupings. Medical urgency is determined at the later of listing date and January 1 of the year.
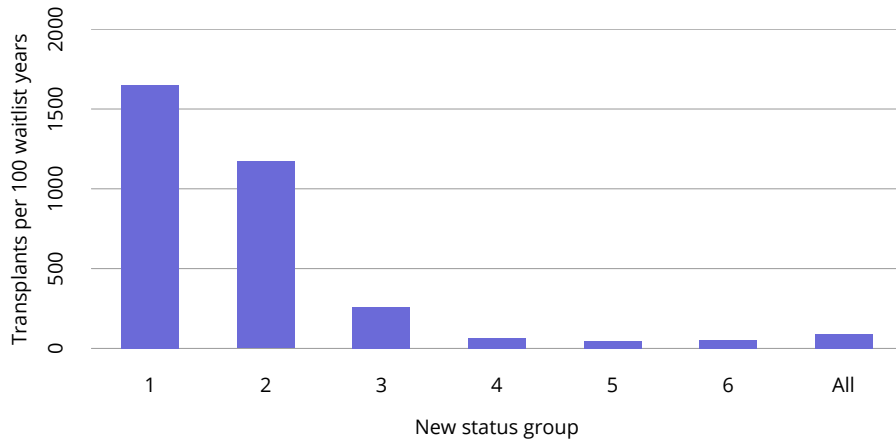
Figure HR 19. Deceased donor heart transplant rates among adult waitlist candidates by new medical urgency groups, 2019. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time. Individual listings are counted separately. Medical urgency is determined at the later of listing date and January 1 of the year.
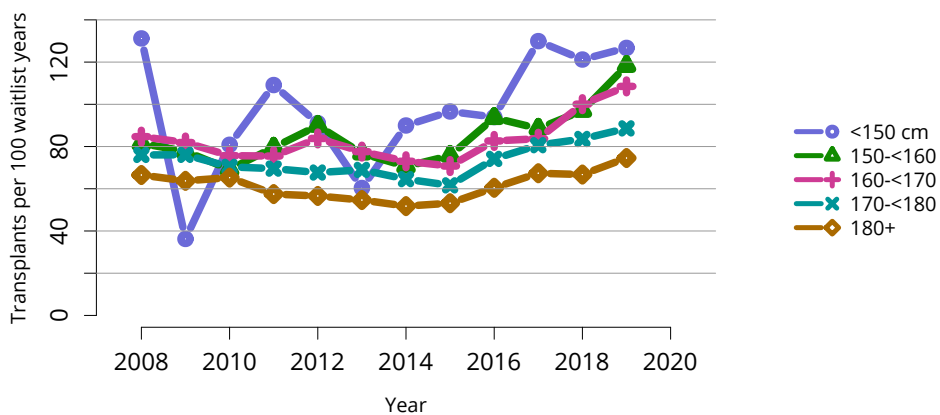

Figure HR 20. Deceased donor heart transplant rates among adult waitlist candidates by height. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately.
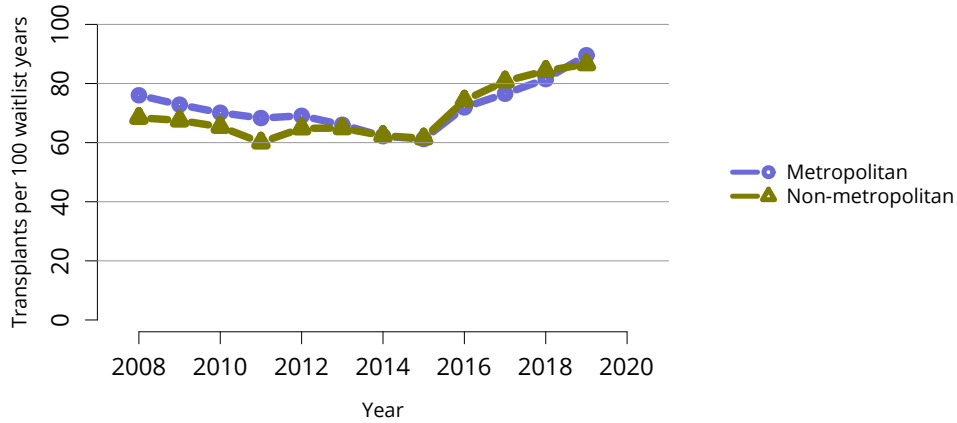
Figure HR 21. Deceased donor heart transplant rates among adult waitlist candidates by metropolitan vs. non-metropolitan residence. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Urban/rural determination is made using the RUCA (Rural-Urban Commuting Area) designation of the candidate's permanent zip code.
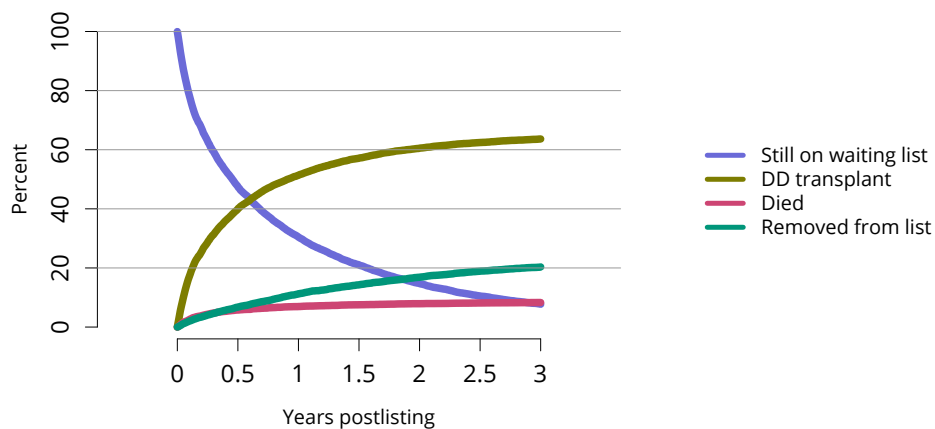

Figure HR 22. Three-year outcomes for adults waiting for heart transplant, new listings in 2016. Candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor.
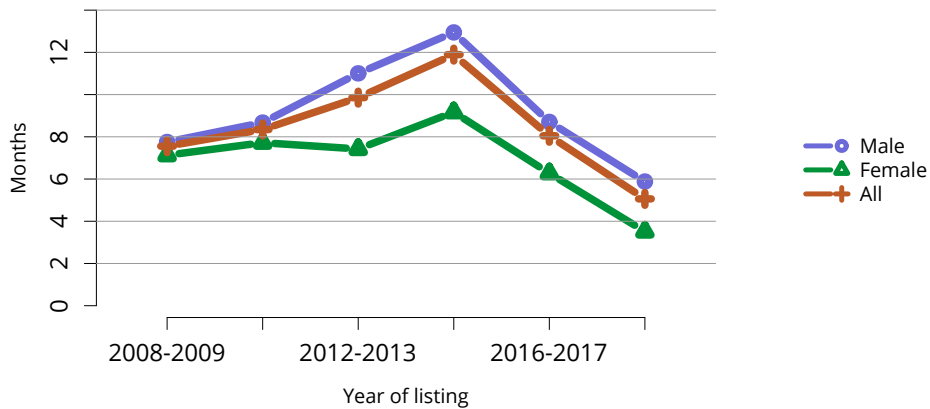
Figure HR 23. Median months to heart transplant for waitlisted adults by sex. Observations censored on December 31, 2019; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.
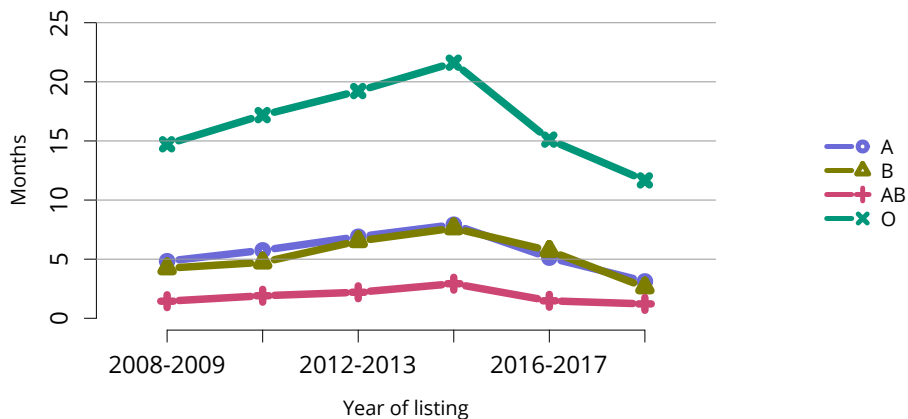

Figure HR 24. Median months to heart transplant for waitlisted adults by blood type. Observations censored on December 31, 2019; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.
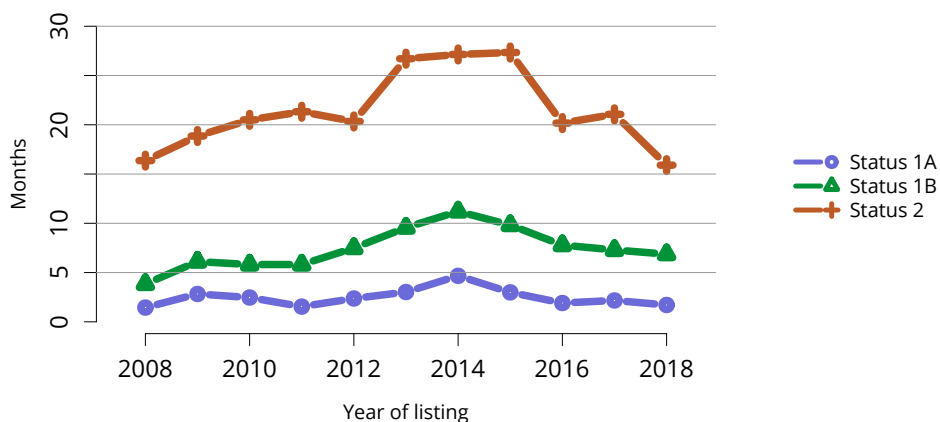
Figure HR 25. Median months to heart transplant for waitlisted adults by old medical urgency at listing. Observations censored on December 31, 2018; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted. The graph only goes through 2018, as the OPTN heart allocation policy changed the status groups in October, 2018. New status codes in use as of October 18, 2018 were converted to their old status equivalents for the 2018 data point.
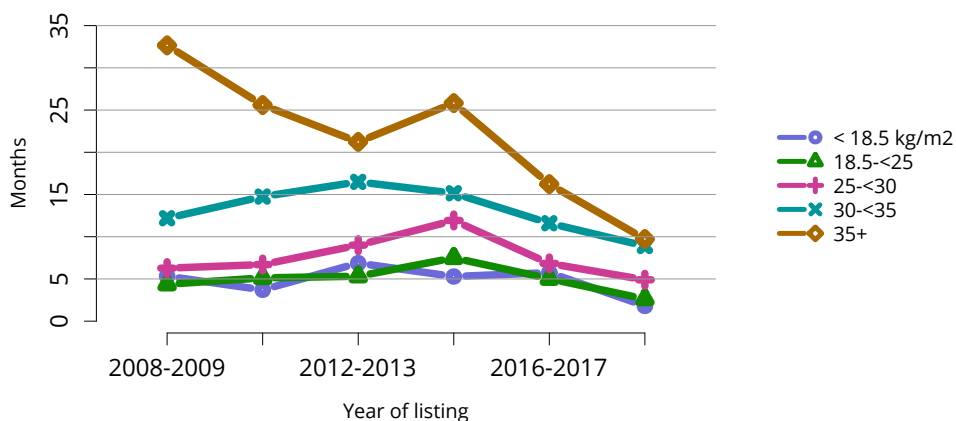

Figure HR 26. Median months to heart transplant for waitlisted adults by BMI at listing. Observations censored on December 31, 2019; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.
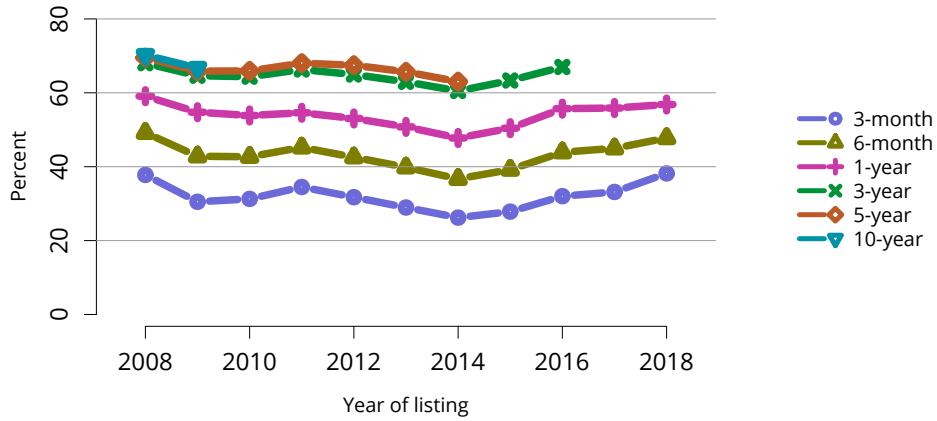
Figure HR 27. Percentage of adults who underwent deceased donor heart transplant within a given time period of listing. Candidates listed at more than one center are counted once per listing.
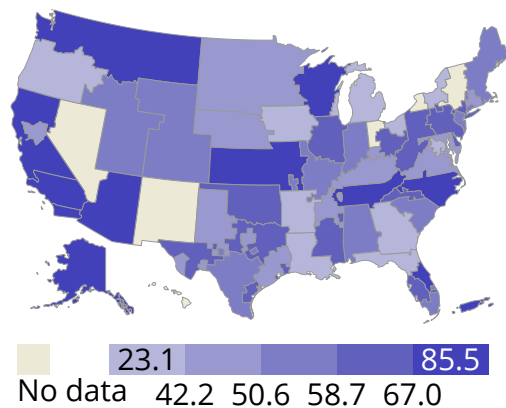

Figure HR 28. Percentage of adults who underwent deceased donor heart transplant within 1 year of listing, 2018, by DSA. Candidates listed at more than one center are counted once per listing.

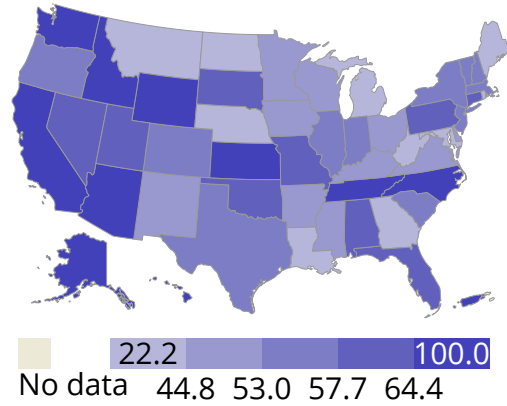| No data | 22.2 | 44.8 | 53.0 | 57.7 | 64.4 | 100.0 |

Figure HR 29. Percentage of adults who underwent deceased donor heart transplant within 1 year of listing, 2018, by state. Candidates listed at more than one center are counted once per listing. State is candidate's home state.
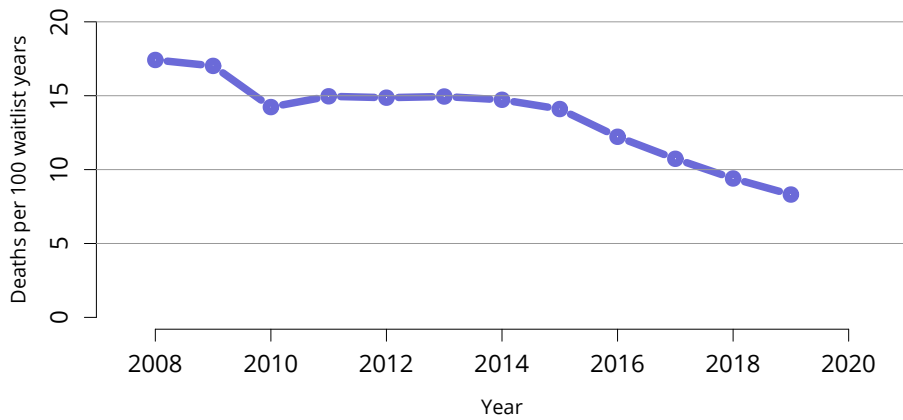

Figure HR 30. Overall pretransplant mortality rates among adults wait-listed for heart transplant. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

Figure HR 31. 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. Age is determined at the later of listing date or January 1 of the given year.
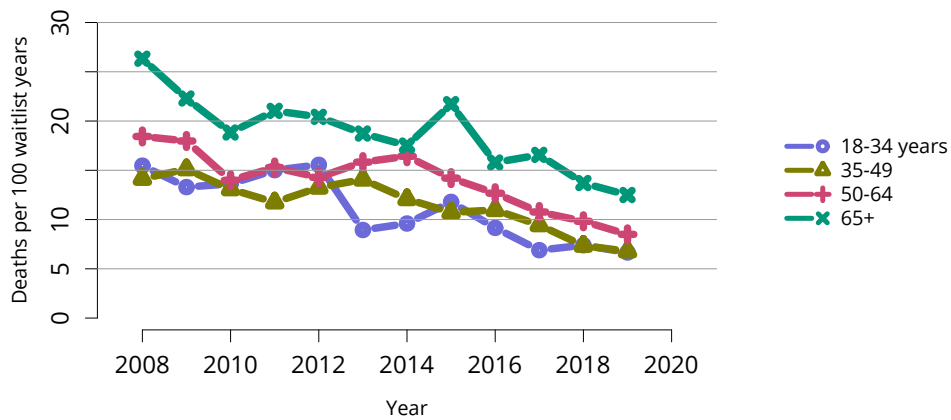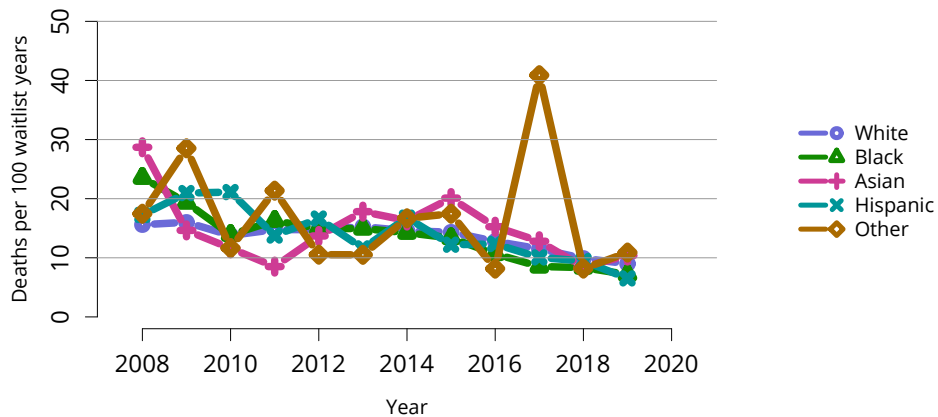

Figure HR 32. Pretransplant mortality rates among adults waitlisted for heart transplant by race. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

Figure HR 33. 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.
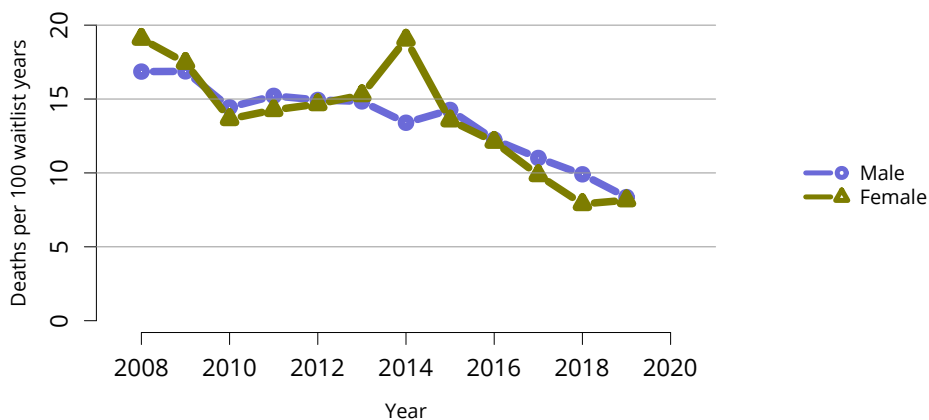

Figure HR 34. Pretransplant mortality rates among adults waitlisted for heart transplant by diagnosis. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.
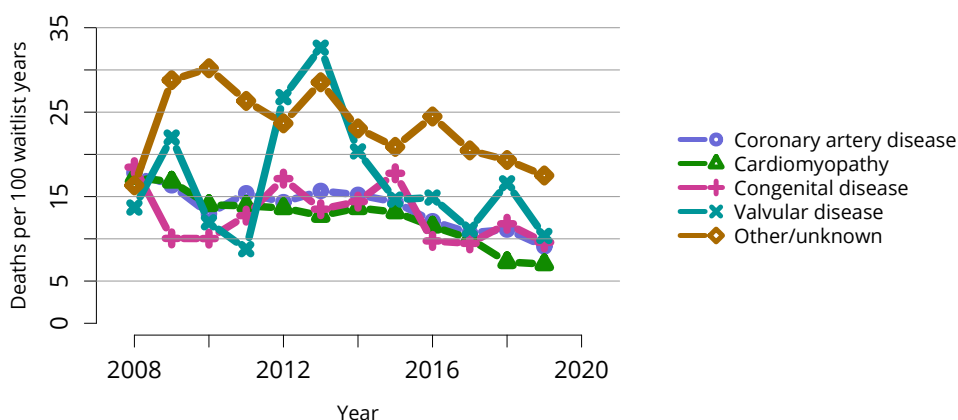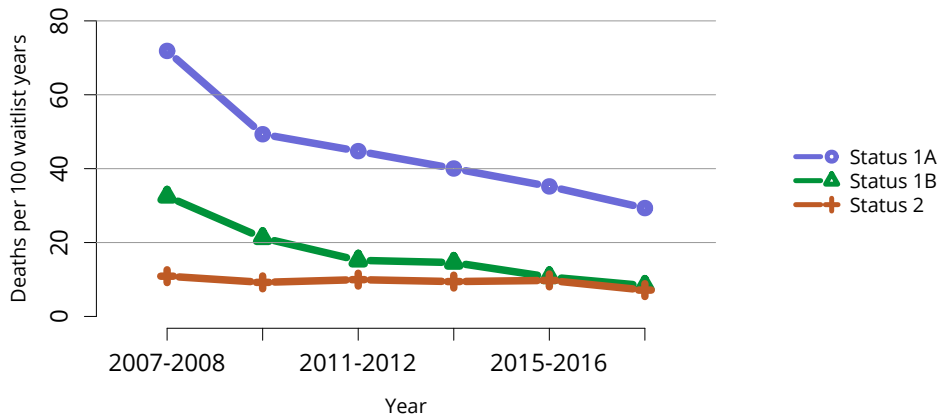
Figure HR 35. Pretransplant mortality rates among adults waitlisted for heart transplant by former medical urgency groups (Status 1A, 1B, 2), through 2018. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Medical urgency is determined at the later of listing date and January 1 of the year.

Figure HR 36. Pretransplant mortality rates among adults waitlisted for heart transplant by new medical urgency groups, 2019. 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. Medical urgency is determined at the later of listing date and January 1 of the year.
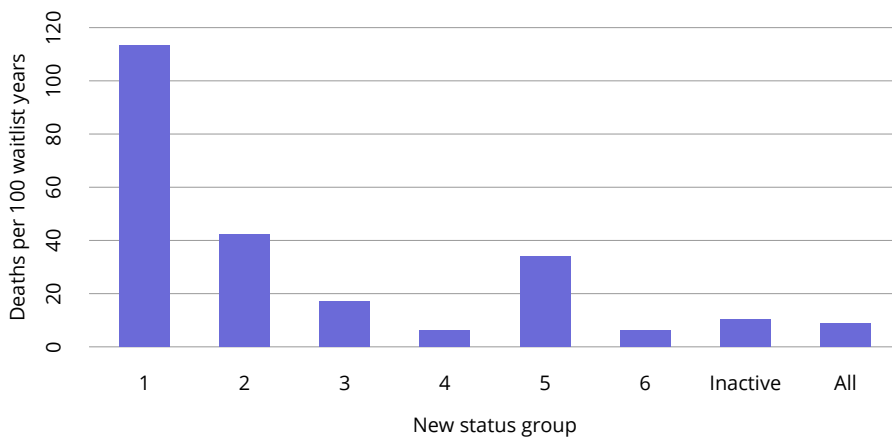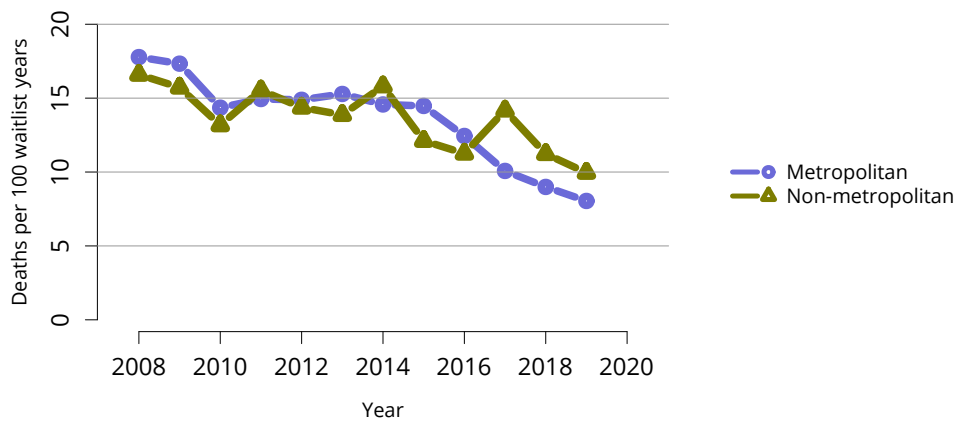
Figure HR 37. Pretransplant mortality rates among adults waitlisted for heart transplant by metropolitan vs. non-metropolitan residence. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Urban/rural determination is made using the RUCA (Rural-Urban Commuting Area) designation of the candidate's permanent zip code.

Figure HR 38. Pretransplant mortality rates among adults waitlisted for heart transplant, by active/inactive status. 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. Status (active/inactive) is assessed on the later of January 1 of the given year and listing date.

No data   0.0   5.0   7.1   10.0   11.8   47.8

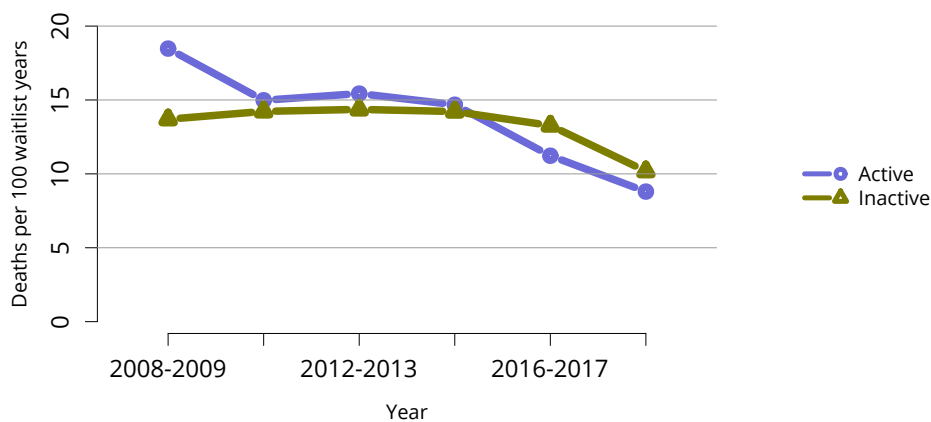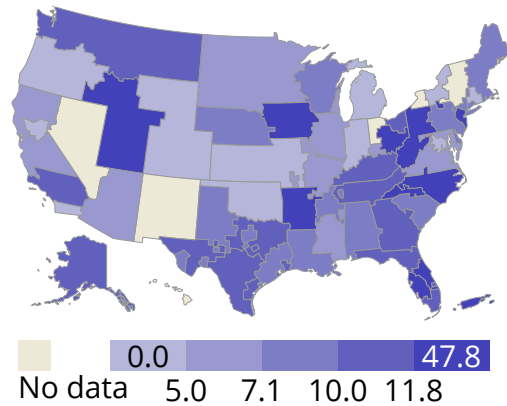**Figure HR 39. Pretransplant mortality rates among adults waitlisted for heart transplant in 2019 by DSA.** Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.
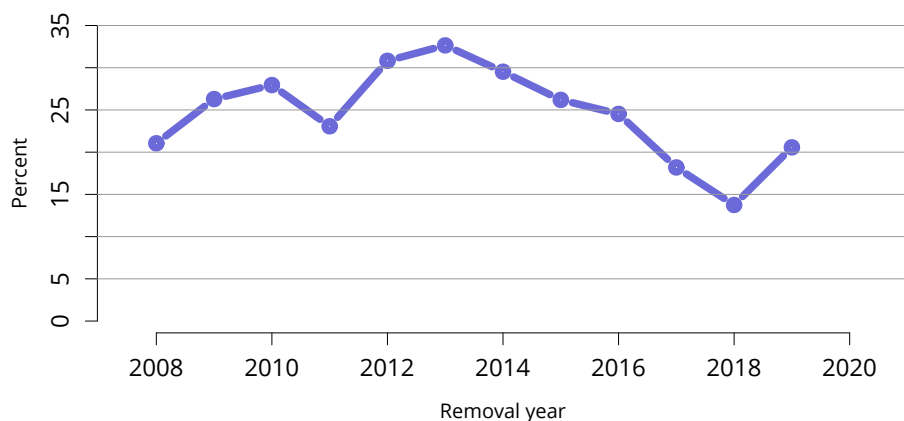

Figure HR 40. Deaths within six months after removal among adult heart waitlist candidates, overall. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

Figure HR 41. 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.
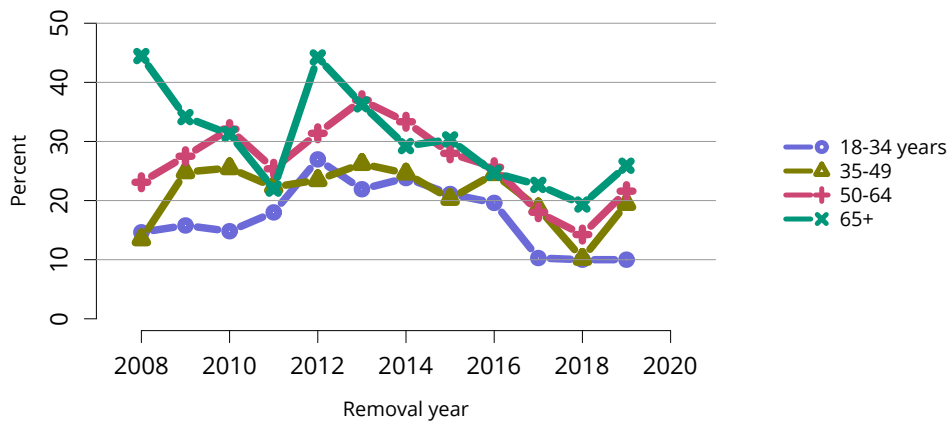
Figure HR 42. Deaths within six months after removal among adult heart waitlist candidates, by age. Denominator includes only candidates removed from the waiting list for reasons 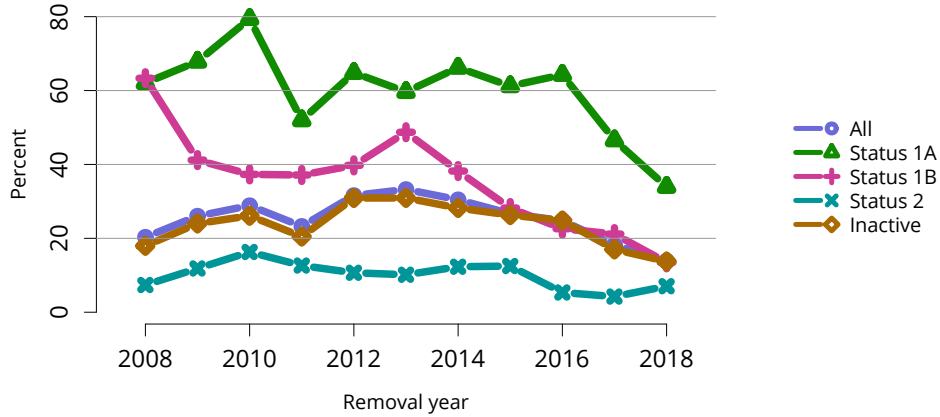other than transplant or death while on the list. Age is determined at the later of listing date or January 1 of the given year.
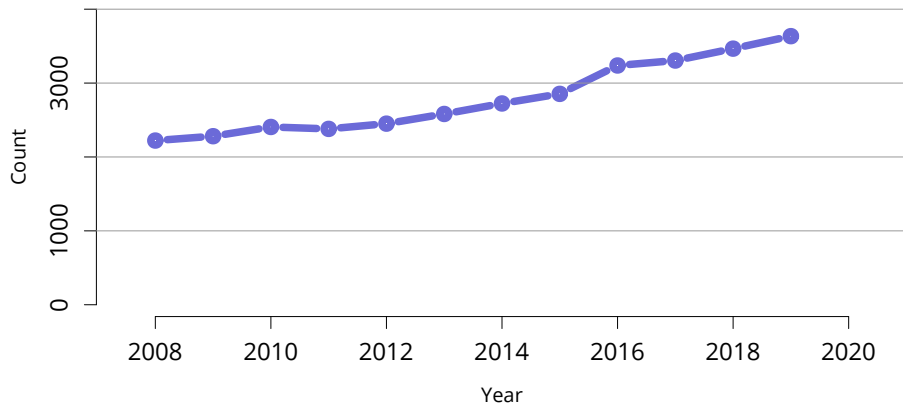
Figure HR 43. Overall deceased heart donor count. Count of deceased donors whose hearts were recovered for transplant.
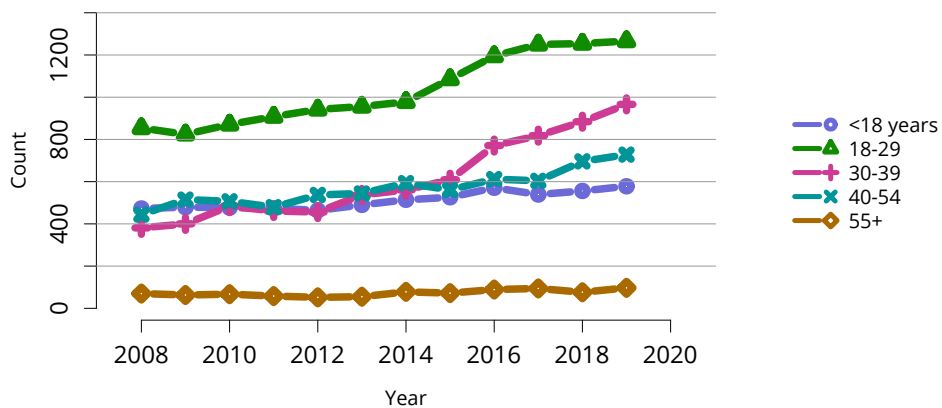
Figure HR 44. Deceased heart donor count by age. Count of deceased donors whose hearts were recovered for transplant.
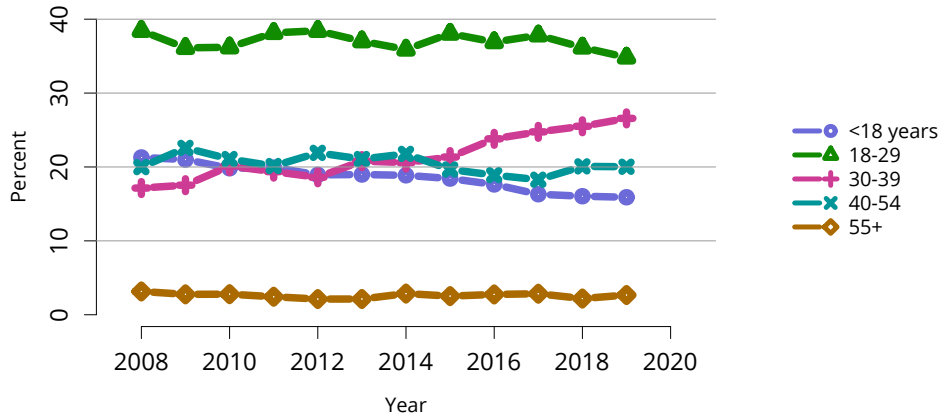
Figure HR 45. Distribution of deceased heart donors by age. Deceased donors whose hearts were recovered for transplant.
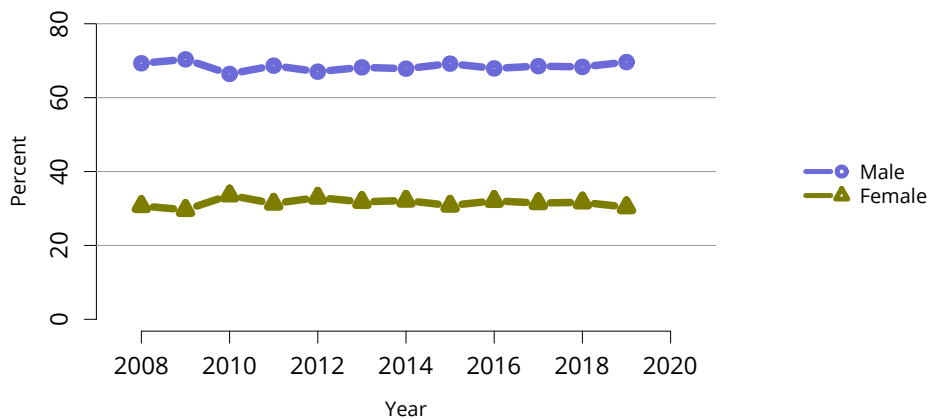
Figure HR 46. Distribution of deceased heart donors by sex. Deceased donors whose hearts were recovered for transplant.
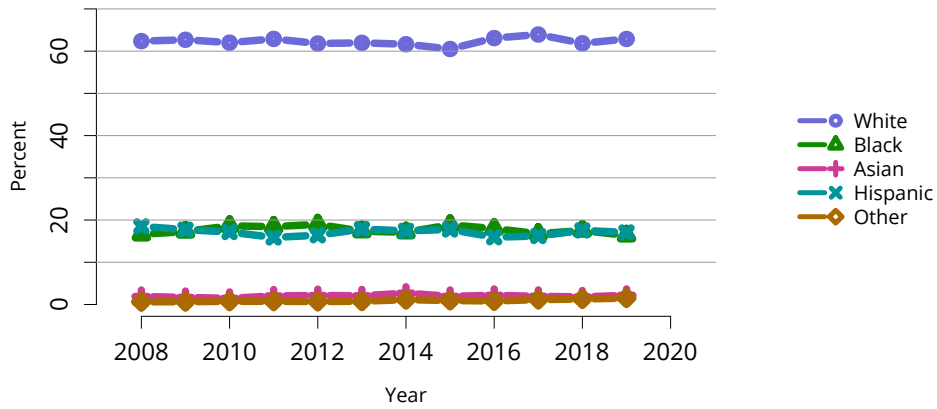
Figure HR 47. Distribution of deceased heart donors by race. Deceased donors whose hearts were recovered for transplant.
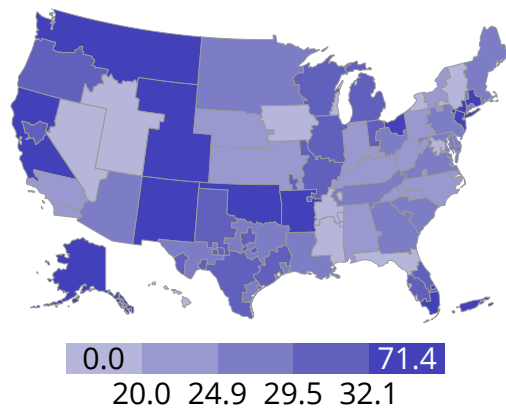
Figure HR 48. Percent of pediatric donor hearts allocated to adult recipients, by DSA of donor hospital, 2015-2019. Numerator: pediatric donor hearts donors allocated to adult recipients. Denominator: total pediatric donor hearts.
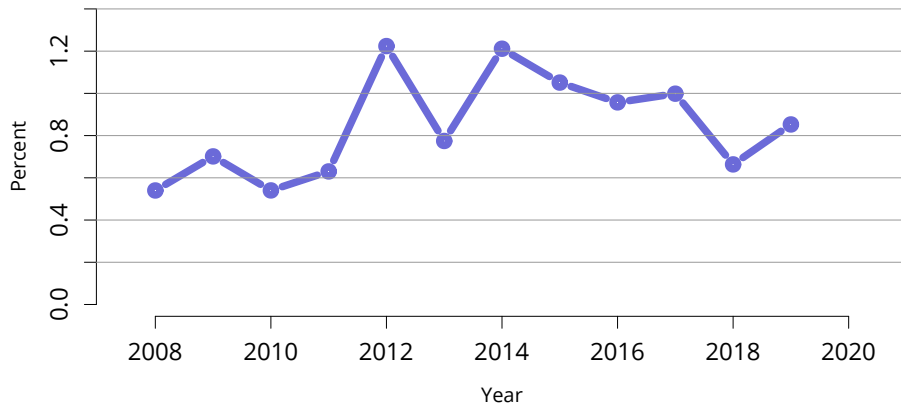
Figure HR 49. Overall rates of hearts recovered for transplant and not transplanted. Percentages of hearts not transplanted out of all hearts recovered for transplant.
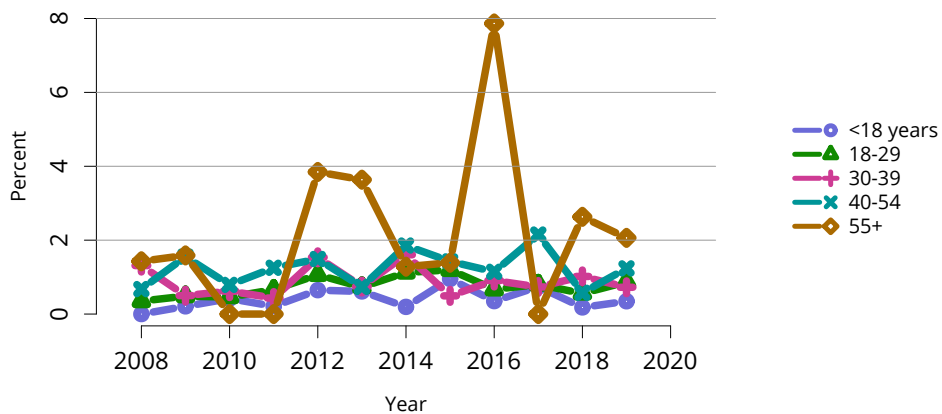
Figure HR 50. Rates of hearts recovered for transplant and not transplanted by donor age. Percentages of hearts not transplanted out of all hearts recovered for transplant.
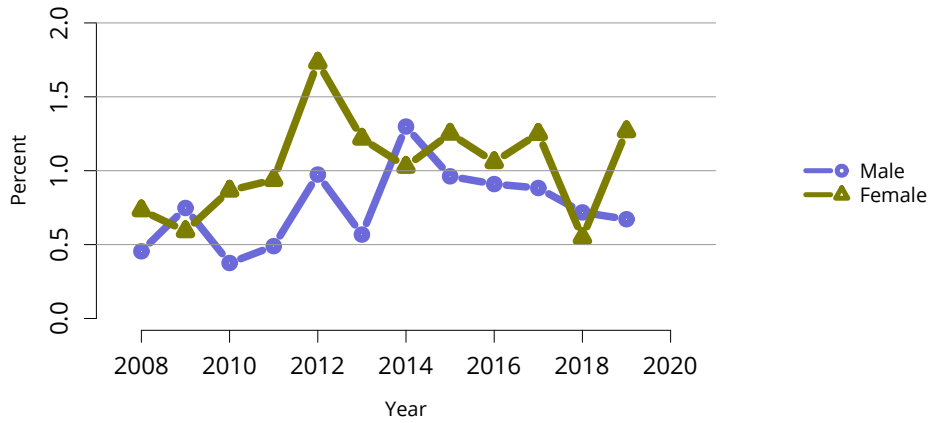
Figure HR 51. Rates of hearts recovered for transplant and not transplanted by donor sex. Percentages of hearts not transplanted out of all hearts recovered for transplant.
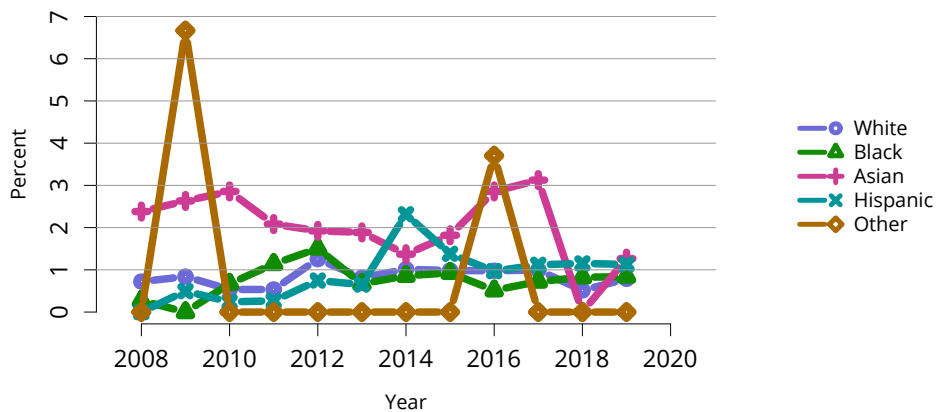
Figure HR 52. Rates of hearts recovered for transplant and not transplanted by donor race. Percentages of hearts not transplanted out of all hearts recovered for transplant.
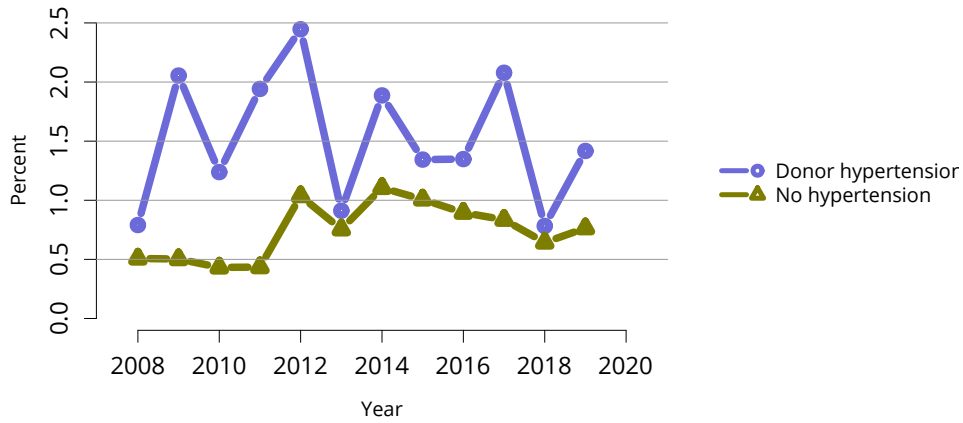
Figure HR 53. Rates of hearts recovered for transplant and not transplanted by donor hypertension status. Percentages of hearts not transplanted out of all hearts recovered for transplant.
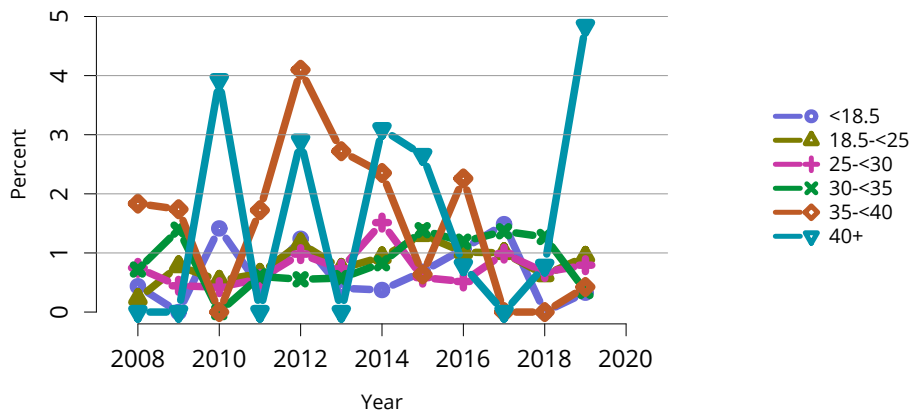
Figure HR 54. Rates of hearts recovered for transplant and not transplanted by donor BMI. Percentages of hearts not transplanted out of all hearts recovered for transplant.
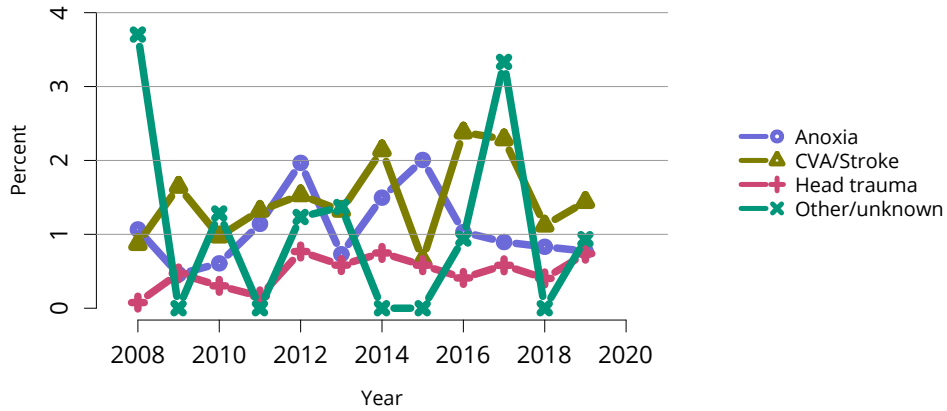
Figure HR 55. Rates of hearts recovered for transplant and not transplanted by donor cause of death. Percentages of hearts not transplanted out of all hearts recovered for transplant.
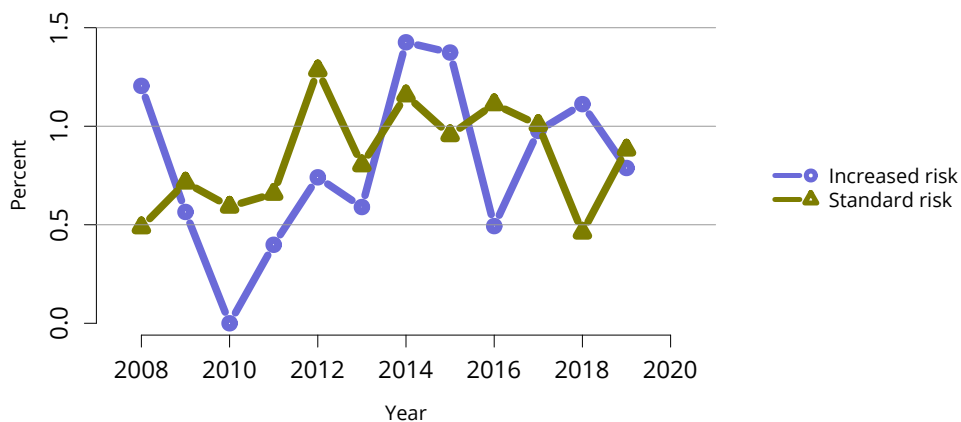
Figure HR 56. Rates of hearts recovered for transplant and not transplanted, by donor risk of disease transmission. Percentages of hearts not transplanted out of all hearts recovered for transplant. "Increased risk" is defined by criteria from the US Public Health Service Guidelines for increased risk for HIV, hepatitis B and hepatitis C transmission.
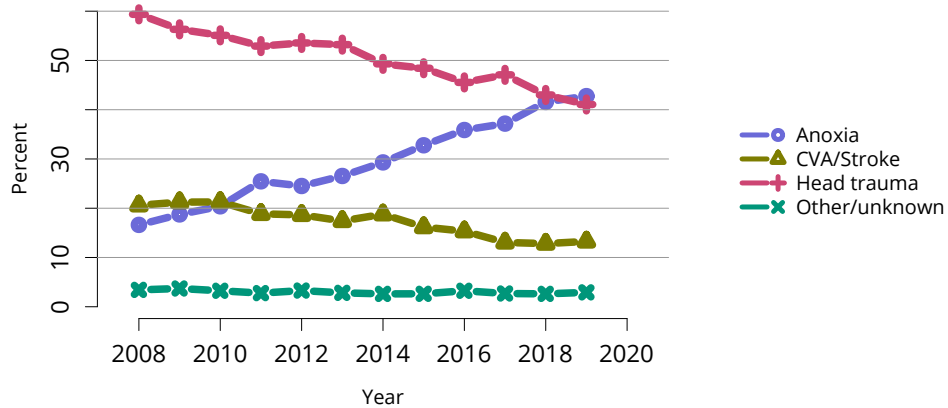
Figure HR 57. Cause of death among deceased heart donors. Deceased donors whose hearts were transplanted. CVA, cerebrovascular accident.
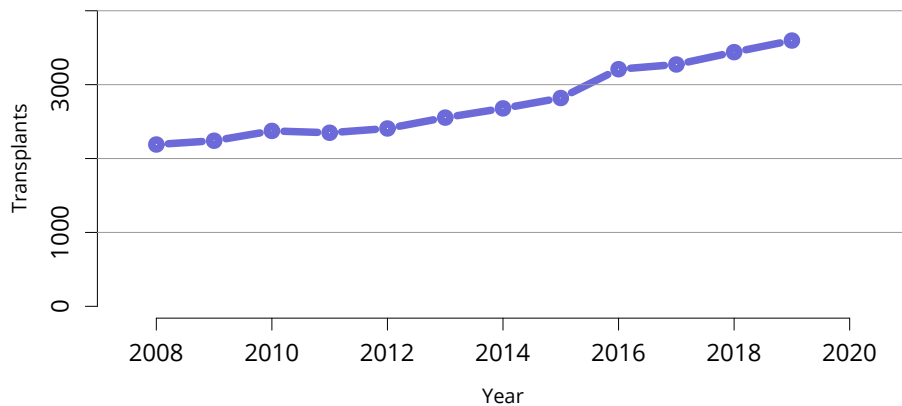
Figure HR 58. Overall heart transplants. All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.
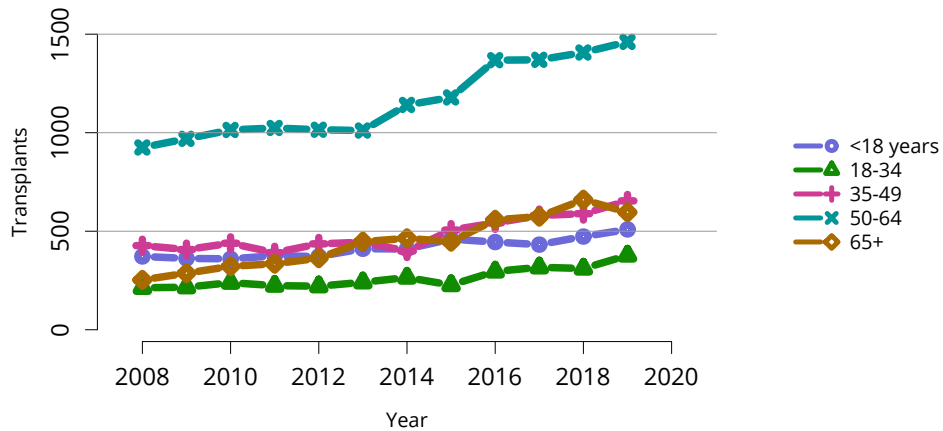
Figure HR 59. Total heart transplants by age. All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.
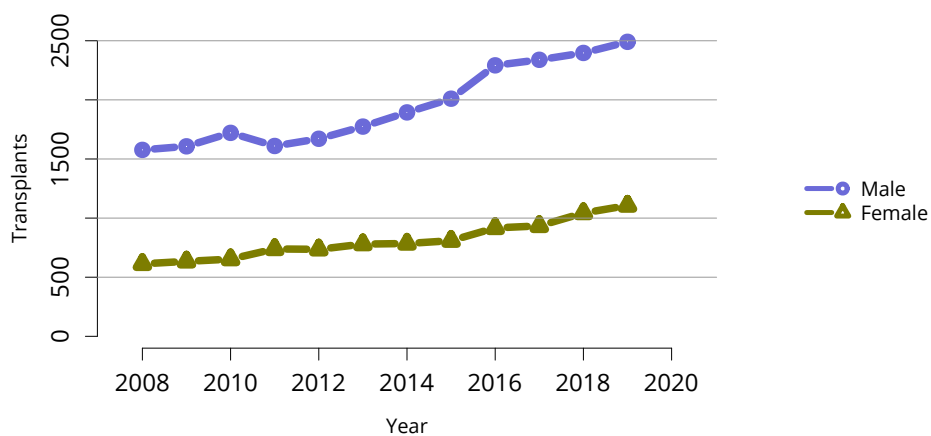
Figure HR 60. Total heart transplants by sex. All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.
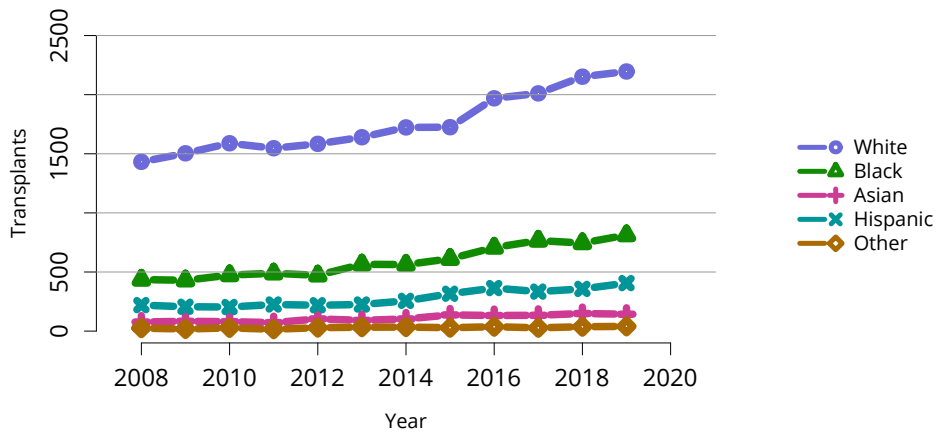
Figure HR 61. Total heart transplants by race. All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.
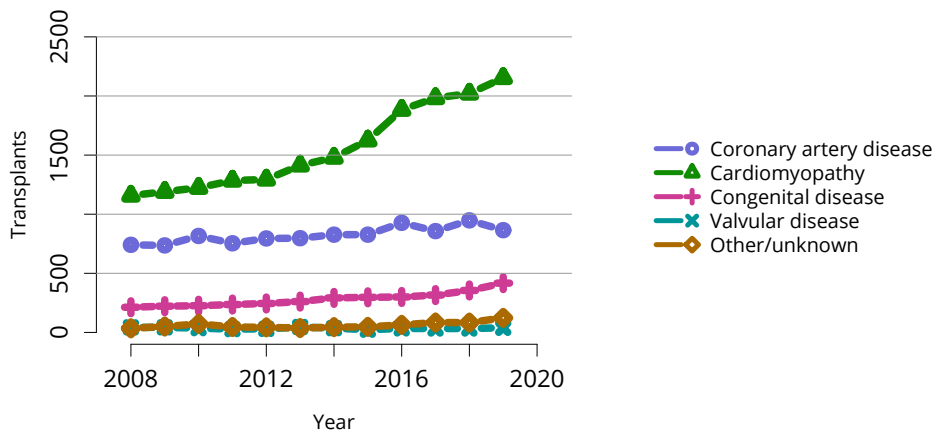
Figure HR 62. Total heart transplants by diagnosis. All heart transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.
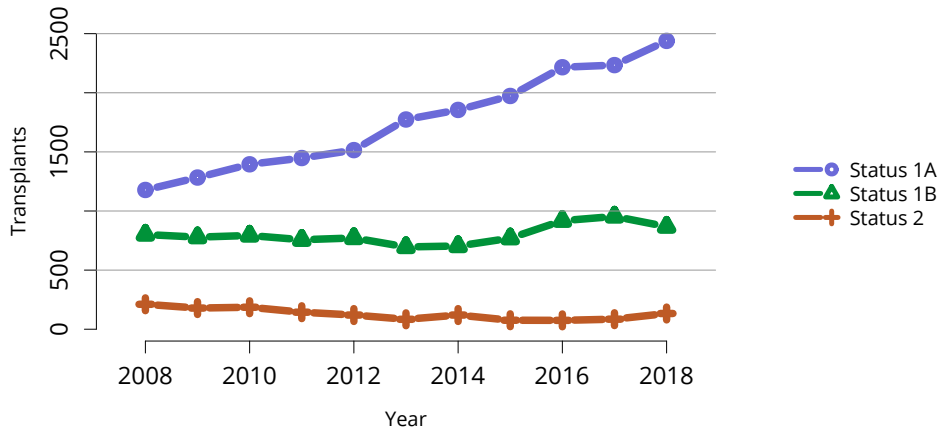
Figure HR 63. Total heart transplants by former medical urgency groups, 2008-2018. All heart transplant recipients, including adult and pediatric, re-transplant, and multi-organ recipients. The graph only goes through 2018, as the OPTN heart allocation policy changed the status groups in October, 2018. Urgency groups for recipients who underwent transplant October 18, 2018 or later were converted to former statuses.
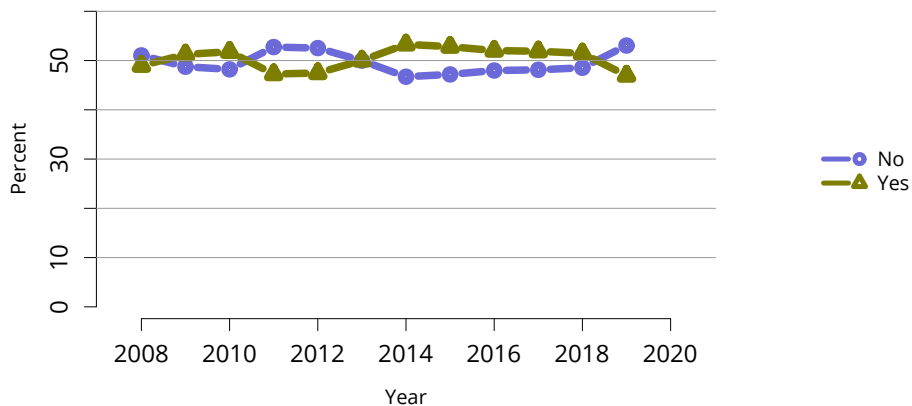
Figure HR 64. Induction agent use in adult heart transplant recipients. Immunosuppression at transplant reported to the OPTN.
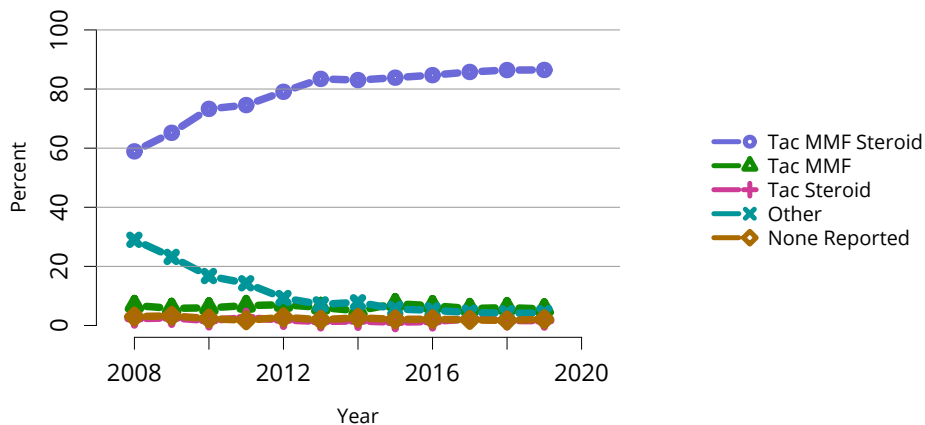
Figure HR 65. Immunosuppression regimen use in adult heart transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. Tac, tacrolimus. MMF, all mycophenolate agents.
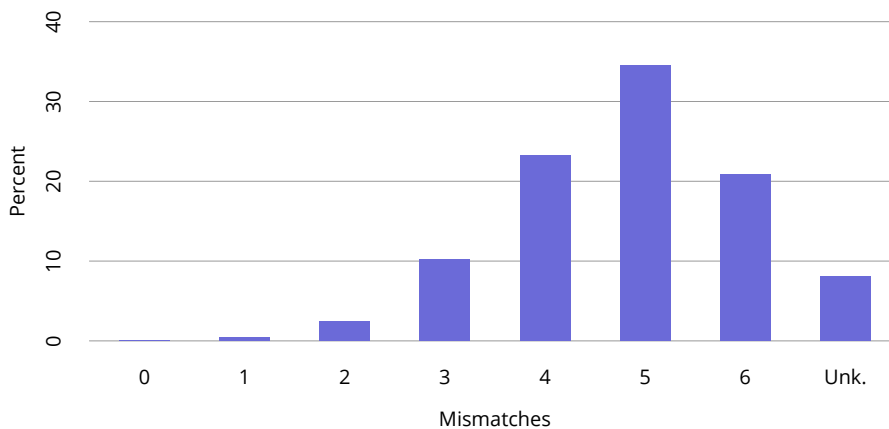
Figure HR 66. Total HLA A, B, and DR mismatches among adult deceased heart transplant recipients, 2015-2019. Donor and recipient antigen matching is based on OPTN antigen values and split equivalences policy as of 2018.
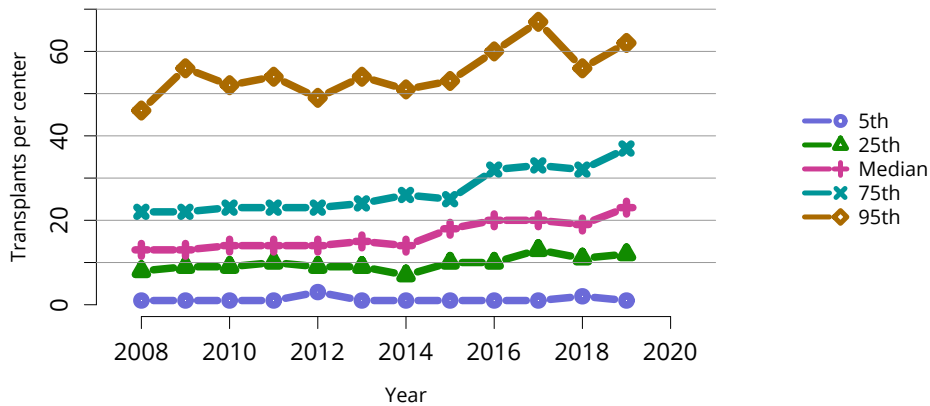
Figure HR 67. Annual adult heart transplant center volumes by percentile. Annual volume data are limited to recipients aged 18 years or older.
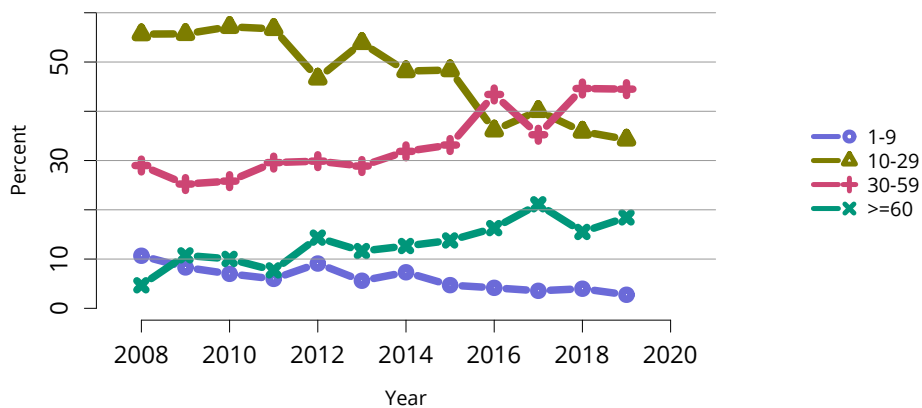
Figure HR 68. Distribution of adult heart transplants by annual center volume. Based on annual volume data among recipients aged 18 or older.
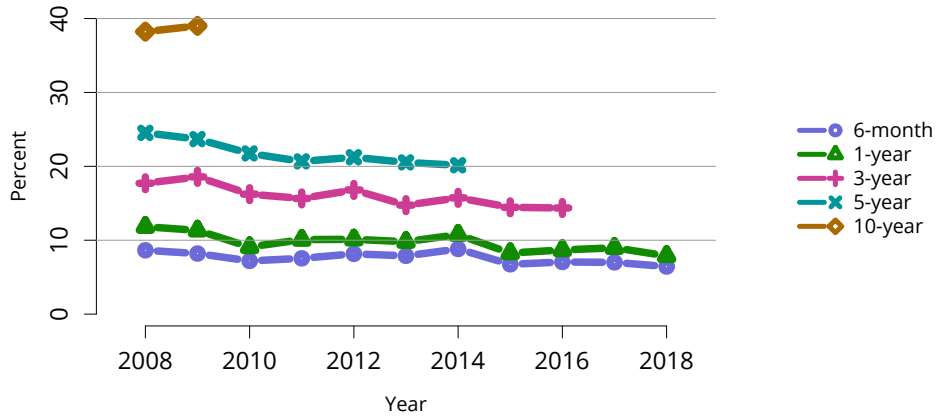
Figure HR 69. Patient death among adult heart transplant recipients. All adult recipients of deceased donor hearts, including multi-organ transplants.
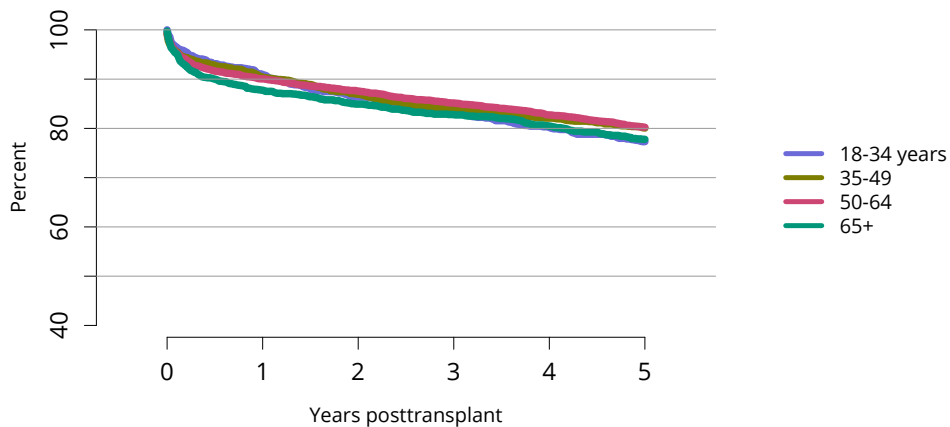
Figure HR 70. Patient survival among adult heart transplant recipients, 2012-2014, by age. Patient survival estimated using unadjusted Kaplan-Meier methods.
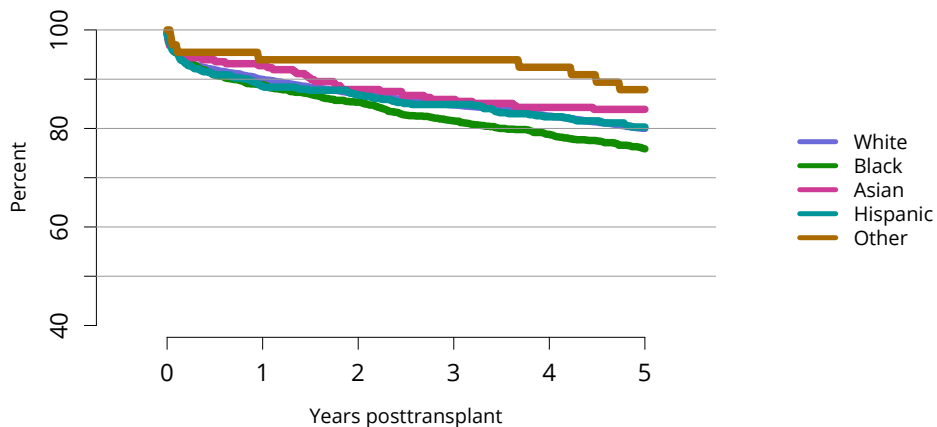
Figure HR 71. Patient survival among adult heart transplant recipients, 2012-2014, by race. Patient survival estimated using unadjusted Kaplan-Meier methods.
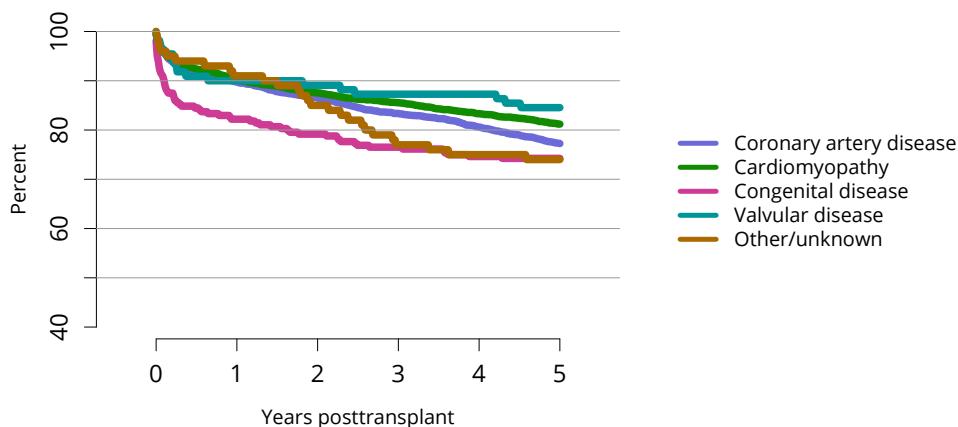
Figure HR 72. Patient survival among adult heart transplant recipients, 2012-2014, by diagnosis group. Patient survival estimated using unadjusted Kaplan-Meier methods.
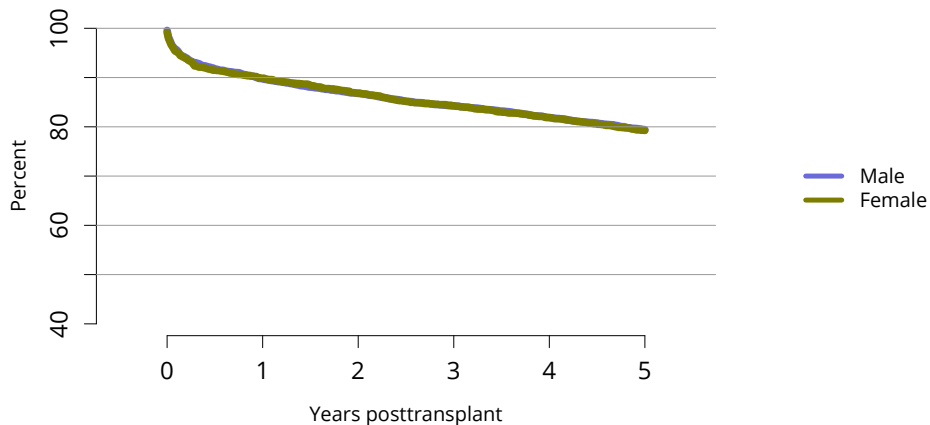
Figure HR 73. Patient survival among adult heart transplant recipients, 2012-2014, by sex. Patient survival estimated using unadjusted Kaplan-Meier methods.
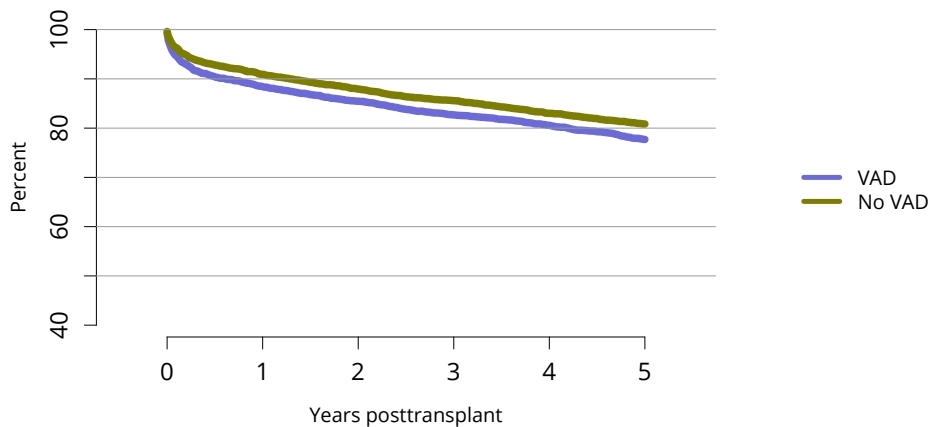
Figure HR 74. Patient survival among adult heart transplant recipients, 2012-2014, by VAD status. Patient survival estimated using unadjusted Kaplan-Meier methods. Ventricular assist device (VAD) status at time of transplant.
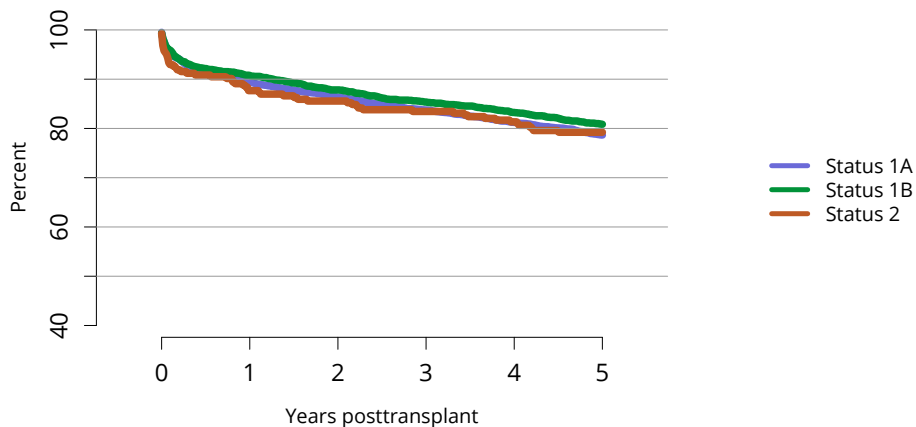
Figure HR 75. Patient survival among adult heart transplant recipients, 2012-2014, by medical urgency. Patient survival estimated using unadjusted Kaplan-Meier methods.
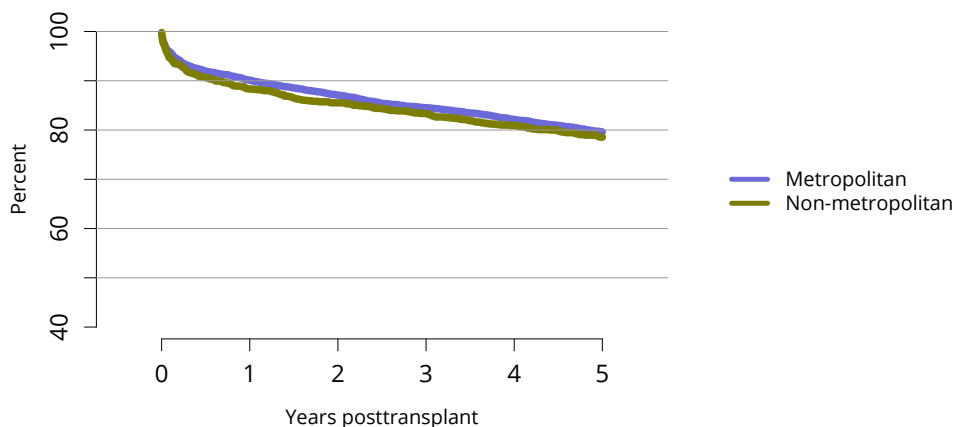
Figure HR 76. Patient survival among adult heart transplant recipients, 2012-2014, by metropolitan vs. non-metropolitan recipient residence. Patient survival estimated using unadjusted Kaplan-Meier methods.
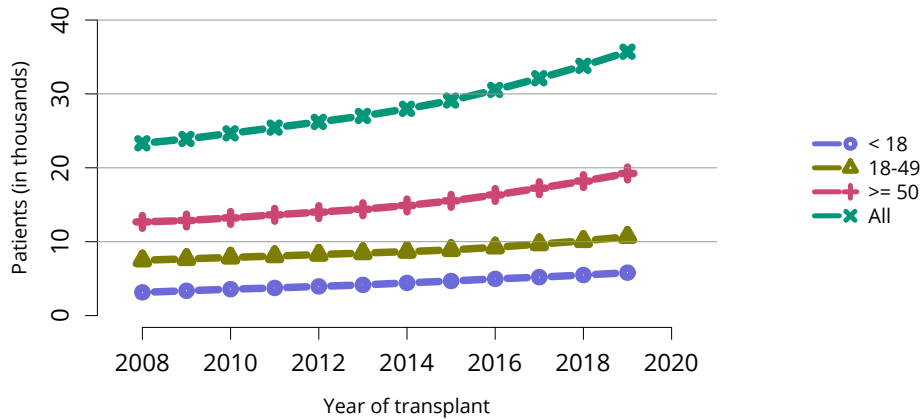
Figure HR 77. Recipients alive with a functioning heart graft on June 30 of the year, by age at transplant. Recipients are assumed to be alive with function unless a death or graft failure is recorded. A recipient may experience a graft failure and be removed from the cohort, undergo retransplant, and re-enter the cohort.
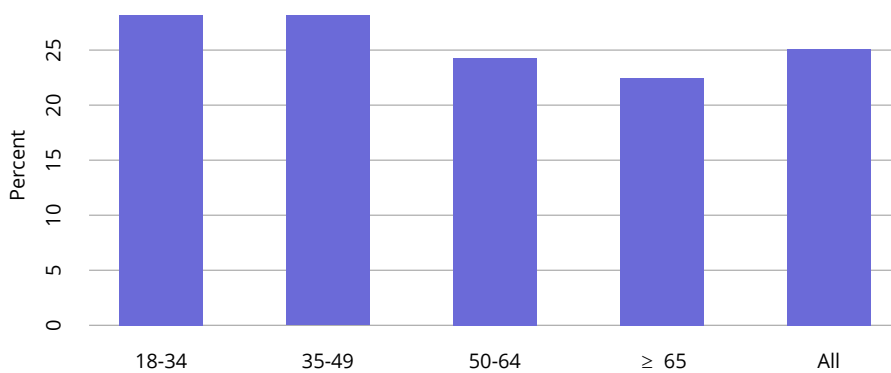
Figure HR 78. Incidence of acute rejection by 1 year posttransplant among adult heart transplant recipients by age, 2017-2018. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method.
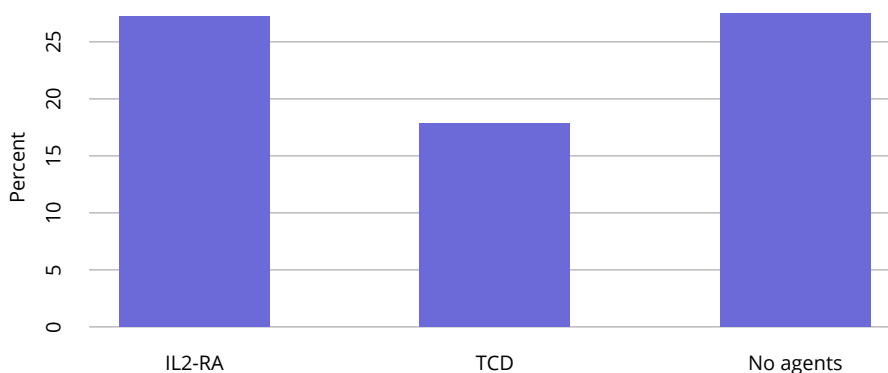
Figure HR 79. Incidence of acute rejection by 1 year posttransplant among adult heart transplant recipients by induction agent, 2017-2018. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method. IL2-RA, interleukin-2 receptor agonist; TCD, T-cell depleting.
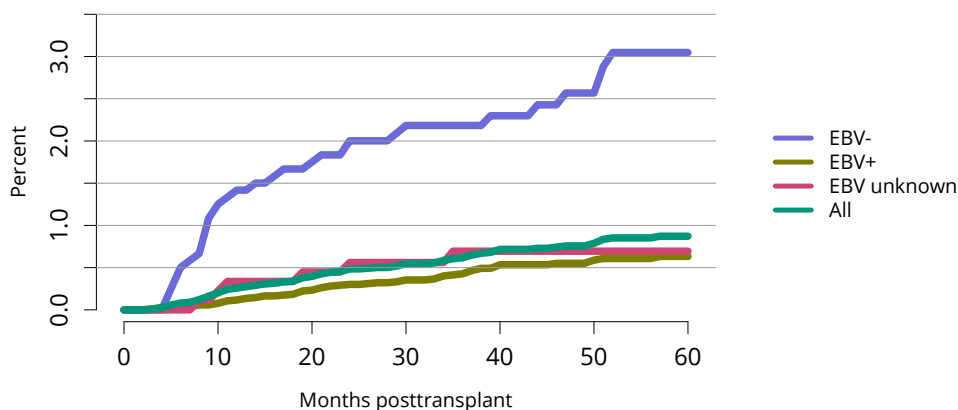
Figure HR 80. Incidence of PTLD among adult heart transplant recipients by recipient EBV status at transplant, 2013-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.
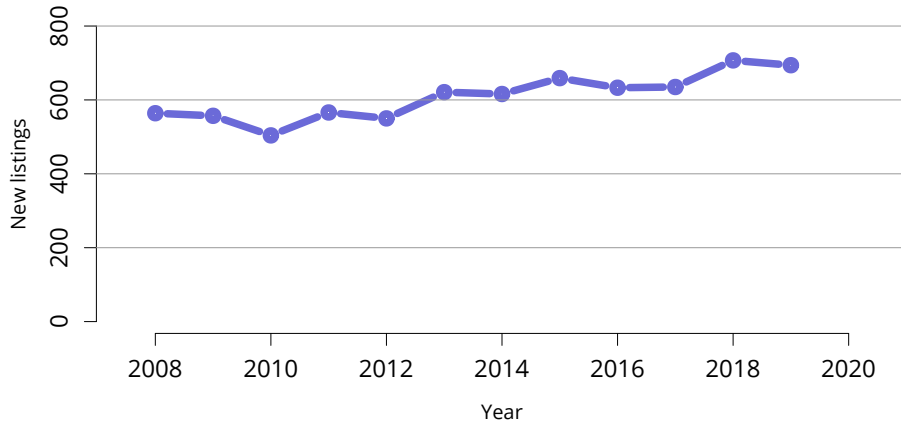
Figure HR 81. New pediatric candidates added to the heart transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.
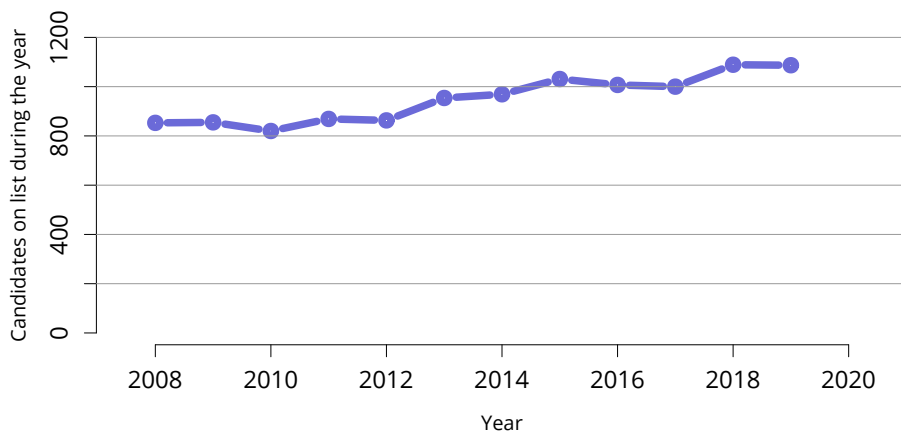
Figure HR 82. All pediatric candidates on the heart transplant waiting list. Pediatric candidates listed at any time during the year. Candidates listed at more than one center are counted once per listing.
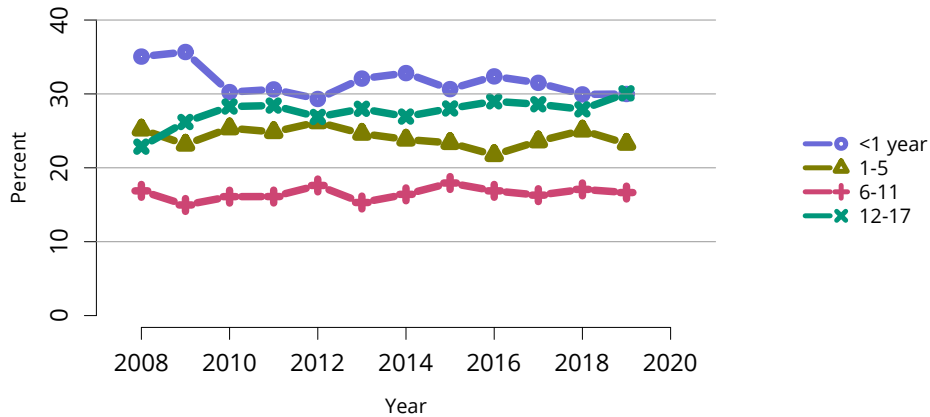
Figure HR 83. Distribution of pediatric candidates waiting for heart transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Age is determined at the later of listing date or January 1 of the given year. Active and inactive candidates are included.
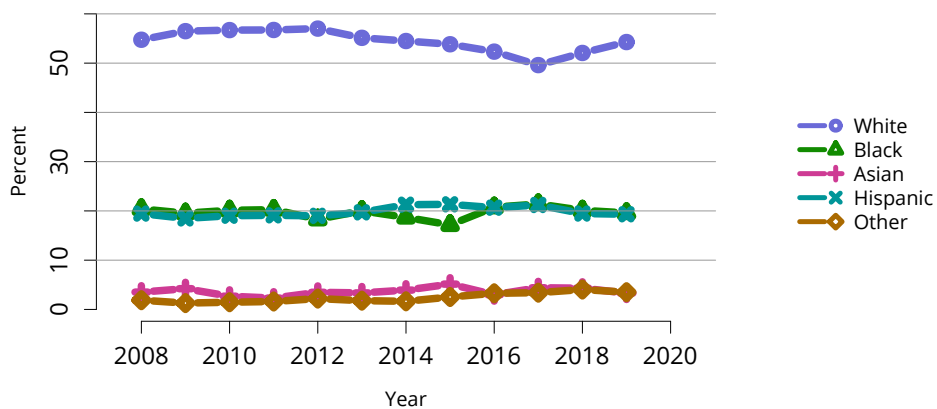
Figure HR 84. Distribution of pediatric candidates waiting for heart transplant by race. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included.
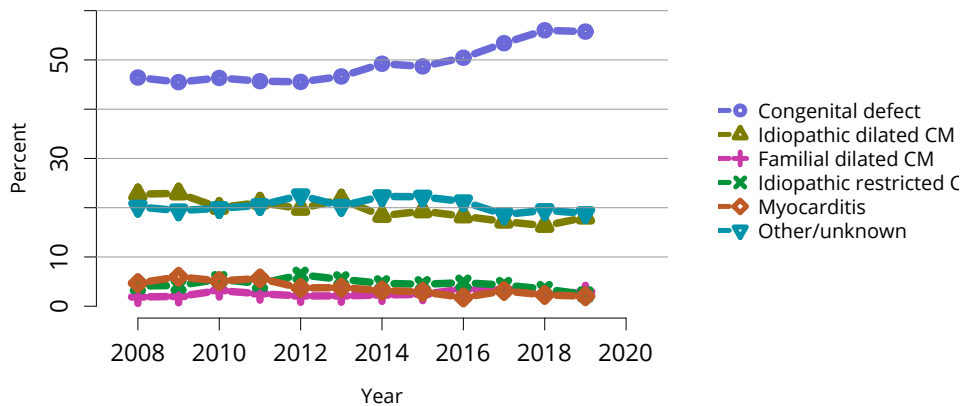
Figure HR 85. Distribution of pediatric candidates waiting for heart transplant by diagnosis. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. CM, cardiomyopathy.
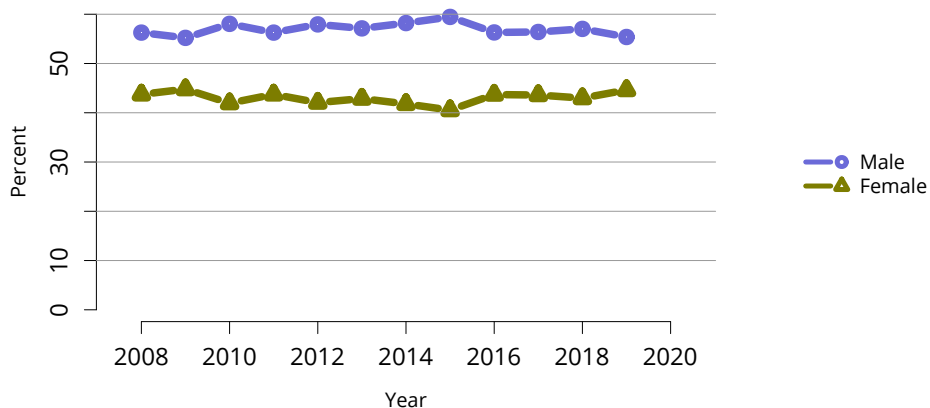
Figure HR 86. Distribution of pediatric candidates waiting for heart transplant by sex. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.
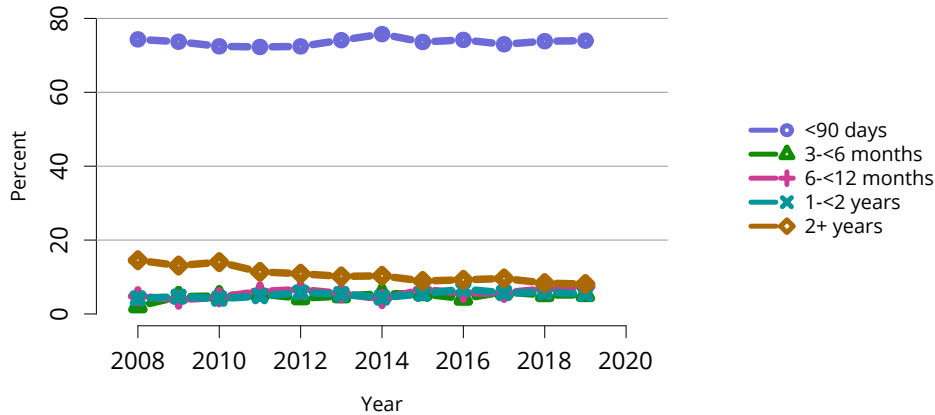
Figure HR 87. Distribution of pediatric candidates waiting for heart transplant by waiting time. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Time on the waiting list is determined at the later of listing date or January 1 of the given year. Active and inactive candidates are included.
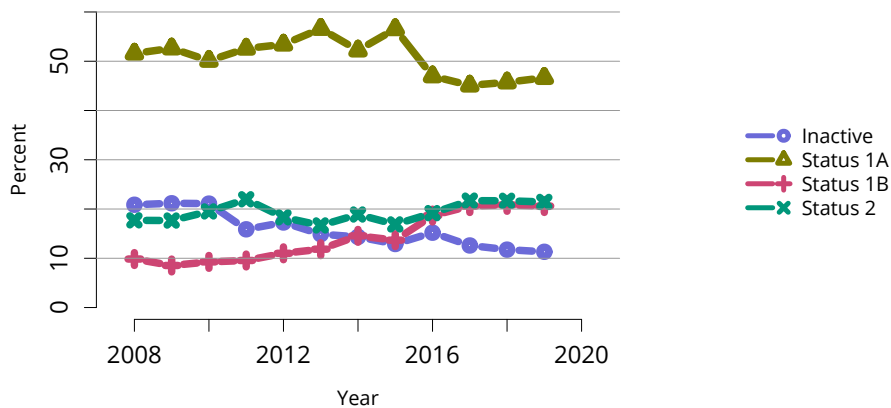
Figure HR 88. Distribution of pediatric candidates waiting for heart transplant by medical urgency. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Medical urgency status is the most severe during the year. Active and inactive patients are included.
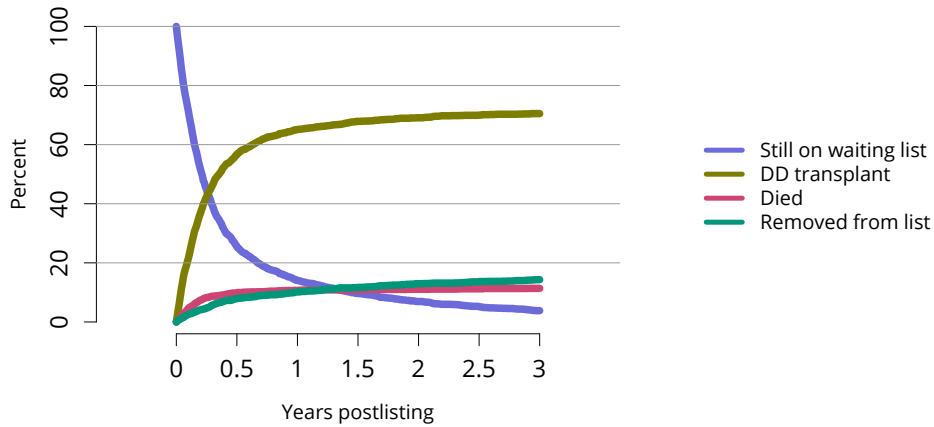
Figure HR 89. Three-year outcomes for newly listed pediatric candidates waiting for heart transplant, 2016. Pediatric candidates who joined the waitlist in 2016. Pediatric candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor.
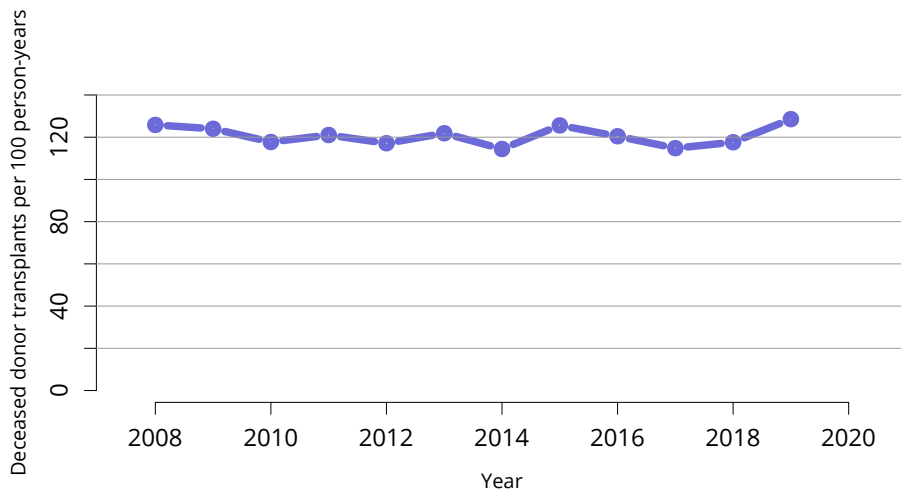
Figure HR 90. Overall deceased donor heart transplant rates among pediatric waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.
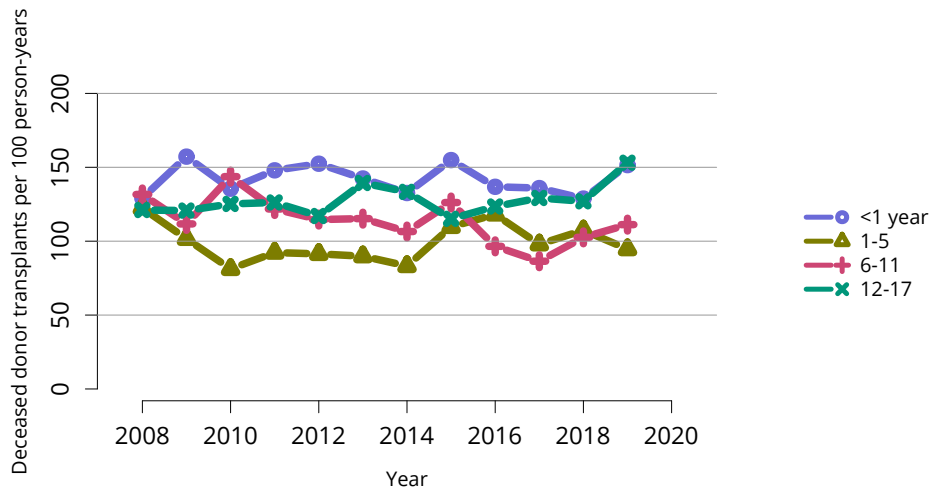
Figure HR 91. Deceased donor heart transplant rates among pediatric waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.
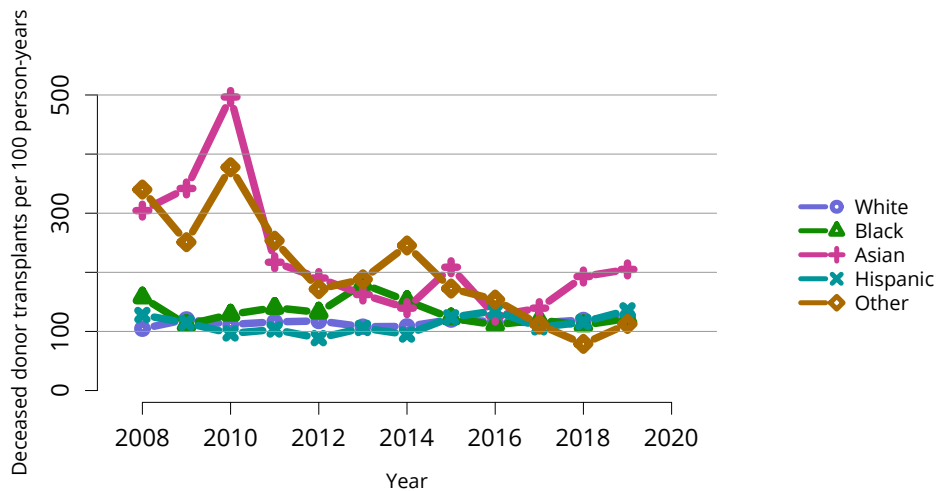
Figure HR 92. Deceased donor heart transplant rates among pediatric waitlist candidates by race. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.
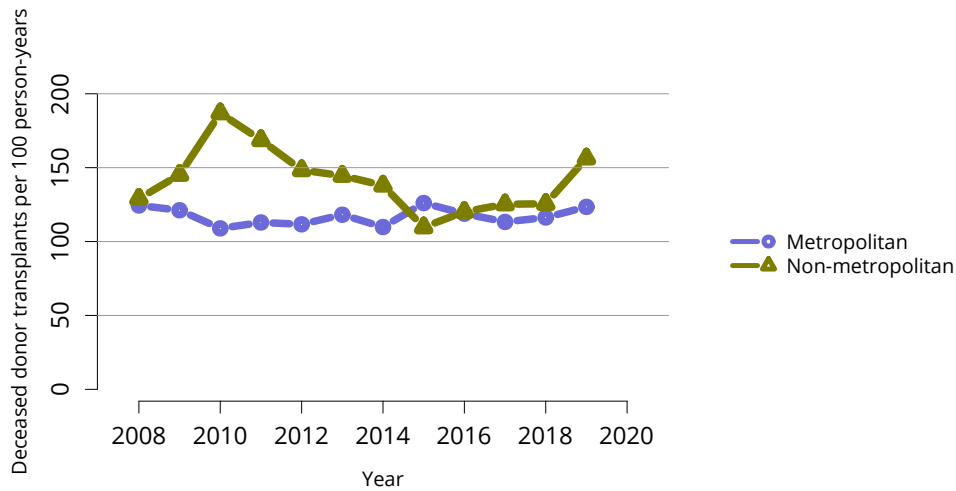
Figure HR 93. Deceased donor heart transplant rates among pediatric waitlist candidates by metropolitan vs. non-metropolitan residence. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given year. Individual listings are counted separately.
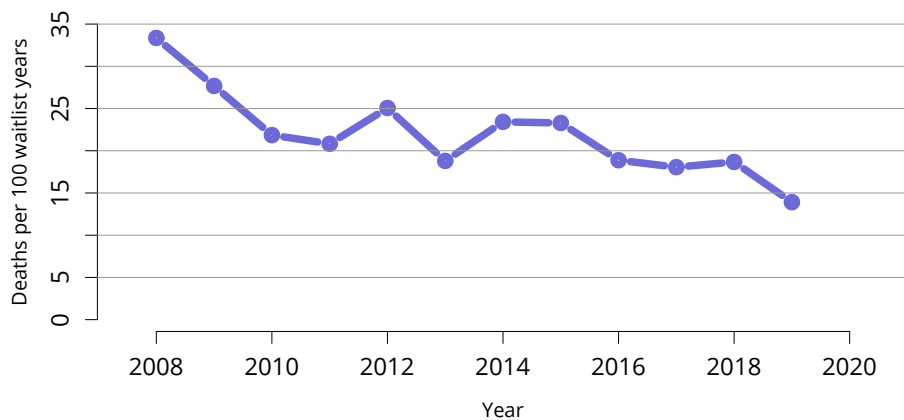
Figure HR 94. Overall pretransplant mortality rates among pediatric candidates waitlisted for heart. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Individual listings are counted separately.
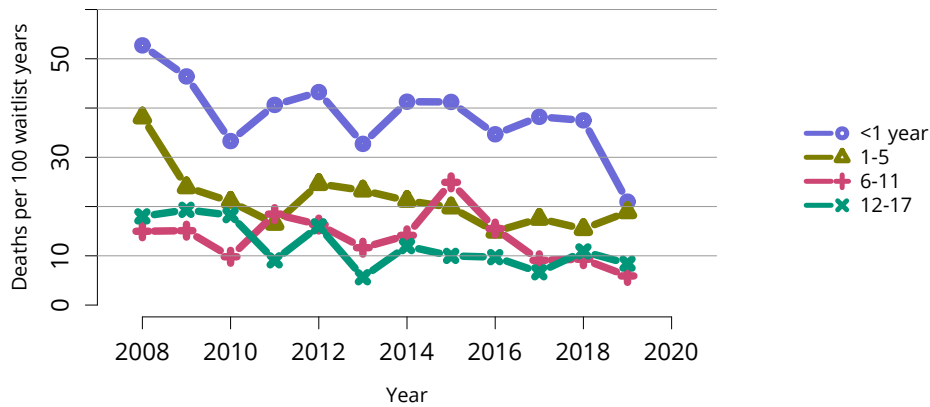
Figure HR 95. Pretransplant mortality rates among pediatric candidates waitlisted for heart transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because 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.
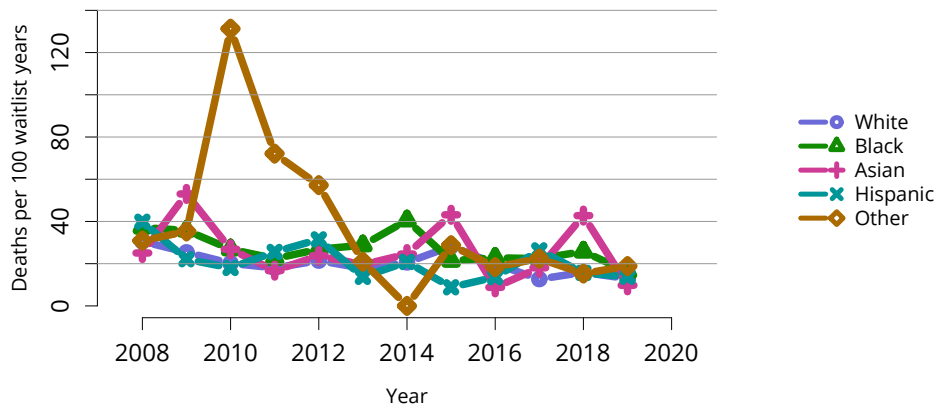
Figure HR 96. Pretransplant mortality rates among pediatric candidates waitlisted for heart transplant by race. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.
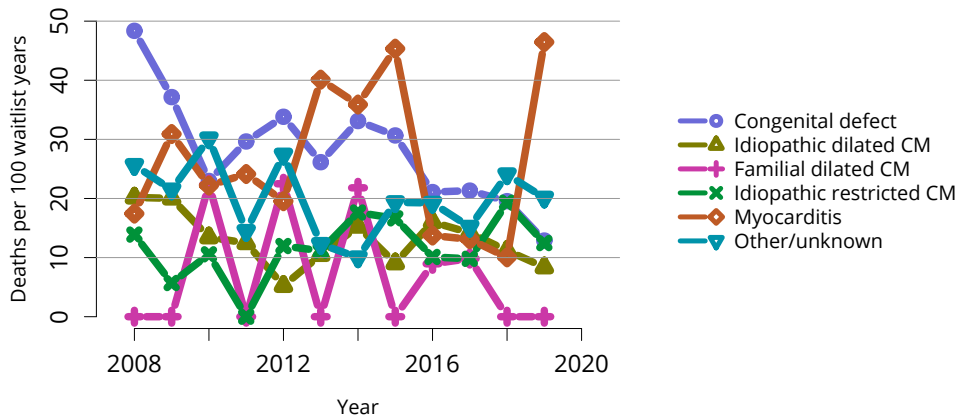
Figure HR 97. Pretransplant mortality rates among pediatrics waitlisted for heart transplant by diagnosis. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. CM, cardiomyopathy.
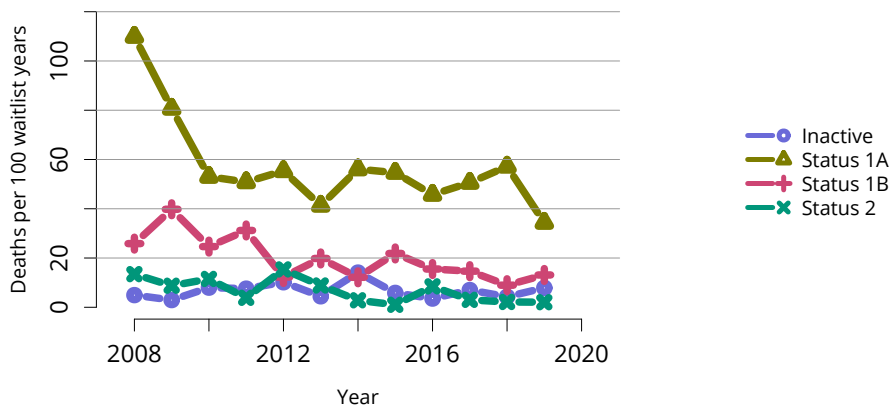
Figure HR 98. Pretransplant mortality rates among pediatrics waitlisted for heart transplant by medical urgency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.
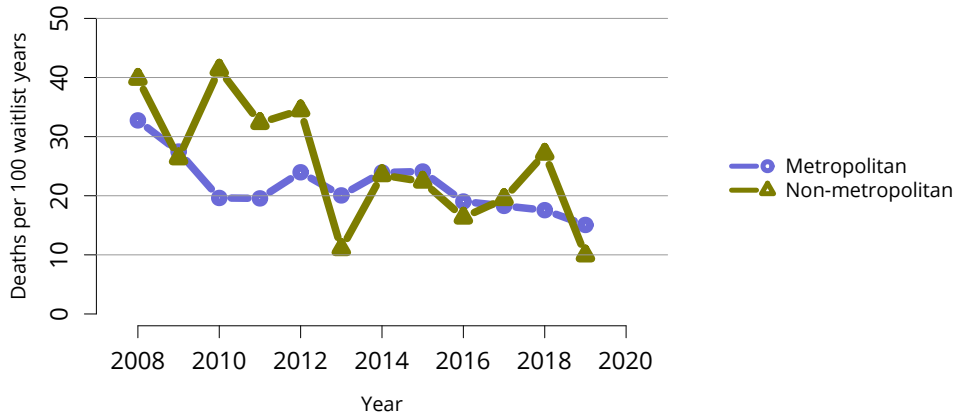
Figure HR 99. Pretransplant mortality rates among pediatric candidates waitlisted for heart transplant by metropolitan vs. non-metropolitan residence. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Urban/rural determination is made using the RUCA (Rural-Urban Commuting Area) designation of the candidate's permanent zip code.
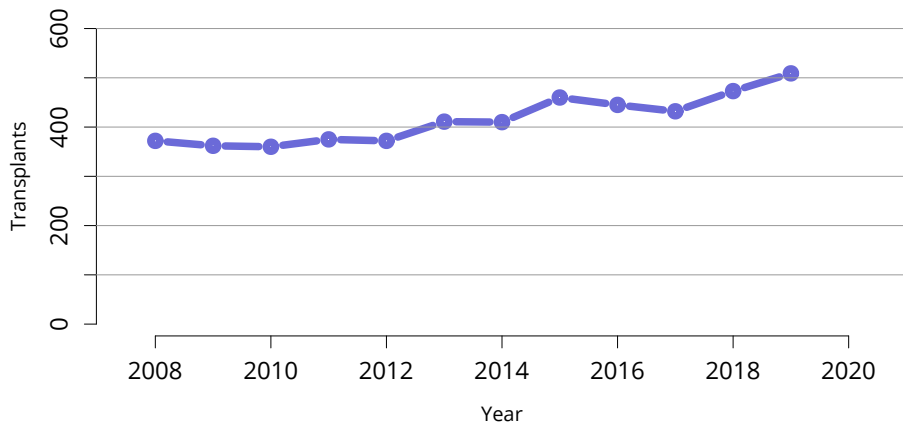
Figure HR 100. Overall pediatric heart transplants. All pediatric heart transplant recipients, including retransplant, and multi-organ recipients.
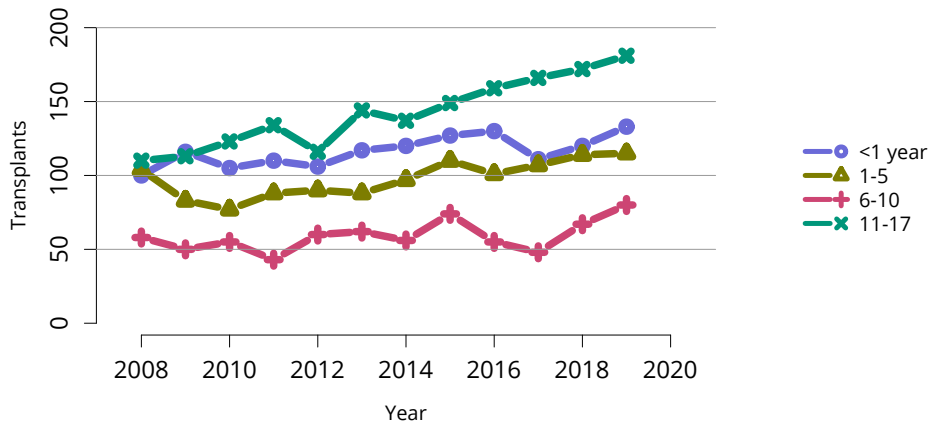
Figure HR 101. Pediatric heart transplants by recipient age. All pediatric heart transplant recipients, including retransplant, and multi-organ recipients.
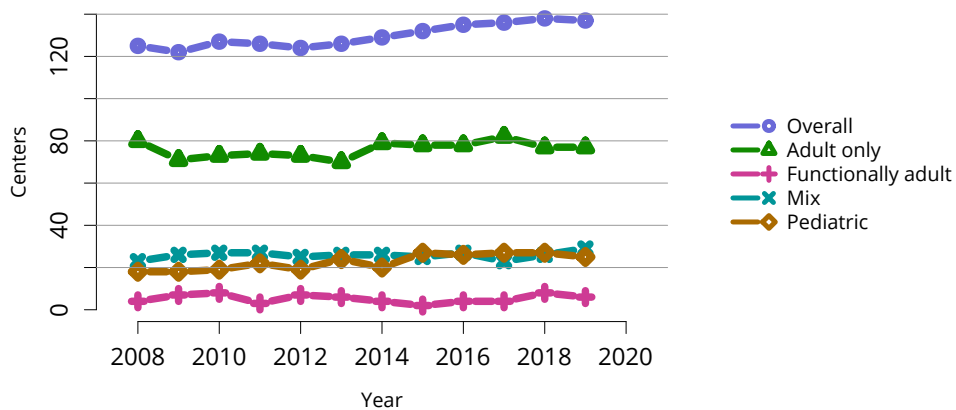
Figure HR 102. Number of centers performing pediatric and adult heart transplants by center's age mix. Adult centers transplanted only recipients aged 18 years or older. Functionally adult centers transplanted 80% adults or more, and the remainder were children aged 15-17 years. Mixed included adults and children of any age groups. Pediatric center transplanted recipients aged 0-17 years, and a small number of adults up to age 21 years.
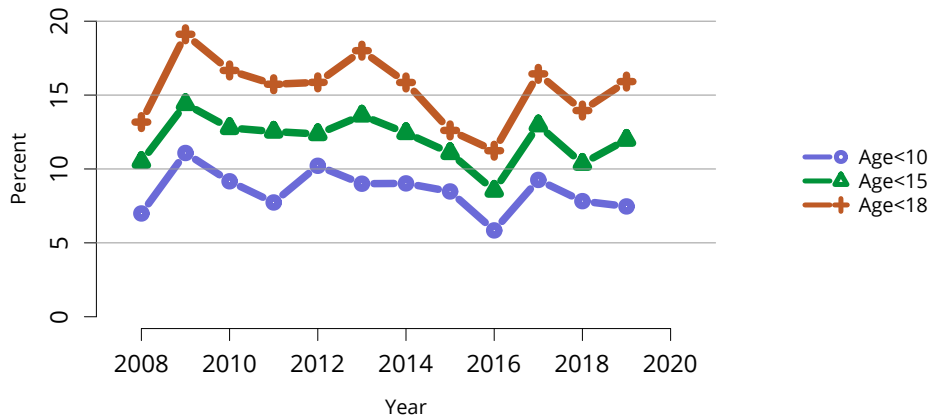
Figure HR 103. Pediatric heart recipients at programs that perform 5 or fewer pediatric transplants annually. Age groups are cumulative.
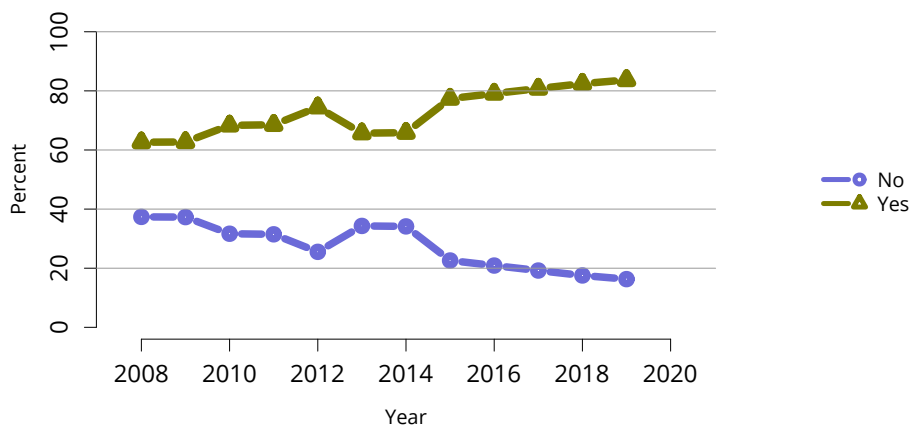
Figure HR 104. Induction agent use in pediatric heart transplant recipients. Immunosuppression at transplant reported to the OPTN.
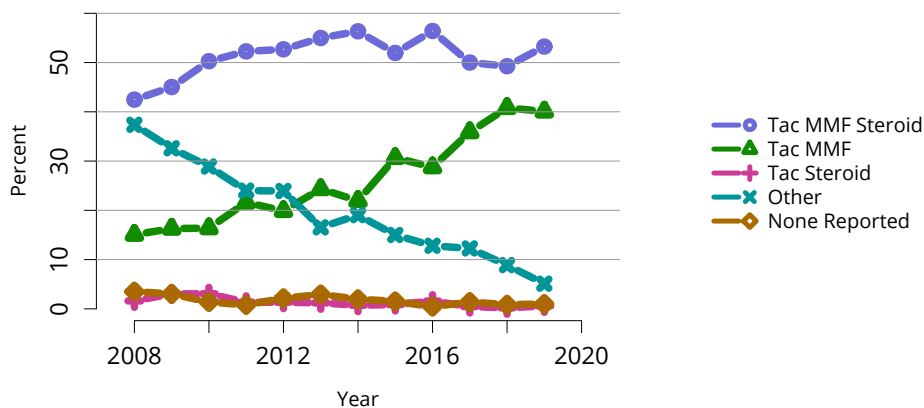
Figure HR 105. Immunosuppression regimen use in pediatric heart transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. Tac, tacrolimus. MMF, all mycophenolate agents.
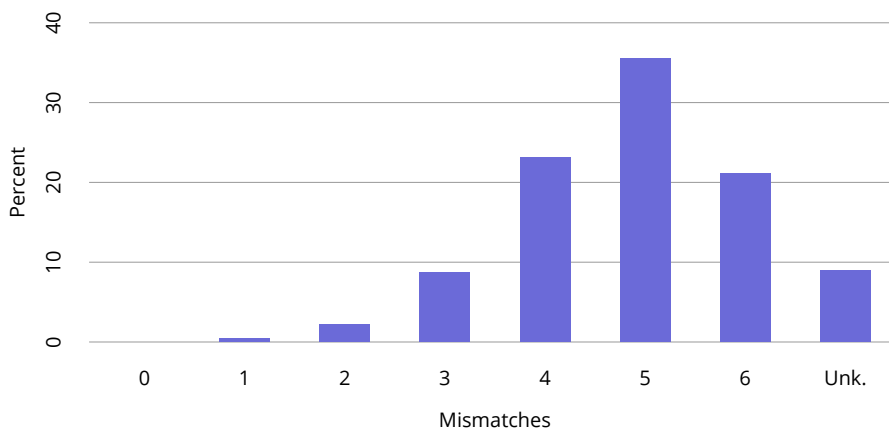
Figure HR 106. Total HLA A, B, and DR mismatches among pediatric deceased donor heart transplant recipients, 2015-2019. Donor and recipient antigen matching is based on OPTN antigen values and split equivalences policy as of 2018.
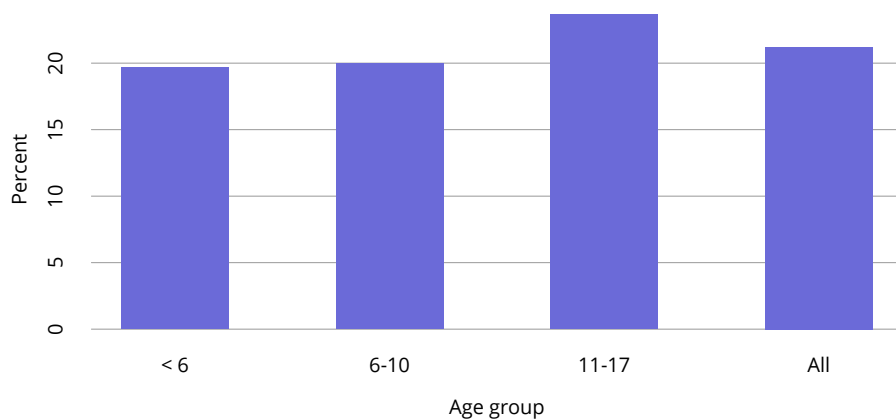
Figure HR 107. Incidence of acute rejection by 1 year posttransplant among pediatric heart transplant recipients by age, 2017-2018. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method.
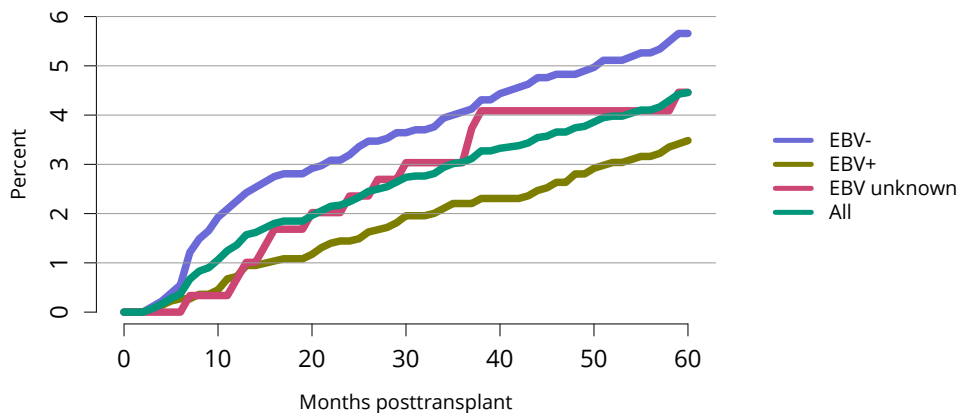
Figure HR 108. Incidence of PTLD among pediatric heart transplant recipients by recipient EBV status at transplant, 2007-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or on the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus.
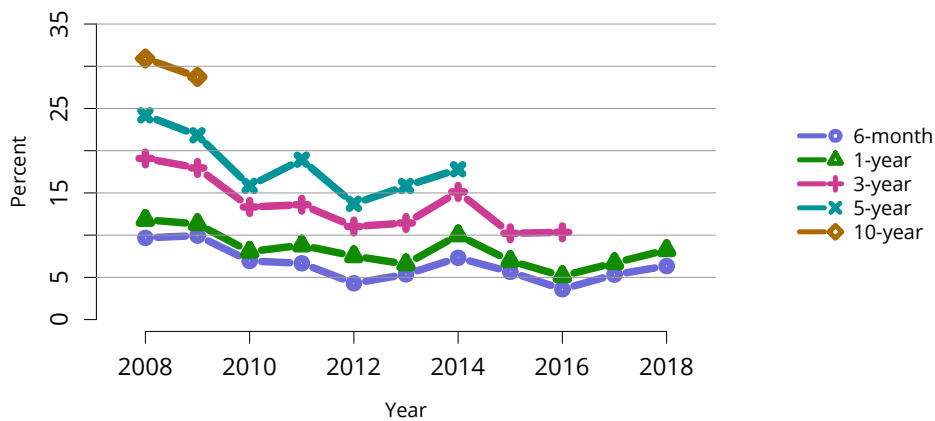
Figure HR 109. Patient death among pediatric heart transplant recipients. All pediatric recipients of deceased donor hearts, including multi-organ transplants. Estimates are unadjusted, computed using Kaplan-Meier competing risk methods. Recipients are followed to the earliest of kidney graft failure; kidney retransplant; return to dialysis; death; or 6 months, 1, 3, 5, or 10 years posttransplant.
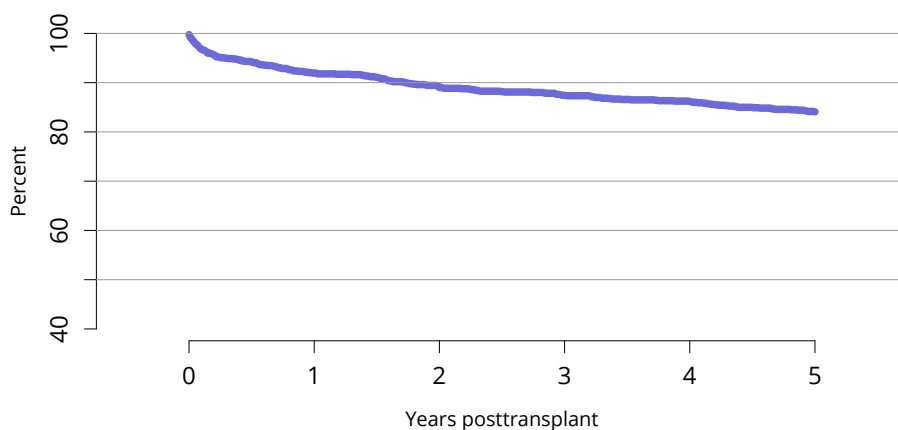
Figure HR 110. Overall patient survival among pediatric deceased donor heart transplant recipients, 2012-2014. Recipient survival estimated using unadjusted Kaplan-Meier methods.
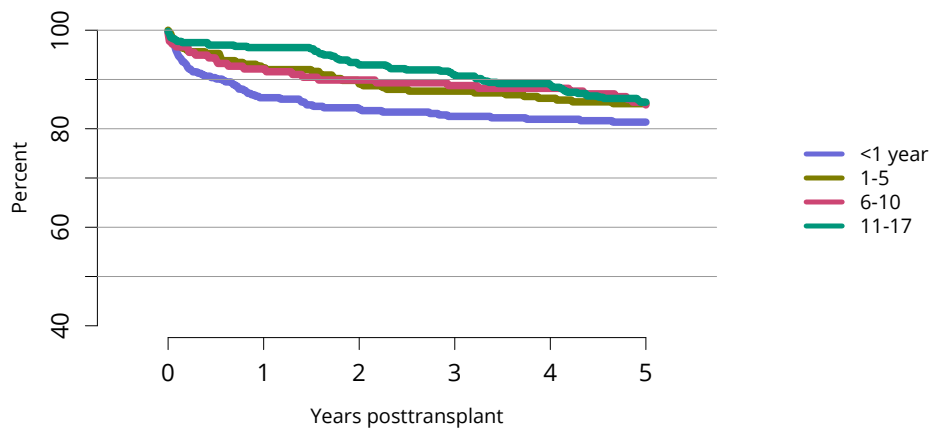
Figure HR 111. Patient survival among pediatric deceased donor heart transplant recipients, 2012-2014, by recipient age. Recipient survival estimated using unadjusted Kaplan-Meier methods.

Characteristic	2009		2019	
	N	Percent	N	Percent
Age				
18-34 years	299	11.0%	374	11.0%
35-49 years	610	22.4%	815	24.1%
50-64 years	1393	51.0%	1642	48.5%
$\geq$ 65 years	427	15.6%	554	16.4%
Sex				
Female	706	25.9%	783	23.1%
Male	2023	74.1%	2602	76.9%
Race/ethnicity				
White	1945	71.3%	1996	59.0%
Black	529	19.4%	965	28.5%
Hispanic	187	6.9%	325	9.6%
Asian	47	1.7%	74	2.2%
Other/unknown	21	0.8%	25	0.7%
Geography				
Metropolitan	2240	82.1%	2879	85.1%
Non-metro	489	17.9%	506	14.9%
Distance				
$<$ 50 miles	1561	57.2%	2081	61.5%
50-$<$100 miles	488	17.9%	537	15.9%
100-$<$150 miles	278	10.2%	335	9.9%
150-$<$250 miles	193	7.1%	210	6.2%
$\geq$ 250 miles	188	6.9%	208	6.1%
Unknown	21	0.8%	14	0.4%
All candidates	2729	100.0%	3385	100.0%

Table HR 1 Demographic characteristics of adults on the heart transplant waiting list on December 31, 2009 and December 31, 2019. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date. Distance is computed from candidate's home zip code to the transplant center.

Characteristic	2009		2019	
	N	Percent	N	Percent
Diagnosis				
Coronary artery disease	1099	40.3%	978	28.9%
Cardiomyopathy	1264	46.3%	2015	59.5%
Congenital disease	154	5.6%	187	5.5%
Valvular disease	57	2.1%	37	1.1%
Other/unknown	155	5.7%	168	5.0%
Blood type				
A	882	32.3%	966	28.5%
B	259	9.5%	369	10.9%
AB	43	1.6%	61	1.8%
O	1545	56.6%	1989	58.8%
Medical urgency				
Former Status 1A	155	5.7%	0	0.0%
Former Status 1B	734	26.9%	0	0.0%
Former Status 2	981	35.9%	1	0.0%
New Status 1	0	0.0%	4	0.1%
New Status 2	0	0.0%	48	1.4%
New Status 3	0	0.0%	217	6.4%
New Status 4	0	0.0%	1710	50.5%
New Status 5	0	0.0%	108	3.2%
New Status 6	0	0.0%	502	14.8%
Inactive	859	31.5%	795	23.5%
VAD at listing	368	13.5%	1257	37.1%
All candidates	2729	100.0%	3385	100.0%

Table HR 2 Clinical characteristics of adults on the heart transplant waiting list on December 31, 2009 and December 31, 2019. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date. VAD, ventricular assist device.

Characteristic	2009		2019	
	N	Percent	N	Percent
Transplant history				
First	2616	95.9%	3289	97.2%
Retransplant	113	4.1%	96	2.8%
Wait time				
< 1 year	1467	53.8%	1616	47.7%
1-< 2 years	508	18.6%	863	25.5%
2-< 3 years	223	8.2%	376	11.1%
3-< 4 years	133	4.9%	212	6.3%
4-< 5 years	61	2.2%	119	3.5%
≥ 5 years	337	12.3%	199	5.9%
Tx type				
Heart only	2545	93.3%	3022	89.3%
Heart-kidney	94	3.4%	253	7.5%
Heart-lung	72	2.6%	74	2.2%
Other	18	0.7%	36	1.1%
All candidates	2729	100.0%	3385	100.0%

Table HR 3 Listing characteristics of adults on the heart transplant waiting list on December 31, 2009 and December 31, 2019. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date.

Waiting list state	2017	2018	2019
Patients at start of year	3703	3591	3467
Patients added during year	3947	4072	4087
Patients removed during year	4050	4187	4167
Patients at end of year	3600	3476	3387

Table HR 4 Heart transplant waitlist activity among adults. Candidates listed at more than one center are counted once per listing. 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	2017	2018	2019
Deceased donor transplant	2820	2948	3066
Patient died	302	273	199
Patient refused transplant	27	27	25
Improved, transplant not needed	185	183	163
Too sick for transplant	294	280	261
Other	420	476	453

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.

Status at listing	Percent
1	80.0%
2	88.6%
3	76.0%
4	42.2%
5	35.7%
6	39.2%

Table HR 6 Percentage of adults who received transplant within 6 months from listing between January 1 and June 30 in 2019 . Candidates are newly listed within the interval.

Support	2017		2019	
	N	Percent	N	Percent
Any life support	2431	85.6%	2519	81.6%
Left ventricular assist device	1358	47.8%	1034	33.5%
Intravenous inotropes	1019	35.9%	1168	37.8%
Intra-aortic balloon pump	235	8.3%	917	29.7%
Right ventricular assist device	48	1.7%	69	2.2%
Extra corporeal membrane oxygenation	34	1.2%	184	6.0%
Total artificial heart	23	0.8%	26	0.8%
Ventilator	22	0.8%	76	2.5%
Inhaled NO	5	0.2%	7	0.2%
Prostaglandins	1	0.0%	7	0.2%

Table HR 7 Adult heart recipients on circulatory support before transplant. Patients may have more than one type of circulatory support.

Characteristic	2009		2019	
	N	Percent	N	Percent
Age				
18-34 years	216	11.5%	377	12.2%
35-49 years	407	21.7%	654	21.2%
50-64 years	969	51.6%	1461	47.3%
≥ 65 years	287	15.3%	596	19.3%
Sex				
Female	459	24.4%	877	28.4%
Male	1420	75.6%	2211	71.6%
Race/ethnicity				
White	1307	69.6%	1924	62.3%
Black	362	19.3%	713	23.1%
Hispanic	141	7.5%	305	9.9%
Asian	58	3.1%	123	4.0%
Other/unknown	11	0.6%	23	0.7%
Insurance				
Private	1031	54.9%	1500	48.6%
Medicare	573	30.5%	1007	32.6%
Medicaid	210	11.2%	419	13.6%
Other government	49	2.6%	124	4.0%
Unknown	16	0.9%	38	1.2%
Geography				
Metropolitan	1554	82.7%	2635	85.3%
Non-metro	325	17.3%	453	14.7%
Distance				
< 50 miles	1122	59.7%	1880	60.9%
50-<100 miles	319	17.0%	483	15.6%
100-<150 miles	197	10.5%	319	10.3%
150-<250 miles	124	6.6%	224	7.3%
≥ 250 miles	102	5.4%	152	4.9%
Unknown	15	0.8%	30	1.0%
All recipients	1879	100.0%	3088	100.0%

Table HR 8 Demographic characteristics of adult heart transplant recipients, 2009 and 2019. Heart transplant recipients, including retransplants. Distance is computed from recipient's home zip code to the transplant center.

Characteristic	2009		2019	
	N	Percent	N	Percent
Diagnosis				
Coronary artery disease	733	39.0%	859	27.8%
Cardiomyopathy	1002	53.3%	1930	62.5%
Congenital disease	60	3.2%	151	4.9%
Valvular disease	41	2.2%	38	1.2%
Other/unknown	43	2.3%	110	3.6%
Blood type				
A	785	41.8%	1247	40.4%
B	278	14.8%	481	15.6%
AB	92	4.9%	165	5.3%
O	724	38.5%	1195	38.7%
On VAD	721	38.4%	1110	35.9%
CPRA				
< 1%	1104	58.8%	1408	45.6%
1-< 20%	384	20.4%	338	10.9%
20-< 80%	267	14.2%	492	15.9%
80-< 98%	59	3.1%	86	2.8%
98-100%	24	1.3%	48	1.6%
Unknown	41	2.2%	716	23.2%
Medical urgency				
Former Status 1A	974	51.8%	0	0.0%
Former Status 1B	750	39.9%	0	0.0%
Former Status 2	155	8.2%	0	0.0%
New Status 1	0	0.0%	289	9.4%
New Status 2	0	0.0%	1456	47.2%
New Status 3	0	0.0%	650	21.0%
New Status 4	0	0.0%	546	17.7%
New Status 5	0	0.0%	29	0.9%
New Status 6	0	0.0%	118	3.8%
All recipients	1879	100.0%	3088	100.0%

Table HR 9 Clinical characteristics of adult heart transplant recipients, 2009 and 2019. 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	2009		2019	
	N	Percent	N	Percent
Wait time				
< 31 days	455	24.2%	1420	46.0%
31-60 days	262	13.9%	334	10.8%
61-90 days	193	10.3%	204	6.6%
3-< 6 months	379	20.2%	335	10.8%
6-< 12 months	322	17.1%	338	10.9%
1-< 2 years	177	9.4%	262	8.5%
≥ 2 years	91	4.8%	195	6.3%
Transplant history				
First	1815	96.6%	2984	96.6%
Retransplant	64	3.4%	104	3.4%
Tx type				
Heart only	1782	94.8%	2782	90.1%
Heart-lung	24	1.3%	42	1.4%
Heart-kidney	59	3.1%	213	6.9%
Heart-liver	11	0.6%	44	1.4%
Other	3	0.2%	7	0.2%
All recipients	1879	100.0%	3088	100.0%

Table HR 10 Transplant characteristics of adult heart transplant recipients, 2009 and 2019. Heart transplant recipients, including retransplants.

Characteristic	2009		2019	
	N	Percent	N	Percent
Age				
< 1 year	43	16.2%	65	17.3%
1-5 years	82	30.8%	120	32.0%
6-10 years	57	21.4%	73	19.5%
11-17 years	84	31.6%	117	31.2%
Sex				
Female	102	38.3%	167	44.5%
Male	164	61.7%	208	55.5%
Race/ethnicity				
White	149	56.0%	208	55.5%
Black	57	21.4%	74	19.7%
Hispanic	53	19.9%	70	18.7%
Asian	6	2.3%	11	2.9%
Other/unknown	1	0.4%	12	3.2%
Geography				
Metropolitan	232	87.2%	306	81.6%
Non-metro	34	12.8%	69	18.4%
Distance				
< 50 miles	135	50.8%	189	50.4%
50-<100 miles	45	16.9%	74	19.7%
100-<150 miles	28	10.5%	44	11.7%
150-<250 miles	25	9.4%	36	9.6%
≥ 250 miles	29	10.9%	27	7.2%
Unknown	4	1.5%	5	1.3%
All candidates	266	100.0%	375	100.0%

Table HR 11 Demographic characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2009 and December 31, 2019. Candidates aged younger than 18 years waiting for transplant on December 31 of given year, regardless of first listing date. Age calculated at snapshot. Candidates listed as children who turned 18 before the cohort date are excluded. Distance is computed from candidate's home zip code to the transplant center.

Characteristic	2009		2019	
	N	Percent	N	Percent
Diagnosis				
Congenital defect	131	49.2%	234	62.4%
Idiopathic dilated CM	58	21.8%	53	14.1%
Familial dilated CM	5	1.9%	6	1.6%
Idiopathic restrictive CM	14	5.3%	10	2.7%
Myocarditis	15	5.6%	5	1.3%
Other/unknown	43	16.2%	67	17.9%
Blood type				
A	74	27.8%	118	31.5%
B	34	12.8%	46	12.3%
AB	10	3.8%	8	2.1%
O	148	55.6%	203	54.1%
Medical urgency				
Former Status 1A	75	28.2%	88	23.5%
Former Status 1B	19	7.1%	72	19.2%
Former Status 2	46	17.3%	113	30.1%
Inactive	126	47.4%	102	27.2%
VAD at listing	9	3.4%	20	5.3%
All candidates	266	100.0%	375	100.0%

Table HR 12 Clinical characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2009 and December 31, 2019. Candidates aged younger than 18 years waiting for transplant on December 31 of the given year, regardless of first listing date. Candidates listed as children who turned 18 before the cohort date are excluded. CM, cardiomyopathy; VAD, ventricular assist device.

Characteristic	2009		2019	
	N	Percent	N	Percent
Transplant history				
First	249	93.6%	357	95.2%
Retransplant	17	6.4%	18	4.8%
Wait time				
< 1 year	160	60.2%	231	61.6%
1-< 2 years	30	11.3%	67	17.9%
2-< 3 years	21	7.9%	36	9.6%
3-< 4 years	8	3.0%	19	5.1%
4-< 5 years	10	3.8%	8	2.1%
≥ 5 years	37	13.9%	14	3.7%
Tx type				
Heart only	252	94.7%	364	97.1%
Heart-kidney	2	0.8%	2	0.5%
Heart-lung	11	4.1%	6	1.6%
Other	1	0.4%	3	0.8%
All candidates	266	100.0%	375	100.0%

Table HR 13 Listing characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2009 and December 31, 2019. Candidates aged younger than 18 years waiting for transplant on December 31 of the given year, regardless of first listing date. Candidates listed as children who turned 18 before the cohort date are excluded.

Waiting list state	2017	2018	2019
Patients at start of year	364	382	392
Patients added during year	636	707	694
Patients removed during year	618	696	672
Patients at end of year	382	393	414

Table HR 14 Heart transplant waitlist activity among pediatric candidates. 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	2017	2018	2019
Deceased donor transplant	443	484	519
Patient died	68	80	55
Patient refused transplant	0	2	3
Improved, transplant not needed	55	62	43
Too sick for transplant	28	31	28
Other	24	37	24

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	2007-09		2017-19	
	N	Percent	N	Percent
Age				
< 1 year	304	28.6%	364	25.7%
1-5 years	263	24.7%	336	23.8%
6-10 years	153	14.4%	195	13.8%
11-17 years	344	32.3%	519	36.7%
Sex				
Female	484	45.5%	625	44.2%
Male	580	54.5%	789	55.8%
Race/ethnicity				
White	567	53.3%	738	52.2%
Black	212	19.9%	280	19.8%
Hispanic	197	18.5%	284	20.1%
Asian	65	6.1%	69	4.9%
Other/unknown	23	2.2%	43	3.0%
Insurance				
Private	513	48.2%	548	38.8%
Medicaid	426	40.0%	733	51.8%
Other government	86	8.1%	96	6.8%
Unknown	39	3.7%	37	2.6%
Geography				
Metropolitan	897	84.3%	1142	80.8%
Non-metro	167	15.7%	272	19.2%
Distance				
< 50 miles	547	51.4%	756	53.5%
50-<100 miles	148	13.9%	248	17.5%
100-<150 miles	119	11.2%	148	10.5%
150-<250 miles	98	9.2%	121	8.6%
≥ 250 miles	130	12.2%	112	7.9%
Unknown	22	2.1%	29	2.1%
All recipients	1064	100.0%	1414	100.0%

Table HR 16 Demographic characteristics of pediatric heart transplant recipients, 2007-2009 and 2017-2019. Pediatric heart transplant recipients, including retransplants. Distance is computed from recipient's home zip code to the transplant center.

Characteristic	2007-09		2017-19	
	N	Percent	N	Percent
Diagnosis				
Congenital defect	455	42.8%	726	51.3%
Idiopathic dilated CM	318	29.9%	306	21.6%
Familial dilated CM	36	3.4%	79	5.6%
Idiopathic restrictive CM	70	6.6%	58	4.1%
Myocarditis	50	4.7%	38	2.7%
Other/unknown	135	12.7%	207	14.6%
Blood type				
A	385	36.2%	487	34.4%
B	146	13.7%	204	14.4%
AB	42	3.9%	66	4.7%
O	491	46.1%	657	46.5%
Medical urgency				
Former Status 1A	875	82.2%	1136	80.3%
Former Status 1B	112	10.5%	229	16.2%
Former Status 2	77	7.2%	49	3.5%
On VAD	167	15.7%	458	32.4%
CPRA				
$< 1\%$	599	56.3%	552	39.0%
$1\text{-}< 20\%$	180	16.9%	188	13.3%
$20\text{-}< 80\%$	138	13.0%	259	18.3%
$80\text{-}< 98\%$	42	3.9%	74	5.2%
98-100%	28	2.6%	57	4.0%
Unknown	77	7.2%	284	20.1%
All recipients	1064	100.0%	1414	100.0%

Table HR 17 Clinical characteristics of pediatric heart transplant recipients, 2007-2009 and 2017-2019. Pediatric heart transplant recipients, including retransplants. Collection of calculated PRA (CPRA) began March 31, 2015. Prior to that, measured PRA values were used. CM, cardiomyopathy; VAD, ventricular assist device.

Characteristic	2007-09		2017-19	
	N	Percent	N	Percent
Wait time				
< 31 days	438	41.2%	403	28.5%
31-60 days	205	19.3%	235	16.6%
61-90 days	127	11.9%	203	14.4%
3-< 6 months	152	14.3%	291	20.6%
6-< 12 months	98	9.2%	167	11.8%
1-< 2 years	25	2.3%	83	5.9%
≥ 2 years	19	1.8%	32	2.3%
ABO				
Compatible/identical	1021	96.0%	1266	89.5%
Incompatible	43	4.0%	148	10.5%
Transplant history				
First	990	93.0%	1360	96.2%
Retransplant	74	7.0%	54	3.8%
Tx type				
Heart only	1043	98.0%	1393	98.5%
Other	1	0.1%	0	0.0%
Heart-lung	12	1.1%	8	0.6%
Heart-kidney	7	0.7%	10	0.7%
Heart-liver	1	0.1%	3	0.2%
All recipients	1064	100.0%	1414	100.0%

Table HR 18 Transplant characteristics of pediatric heart transplant recipients, 2007-2009 and 2017-2019. Pediatric transplant recipients, including retransplants.

Support	2014		2019	
	N	Percent	N	Percent
Any life support	293	71.5%	378	74.3%
Intravenous inotropes	198	48.3%	240	47.2%
Left ventricular assist device	103	25.1%	164	32.2%
Ventilator	59	14.4%	53	10.4%
Right ventricular assist device	27	6.6%	34	6.7%
Prostaglandins	15	3.7%	8	1.6%
Extra corporeal membrane oxygenation	13	3.2%	10	2.0%
Inhaled NO	8	2.0%	4	0.8%
Intra-aortic balloon pump	2	0.5%	4	0.8%
Total artificial heart	1	0.2%	1	0.2%

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-	33.4%	16.6%
D-	R+	16.1%	14.2%
D-	R unk	0.8%	1.4%
D+	R-	28.3%	28.6%
D+	R+	19.8%	36.9%
D+	R unk	0.8%	1.7%
D unk	R-	0.6%	0.1%
D unk	R+	0.3%	0.4%
D unk	R unk	0.0%	0.1%

Table HR 20 Pediatric heart donor-recipient serology matching, 2017-2019. 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. CMV, cytomegalovirus; EBV, Epstein-Barr virus.