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OPTN/SRTR 2018 Annual Data Report: Lung

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Abstract

The primary goal of US lung allocation policy is to ensure that candidates with the highest risk for mortality receive appropriate access to lung transplant. In 2018, 2562 lung transplants were performed in the US, reflecting a 31% increase over the past 5 years. More candidates are being listed for lung transplant, and the number of donors has increased substantially. Despite an increase of 84 lung transplants in 2018, 365 adult candidates died or became too sick to undergo transplant. In 2018, 24 new child (ages 0-11 years) candidates were added to the lung transplant waiting list. Fifteen lung transplants were performed in recipients aged 0-11 years, three in recipients aged younger than 1 year, two in recipients aged 1-5 years, and ten in recipients aged 6-11 years. Of 27 child candidates removed from the waiting list in 2018, 16 (59.3%) were removed due to undergoing transplant, six (22.2%) due to death, one (3.7%) due to improved condition, and one (3.7%) due to becoming too sick to undergo transplant.

Keywords: End-stage lung disease, LAS, lung allocation score, lung transplant, organ allocation, revised lung allocation score, transplant outcomes.

1 Adult lung transplant

1.1 Introduction

In 2018, 2562 lung transplants were performed in the US, reflecting a 31% increase over the past 5 years (Figure LU 46). More lung transplants are being performed due to more candidates being listed for lung transplant (Figure LU 1) and a precipitous increase in numbers of donors (Figure LU 37). The number of candidates added to the waiting list increased by 233 in 2018 (Figure LU 1), and the number of donors increased by 80 (Figure LU 37). Despite an increase of 84 lung transplants in 2018, 365 candidates died or became too sick to undergo transplant (Table LU 5).

The primary goal of US lung allocation policy is to ensure that candidates with the highest risk for mortality receive appropriate access to lung transplant. The Organ Procurement and Transplantation Network (OPTN) monitors the status of transplant candidates and recipients and adjusts the system to meet this key objective. Candidates aged 12 years or older access lung transplant based on calculated lung allocation score (LAS), age, geography, and blood type (ABO) compatibility, and, if necessary, waiting time. Candidates aged younger than 12 years access transplant based on illness-based priority status, age, geography, blood type (ABO) compatibility, and waiting time.

The LAS considers waitlist mortality and posttransplant survival in its calculation, with more weight given to waitlist mortality to allow candidates at the highest risk of mortality increased access to transplant. Posttransplant survival is included in the model to minimize allocation of lungs to candidates with poor likelihood of posttransplant survival. In calculating the LAS, pulmonary diseases are categorized into four main groups based on similar survival probability and disease pathophysiology. These are group A, obstructive lung disease; group B, pulmonary vascular disease; group C, cystic fibrosis and immunodeficiency disorders; and group D, restrictive lung disease.

The LAS was implemented in 2005, resulting in candidates who were older and/or sicker being listed for transplant and ultimately undergoing transplant. The LAS was most recently updated in February 2015 with an updated cohort and new variables to more accurately reflect disease severity for the entire transplant population, and in particular group B candidates. Due to the changes in LAS calculation, scores prior to 2015 may not be directly comparable to those after. In March 2017, OPTN implemented a policy to improve transplant access for the pediatric population, with broader geographic sharing of organs for child (age 0-11 years) and adolescent (age 12-17 years) candidates. Additionally, adolescents and adults receive equal preference for adult donor lungs in the LAS system. Finally, in November 2017, a policy was implemented to eliminate donation service area as the first unit of allocation for donor lungs in favor of a more uniform 250-nautical-mile circle from the donor hospital. This policy has now been in effect for 1 year, and some of its impact is reflected in this year's data report.

In this report, all lung transplant candidates and recipients aged 12 years or older are included under Adult Lung Transplant, and those aged 0-11 years are included under Lung Transplant in Children. Heart-lung patients are included in all tabulations.

1.2 Waiting list

1.3 Characteristics of US candidates waiting for a lung transplant

In 2018, 3134 candidates were added to the lung transplant waiting list, reflecting an 8.0% increase from 2017 (Figure LU 1), and a 42.2% increase over the past decade. Mostly keeping pace with the increasing demand, the number of lung transplants being performed continued to increase annually (Figure LU 46), although the number of candidates remaining on the waiting list at the end of 2018 increased for the first time since the end of 2014 (Figure LU 2).

The proportion of candidates aged 65 years or older continued to increase, comprising 32.0% of the waiting list in 2018 (Figure LU 3). Men outnumbered women and made up 52.7% of the waiting list (Figure LU 4). The percentage of white candidates decreased from 81.9% in 2013 to 75.9% in 2018 (Figure LU 5). The composition of the waiting list continued to change, with an increasing proportion of group D candidates and a decreasing proportion of group A candidates (Figure LU 6). Smaller changes occurred for groups B and C, but the waiting list included a larger proportion of group B candidates and a smaller proportion of group C candidates over the past 5 years. Candidates with type O blood comprised 49.2% of the waiting list, followed by types A, 36.1%; B, 11.1%; and AB, 3.7% (Figure LU 10). The percentage of candidates with lower LAS values at listing continued to decrease; 35.1% of candidates had a LAS of less than 35 at the time of listing, and the proportion of sicker candidates with of LAS 50 or higher continued to increase (Figure LU 8). In 2018, proportions of candidates by LAS values were: <30, 0.4%; 30-<35, 34.7%; 35-<40, 28.7%; 40-<50, 19.0%; and 50-100, 17.1% (Figure LU 8).

1.3.1 Outcome of US candidates listed for lung transplant

Overall lung transplant rates increased from 87.1 per 100 waitlist years in 2009 to 172.3 in 2018 (Figure LU 13). Transplant rates decreased for adolescents aged 12-17 years, although rates fluctuated widely in this age group due to the small number of candidates. From 2017 to 2018, transplant rates decreased slightly for candidates aged older than 50 years, remained similar for those aged 18-34 years, and increased for those aged 35-49 years (Figure LU 11). Candidate time on the waiting list remained stable in 2018; 53.4% of candidates had been listed for less than 90 days (Figure LU 7). The overall median time to transplant was 2.5 months, a decrease of 1.5 months compared with 2013 (Figure LU 19). Waiting time differed by diagnosis group, and was shortest for group D, 1.8 months; followed by group C, 2.7 months; group B, 2.8 months; and group A, 4.6 months (Figure LU 19). The greatest change occurred

in group B, with a 41.3% improved waiting time over the past year, likely due to the 2015 LAS revision. As expected, time to transplant was related to LAS values, and was shortest for those with the highest LAS (Figure LU 20). However, waiting times have converged with time, with a 4-month difference in median waiting time between candidates with LAS below 35 and 50-100, due to the increasing transplant rates, allowing lower-LAS candidates to access transplant more readily (Figure LU 20).

Transplant rates differed by age, diagnosis, height, and blood type. By age, rates were highest for candidates aged 65 years or older, 220.1 transplants per 100 waitlist-years (Figure LU 11). By diagnosis, rates were highest for group D, 238.4 transplants per 100 waitlist-years, followed by groups C (205.6), A (109.1), and B (103.5) (Figure LU 13). By height, rates were highest for the tallest candidates, 302.4 transplants per 100 waitlist-years, and lowest for the shortest candidates, 102.7 (Figure LU 15). By blood type, rates were highest for candidates with type AB, 259.3 transplants per 100 waitlist-years, and lowest for candidates with type O, 152.1 (Figure LU 14). Generally, transplant rates did not differ based on distance between candidate residence and transplant program (Figure LU 17). Over the past 5 years, transplant rates for residents of metropolitan regions slowly outpaced rates for residents of non-metropolitan regions (Figure LU 16). Percentages of candidates who underwent lung transplant within one year of listing differed widely by state, from 33.3% to 100% (Figure LU 23).

Waitlist mortality rates generally continued to decrease but varied by age, diagnosis group, LAS, blood type, and sex. By age, waitlist mortality was highest for adolescents, 28.4 deaths per 100 waitlist-years, followed by ages 65 years or older (26.0), 35-49 years (18.2) 50-64 years (17.5), and 18-34 years (14.4) (Figure LU 24). By diagnosis, waitlist mortality was highest for group-D candidates, 29.7 deaths per 100 waitlist-years, and lowest for group-A candidates, 9.4 (Figure LU 27). By blood type, waitlist mortality was higher for candidates with type AB (Figure LU 29). By LAS, waitlist mortality was substantially higher for candidates with an LAS of 50 or higher (121.8 deaths per 100 waitlist-years), and ranged from 6.6 for candidates with LAS 30-<35 to 28.7 for candidates with LAS 40-<50 (Figure LU 28). Waitlist mortality was higher for men in this unadjusted analysis (Figure LU 26). Of candidates removed from the waiting list, 22.6% died within 6 months, but this varied by age and LAS (Figure LU 35, Figure LU 36).

Pretransplant use of extra-corporeal membrane oxygenation (ECMO) and mechanical ventilation continued, with 8% of candidates bridged using one or both of these modalities, although this population has decreased from 9.6% in 2013 (Table LU 7). A quarter of candidates were hospitalized prior to transplant, and 13.6% required an intensive care unit stay (Table LU 7).

1.4 Donors

Of 2407 deceased lung donors in 2018, 1.3% were aged younger than 12 years, 6.9% 12-17 years, 46.2% 18-34 years, 26.7% 35-49 years, and 18.9% 50 years or older (Figure LU 38); 39.2% of donors were female (Figure LU 39), 18.2% black, and 15.5% Hispanic (Figure LU 40). Discard rates differed by donor age; discard rates were highest for donors aged 35 years or older, but did not meaningfully differ between increased risk and standard infectious risk donors (Figure LU 42, Figure LU 43). The proportion of donors with a smoking history of 20 pack-years or longer decreased slightly over time and was 7.9% in 2018 (Figure LU 44). Use of organs from donation after circulatory death donors increased over the past 5 years, 4.8% in 2018 compared with 1.8% in 2013 (Table LU 8). The percentage of donors with anoxia as a cause of death increased over time from 10.8% in 2007 to 32.8% in 2018 (Figure LU 45). Head trauma and stroke continued to decline as causes of death among deceased lung donors.

1.5 Transplant

1.5.1 Characteristics of US lung transplant recipients

In 2018, 2562 lung transplants were performed, 75% bilateral (Figure LU 46); 97.4% were first lung transplants and only 2.6% were re-transplants (Table LU 8). Recipients aged 65 years or older underwent 886 transplants; 18-64 years, 1636 transplants; and younger than 18 years, 40 transplants (Figure LU 47). Men continued to undergo more transplants than women, and most recipients were of white race (Figure LU 48, Figure LU 49). Group D recipients underwent 60.0% of transplants, group A 23.8%, group C 10.3%, and group B 5.9% (Table LU 7). The median LAS at transplant was 42.3, an increase of two points from the previous year (Figure LU 53); LAS distribution was: 21.9%, <35; 21.3%, 35-<40; 23.0%, 40-<50; 10.3%, 50-<60; and 23.4%, 60-100 (Table LU 7). Notably, median LAS at transplant differed by primary diagnosis, and was highest for recipients in group B (49.0) and lowest for those in group A (33.6) (Figure LU 54).

In 2018, 67 programs in the US performed lung transplants in adults; a median of 27 transplants were performed at a program (Figure LU 59). Programs in the 25th percentile performed 2-17 transplants per year, and those in the 75th percentile 28-50 (Figure LU 59). The annual transplant volume for programs in the 95th percentile was 104, a value that ranged from 87 to 104 over the past 5 years (Figure LU 59); three programs accounted for nearly 20% of total volume of lung transplants performed in the US (Figure LU 60). Most lung transplants in the US were performed at programs performing 41-100 transplants per year (49.0%), followed by those performing 11-40 (30.5%), more than 100 (18.9%), and 1-10 (1.6%) (Figure LU 60).

In 2018, most transplant recipients lived in metropolitan regions, and only 15.2% in non-metropolitan regions (Table LU 6). Most recipients lived near their transplant programs, 51.3% within less than 50 miles and 16.7% within

50 to less than 100 miles (Table LU 6). The proportion of recipients with private insurance declined to 41.0%, compared with 50.6% in 2013, with a corresponding increase in the proportion with public insurance, likely due to increasing age of the lung transplant population (Table LU 6).

1.5.2 Outcomes of US lung transplant recipients

In 2018, over 15,000 individuals were living with a lung transplant, 426 who underwent transplant at age 17 or younger, 14,585 who underwent transplant as adults (Figure LU 70). Survival improved slightly at all time-points; 89.4% of recipients survived to 1 year, 73.5% to 3 years, and 59.4% to 5 years (Figure LU 69). Induction agents were used commonly; 68.9% of recipients received an IL-2 receptor antagonist and 9.1% T-cell depleting agents (Figure LU 56). Rates of acute rejection were only slightly lower (15.7%-15.9%) in recipients who received induction than in those who did not (18.0%) (Figure LU 72), and choice of induction did not seem to make a difference in incidence of rejection. Tacrolimus, mycophenolate, and steroids remained the most common immunosuppression regimen, used in 85.5% of transplant recipients (Figure LU 57). Half of recipients received a matched serology donor for cytomegalovirus (CMV) and 82.2% for Epstein Barr virus (EBV) (Table LU 9).

Infection and cardiovascular and cerebrovascular causes remained common causes of death in the first year posttransplant (Figure LU 75), with infection the most prevalent, and graft failure predominating by 3 years posttransplant (Figure LU 76). Programs reported development of bronchiolitis obliterans syndrome in 6.4% of recipients by 1 year and in 41.8% by 5 years (Table LU 10). Malignancy remained a common complication; 23.7% of recipients were diagnosed with malignancy by 5 years posttransplant (Table LU 10). Chronic kidney disease affected 12.9% of recipients by 5 years, with 2.7% requiring dialysis, but only 20 individuals underwent renal transplant within 5 years of lung transplant (Table LU 10). Despite these complications, nearly 81.4% of recipients were at normal functional status and did not require assistance to complete activities of daily living.

2 Lung transplant in children

2.1 Waiting list

In 2018, 24 new child (ages 0-11 years) candidates were added to the lung transplant waiting list; one was inactive at the time of listing (Figure LU 77). The number of prevalent child candidates (i.e., on the waiting list on December 31 of a given year) steadily decreased from a peak of 107 in 2007 to 22 in 2018 (Figure LU 78). The largest age group of child candidates on the waiting list in 2018 was 6-11 years; these candidates made up 65.0%, followed by candidates aged 1-5 years, 22.5%, and younger than 1 year, 12.5% (Figure LU 79). Most child lung transplant candidates were white (57.5%), followed by

Hispanic (20.0%), other or unknown race (12.5%), and black (10.0%) (Figure LU 80).

Of 27 candidates removed from the waiting list in 2018, 16 (59.3%) were removed due to undergoing transplant, six (22.2%) due to death, one (3.7%) due to improved condition, and one (3.7%) due to becoming too sick to undergo transplant (Table LU 14, Table LU 15). Regarding 3-year outcomes for child lung transplant candidates listed in 2015, 73.9% underwent deceased donor transplant, 8.7% died waiting, 13.0% were removed from the list for reasons other than transplant or death, and 4.4% were still waiting (Figure LU 83). The overall child lung transplant rate rose dramatically in 2013 and has remained steady since, with a rate of 68.3 per 100 waitlist-years in 2018 (Figure LU 84). In general, pretransplant mortality has increased over the decade; the rate was 31.1 deaths per 100 waitlist-years among candidates aged 0-11 years in 2017-2018, compared with 11.7 in 2007-2008 (Figure LU 86).

2.2 Transplant

In 2018, a total of 15 lung transplants were performed in recipients aged 0-11 years, three in recipients aged younger than 1 year, two in recipients aged 1-5 years, and ten in recipients aged 6-11 years (Figure LU 88). In 2018, seven programs were characterized as pediatric, compared with 55 adult-only programs (Figure LU 89). Cystic fibrosis and pulmonary hypertension were the leading known causes of disease, but almost 50% of causes were identified as other or unknown (Table LU 17). Half of child lung transplant recipients in 2016-2018 were not hospitalized at the time of transplant, with 77.3% as priority 1. Ventilator support and ECMO use remained stable over the past decade. In 2016-2018, lung-only transplants increased to 93.2% from 82.3% in 2006-2008 (Table LU 18).

2.2.1 Pediatric Immunosuppression and Outcomes

Induction therapy has changed over time, with increased use of T-cell-depleting agents to 60.0% of patients in 2017-2018 and continued decreased use of interleukin-2 receptor antagonists to 30.0% (Figure LU 90). The most common initial immunosuppression agent regimen was tacrolimus, mycophenolate, and steroids, used in 92.9% of child recipients (Figure LU 91). The incidence of posttransplant lymphoproliferative disorder among EBV-negative recipients who underwent transplant in 2006-2016 was 5.7% at 5 years posttransplant, compared with 1.1% among EBV-positive recipients (Figure LU 93). Incidence of death was 17.2% at 6 months and 24.1% at 1 year for transplants in 2016-2017, 41.7% at 3 years for transplants in 2014-2015, 33.3% at 5 years for transplants in 2012-2013, and 45.7% at 10 years for transplants in 2008-2009 (Figure LU 94). For children who underwent transplant in 2006-2013, overall 1-, 3-, and 5-year patient survival was 85.0%, 68.8%, and 60.6%, respectively (Figure LU 95). By age, patient survival rates were highest for recipients

aged 6-11 years at all time-points. Among children, cystic fibrosis was associated with higher survival rates than pulmonary hypertension or other diagnoses (Figure LU 96). Leading causes of death at 1 year posttransplant were respiratory- and infection-related, and at 5 years graft failure and respiratory-related (Figure LU 97, Figure LU 98). The incidence of acute rejection among child lung transplant recipients in 2012-2017 was 7.1%.

Among child lung transplant recipients in 2016-2018, the combination of a CMV-positive donor and CMV-negative recipient occurred in 27.3% of transplants; this combination for EBV occurred in 43.2% of transplants (Table LU 19).

Complication rates in child lung transplant recipients increased with time posttransplant, including bronchiolitis obliterans syndrome (4.1% at 1 year and 26.0% at 5 years) (Table LU 20). For most surviving child lung transplant recipients (94.0%), functional status was reported as fully active at 5 years posttransplant.

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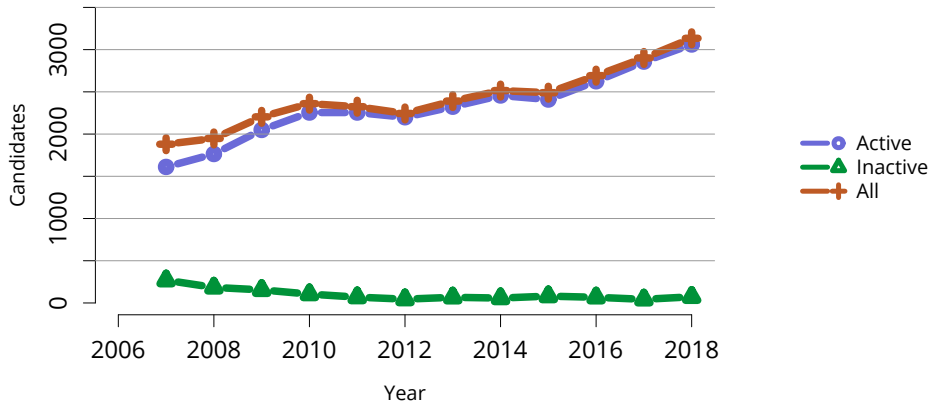

Figure LU 1. New candidates aged 12 years or older added to the lung transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates concurrently listed at multiple centers are counted once. Active and inactive patients are included.

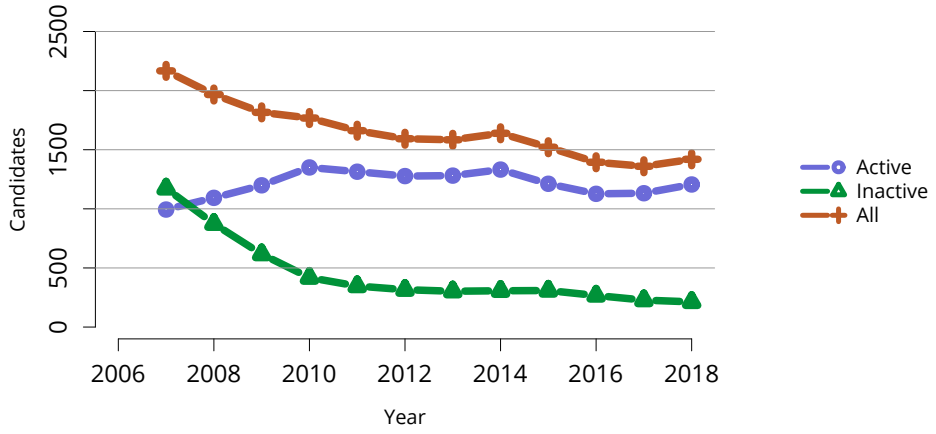

Figure LU 2. Candidates aged 12 years or older listed for lung transplant on December 31 of each year. Candidates concurrently listed at multiple centers are counted once. Those with concurrent listings and active at any program are considered active.

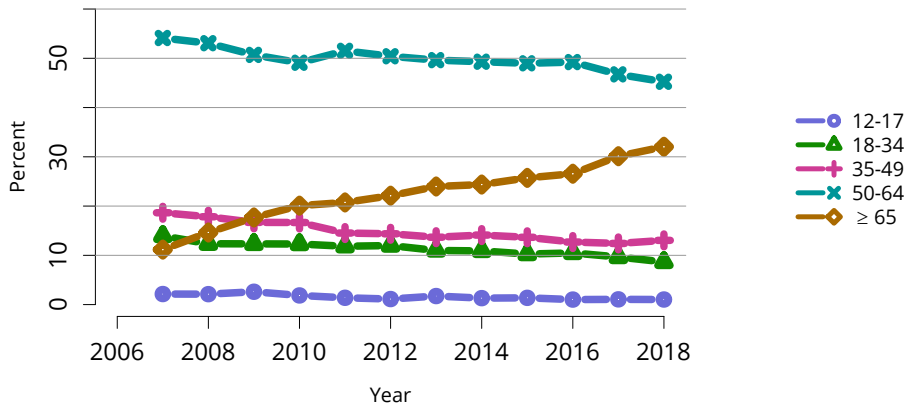

Figure LU 3. Distribution of candidates aged 12 years or older actively waiting for lung transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Age is determined at the later of listing date or January 1 of the given year. Only candidates who were active for at least 1 day are included.

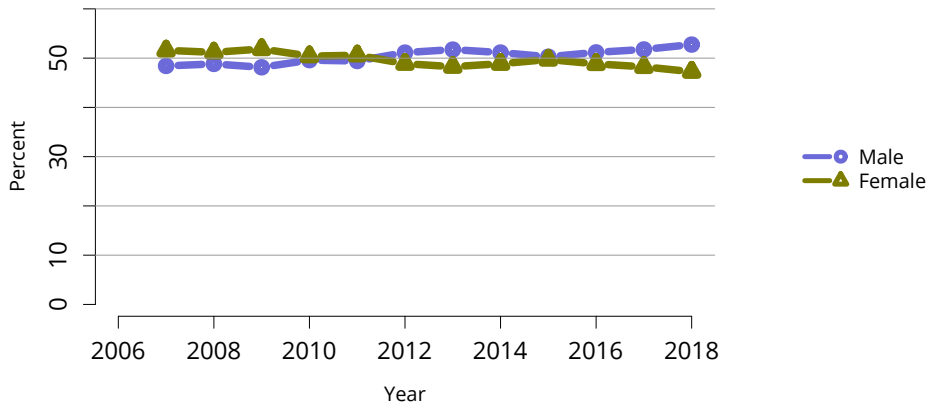

Figure LU 4. Distribution of candidates aged 12 years or older actively waiting for lung transplant by sex. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included.

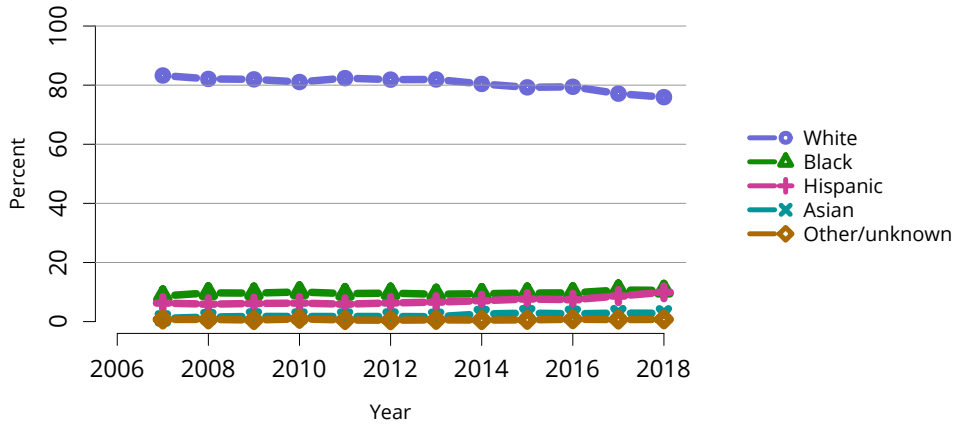

Figure LU 5. Distribution of candidates aged 12 years or older actively waiting for lung transplant by race. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Only candidates who were active for at least 1 day are included.

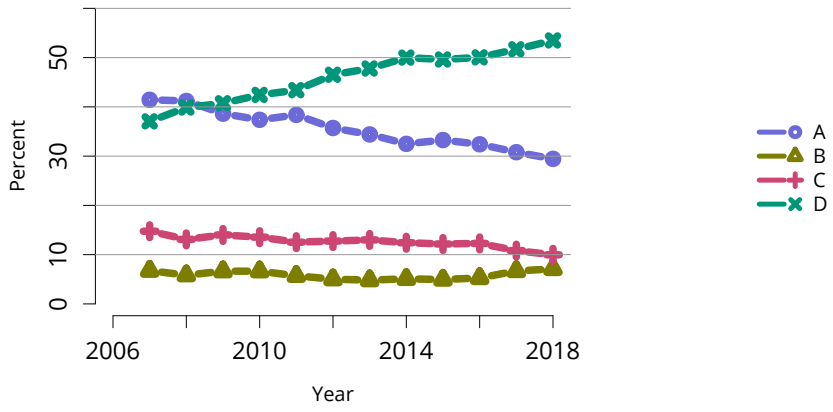

Figure LU 6. Distribution of candidates aged 12 years or older actively waiting for lung transplant by diagnosis group. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Only candidates who were active for at least 1 day are included.

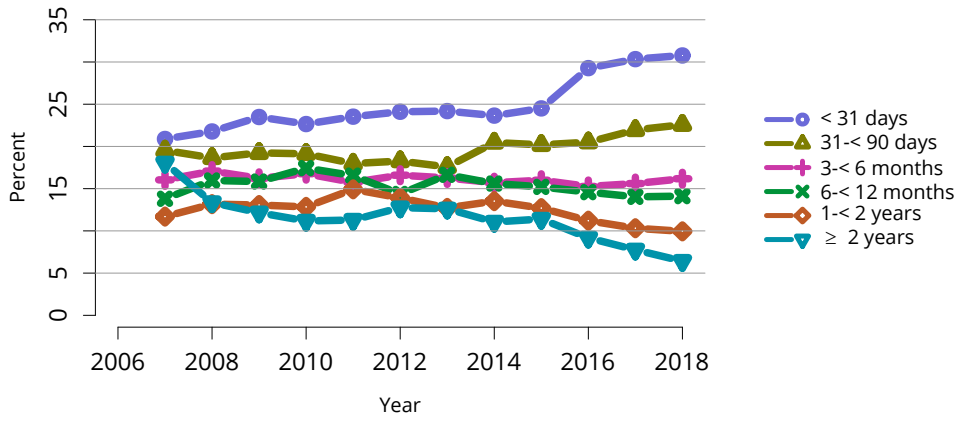

Figure LU 7. Distribution of candidates aged 12 years or older actively waiting for lung transplant by waiting time. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Time on the waiting list is determined at the earlier of December 31 or removal from the waiting list. Only candidates who were active for at least 1 day are included.

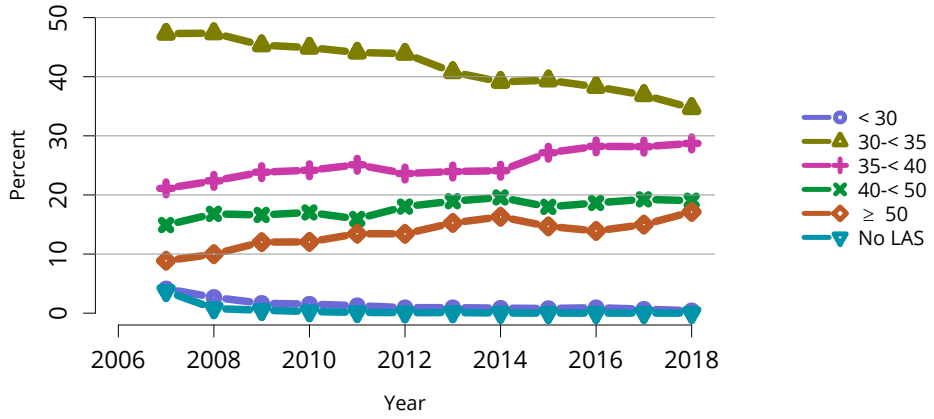

Figure LU 8. Distribution of candidates aged 12 years or older actively waiting for lung transplant by LAS at listing. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Only candidates who were active for at least 1 day are included. LAS, lung allocation score.

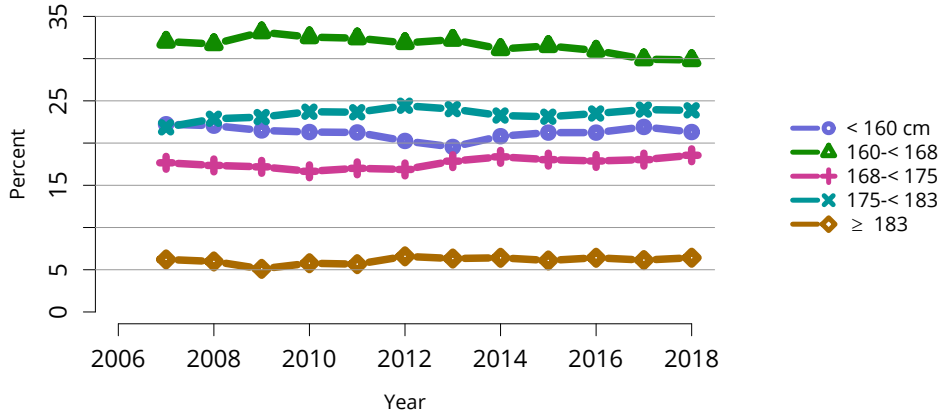

Figure LU 9. Distribution of candidates aged 12 years or older actively waiting for lung transplant by height. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Only candidates who were active for at least 1 day are included.

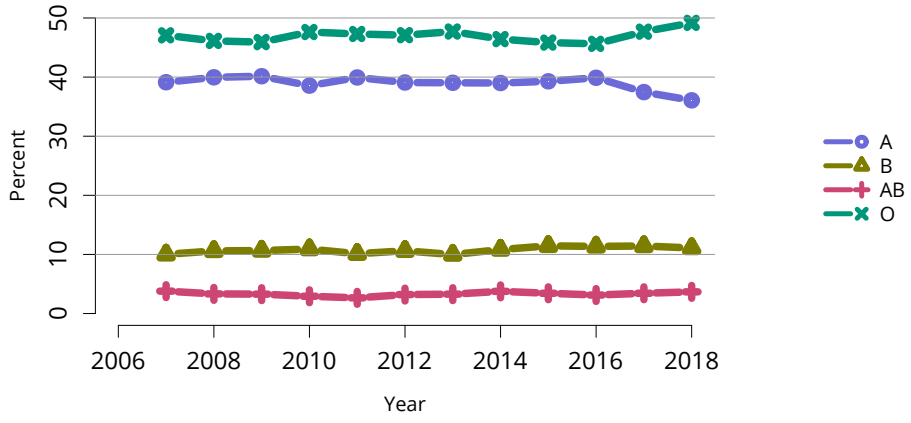

Figure LU 10. Distribution of candidates aged 12 years or older actively waiting for lung transplant by blood type. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Only candidates who were active for at least 1 day are included.

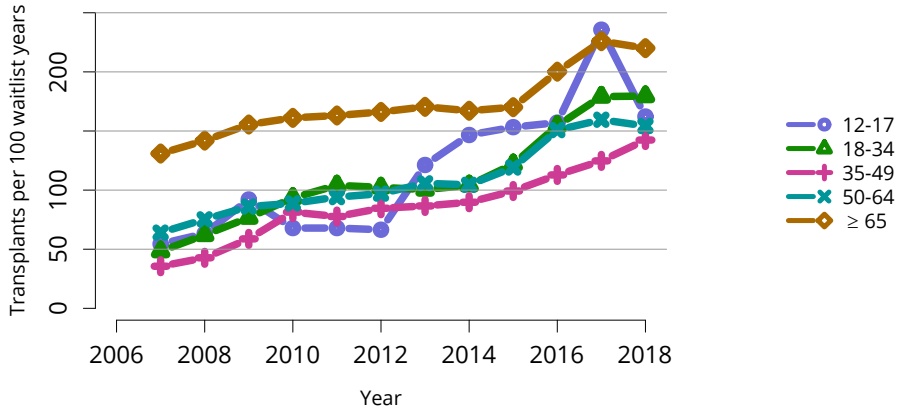

Figure LU 11. Deceased donor lung transplant rates among waitlist candidates aged 12 years or older by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

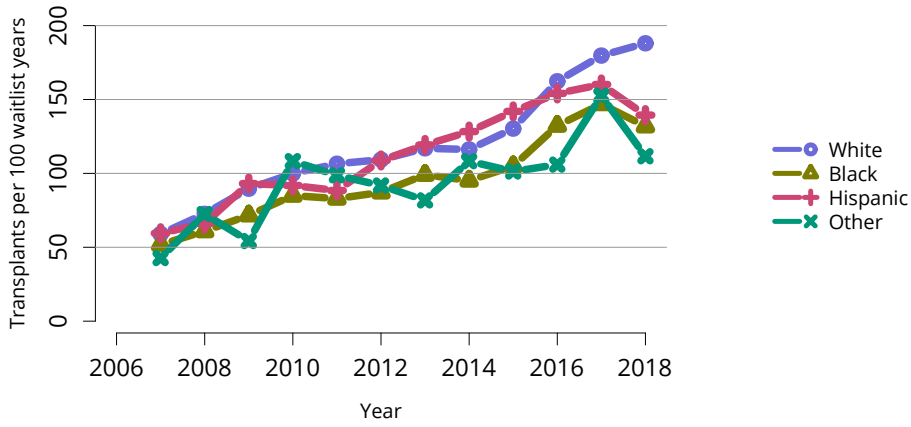

Figure LU 12. Deceased donor lung transplant rates among waitlist candidates aged 12 years or older by race. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Rates with less than 10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

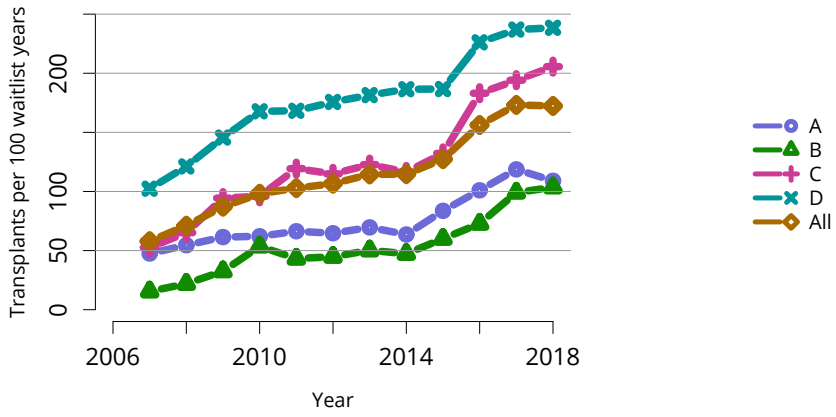

Figure LU 13. Deceased donor lung transplant rates among waitlist candidates aged 12 years or older by diagnosis group. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

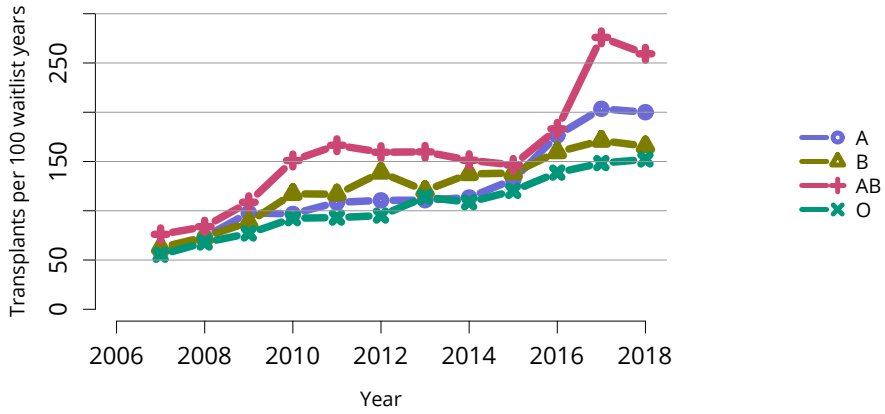

Figure LU 14. Deceased donor lung transplant rates among waitlist candidates aged 12 years or older by blood type. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

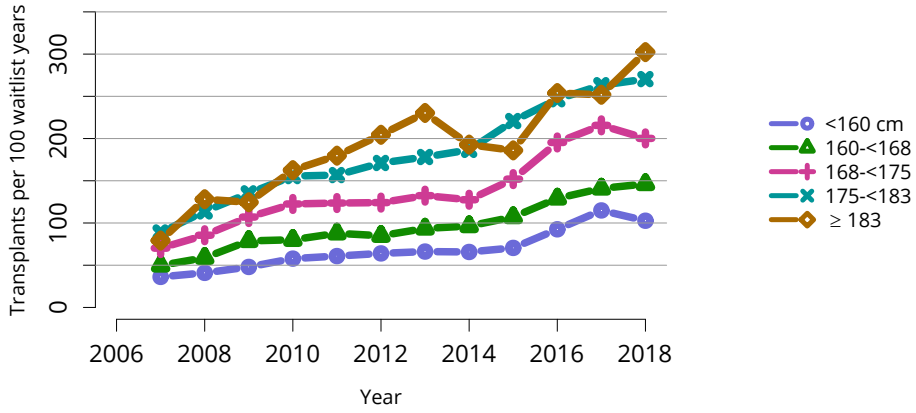

Figure LU 15. Deceased donor lung transplant rates among waitlist candidates aged 12 years or older by height. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

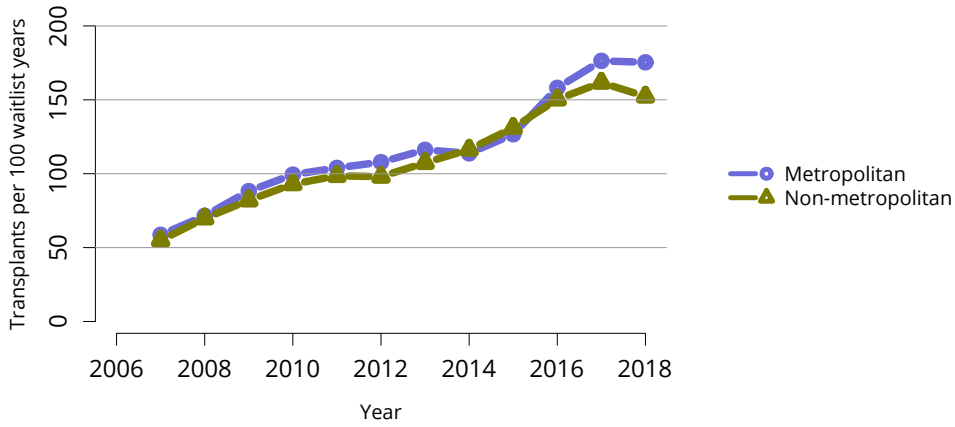

Figure LU 16. Deceased donor lung transplant rates among waitlist candidates aged 12 years or older by metropolitan vs. non-metropolitan residence. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Urban/rural determination is made using the RUCA (Rural-Urban Commuting Area) designation of the candidate's permanent zip code. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

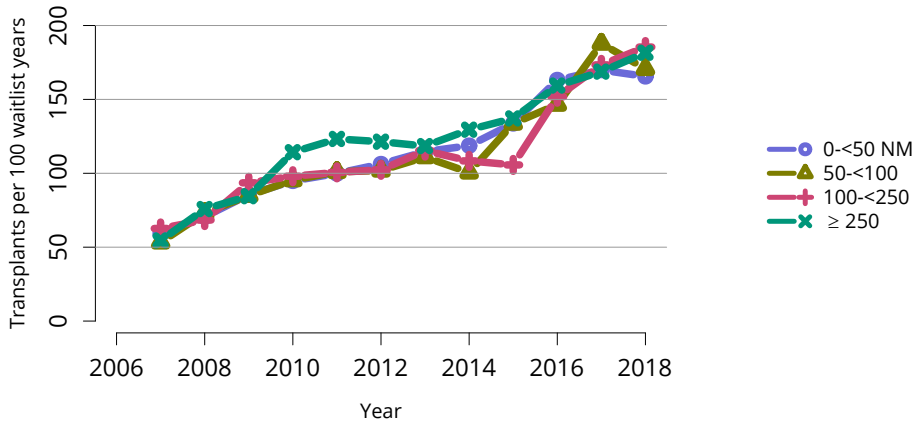

Figure LU 17. Deceased donor lung transplant rates among waitlist candidates aged 12 years or older by distance from listing center. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of wait time in a given year. Individual listings are counted separately. Distance is nautical miles (NM) between the zip code centroids of the candidate's listing center and candidate's permanent zip code. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

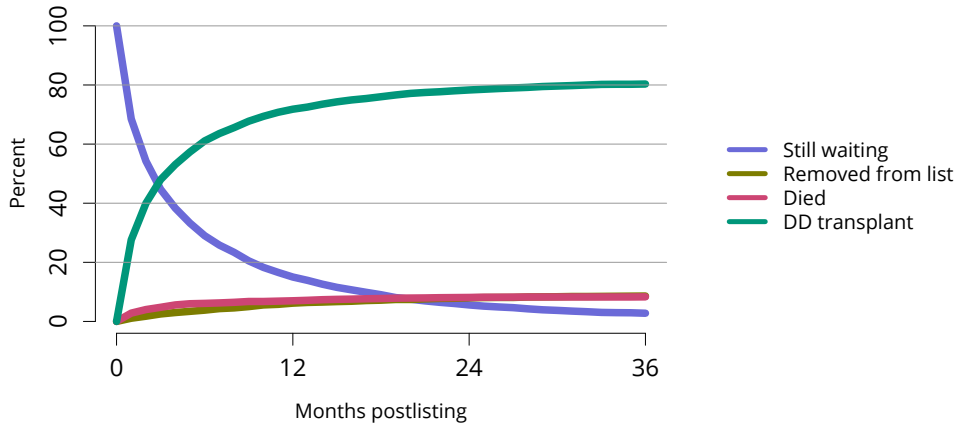

Figure LU 18. Three-year outcomes for candidates aged 12 years or older waiting for lung transplant, new listings in 2015. Candidates aged 12 years or older waiting for lung transplant and first listed in 2015. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. DD, deceased donor.

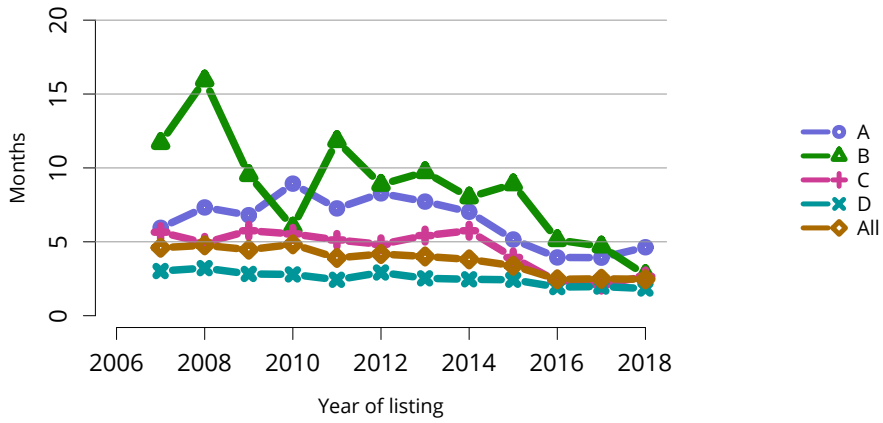

Figure LU 19. Median months to lung transplant for waitlisted candidates aged 12 years or older, by diagnosis group. Observations censored on December 31, 2018; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per candidate, not per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.

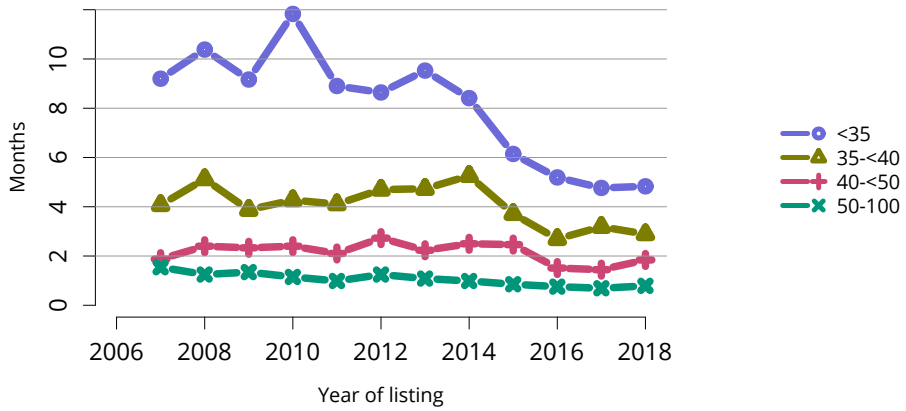

Figure LU 20. Median months to lung transplant for waitlisted candidates aged 12 years or older, by LAS at listing. Observations censored on December 31, 2018; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per candidate, not per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.

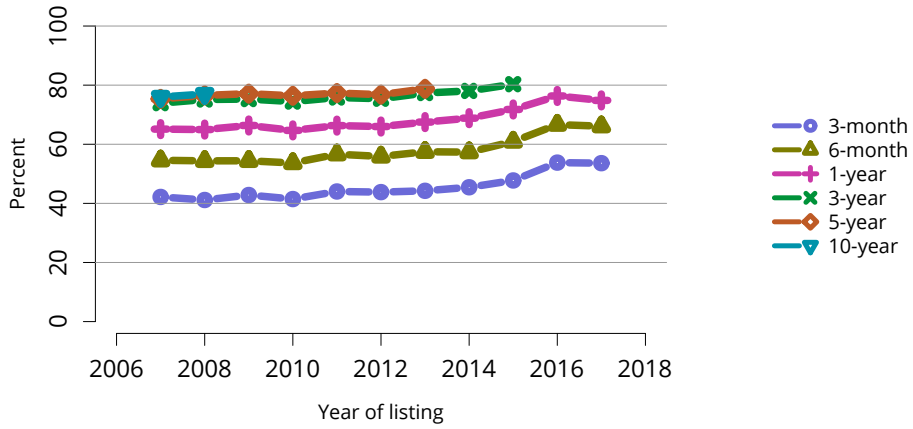

Figure LU 21. Percentage of candidates aged 12 years or older who underwent deceased donor lung transplant within a given time period of listing. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal.

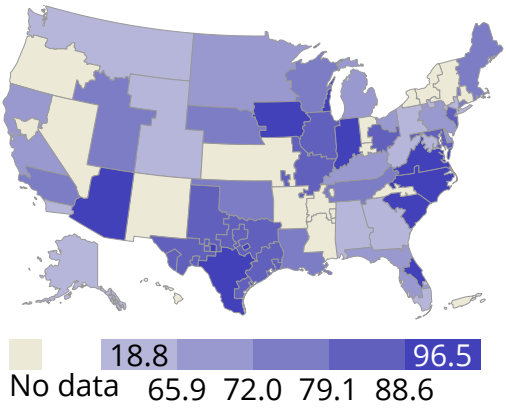

Figure LU 22. Percentage of candidates aged 12 years or older who underwent deceased donor lung transplant within 1 year of listing in 2017 by DSA. Candidates listed concurrently in a single DSA are counted once in that DSA, from the time of earliest listing to the time of latest removal; candidates listed in multiple DSAs are counted separately per DSA.

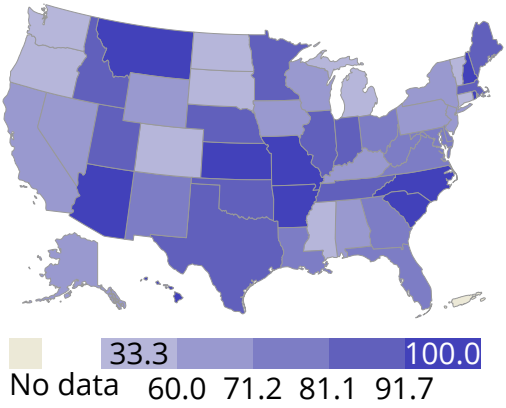

Figure LU 23. Percentage of candidates aged 12 years or older who underwent deceased donor lung transplant within 1 year of listing in 2017 by state. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal.

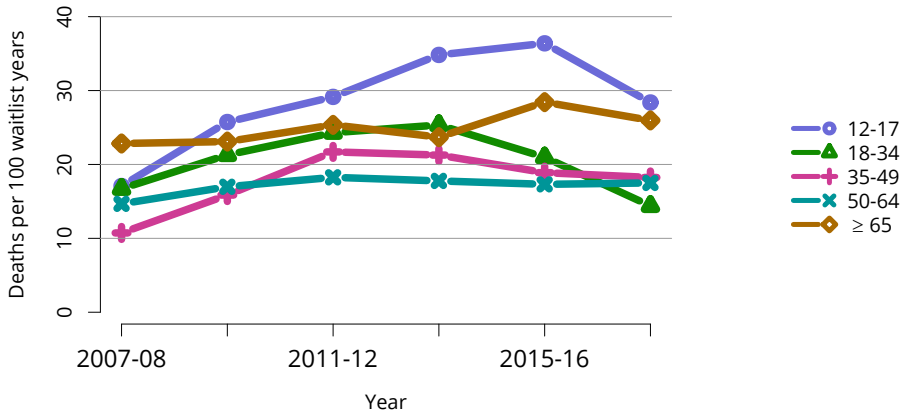

Figure LU 24. Pretransplant mortality rates among candidates aged 12 years or older waitlisted for lung transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Age is determined at the later of listing date or January 1 of the given year.

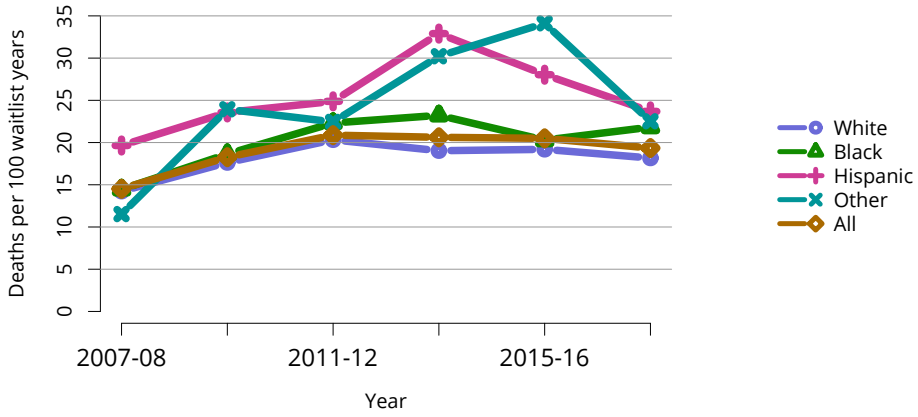

Figure LU 25. Pretransplant mortality rates among candidates aged 12 years or older waitlisted for lung transplant by race. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

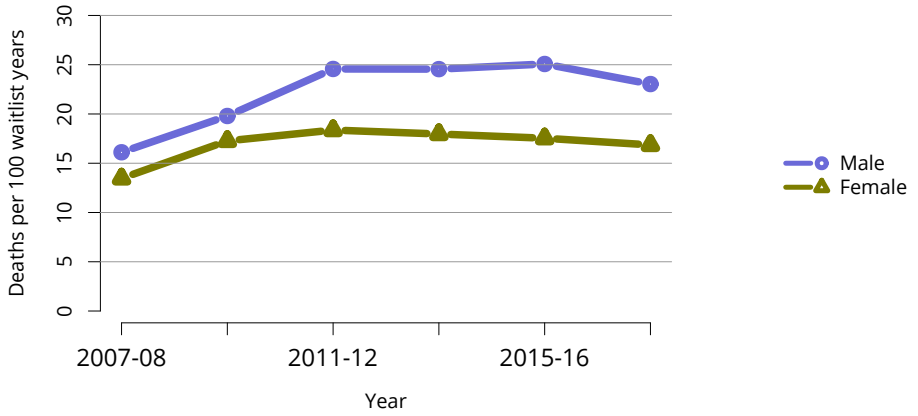

Figure LU 26. Pretransplant mortality rates among candidates aged 12 years or older waitlisted for lung transplant by sex. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

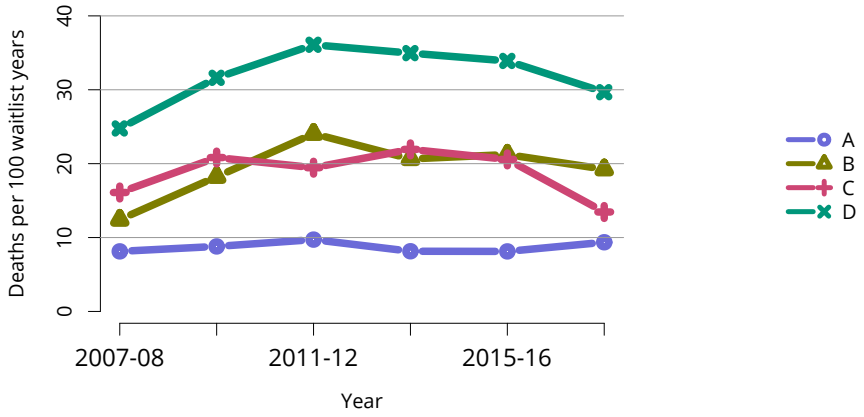

Figure LU 27. Pretransplant mortality rates among candidates aged 12 years or older waitlisted for lung transplant by diagnosis group. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

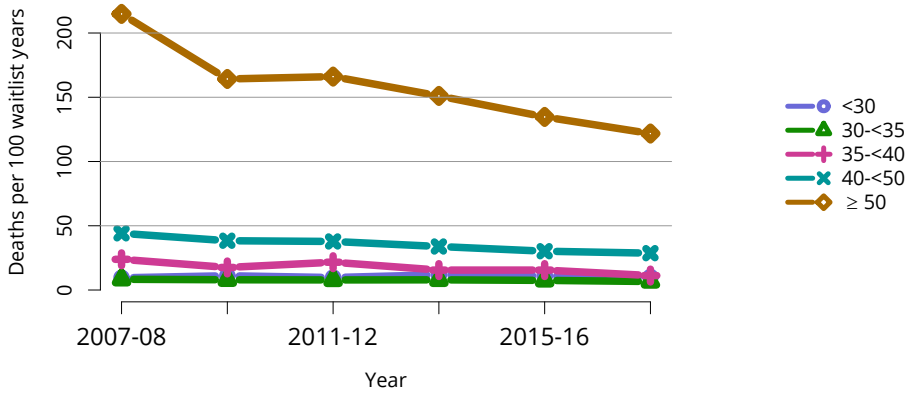

Figure LU 28. Pretransplant mortality rates among candidates aged 12 years or older waitlisted for lung transplant by LAS. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

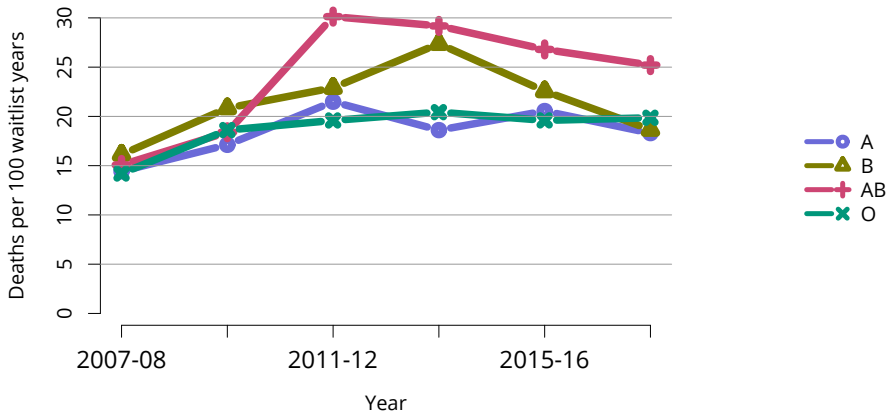

Figure LU 29. Pretransplant mortality rates among candidates aged 12 years or older waitlisted for lung transplant by blood type. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

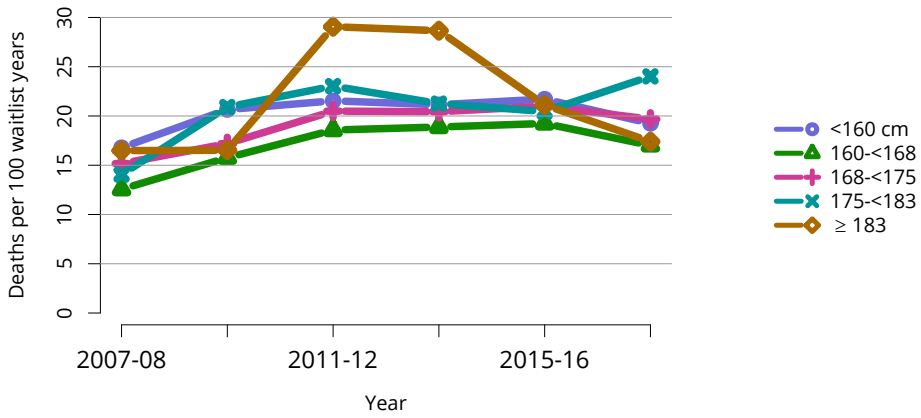

Figure LU 30. Pretransplant mortality rates among candidates aged 12 years or older waitlisted for lung transplant by height. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

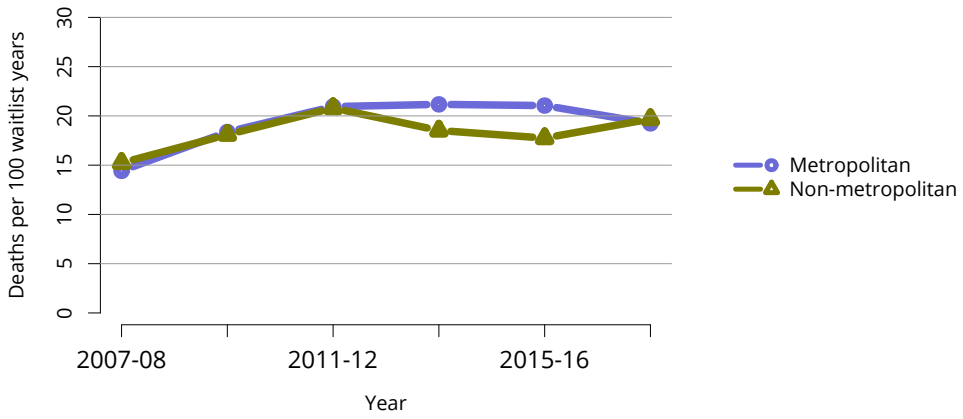

Figure LU 31. Pretransplant mortality rates among candidates aged 12 years or older waitlisted for lung transplant by metropolitan vs. non-metropolitan residence. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Urban/rural determination is made using the RUCA (Rural-Urban Commuting Area) designation of the candidate's permanent zip code.

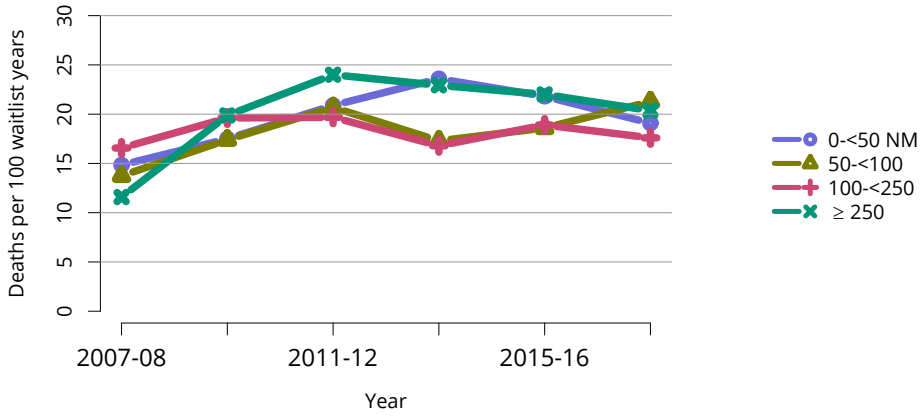

Figure LU 32. Pretransplant mortality rates among candidates aged 12 years or older waitlisted for lung transplant by distance from listing center. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Distance is nautical miles (NM) between the zip code centroids of the candidate's listing center and candidate's permanent zip code.

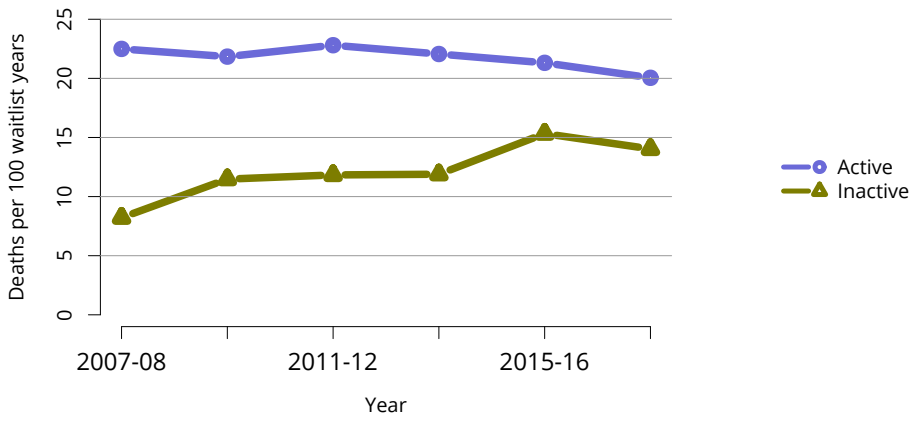

Figure LU 33. Pretransplant mortality rates among candidates aged 12 years or older waitlisted for lung, by active/inactive status. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Status (active/inactive) is assessed on the later of January 1 of the given year and listing date.

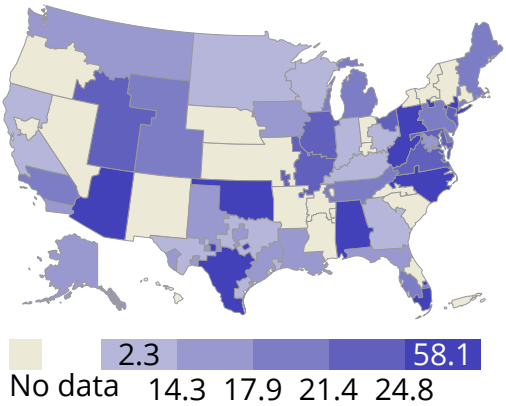

Figure LU 34. Pretransplant mortality rates among candidates aged 12 years or older waitlisted for lung transplant in 2016-2018, by DSA. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the DSA. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.

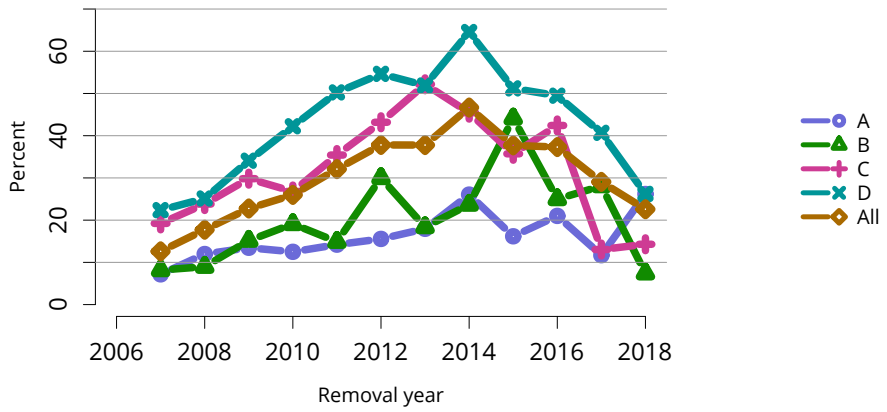

Figure LU 35. Deaths within six months after removal among lung waitlist candidates aged 12 years or older, by diagnosis. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

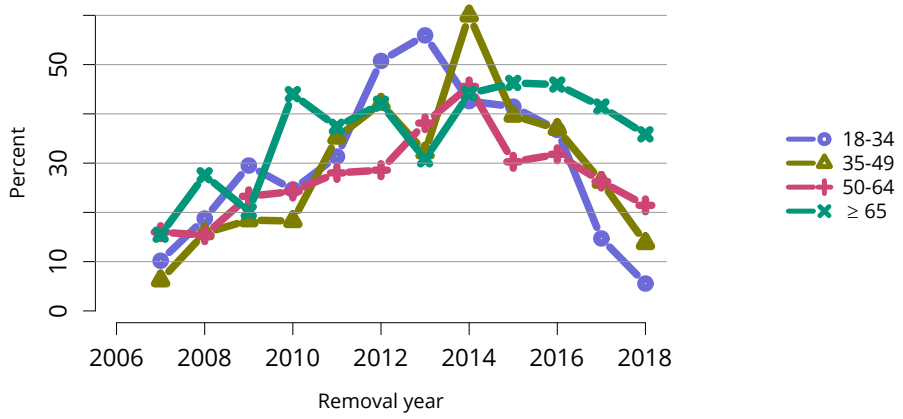

Figure LU 36. Deaths within six months after removal among lung waitlist candidates aged 12 years or older, by age at removal. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list. Data for candidates aged 12-17 years are not shown due to insufficient patient counts.

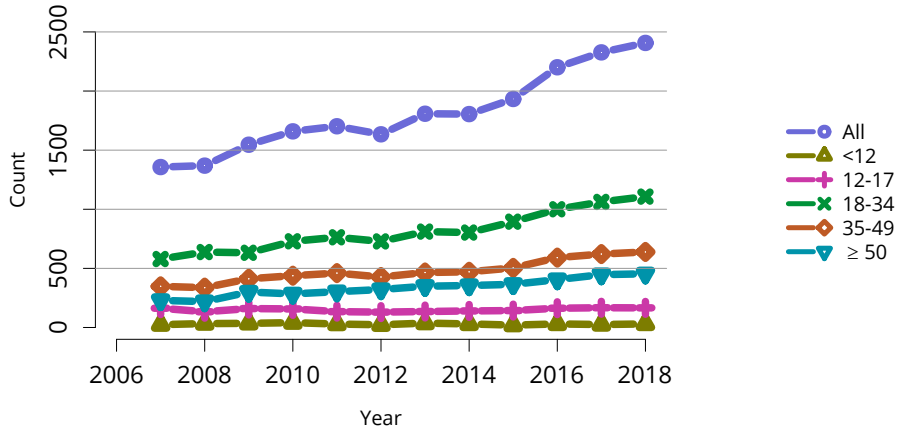

Figure LU 37. Deceased lung donor count by age. Count of deceased donors with at least one lung recovered for transplant, by age at donation. Donors are counted once, regardless of number of lungs recovered.

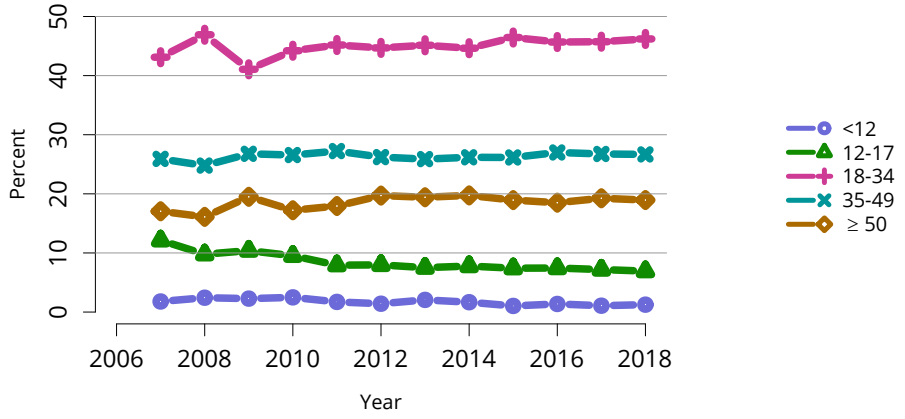

Figure LU 38. Distribution of deceased lung donors by age. Deceased donors with at least one lung recovered for transplant. Donors who donated more than one lung are counted once.

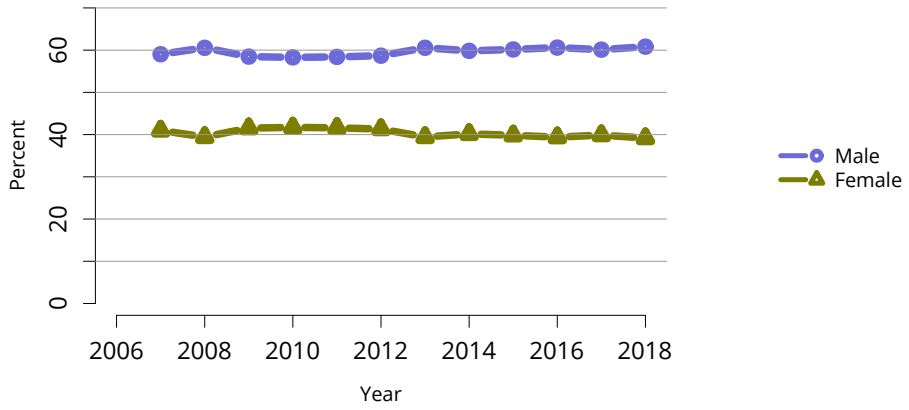

Figure LU 39. Distribution of deceased lung donors by sex. Deceased donors with at least one lung recovered for transplant. Donors who donated more than one lung are counted once.

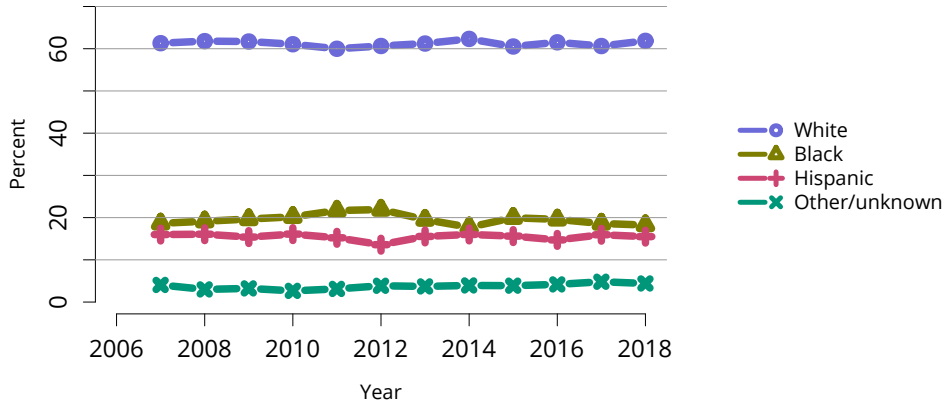

Figure LU 40. Distribution of deceased lung donors by race. Deceased donors with at least one lung recovered for transplant. Donors who donated more than one lung are counted once.

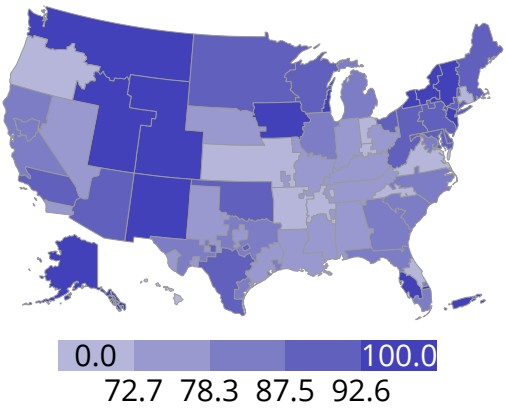

Figure LU 41. Percent of pediatric donor lungs allocated to adult recipients, by DSA of donor hospital, 2014-2018. Numerator: pediatric donor lungs donors allocated to adult recipients. Denominator: total pediatric donor lungs. When lungs are transplanted individually, we count them separately. When they are transplanted as a block, the are considered one lung.

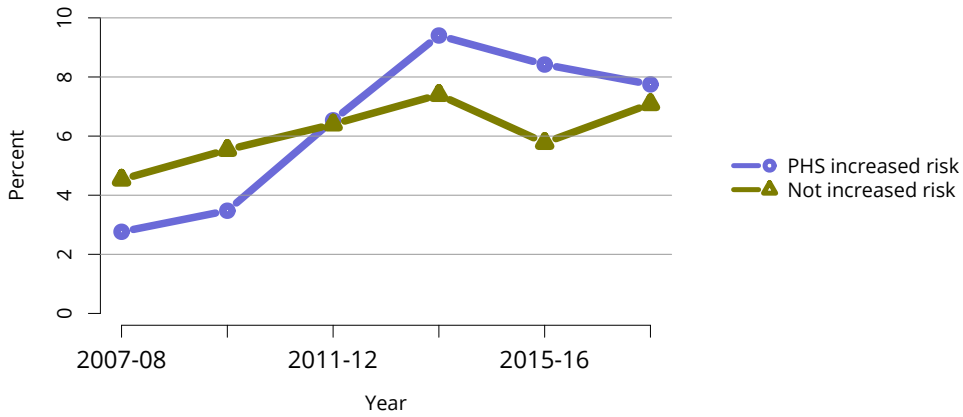

Figure LU 43. Rates of lungs recovered for transplant and not transplanted, by donor risk of disease transmission. "Increased risk" is defined by criteria from the US Public Health Service Guidelines for increased risk for HIV, hepatitis B and hepatitis C transmission.

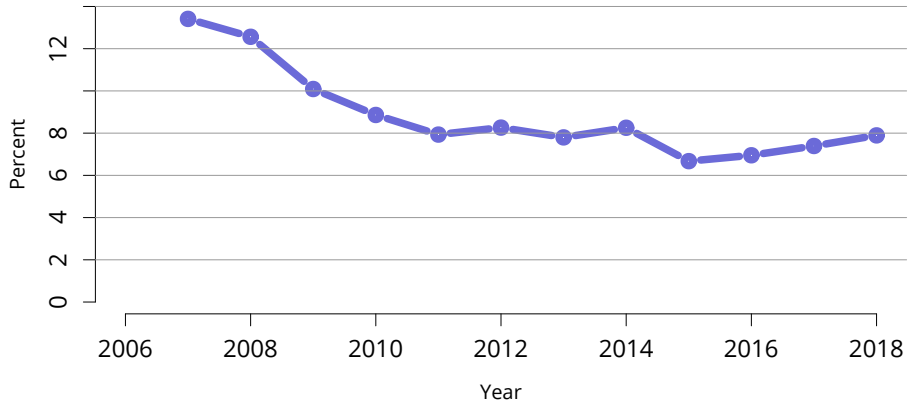

Figure LU 44. Lung donors with a smoking history of 20 pack-years or more. All deceased donors whose lungs were transplanted in the given year.

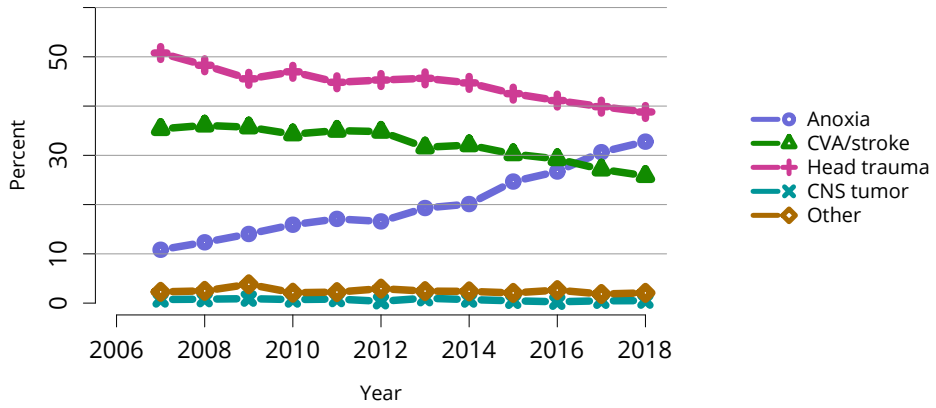

Figure LU 45. Cause of death among deceased lung donors. Deceased donors whose lungs were transplanted. Each donor is counted once. CNS, central nervous system; CVA, cerebrovascular accident.

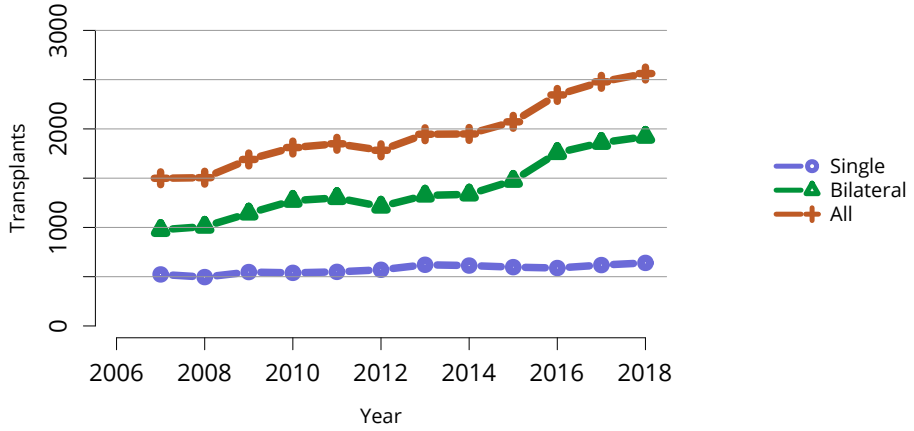

Figure LU 46. Total lung transplants. All lung transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

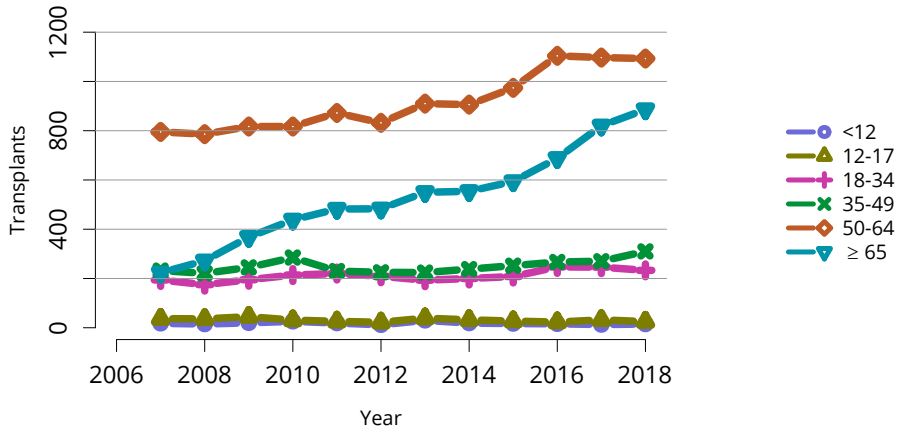

Figure LU 47. Total lung transplants by age. All lung transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

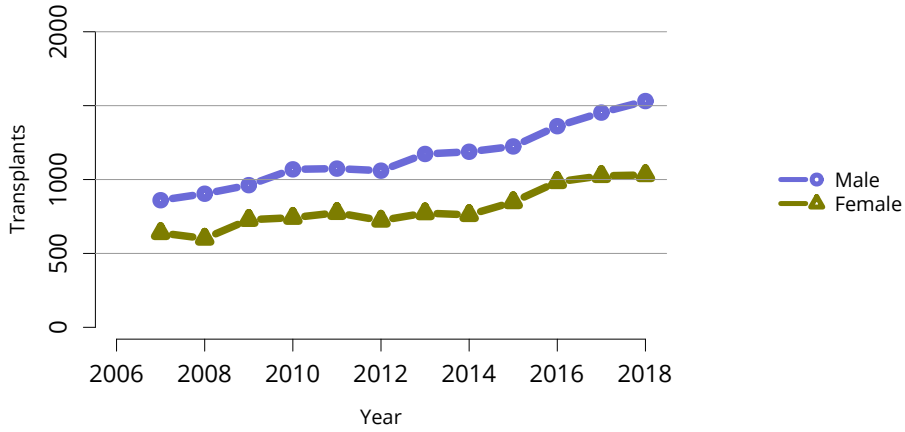

Figure LU 48. Total lung transplants by sex. All lung transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

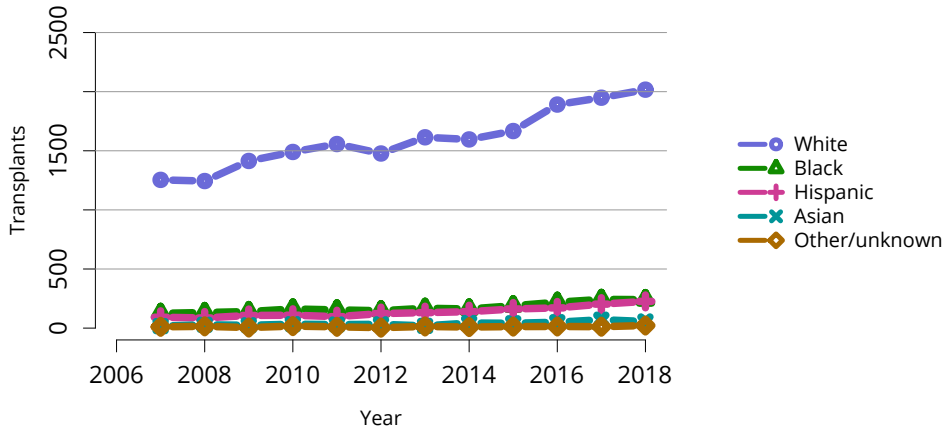

Figure LU 49. Total lung transplants by race. All lung transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

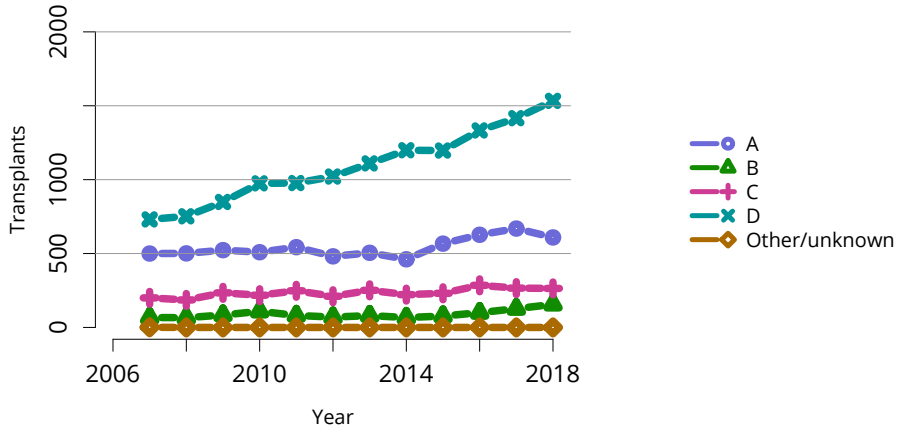

Figure LU 50. Total lung transplants by diagnosis group. All lung transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

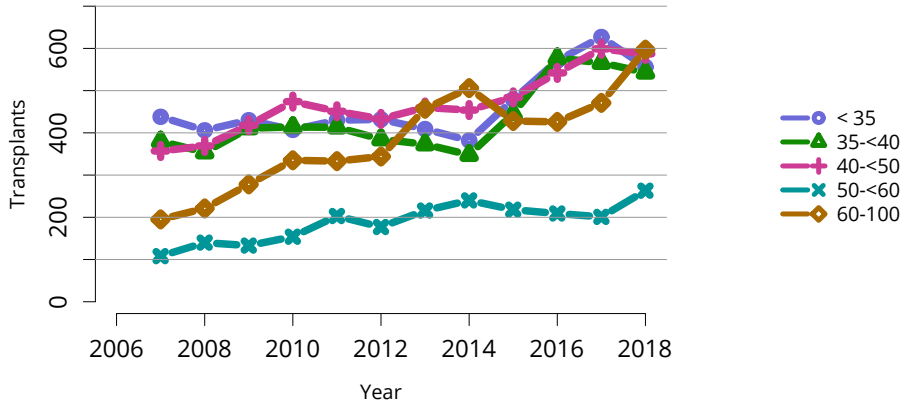

Figure LU 51. Total lung transplants by LAS. All lung transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

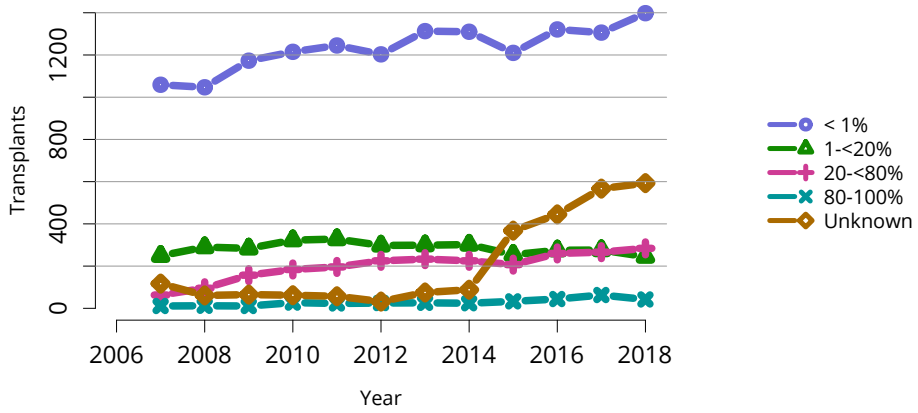

Figure LU 52. Total lung transplants by CPRA. All lung transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

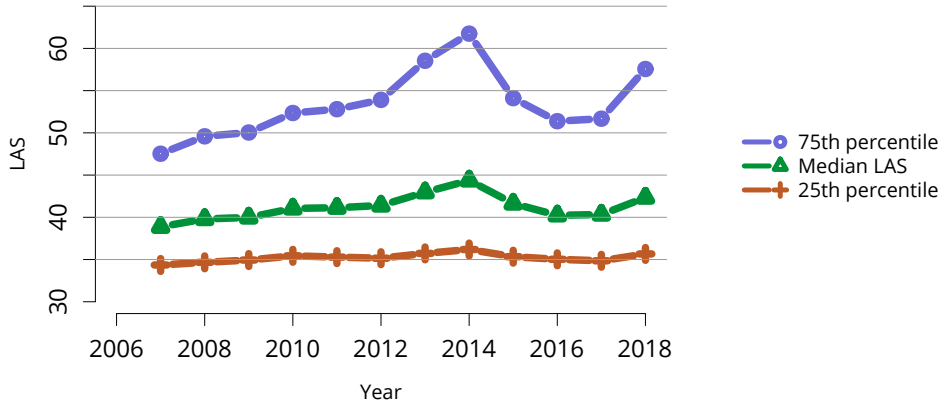

Figure LU 53. Median LAS at transplant. Recipients aged 12 years or older; last LAS before transplant.

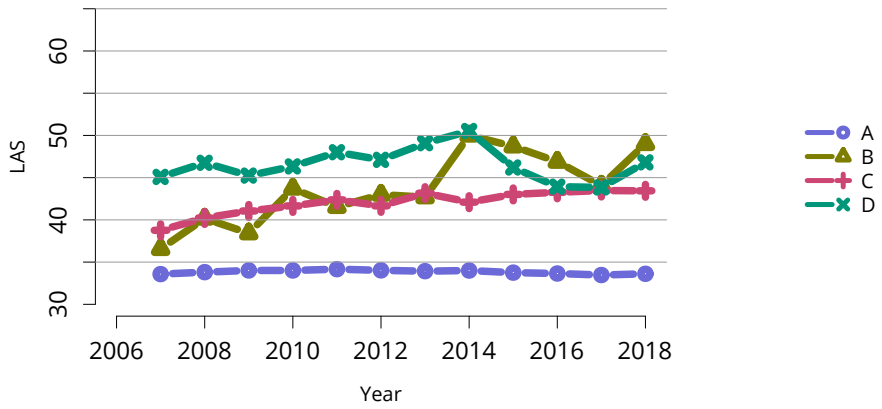

Figure LU 54. Median LAS at transplant by diagnosis group. Recipients aged 12 years or older; last LAS before transplant.

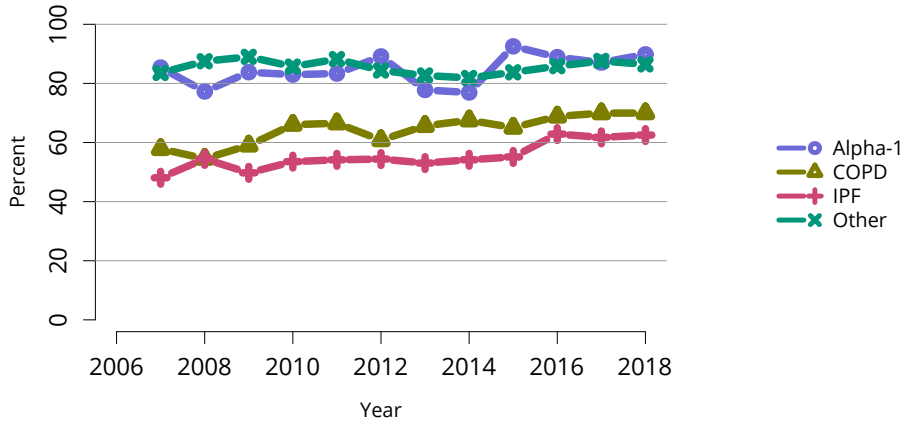

Figure LU 55. Percentage of transplants that were bilateral among lung recipients aged 12 years or older by diagnosis. Heart-lung transplants are excluded. COPD, chronic obstructive pulmonary disease; IPF, idiopathic pulmonary fibrosis.

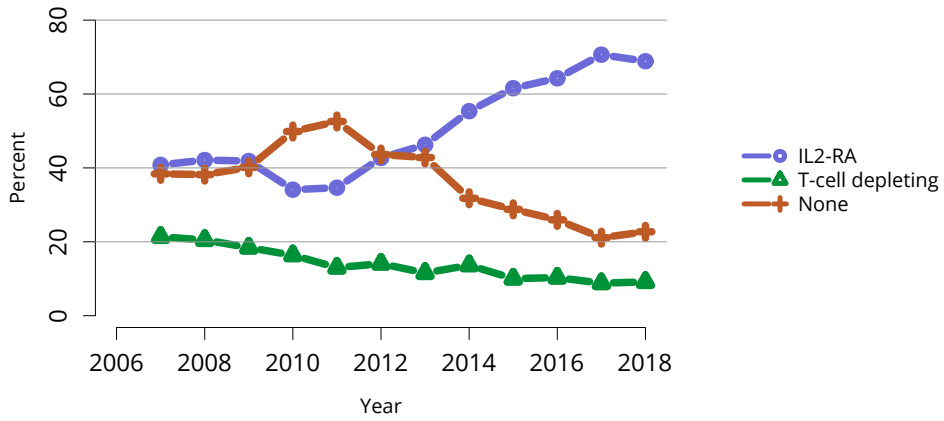

Figure LU 56. Induction agent use in lung transplant recipients aged 12 years or older. Immunosuppression at transplant reported to the OPTN. IL2-RA, interleukin-2 receptor antagonist.

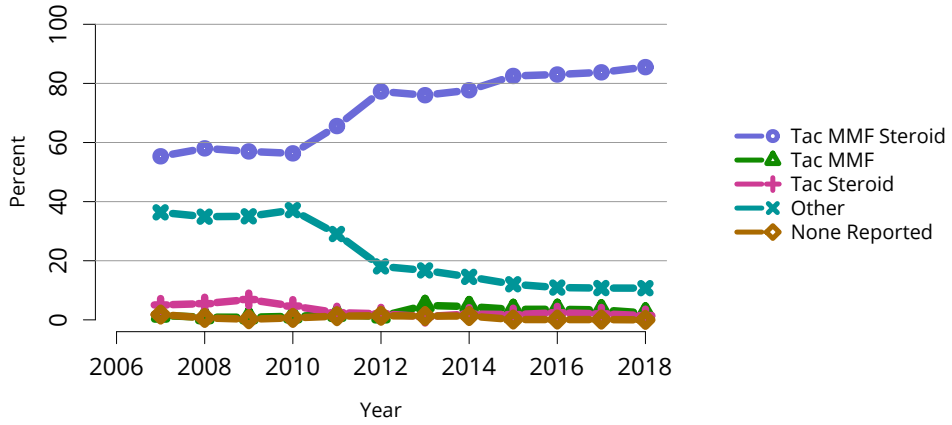

Figure LU 57. Immunosuppression regimen use in transplant recipients aged 12 years or older. Immunosuppression regimen at transplant reported to the OPTN. Tac, tacrolimus. MMF, mycophenolate mofetil.

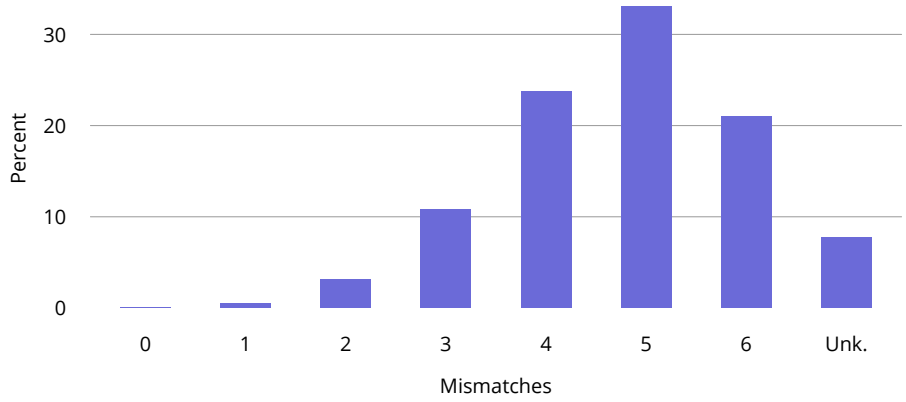

Figure LU 58. Total HLA A, B, and DR mismatches among deceased donor lung transplant recipients aged 12 years or older, 2014-2018. Donor and recipient antigen matching is based on OPTN antigen values and split equivalences policy as of 2018.

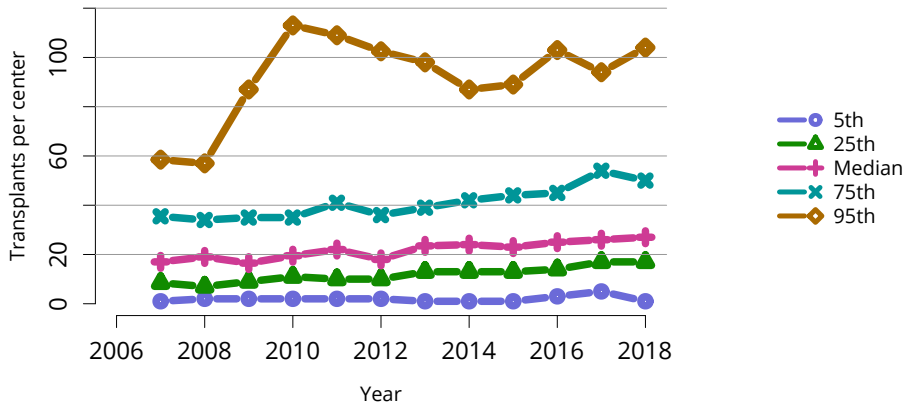

Figure LU 59. Annual adult lung transplant center volumes, by percentile. Annual volume data are limited to recipients aged 18 or older.

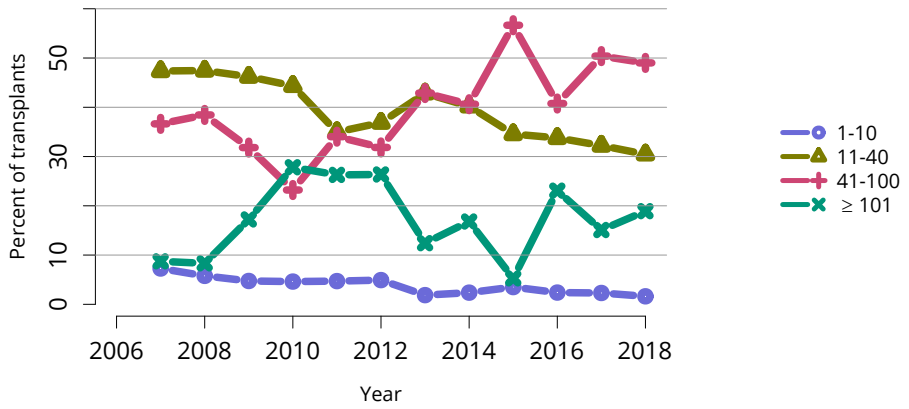

Figure LU 60. Distribution of adult lung transplants by annual center volume. Based on annual volume data among recipients aged 18 or older.

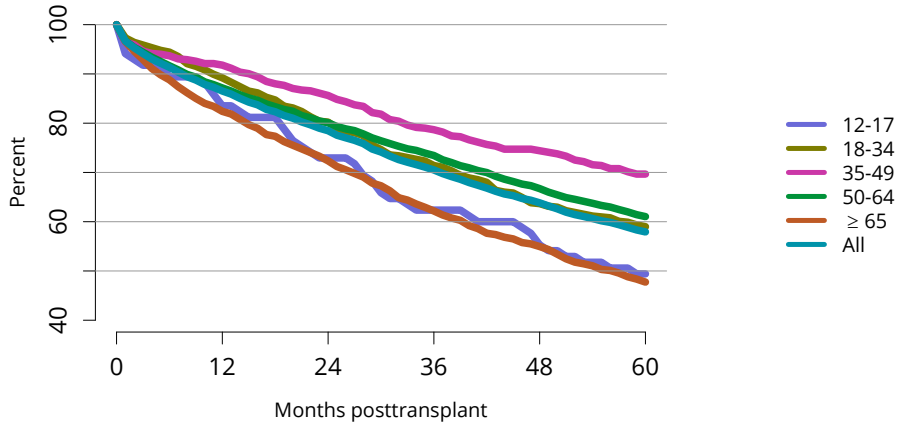

Figure LU 61. Patient survival among lung transplant recipients aged 12 years or older, 2011-2013, by age. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

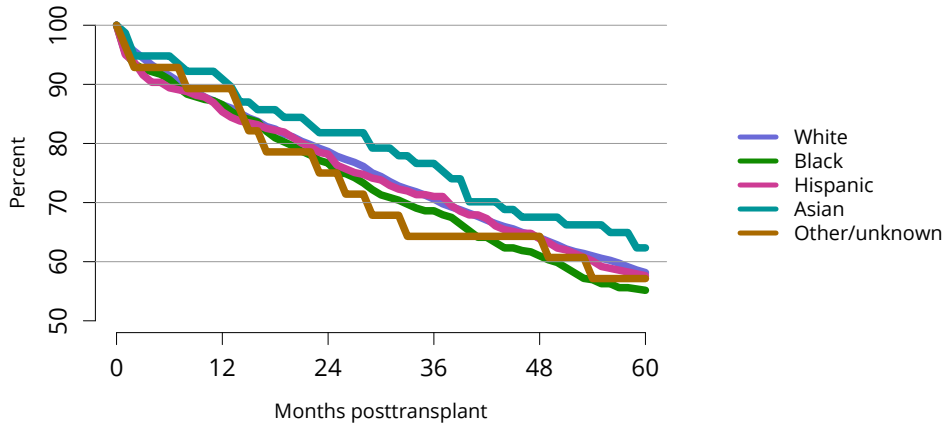

Figure LU 62. Patient survival among lung transplant recipients aged 12 years or older, 2011-2013, by race. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

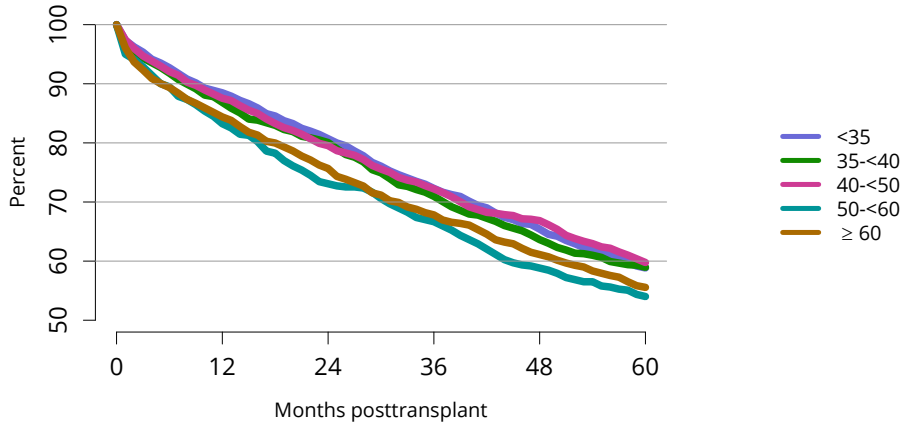

Figure LU 63. Patient survival among lung transplant recipients aged 12 years or older, 2011-2013, by LAS. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

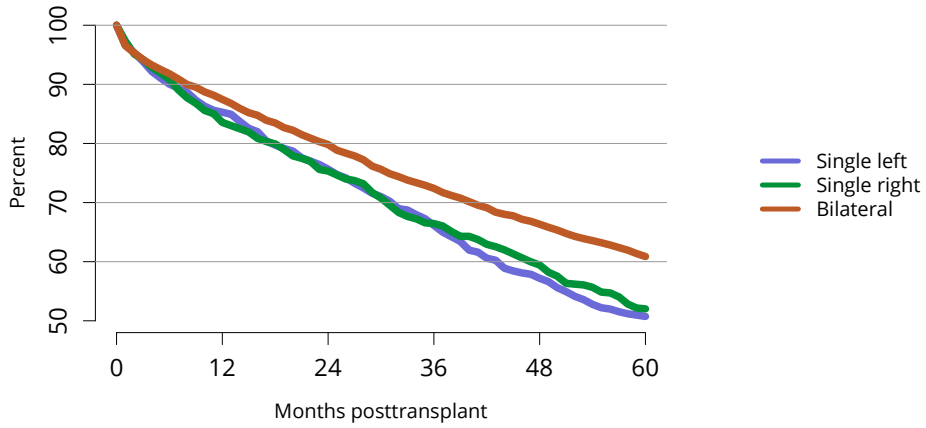

Figure LU 64. Patient survival among lung transplant recipients aged 12 years or older, 2011-2013, by transplant type. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

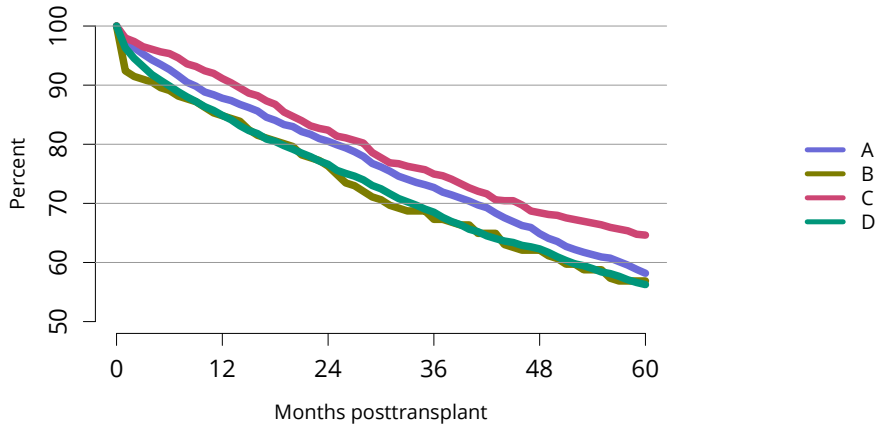

Figure LU 65. Patient survival among lung transplant recipients aged 12 years or older, 2011-2013, by diagnosis group. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

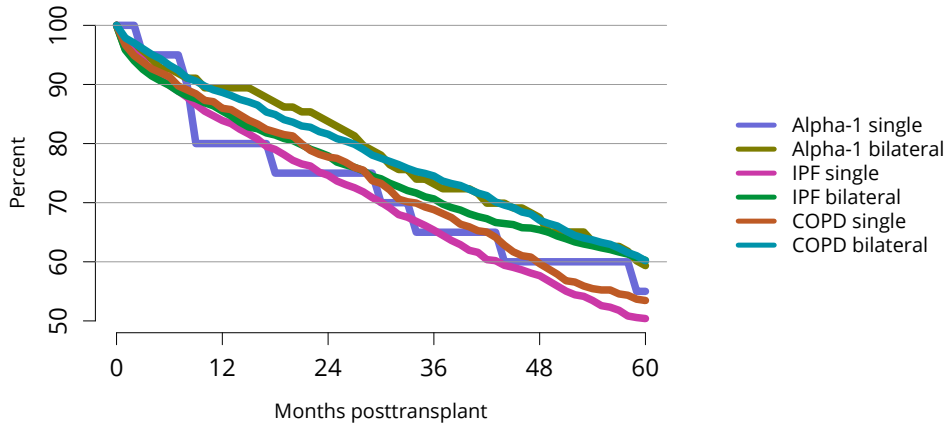

Figure LU 66. Patient survival among lung transplant recipients aged 12 years or older, 2011-2013, by diagnosis and transplant type. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered. COPD, chronic obstructive pulmonary disease; IPF, idiopathic pulmonary fibrosis.

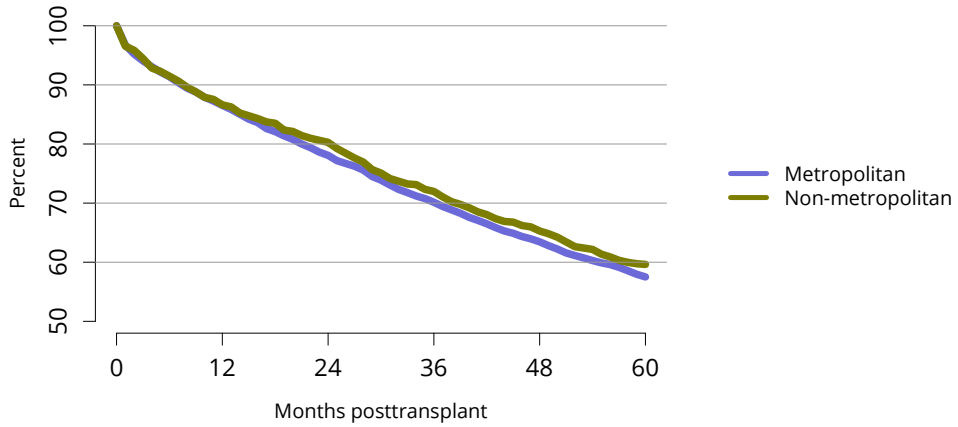

Figure LU 67. Patient survival among lung transplant recipients aged 12 years or older, 2011-2013, by metropolitan vs. non-metropolitan recipient residence. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

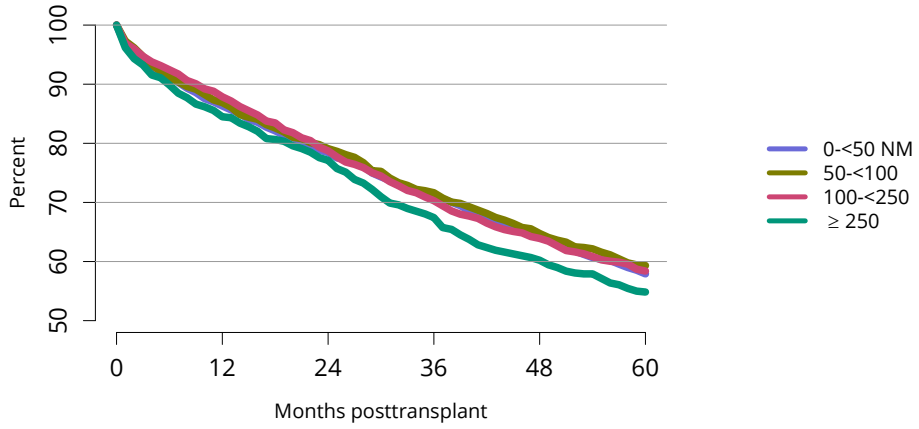

Figure LU 68. Patient survival among lung transplant recipients aged 12 years or older, 2011-2013, by recipients' distance from transplant center. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered. Distance is between the zipcode centroids of the TX center and the recipient's permanent residence, measured in nautical miles (NM).

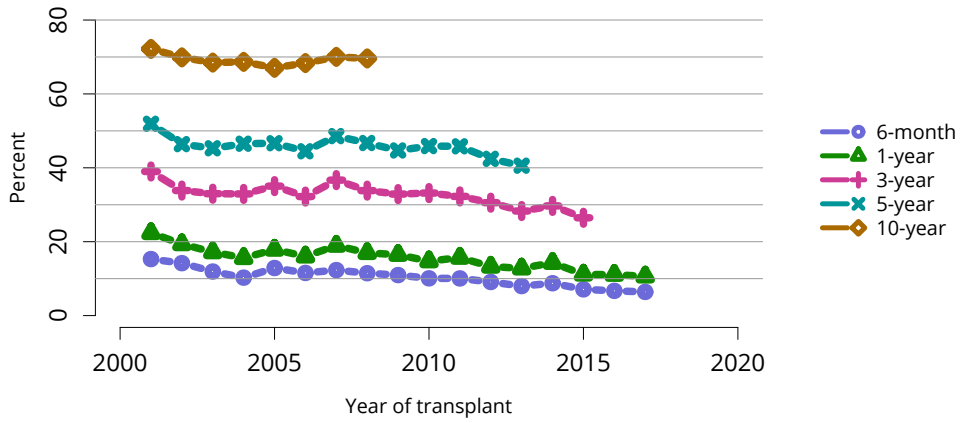

Figure LU 69. Patient death among lung transplant recipients aged 12 years or older. All recipients aged 12 years or older of deceased donor lungs, including multi-organ transplants. Patients are followed until the earlier of death or December 31, 2018.

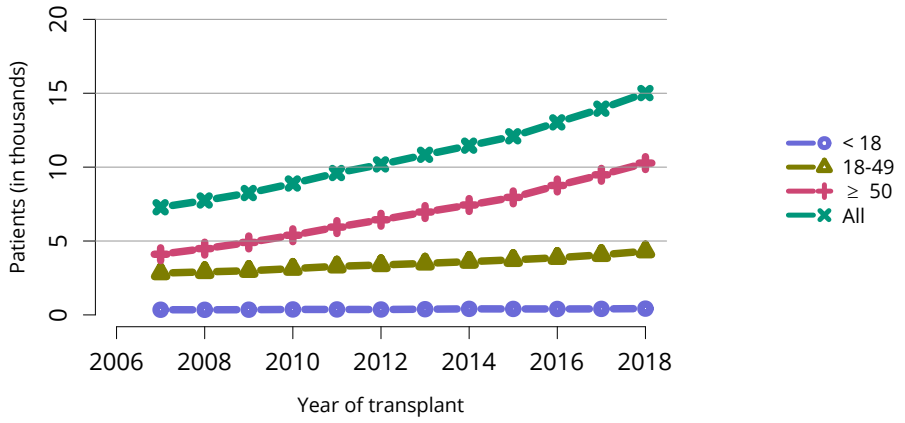

Figure LU 70. Recipients alive with a functioning lung graft on June 30 of the year, by age at transplant. Recipients are assumed to be alive with function unless a death or graft failure is recorded. A recipient may experience a graft failure and be removed from the cohort, undergo retransplant, and re-enter the cohort.

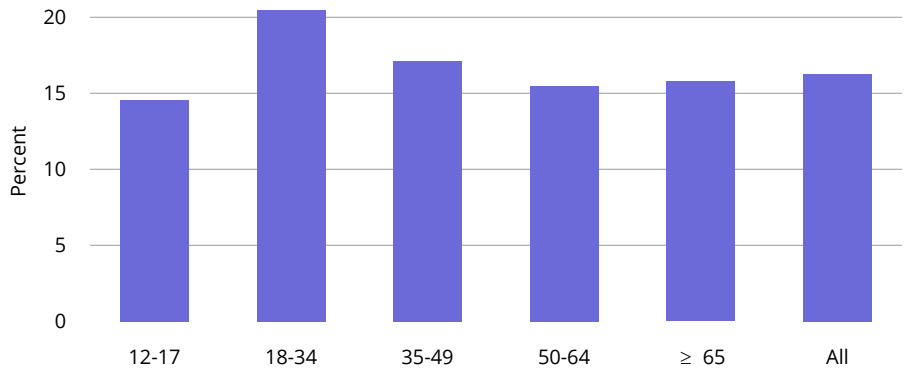

Figure LU 71. Incidence of acute rejection by 1 year posttransplant among lung transplant recipients aged 12 years or older by age, 2016-2017. Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method.

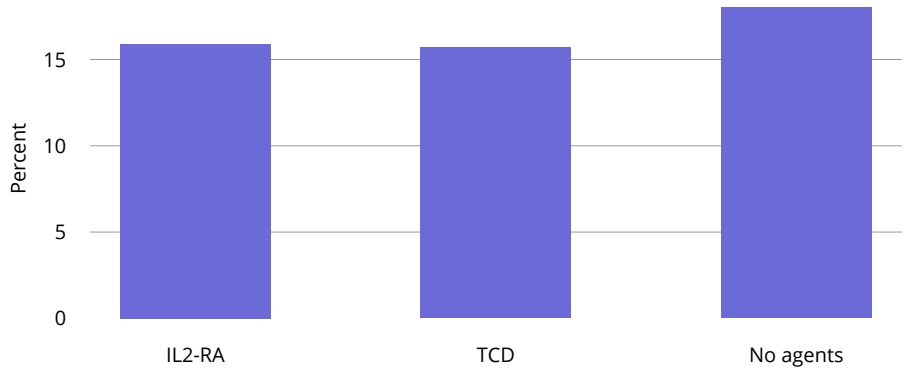

Figure LU 72. Incidence of acute rejection by 1 year posttransplant among lung transplant recipients aged 12 years or older by induction agent 2016-2017. Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method. If a recipient used both IL-2-RA and TCD agents, s/he will contribute to both of those cumulative incidence estimates.

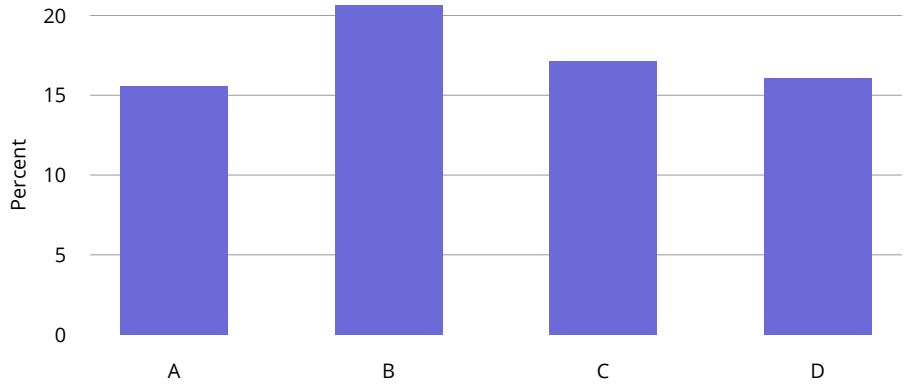

Figure LU 73. Incidence of acute rejection by 1 year posttransplant among lung transplant recipients aged 12 years or older by diagnosis group, 2016-2017. Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method.

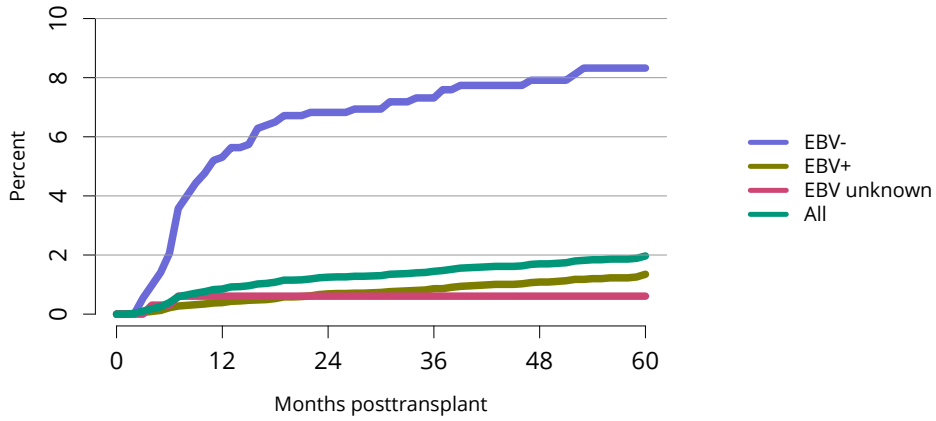

Figure LU 74. Incidence of PTLD among lung transplant recipients aged 12 years or older by recipient EBV status at transplant, 2012-2016. Cumulative incidence is estimated using the Kaplan-Meier competing risk method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.

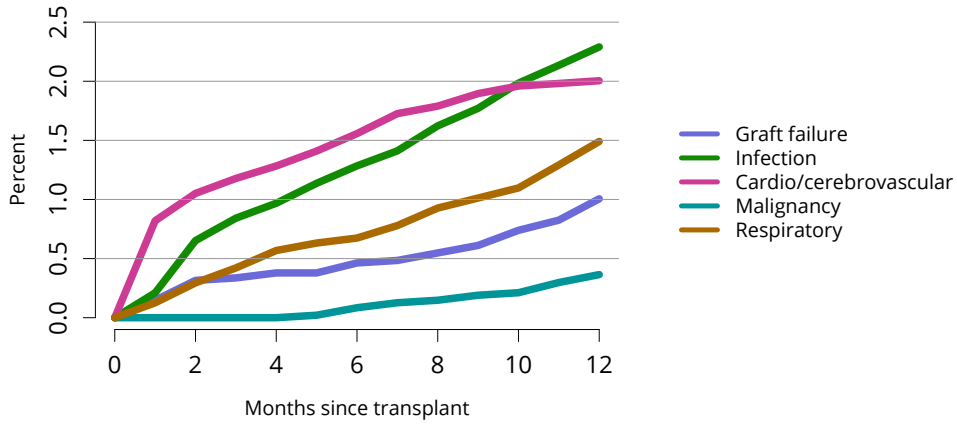

Figure LU 75. One-year cumulative incidence of death by cause among lung recipients aged 12 years or older, 2016-2017. Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

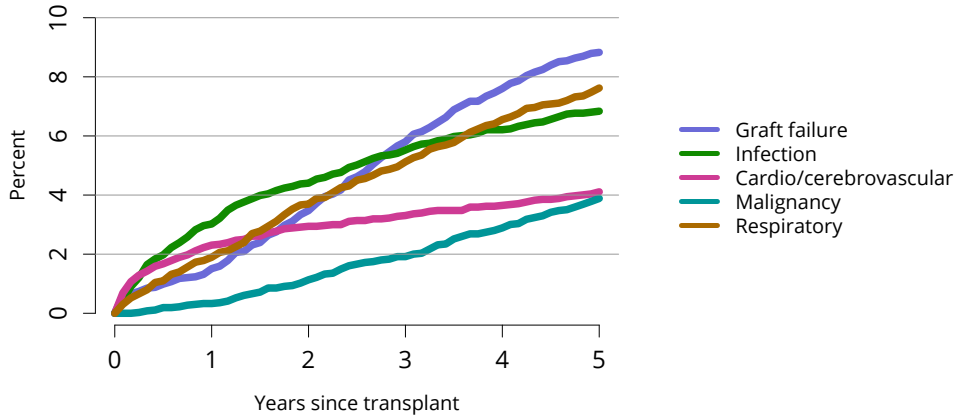

Figure LU 76. Five-year cumulative incidence of death by cause among lung recipients aged 12 years or older, 2012-2013. Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

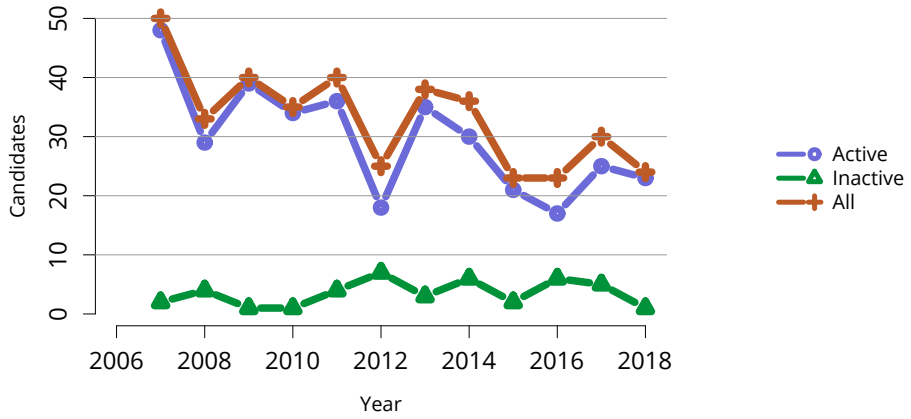

Figure LU 77. New candidates aged 0-11 years added to the lung transplant waiting list. Candidates concurrently listed at multiple centers are counted once. Candidates who are active at at least one program are considered active; otherwise they are inactive. A new patient is one who first joined the list during the given year without ever listing in a prior year, or one who listed and underwent transplant in a prior year and relisted in the given year. Patients on the list on December 31 were aged 0-11 years at listing.

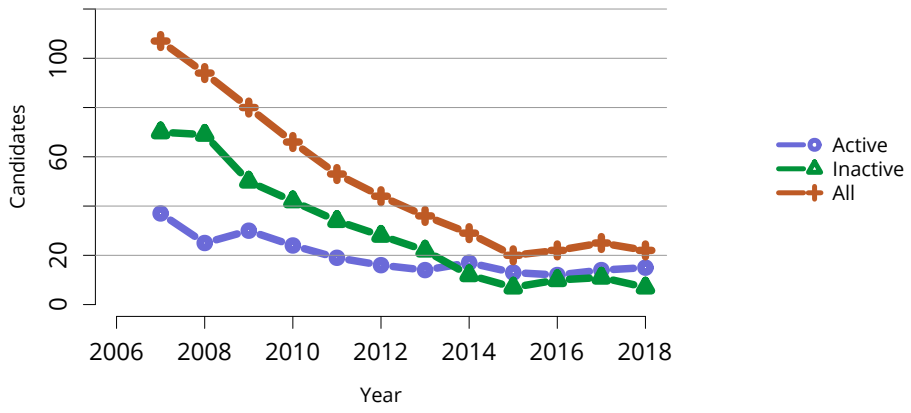

Figure LU 78. Candidates aged 0-11 years waiting for lung transplant. Candidates concurrently listed at multiple centers are counted once. Those with concurrent listings and active at any program are considered active.

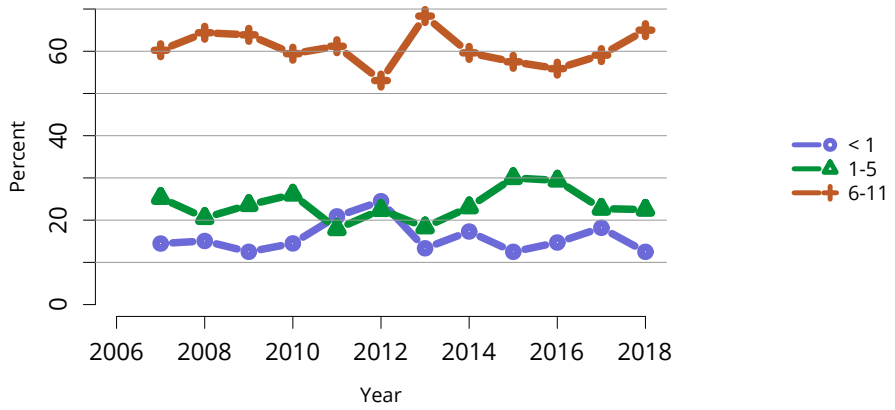

Figure LU 79. Distribution of candidates aged 0-11 years actively waiting for lung transplant, by age. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Age is determined at the later of listing date or January 1 of the given year. Only candidates who were active for at least 1 day are included.

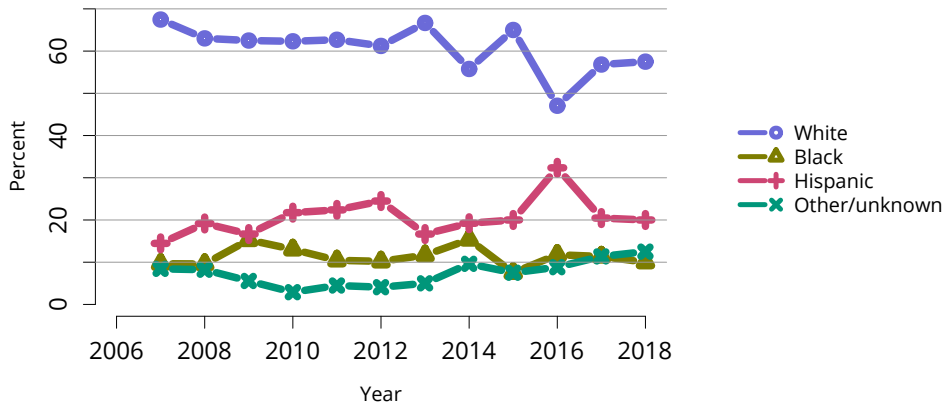

Figure LU 80. Distribution of candidates aged 0-11 years actively waiting for lung transplant by race. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Only candidates who were active for at least 1 day are included.

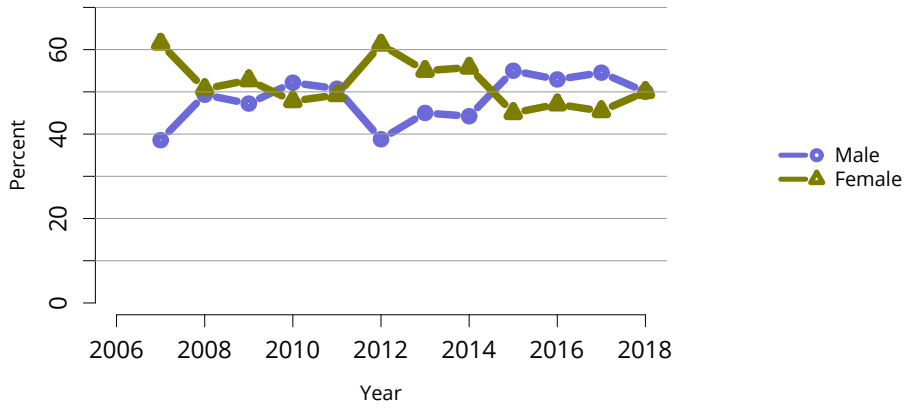

Figure LU 81. Distribution of candidates aged 0-11 years actively waiting for lung transplant by sex. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Only candidates who were active for at least 1 day are included.

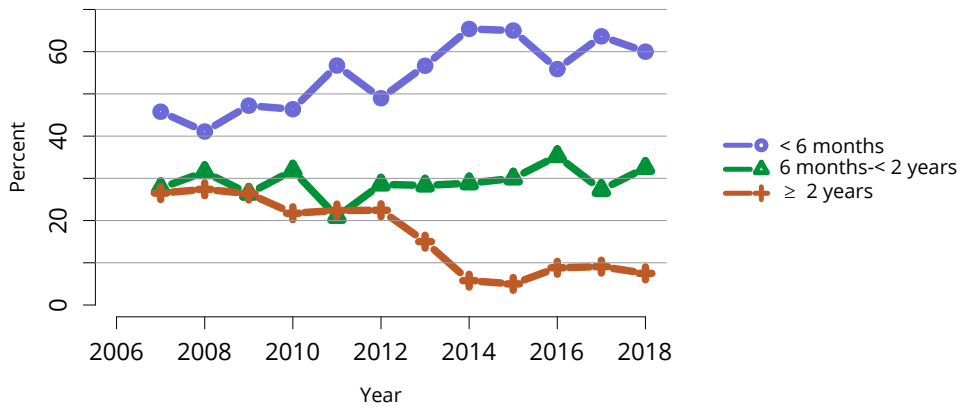

Figure LU 82. Distribution of candidates aged 0-11 years actively waiting for lung transplant by waiting time. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Time on the waiting list is determined at the earlier of December 31 or removal from the waiting list. Only candidates who were active for at least 1 day are included.

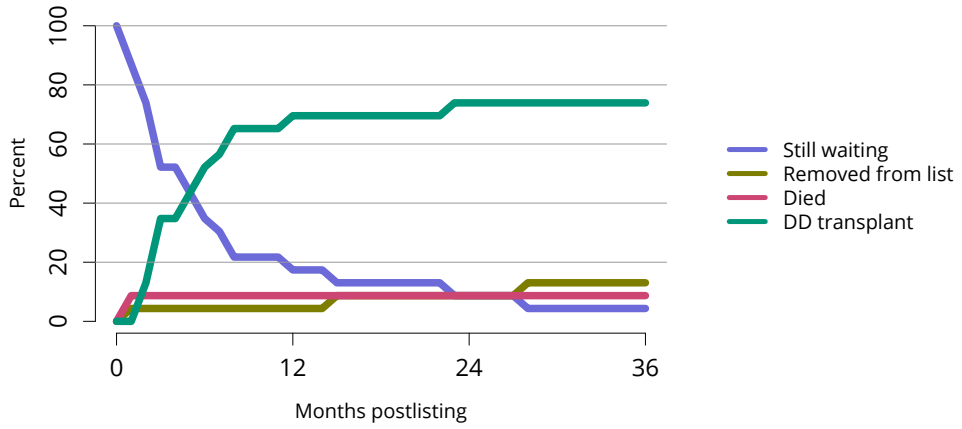

Figure LU 83. Three-year outcomes for newly listed candidates aged 0-11 years waiting for lung transplant, 2015. Candidates aged 0-11 who joined the waitlist in 2015. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. DD, deceased donor.

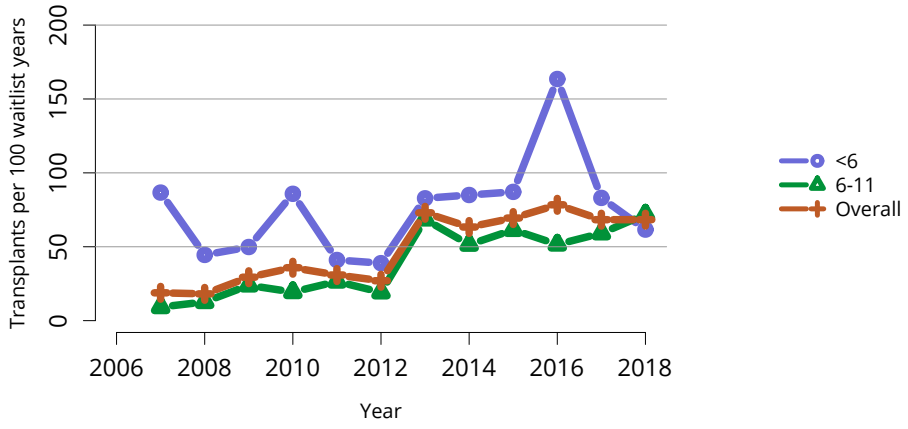

Figure LU 84. Deceased donor lung transplant rates among waitlist candidates aged 0-11 years, by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

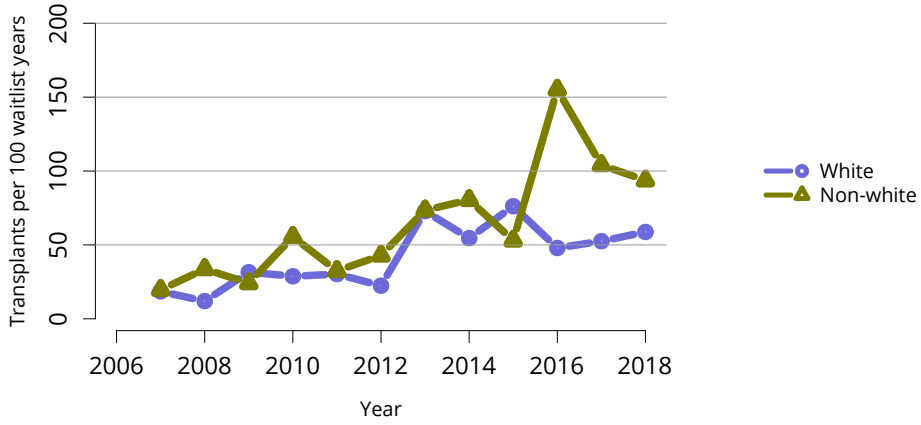

Figure LU 85. Deceased donor lung transplant rates among waitlist candidates aged 0-11 years, by race. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

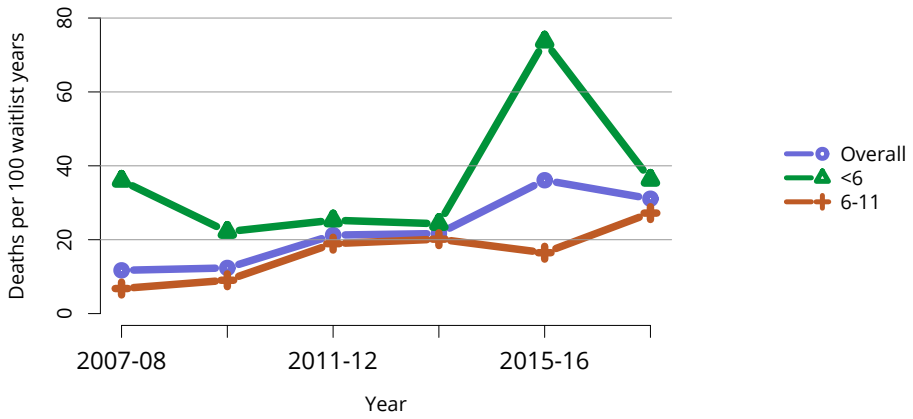

Figure LU 86. Pretransplant mortality rates among candidates aged 0-11 years waitlisted for lung transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown.

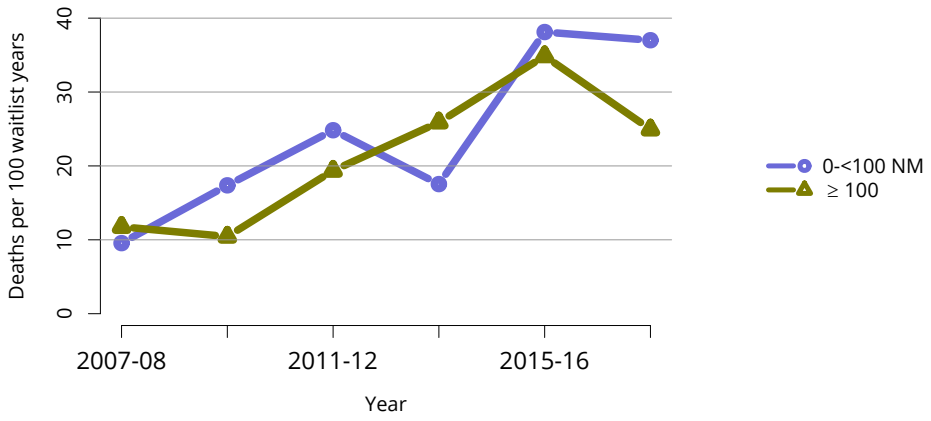

Figure LU 87. Pretransplant mortality rates among candidates aged 0-11 years waitlisted for lung transplant by distance from listing center. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Rates with less than 10 patient-years of exposure or fewer than 20 candidates at risk are not shown. Distance is between the zipcode centroids of the TX center and the recipient's permanent residence, measured in nautical miles (NM).

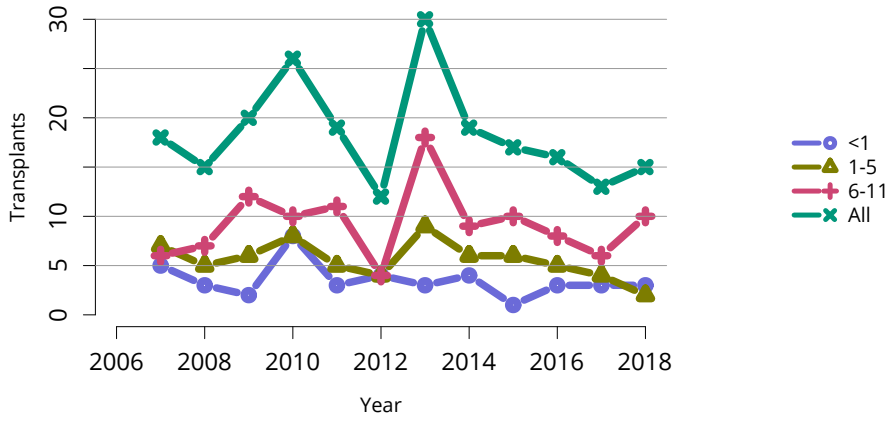

Figure LU 88. Lung transplants, recipients aged 0-11 years by age. All lung transplant recipients aged 0-11 years, including retransplant and multi-organ recipients.

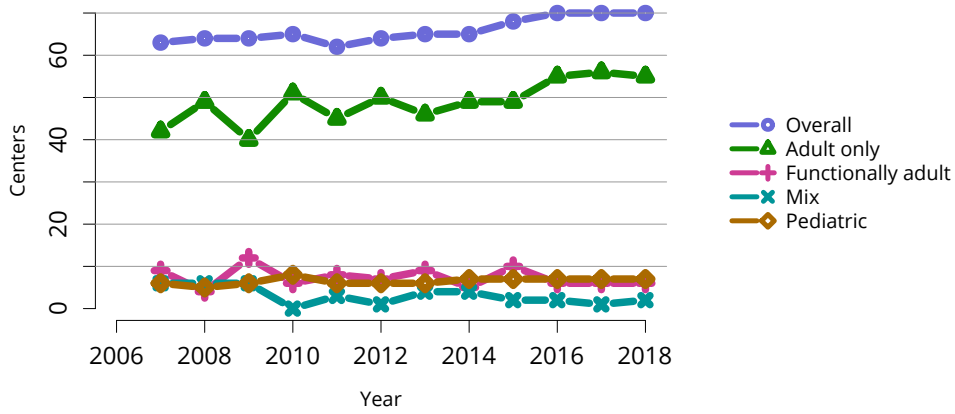

Figure LU 89. Number of centers performing pediatric and adult lung transplants by center's age mix. Adult centers transplanted only recipients aged 18 years or older. Functionally adult centers transplant 80% adults or more, and the remainder were children aged 15-17 years. Mixed included adults and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

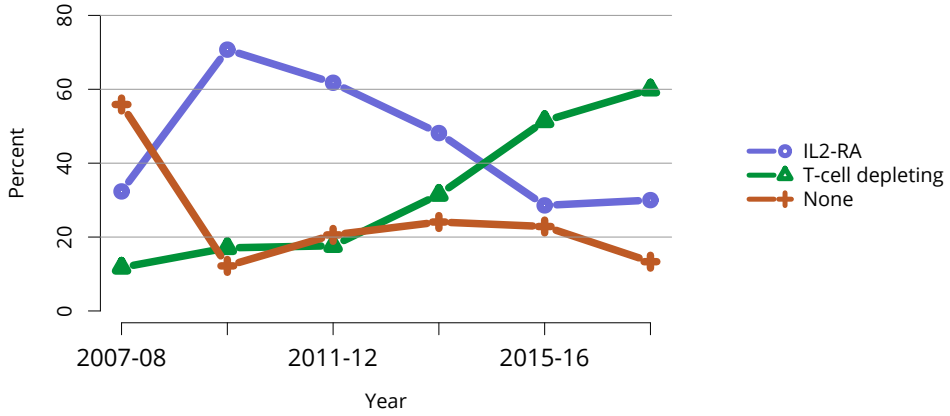

Figure LU 90. Induction agent use in lung transplant recipients aged 0-11 years. Immunosuppression at transplant reported to the OPTN. IL2-RA, interleukin-2 receptor antagonist.

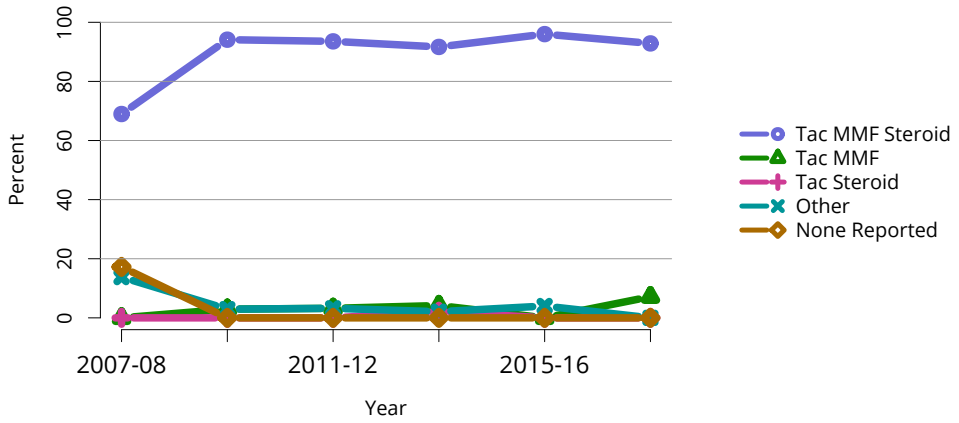

Figure LU 91. Immunosuppression regimen use in transplant recipients aged 0-11 years. Immunosuppression regimen at transplant reported to the OPTN. Tac, tacrolimus. MMF, mycophenolate mofetil.

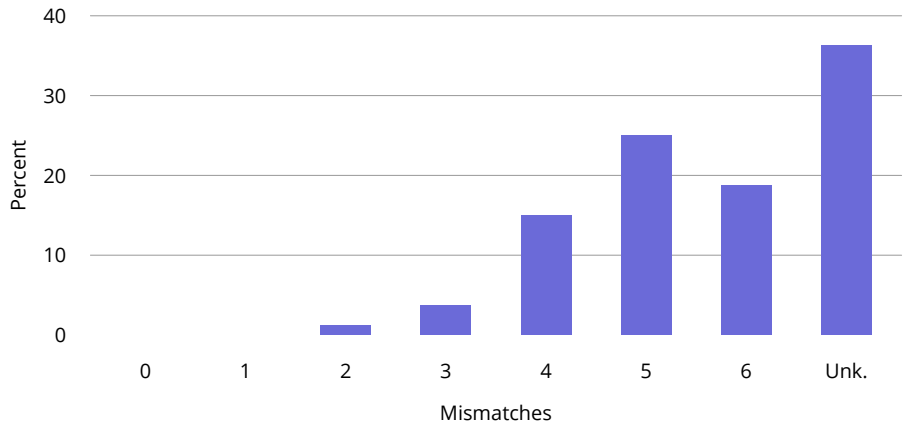

Figure LU 92. Total HLA A, B, and DR mismatches among deceased donor lung transplant recipients aged 0-11 years, 2014-2018. Donor and recipient antigen matching is based on OPTN antigen values and split equivalences policy as of 2018.

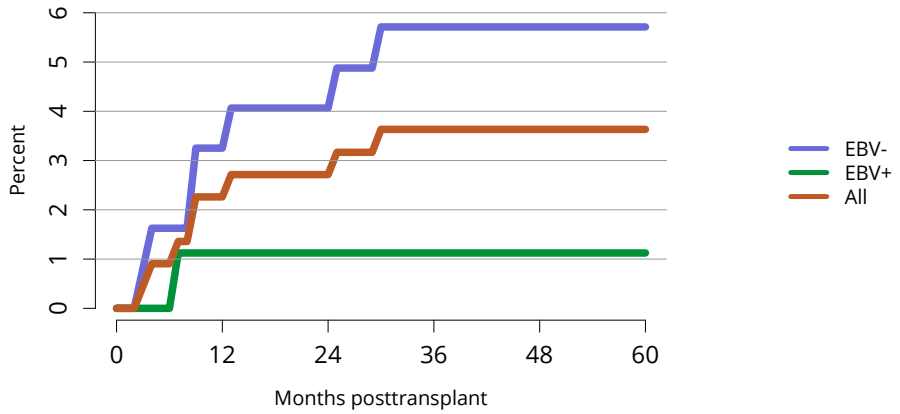

Figure LU 93. Incidence of PTLD among lung transplant recipients aged 0-11 years by recipient EBV status at transplant, 2006-2016. Cumulative incidence is estimated using the Kaplan-Meier competing risk method. Post-transplant lymphoproliferative disorder (PTLD) is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or on the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus.

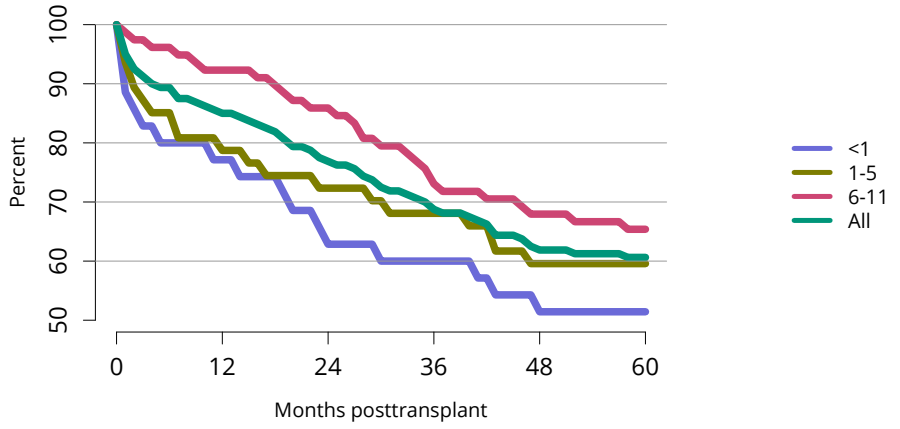

Figure LU 95. Patient survival among lung transplant recipients aged 0-11 years, 2006-2013, by age. Recipient survival estimated using unadjusted Kaplan-Meier methods.

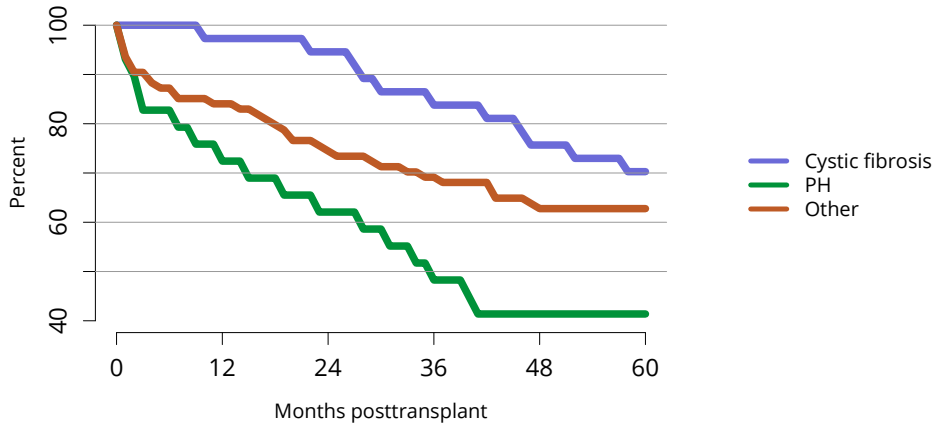

Figure LU 96. Patient survival among lung transplant recipients aged 0-11 years, 2006-2013, by diagnosis. Recipient survival estimated using unadjusted Kaplan-Meier methods. PH, pulmonary hypertension.

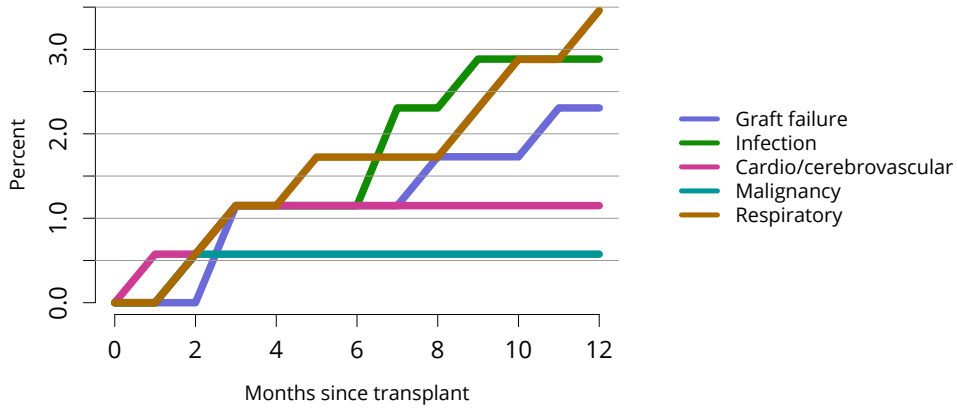

Figure LU 97. One-year cumulative incidence of death by cause among lung transplant recipients aged 0-11 years, 2008-2017. Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

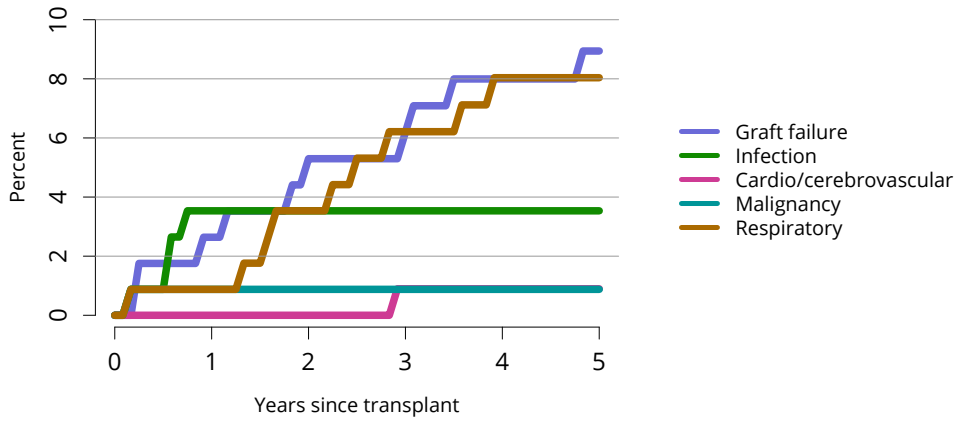

Figure LU 98. Five-year cumulative incidence of death by cause among lung transplant recipients aged 0-11 years, 2008-2013. Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

Characteristic	2013 N	2013 Percent	2018 N	2018 Percent
Age				
12-17 years	20	1.3%	13	0.9%
18-34 years	175	11.0%	112	7.9%
35-49 years	240	15.2%	199	14.0%
50-64 years	813	51.3%	673	47.4%
≥ 65 years	336	21.2%	422	29.7%
Sex				
Female	944	59.6%	825	58.1%
Male	640	40.4%	594	41.9%
Race/ethnicity				
White	1280	80.8%	1041	73.4%
Black	158	10.0%	162	11.4%
Hispanic	99	6.2%	159	11.2%
Asian	40	2.5%	49	3.5%
Other/unknown	7	0.4%	8	0.6%
Geography				
Metropolitan	1286	81.2%	1193	84.1%
Non-metro	298	18.8%	226	15.9%
Distance				
< 50 miles	728	46.0%	760	53.6%
50-<100 miles	294	18.6%	249	17.5%
100-<150 miles	153	9.7%	134	9.4%
150-<250 miles	205	12.9%	146	10.3%
≥ 250 miles	191	12.1%	125	8.8%
Unknown	13	0.8%	5	0.4%
Height				
< 150 cm	69	4.4%	63	4.4%
150-< 160 cm	325	20.5%	336	23.7%
160-< 170 cm	589	37.2%	483	34.0%
170-< 180 cm	428	27.0%	366	25.8%
≥ 180 cm	171	10.8%	170	12.0%
Unknown	2	0.1%	1	0.1%

Table LU 1 Demographic characteristics of candidates aged 12 years or older on the lung transplant waiting list on December 31, 2013, and December 31, 2018 (continued on next page). Candidates waiting for transplant on December 31 of the given year, regardless of first listing date; multiple listings are collapsed. Distance is computed from candidate's home zip code to the transplant center.

Characteristic	2013		2018	
	N	Percent	N	Percent
All candidates	1584	100.0%	1419	100.0%

Table LU 1 Demographic characteristics of candidates aged 12 years or older on the lung transplant waiting list on December 31, 2013, and December 31, 2018 (continued from previous page). Candidates waiting for transplant on December 31 of the given year, regardless of first listing date; multiple listings are collapsed. Distance is computed from candidate's home zip code to the transplant center.

Characteristic	2013		2018	
	N	Percent	N	Percent
Diagnosis group				
A	724	45.7%	572	40.3%
B	113	7.1%	134	9.4%
C	189	11.9%	119	8.4%
D	558	35.2%	594	41.9%
LAS				
<30	33	2.1%	74	5.2%
30-<35	741	46.8%	558	39.3%
35-<40	370	23.4%	428	30.2%
40-<50	266	16.8%	246	17.3%
50-<60	78	4.9%	52	3.7%
≥ 60	74	4.7%	61	4.3%
Unknown	22	1.4%	0	0.0%
Blood type				
A	621	39.2%	498	35.1%
B	155	9.8%	155	10.9%
AB	47	3.0%	28	2.0%
O	761	48.0%	738	52.0%
All candidates	1584	100.0%	1419	100.0%

Table LU 2 Clinical characteristics of candidates aged 12 years or older on the lung transplant waiting list on December 31, 2013, and December 31, 2018. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date; multiple listings are collapsed. All candidates with unknown LAS in are inactive.

Characteristic	2013		2018	
	N	Percent	N	Percent
Wait time				
< 31 days	143	9.0%	188	13.2%
31-60 days	104	6.6%	119	8.4%
61-90 days	99	6.2%	118	8.3%
3-< 6 months	234	14.8%	243	17.1%
6-< 12 months	311	19.6%	292	20.6%
1-< 2 years	272	17.2%	251	17.7%
2-< 3 years	145	9.2%	86	6.1%
≥ 3 years	276	17.4%	122	8.6%
Waitlist status				
Active	1281	80.9%	1194	84.1%
Inactive	303	19.1%	213	15.0%
Unknown	0	0.0%	12	0.8%
Transplant history				
First	1534	96.8%	1387	97.7%
Retransplant	50	3.2%	32	2.3%
Tx type				
Lung only	1522	96.1%	1356	95.6%
Heart-lung	45	2.8%	42	3.0%
Other	17	1.1%	21	1.5%
All candidates	1584	100.0%	1419	100.0%

Table LU 3 Listing characteristics of candidates aged 12 years or older on the lung transplant waiting list on December 31, 2013, and December 31, 2018. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date; multiple listings are collapsed.

Waiting list state	2016	2017	2018
Patients at start of year	1518	1387	1354
Patients added during year	2692	2901	3134
Patients removed during year	2816	2928	3069
Patients at end of year	1394	1360	1419

Table LU 4 Lung transplant waitlist activity among candidates aged 12 years or older. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multi-organ transplants are included.

Removal reason	2016	2017	2018
Deceased donor transplant	2322	2449	2541
Living donor transplant	0	0	0
Patient died	202	214	238
Patient refused transplant	16	12	21
Improved, transplant not needed	29	38	47
Too sick for transplant	136	112	127
Other	111	103	95

Table LU 5 Removal reason among lung transplant candidats aged 12 years or older. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Characteristic	2013		2018	
	N	Percent	N	Percent
Age				
12-17 years	39	2.0%	25	1.0%
18-34 years	193	10.1%	233	9.1%
35-49 years	224	11.7%	310	12.2%
50-64 years	910	47.5%	1093	42.9%
$\geq$ 65 years	550	28.7%	886	34.8%
Sex				
Female	755	39.4%	1022	40.1%
Male	1161	60.6%	1525	59.9%
Race/ethnicity				
White	1591	83.0%	2007	78.8%
Black	167	8.7%	240	9.4%
Hispanic	125	6.5%	224	8.8%
Asian	19	1.0%	56	2.2%
Other/unknown	14	0.7%	20	0.8%
Height				
$<$ 150 cm	44	2.3%	57	2.2%
150-$<$ 160 cm	233	12.2%	360	14.1%
160-$<$ 170 cm	596	31.1%	763	30.0%
170-$<$ 180 cm	666	34.8%	873	34.3%
$\geq$ 180 cm	374	19.5%	492	19.3%
Unknown	3	0.2%	2	0.1%
Insurance				
Private	969	50.6%	1044	41.0%
Medicare	753	39.3%	1146	45.0%
Other government	173	9.0%	296	11.6%
Unknown	21	1.1%	61	2.4%
Geography				
Metropolitan	1586	82.8%	2159	84.8%
Non-metro	330	17.2%	388	15.2%

Table LU 6 Demographic characteristics of lung transplant recipients aged 12 years or older, 2013 and 2018 (continued on next page). Lung transplant recipients, including retransplants. Distance is computed from recipient's home zip code to the transplant center.

Characteristic	2013		2018	
	N	Percent	N	Percent
Distance				
< 50 miles	889	46.4%	1306	51.3%
50-<100 miles	325	17.0%	425	16.7%
100-<150 miles	229	12.0%	265	10.4%
150-<250 miles	232	12.1%	250	9.8%
≥ 250 miles	225	11.7%	237	9.3%
Unknown	16	0.8%	64	2.5%
All recipients	1916	100.0%	2547	100.0%

Table LU 6 Demographic characteristics of lung transplant recipients aged 12 years or older, 2013 and 2018 (continued from previous page). Lung transplant recipients, including retransplants. Distance is computed from recipient's home zip code to the transplant center.

Characteristic	2013 N	2013 Percent	2018 N	2018 Percent
Diagnosis group				
A	504	26.3%	607	23.8%
B	70	3.7%	150	5.9%
C	240	12.5%	262	10.3%
D	1102	57.5%	1528	60.0%
Blood type				
A	745	38.9%	956	37.5%
B	184	9.6%	285	11.2%
AB	73	3.8%	113	4.4%
O	914	47.7%	1193	46.8%
Medical condition				
Hospitalized in ICU	290	15.1%	347	13.6%
Hospitalized, not ICU	165	8.6%	293	11.5%
Not hospitalized	1461	76.3%	1874	73.6%
Hospitalization unknown	0	0.0%	33	1.3%
LAS				
<30	4	0.2%	3	0.1%
30-<35	405	21.1%	554	21.8%
35-<40	373	19.5%	543	21.3%
40-<50	461	24.1%	587	23.0%
50-<60	216	11.3%	263	10.3%
≥ 60	457	23.9%	597	23.4%
Vent/ECMO at transplant				
Vent + ECMO	61	3.2%	79	3.1%
Vent only	91	4.7%	41	1.6%
ECMO only	32	1.7%	84	3.3%
Neither	1732	90.4%	2343	92.0%
All recipients	1916	100.0%	2547	100.0%

Table LU 7 Clinical characteristics of lung transplant recipients aged 12 years or older, 2013 and 2018. Lung transplant recipients, including retransplants. ECMO, extracorporeal membrane oxygenation.

Characteristic	2013		2018	
	N	Percent	N	Percent
Wait time				
< 31 days	665	34.7%	1020	40.0%
31-60 days	279	14.6%	434	17.0%
61-90 days	130	6.8%	256	10.1%
3-< 6 months	314	16.4%	399	15.7%
6-< 12 months	252	13.2%	246	9.7%
≥ 1 year	276	14.4%	192	7.5%
Procedure				
Lobar	2	0.1%	0	0.0%
Single	619	32.3%	640	25.1%
Bilateral	1295	67.6%	1907	74.9%
Donor type				
DBD	1880	98.1%	2426	95.2%
DCD	35	1.8%	121	4.8%
Living	1	0.1%	0	0.0%
Transplant history				
First	1838	95.9%	2481	97.4%
Retransplant	78	4.1%	66	2.6%
Tx type				
Lung only	1884	98.3%	2493	97.9%
Heart-lung	19	1.0%	28	1.1%
Other	13	0.7%	26	1.0%
All recipients	1916	100.0%	2547	100.0%

Table LU 8 Transplant characteristics of lung transplant recipients aged 12 years or older, 2013 and 2018. Lung transplant recipients, including re-transplants. DBD, donation after brain death; DCD, donation after circulatory death.

Donor	Recipient	CMV	EBV
D-	R-	18.1%	0.7%
D-	R+	19.8%	7.5%
D-	R unk	0.3%	0.2%
D+	R-	27.7%	7.8%
D+	R+	33.0%	81.6%
D+	R unk	0.5%	2.2%
D unk	R-	0.2%	0.0%
D unk	R+	0.3%	0.1%
D unk	R unk	0.0%	0.0%

Table LU 9 Donor-recipient serology matching among lung transplant recipients aged 12 years or older, 2016-2018. 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.

Event	One-year		Five-year	
	N	Pct	N	Pct
BOS				
None reported	5449	90.6%	1757	58.1%
Reported	382	6.4%	1262	41.8%
Unknown	184	3.1%	3	0.1%
Creatinine $>$ 2.5 mg/dl	251	4.2%	390	12.9%
Chronic dialysis	95	1.6%	82	2.7%
Renal transplant	5	0.1%	20	0.7%
Diabetes	483	8.0%	568	18.8%
Malignancy	218	3.6%	717	23.7%
Re-hospitalization	2889	48.0%	2366	78.3%
Functional status				
No assistance needed	4828	80.3%	2459	81.4%
Some assistance needed	428	7.1%	212	7.0%
Total assistance needed	126	2.1%	74	2.4%
Unknown	632	10.5%	277	9.2%
All recipients	6015	100.0%	3022	100.0%

Table LU 10 Posttransplant events among lung transplant recipients aged 12 years or older. Posttransplant morbidities are recorded on the OPTN Transplant Recipient Follow-up Form and are included in the table if they were reported anytime on or before 1-year and 5-year follow-up. One-year events are reported for recipients in 2015-2017 and 5-year events for recipients in 2011-2013. Recipients of more than one transplant are counted separately per transplant.

Characteristic	2008 N	2008 Percent	2018 N	2018 Percent
Age				
< 1 year	4	7.7%	0	0.0%
1-5 years	12	23.1%	7	41.2%
6-11 years	36	69.2%	10	58.8%
Sex				
Female	28	53.8%	7	41.2%
Male	24	46.2%	10	58.8%
Race/ethnicity				
White	38	73.1%	12	70.6%
Black	5	9.6%	1	5.9%
Hispanic	9	17.3%	4	23.5%
Geography				
Metropolitan	41	78.8%	13	76.5%
Non-metro	11	21.2%	4	23.5%
Distance				
< 50 miles	12	23.1%	6	35.3%
50-<100 miles	7	13.5%	1	5.9%
100-<150 miles	3	5.8%	2	11.8%
150-<250 miles	6	11.5%	2	11.8%
≥ 250 miles	24	46.2%	5	29.4%
Unknown	0	0.0%	1	5.9%
Height				
< 70 cm	9	17.3%	2	11.8%
70-< 90 cm	15	28.8%	2	11.8%
90-< 110 cm	11	21.2%	4	23.5%
110-< 130 cm	15	28.8%	8	47.1%
≥ 130 cm	2	3.8%	1	5.9%
All candidates	52	100.0%	17	100.0%

Table LU 11 Demographic characteristics of candidates aged 0-11 years on the lung transplant waiting list on December 31, 2008 and December 31, 2018. Candidates aged 0-11 years waiting for transplant on December 31 of the given year, regardless of first listing date; multiple listings are collapsed. Age calculated at snapshot. Candidates listed as before age 12 who turned 12 before the cohort date are excluded. Distance is computed from candidate's home zip code to the transplant center.

Characteristic	2008 N	2008 Percent	2018 N	2018 Percent
Diagnosis				
Cystic fibrosis	7	13.5%	4	23.5%
Pulmonary hypertension	21	40.4%	2	11.8%
Pulmonary fibrosis	8	15.4%	0	0.0%
Other vascular	3	5.8%	2	11.8%
Other/unknown	13	25.0%	9	52.9%
Blood type				
A	22	42.3%	6	35.3%
B	8	15.4%	0	0.0%
AB	2	3.8%	2	11.8%
O	20	38.5%	9	52.9%
All candidates	52	100.0%	17	100.0%

Table LU 12 Clinical characteristics of candidates aged 0-11 years on the lung transplant waiting list on December 31, 2008 and December 31, 2018.
Candidates aged 0-11 years waiting for transplant on December 31, 2008, and December 31, 2018, regardless of first listing date; multiple listings are collapsed. Candidates listed as before age 12 who turned 12 before the cohort date are excluded.

Characteristic	2008 N	2008 Percent	2018 N	2018 Percent
Wait time				
< 31 days	3	5.8%	0	0.0%
31-60 days	0	0.0%	2	11.8%
61-90 days	1	1.9%	4	23.5%
3-< 6 months	7	13.5%	1	5.9%
6-< 12 months	4	7.7%	3	17.6%
1-< 2 years	11	21.2%	4	23.5%
2-< 3 years	6	11.5%	2	11.8%
≥ 3 years	20	38.5%	1	5.9%
Waitlist status				
Active	15	28.8%	12	70.6%
Inactive	37	71.2%	5	29.4%
Transplant history	52	100.0%	17	100.0%
Tx type				
Lung only	44	84.6%	14	82.4%
Heart-lung	7	13.5%	2	11.8%
Other	1	1.9%	1	5.9%
All candidates	52	100.0%	17	100.0%

Table LU 13 Listing characteristics of candidates aged 0-11 years on the lung transplant waiting list on December 31, 2008 and December 31, 2018. Candidates aged 0-11 years waiting for transplant on December 31, 2008, and December 31, 2018, regardless of first listing date; multiple listings are collapsed. Candidates listed as before age 12 who turned 12 before the cohort date are excluded.

Waiting list state	2016	2017	2018
Patients at start of year	20	22	25
Patients added during year	23	30	24
Patients removed during year	21	27	27
Patients at end of year	22	25	22

Table LU 14 Lung transplant waitlist activity among candidates aged 0-11 years. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multi-organ transplants are included.

Removal reason	2016	2017	2018
Deceased donor transplant	15	16	16
Living donor transplant	0	0	0
Patient died	4	8	6
Patient refused transplant	0	0	0
Improved, transplant not needed	2	2	1
Too sick for transplant	0	1	1
Other	0	0	3

Table LU 15 Removal reason among lung transplant candidates aged 0-11 years. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Characteristic	2006-08 N	2006-08 Percent	2016-18 N	2016-18 Percent
Age				
< 1 year	15	24.2%	9	20.5%
1-5 years	19	30.6%	11	25.0%
6-11 years	28	45.2%	24	54.5%
Sex				
Female	33	53.2%	25	56.8%
Male	29	46.8%	19	43.2%
Race/ethnicity				
White	39	62.9%	25	56.8%
Black	7	11.3%	4	9.1%
Hispanic	11	17.7%	11	25.0%
Asian	5	8.1%	2	4.5%
Other/unknown	0	0.0%	2	4.5%
Height				
< 70 cm	17	27.4%	11	25.0%
70-< 90 cm	10	16.1%	7	15.9%
90-< 110 cm	10	16.1%	4	9.1%
110-< 130 cm	15	24.2%	16	36.4%
≥ 130 cm	10	16.1%	6	13.6%
Insurance				
Private	31	50.0%	14	31.8%
Medicaid	30	48.4%	24	54.5%
Unknown	1	1.6%	6	13.6%
Geography				
Metropolitan	50	80.6%	34	77.3%
Non-metro	12	19.4%	10	22.7%

Table LU 16 Demographic characteristics of lung transplant recipients aged 0-11 years, 2006-2008 and 2016-2018 (continued on next page). Lung transplant recipients aged 0-11 years, including retransplants. Distance is computed from recipient's home zip code to the transplant center.

Characteristic	2006-08		2016-18	
	N	Percent	N	Percent
Distance				
< 50 miles	16	25.8%	11	25.0%
50-<100 miles	5	8.1%	6	13.6%
100-<150 miles	5	8.1%	0	0.0%
150-<250 miles	4	6.5%	6	13.6%
≥ 250 miles	32	51.6%	17	38.6%
Unknown	0	0.0%	4	9.1%
All recipients	62	100.0%	44	100.0%

Table LU 16 Demographic characteristics of lung transplant recipients aged 0-11 years, 2006-2008 and 2016-2018 (continued from previous page). Lung transplant recipients aged 0-11 years, including retransplants. Distance is computed from recipient's home zip code to the transplant center.

Characteristic	2006-08		2016-18	
	N	Percent	N	Percent
Diagnosis				
Cystic fibrosis	12	19.4%	10	22.7%
Pulmonary hypertension	12	19.4%	10	22.7%
Pulmonary fibrosis	6	9.7%	2	4.5%
Other vascular	2	3.2%	2	4.5%
Other/unknown	30	48.4%	20	45.5%
Blood type				
A	25	40.3%	13	29.5%
B	5	8.1%	8	18.2%
AB	7	11.3%	2	4.5%
O	25	40.3%	21	47.7%
Medical condition				
Hospitalized in ICU	21	33.9%	17	38.6%
Hospitalized, not ICU	16	25.8%	5	11.4%
Not hospitalized	25	40.3%	22	50.0%
Medical urgency				
priority 1			34	77.3%
priority 2			10	22.7%
Vent/ECMO at transplant				
Vent + ECMO	2	3.2%	2	4.5%
Vent only	21	33.9%	12	27.3%
ECMO only	0	0.0%	1	2.3%
Neither	39	62.9%	29	65.9%
All recipients	62	100.0%	44	100.0%

Table LU 17 Clinical characteristics of lung transplant recipients aged 0-11 years, 2006-2008 and 2016-2018. Lung transplant recipients, including re-transplants. Pediatric priority was reported in 2012 and later. ECMO, extra-corporeal membrane oxygenation.

Characteristic	2006-08		2016-18	
	N	Percent	N	Percent
Wait time				
< 31 days	18	29.0%	5	11.4%
31-60 days	13	21.0%	11	25.0%
61-90 days	8	12.9%	7	15.9%
3-< 6 months	10	16.1%	7	15.9%
6-< 12 months	10	16.1%	10	22.7%
≥ 1 year	3	4.8%	4	9.1%
Bilateral procedure	62	100.0%	44	100.0%
Transplant history				
First	59	95.2%	44	100.0%
Retransplant	3	4.8%	0	0.0%
Tx type				
Lung only	51	82.3%	41	93.2%
Heart-lung	11	17.7%	2	4.5%
Other	0	0.0%	1	2.3%
All recipients	62	100.0%	44	100.0%

Table LU 18 Transplant characteristics of lung transplant recipients aged 0-11 years, 2006-2008 and 2016-2018. Lung transplant recipients, including retransplants.

Donor	Recipient	CMV	EBV
D-	R-	36.4%	20.5%
D-	R+	15.9%	15.9%
D-	R unk	2.3%	0.0%
D+	R-	27.3%	43.2%
D+	R+	18.2%	20.5%
D+	R unk	0.0%	0.0%

Table LU 19 Donor-recipient serology matching among lung transplant recipients aged 0-11 years, 2016-2018. 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.

Event	One-year		Five-year	
	N	Pct	N	Pct
BOS				
None reported	44	89.8%	37	74.0%
Reported	2	4.1%	13	26.0%
Unknown	3	6.1%	0	0.0%
Diabetes	0	0.0%	4	8.0%
Malignancy	1	2.0%	1	2.0%
Re-hospitalization	22	44.9%	43	86.0%
Functional status				
Fully active	45	91.8%	47	94.0%
Min. active	1	2.0%	1	2.0%
Bedbound	1	2.0%	0	0.0%
Unknown	2	4.1%	2	4.0%
All recipients	49	100.0%	50	100.0%

Table LU 20 Posttransplant events among lung transplant recipients aged 0-11 years. Posttransplant morbidities are recorded on the OPTN Pediatric Transplant Recipient Follow-up Form and are included in the table if they were reported anytime on or before 1-year and 5-year follow-up. One-year events are reported for recipients in 2014-2017 and 5-year events for recipients in 2010-2013. Recipients of more than one transplant are counted separately per transplant.