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OPTN/SRTR 2021 Annual Data Report: COVID-19

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Abstract

This chapter updates the COVID-19 chapter from the 2020 Annual Data Report with trends through February 12, 2022, and introduces trends in COVID-19–specific cause of death on the waiting list and posttransplant. Transplant rates remain at or above prepandemic levels for all organs, indicating a sustained transplantation system recovery following the initial 3-month disruption due to the onset of the pandemic. Posttransplant mortality and graft failure remain a concern in all organs, with rates surging corresponding to waves of the pandemic. Waitlist mortality due to COVID-19 is also a concern, particularly among kidney candidates. While the recovery of the transplantation system has been sustained in the second year of the pandemic, ongoing efforts should focus on reducing posttransplant and waitlist mortality due to COVID-19, and graft failure.

Keywords: COVID-19, solid organ transplant, transplant outcomes, waitlist mortality

1 INTRODUCTION

The COVID-19 pandemic has now continued for more than 2 years. While the most dramatic disruptions to transplant activity happened in the first months of the pandemic,[1,2,3,4] the effects of COVID-19 on the US transplantation system are ongoing. This chapter updates the COVID-19 chapter from the Organ Procurement and Transplantation Network (OPTN)/Scientific Registry of Transplant Recipients (SRTR) 2020 Annual Data Report[5] with trends through February 12, 2022 (the most recent available complete data) and includes figures on COVID-19–specific pretransplant and posttransplant mortality that were not available in that previous Annual Data Report. SRTR continues to maintain an online app that is now updated quarterly and tracks these metrics, as well as more detailed subgroup and adjusted analyses, at www.srtr.org/tools/covid-19-evaluation.

The previous (2020) Annual Data Report presented monthly trends before and after the March 13, 2020, declaration of a national emergency through March 12, 2021. Since that previous report, vaccines and vaccine boosters have become widely available for all age groups except children younger than 5 years. In the fall and winter of 2021 to 2022, variants of COVID-19 that demonstrated more immune evasiveness to the early iterations of the vaccines arose: the Delta variant corresponding to months 17 and 18 after the national emergency declaration (August 13, 2021, through October 12, 2021) and the Omicron variant corresponding to months 21 and 22 after the national emergency declaration (December 13, 2021, through February 12, 2022). These led to two COVID-19 waves in the fall and winter of 2021 to 2022, which are detailed in this chapter. In many cases we note where increases in mortality correspond to waves of COVID-19 that were linked to the Delta variant or the Omicron variant. It is not possible to fully attribute mortality to these variants, and, for example, some mortality that occurred during the wave dominated by the Omicron variant may have been attributable to the Delta variant due to the lag between infection and mortality; there may have also been geographic variability in the timing of waves of the different variants.

2 KIDNEY

The number of prevalent kidney listings, which fell by almost 5,000 in the first year of the pandemic, remained low. There were 104,648 adult kidney transplant listings in the month before the onset of the pandemic (February 13, 2020, through March 12, 2020), and there were 99,414 adult kidney transplant listings in the most recent month for which data are available (January 13, 2022, through February 12, 2022) (Figure COV 1).

The numbers of new adult kidney candidates added to the waiting list each month in the second year of the pandemic were similar to numbers added each month before the pandemic (Figure COV 2).

Living donor transplant rates in the second year of the pandemic were similar to monthly rates before the pandemic (Figure COV 4), and deceased donor transplant rates in the second year of the pandemic were slightly higher than those before the pandemic (Figure COV 3). The number of kidney offers made increased substantially (Figure COV 5) and the unadjusted offer acceptance rate decreased substantially (Figure COV 6) in the second year of the pandemic. However, these changes also correspond with the implementation of the 250–nautical-mile circle kidney allocation policy on March 15, 2021, which replaced organ procurement organization (OPO) donation service area (DSA) with a 250–nautical-mile circle around the donor hospital as the unit for local allocation.

Adult waitlist mortality rates showed spikes that correlated to the Delta variant wave and Omicron variant wave (Figure COV 7). Corresponding to the overall spikes in waitlist mortality are spikes in mortality with COVID-19 listed as the cause of death (Figure COV 8). The spikes during the Delta and Omicron variant waves in COVID-19–specific cause of death are notably smaller than the spike during the winter 2020-2021 wave. Concerningly, there was a substantial increase in overall waitlist mortality rates for pediatric candidates during the Delta variant wave, rising to 4.6 deaths per 100 person-years in the month from September 13, 2021, through October 12, 2021, although there did not seem to be a similar spike during the Omicron variant wave (Figure COV 7).

Adult all-cause kidney graft failure rates rose during the Delta variant wave and showed their biggest spike in the past 3 years during the Omicron variant wave, rising to 12.1 graft failures per 100 person-years from January 13, 2022, through February 12, 2022 (Figure COV 9). Corresponding to these graft failure spikes were spikes in posttransplant mortality with COVID-19 cause of death (Figure COV 10).

Geographically, differences in the adjusted rates of kidney waitlist mortality from before to after the start of the COVID-19 pandemic differed slightly by OPO DSA, with some increasing and some decreasing. Hazard ratios for waitlist mortality, the difference in the OPO's hazard ratio compared with the nation as a whole in the 12 months after the start of the COVID-19 pandemic as compared with the 12 months before, ranged from 0.86 to 1.11 (Figure COV 11). Similarly, differences in adjusted rates of adult kidney transplant from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.60 to 2.02 (Figure COV 12). Differences in adjusted rates of kidney graft failure from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.88 to 1.20 (Figure COV 13).

3 PANCREAS

The number of prevalent pancreas candidates has continued a gradual increase that started before the pandemic (Figure COV 14). The number of new pancreas candidates added each month remains similar to levels before the start of the pandemic (Figure COV 15), as does the pancreas waitlist mortality rate (Figure COV 17) and there have been very few recorded COVID-19–specific cause of death among pancreas waitlist candidates. The pancreas deceased donor transplant rate remains slightly lower than before the pandemic, although not as low as in the first months after the national emergency declaration (Figure COV 16). The only recorded COVID-19–specific cause of death among pancreas waitlist candidates occurred during month 22 after the national emergency declaration, but the rate was small (0.7 deaths per 100 person-years).

Pancreas all-cause graft failure shows slight peaks that correspond to waves of the pandemic, and reached a level of 8.9 graft failures per 100 person-years from January 13, 2022, through February 12, 2022, compared with a highest monthly level of 6.6 graft failures per 100 person-years in the year before the start of the pandemic (Figure COV 18). There are peaks in COVID-19–specific deaths among pancreas transplant recipients during waves of the pandemic, with the highest level observed during the Omicron variant wave from January 13, 2022, through February 12, 2022, at 2.9 deaths per 100 person-years (Figure COV 19).

Geographically, differences in the adjusted rates of pancreas waitlist mortality from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.68 to 1.36 (Figure COV 20). Differences in adjusted rates of adult pancreas transplant from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.77 to 1.45 (Figure COV 21). Differences in adjusted rates of pancreas graft failure from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.93 to 1.05 (Figure COV 22).

4 LIVER

The ongoing downward trend in prevalent adult liver listings continued from March 2021 to February 2022 (Figure COV 23), and the monthly number of new listings remained similar to levels before the start of the pandemic (Figure COV 24). Deceased donor transplant rates (Figure COV 25) and living donor transplant rates (Figure COV 26) also remained similar to levels before the start of the pandemic. Numbers of liver offers continued their increase relative to levels before the pandemic (Figure COV 27), and unadjusted offer acceptance rates remained lower than levels before the pandemic (Figure COV 28); these trends are likely due to the implementation of the liver acuity circle allocation policy in

February 2020.

Liver waitlist mortality was higher during waves of the pandemic, although these peaks were no higher than levels seen in some months before the pandemic (Figure COV 29). COVID-19–specific cause of death was higher among liver candidates during waves of the pandemic, although the rates during the Delta and Omicron variant waves were lower than the rate during the winter 2020-2021 wave (Figure COV 30).

Liver all-cause graft failure was notably higher during waves of the pandemic and rose to 7.0 graft failures per 100 person-years from January 13, 2022, through February 12, 2022, during the Omicron variant wave, as compared with a highest monthly rate of 5.3 failures per 100 person-years in the year before the start of the pandemic (Figure COV 31). There were also notable increases in COVID-19–specific cause of death among liver recipients during waves of the pandemic (Figure COV 32).

Geographically, differences in the adjusted rates of liver waitlist mortality from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.92 to 1.06 (Figure COV 33). Differences in adjusted rates of adult liver transplant from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.49 to 1.84 (Figure COV 34). Differences in adjusted rates of liver graft failure before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.98 to 1.03 (Figure COV 35).

5 INTESTINE

Small numbers of patients receiving or waiting for an intestine transplant led to high month-to-month variability in metrics, making it difficult to detect any trends related to the pandemic (Figures COV 36, 37, 38, 39, 40, 41, and 42). The decrease in the number of prevalent pediatric candidates and increase in the number of prevalent adult candidates during the pandemic noted in the previous (2020) Annual Data Report continued from March 2021 to February 2022 (Figure COV 36).

6 HEART

The number of prevalent heart listings remained slightly lower than before the pandemic (Figure COV 43), although the number of new monthly heart listings was slightly higher than before the pandemic (Figure COV 44). As with other organs, heart allocation policy was changed recently, with the January 2020 removal of DSA from heart allocation, making it difficult to attribute any changes in listings solely to COVID-19. The heart transplant rate remained slightly higher after the start of the pandemic compared with before (Figure COV 45). There was no discernable trend in heart offer numbers (Figure COV 46) or

unadjusted offer acceptance rates (Figure COV 47) before to after the start of the pandemic. While there were deaths due to COVID-19 among heart waitlist candidates (Figure COV 49), rates of overall heart waitlist mortality were not substantially higher after the start of the pandemic (Figure COV 48).

All-cause heart graft failure increased during the waves of the pandemic, and reached a rate of 9.6 graft failures per 100 person-years from January 13, 2022, through February 12, 2022, as compared with a highest monthly rate of 5.7 graft failures per 100 person-years in the year before the start of the pandemic (Figure COV 50). COVID-19–specific cause of death increased among heart transplant recipients during waves of the pandemic, with a highest monthly level of 2.5 deaths per 100 patient-years from January 13, 2022, through February 12, 2022, during the Omicron variant wave (Figure COV 51).

Geographically, differences in the adjusted rates of heart waitlist mortality from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.93 to 1.07 (Figure COV 52). Differences in adjusted rates of adult heart transplant from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.68 to 1.53 (Figure COV 53). Differences in adjusted rates of heart graft failure from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.99 to 1.02 (Figure COV 54).

7 LUNG

The number of prevalent lung listings (Figure COV 55) and the number of monthly new lung listings (Figure COV 56) remained lower after the start of the pandemic as compared with before, while the lung transplant rate remained higher (Figure COV 57). Lung transplant has emerged as a treatment for severe COVID-19, so higher transplant rates are not surprising, although lower numbers of new and prevalent listings are somewhat unexpected. Offer numbers remained lower after the start of the pandemic (Figure COV 58), but there was no noticeable trend in unadjusted offer acceptance rates (Figure COV 59). Rates of overall lung waitlist mortality were not substantially higher after the start of the pandemic (Figure COV 60), although there were deaths due to COVID-19 among lung waitlist candidates (Figure COV 61).

All-cause lung graft failure increased during the waves of the pandemic and reached a rate of 20.5 graft failures per 100 person-years from January 13, 2022, through February 12, 2022, as compared with a highest monthly rate of 12.7 graft failures per 100 person-years in the year before the start of the pandemic (Figure COV 62). COVID-19–specific cause of death increased among lung transplant recipients during waves of the pandemic, with a highest monthly level of 6.5 deaths per 100 patient-years from January

13, 2022, through February 12, 2022, during the Omicron variant wave (Figure COV 63).

Geographically, differences in the adjusted rates of lung waitlist mortality from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.87 to 1.13 (Figure COV 64). Differences in adjusted rates of adult lung transplant from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.49 to 2.25 (Figure COV 65). Differences in adjusted rates of lung graft failure from before to after the start of the COVID-19 pandemic by OPO DSA ranged from 0.92 to 1.05 (Figure COV 66).

8 DISCUSSION

The previous (2020) Annual Data Report noted a decrease in transplants in the early months of the pandemic, followed by a return to prepandemic levels.[5] The return to, or even slight increase from, prepandemic transplant rates continued in the second year of the pandemic, indicating that the transplantation system has generally stayed at prepandemic functioning after the initial 3-month disruption.

Transplant recipient outcomes, however, remain a point of concern. While notable increases in waitlist mortality were only observed among kidney candidates, there were dramatic increases in posttransplant graft failure and COVID-19–specific mortality among recipients of all solid organs. For most organs, the increase in mortality and all-cause graft failure was highest during the Omicron variant wave of the pandemic. While there is evidence in the general population that Omicron is less virulent than the original COVID-19 strain,[6,7] this chapter shows that mortality remains high among transplant recipients.

Kidney candidates, many of whom have to undergo in-center dialysis where there may be risk for viral spread, and who have longer waiting times before transplant, showed higher levels of mortality during waves of the pandemic. Increases in pretransplant mortality were generally among adult kidney candidates, although there was a concerning rise in pediatric kidney candidate mortality during the Delta variant wave. Because the kidney allocation policies give priority based on waiting time, additional candidate information is available from the OPTN to assess waitlist mortality due to COVID-19. It is possible that potential candidates of other organs also had increased mortality, but they may have never been listed as a result of their COVID-19 infection. Thus, mortality for non-kidney patients in end-organ failure may not have been captured as well as it was for kidney candidates.

While transplant activity seems to have resumed as normal, transplant professionals need to seek continued improvements in protecting transplant recipients and kidney transplant candidates against COVID-19 infection.

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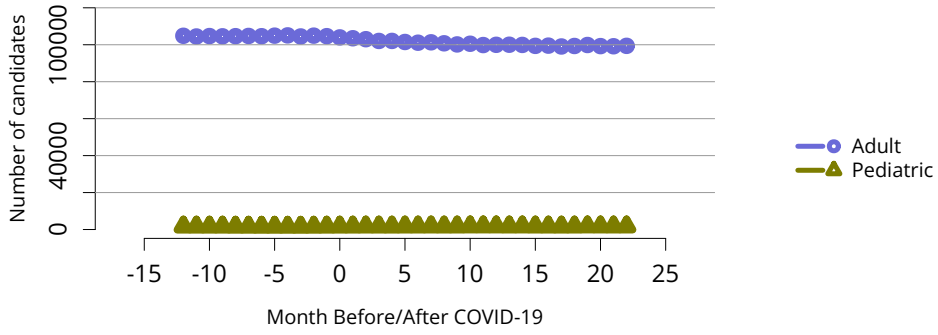

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Figure COV 1: Number of prevalent kidney candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.

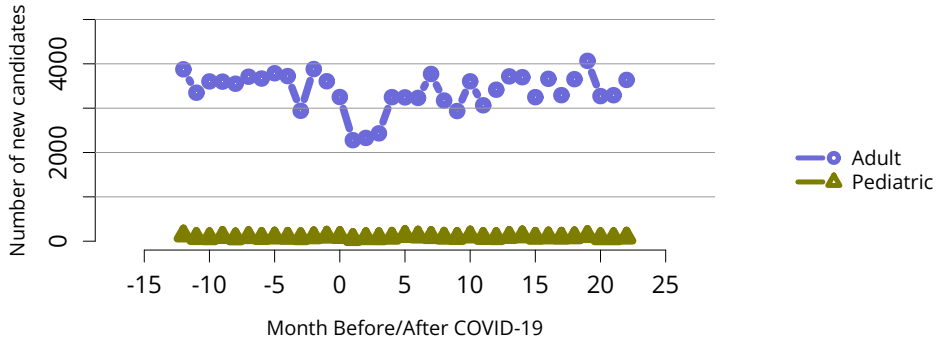

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Figure COV 2: Number of new kidney candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.

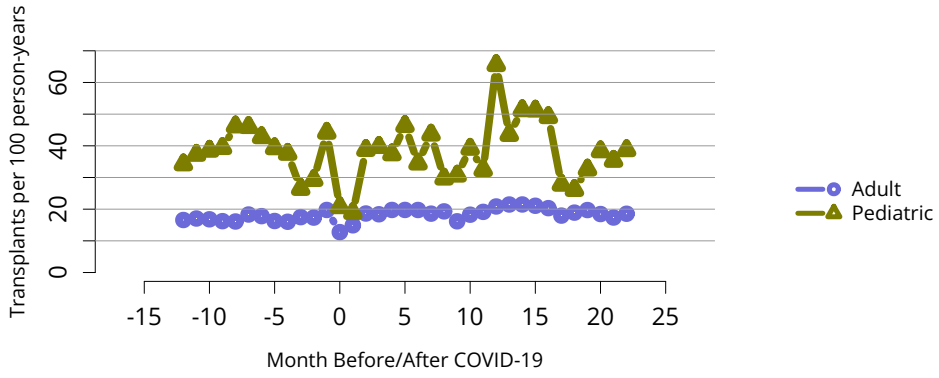

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Figure COV 3: Deceased donor kidney transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given month. Individual listings are counted separately.

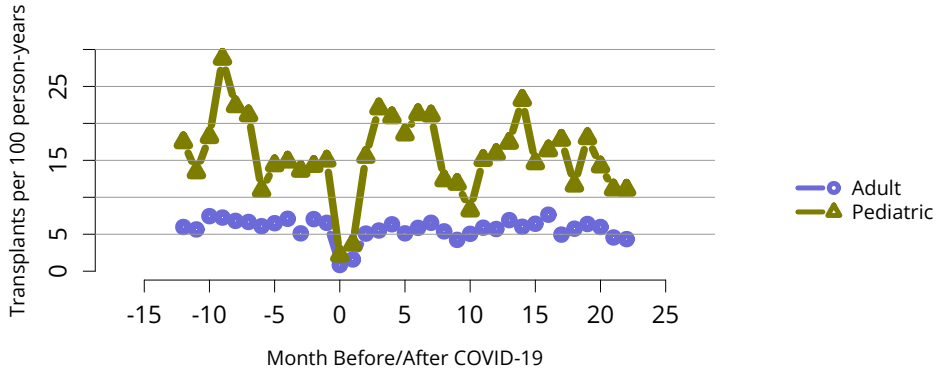

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Figure COV 4: Living donor kidney transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of living donor transplants per 100 patient-years of waiting in a given month. Individual listings are counted separately.

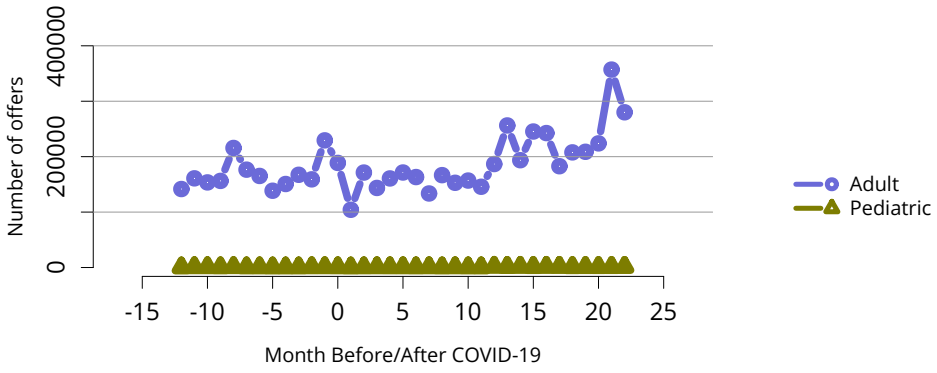

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Figure COV 5: Number of kidney offers. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

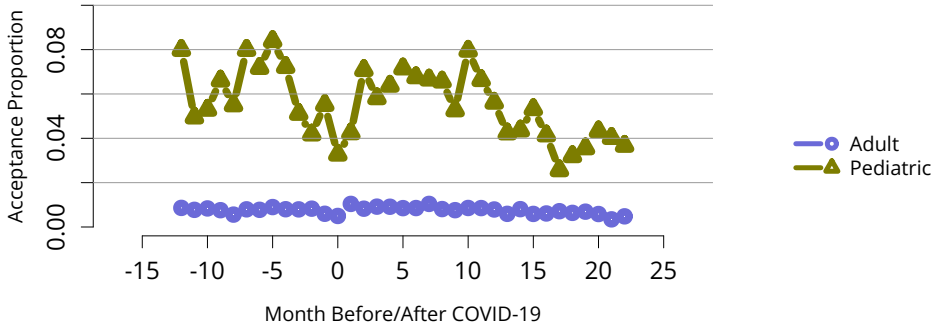

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Figure COV 6: Kidney offer acceptance rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

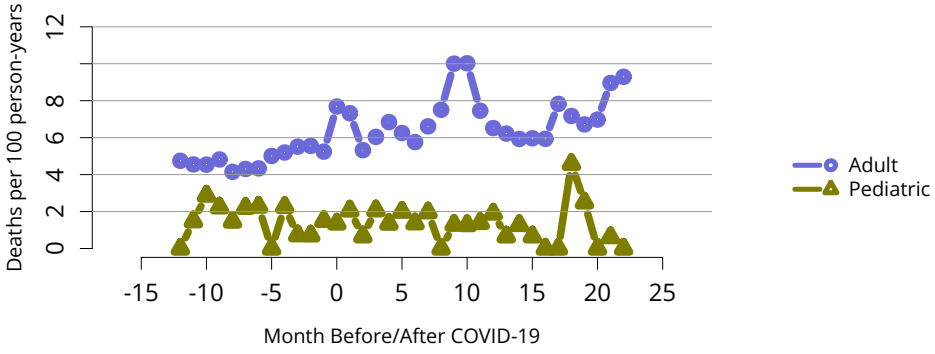

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Figure COV 7: Kidney waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

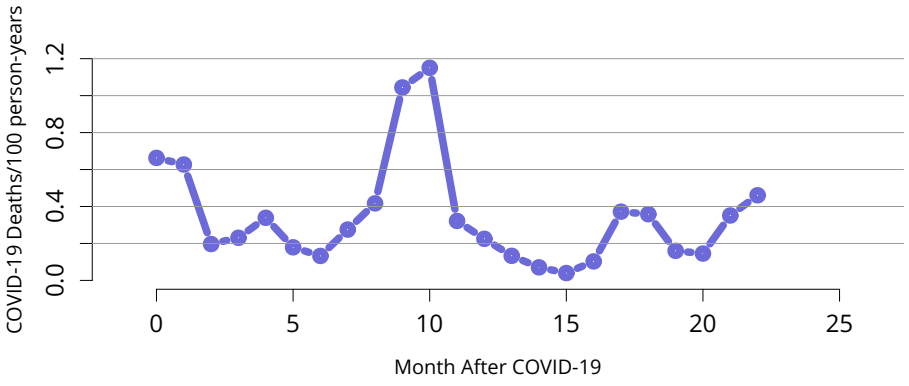

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Figure COV 8: Kidney waitlist COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

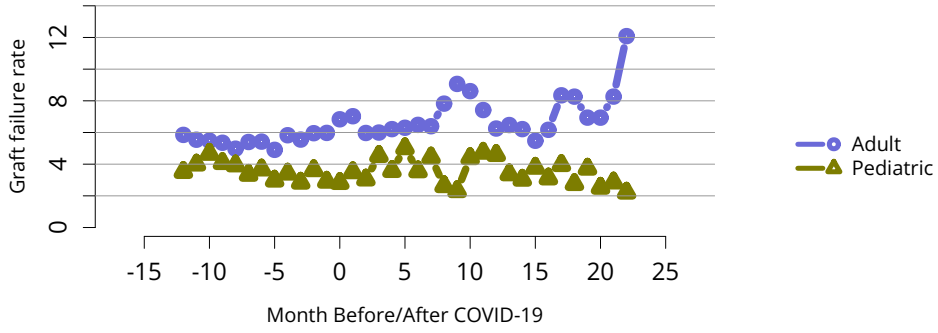

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Figure COV 9: Kidney all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

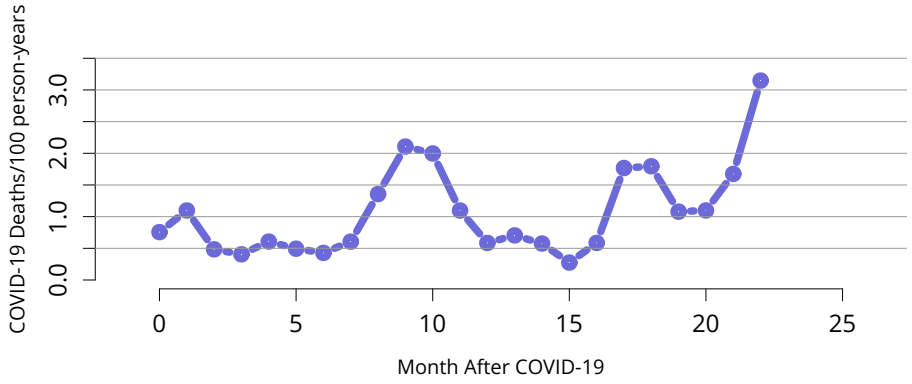

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Figure COV 10: Kidney post-transplant COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

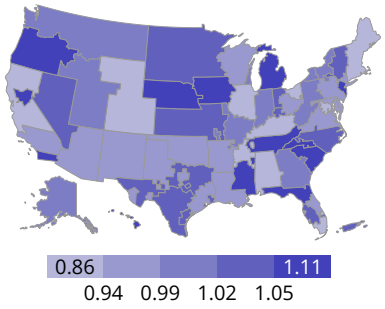

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Figure COV 11: Difference in risk adjusted kidney waitlist mortality hazard ratio before to after COVID-19 by OPO. Waitlist mortality hazard ratio is the difference in the organ procurement organization's (OPO's) hazard ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. 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. Model adjusted for blood type, age in years, body mass index, calculated panel reactive antibody, primary diagnosis, duration of dialysis, miles between candidate and program, ethnicity, sex, type of kidney transplant, candidate insurance type, race, previous transplant for candidates, candidate urbanicity, and waiting time (years).

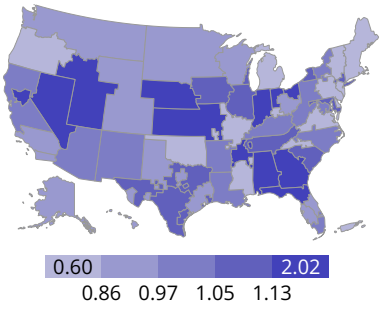

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Figure COV 12: Difference in risk adjusted kidney transplant rate before to after COVID-19 by OPO. Transplant rate ratio is the difference in the organ procurement organization's (OPO's) rate ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Individual listings are counted separately. Model adjusted for blood type, age in years, body mass index, calculated panel reactive antibody, primary diagnosis, duration of dialysis, miles between candidate and program, ethnicity, sex, type of kidney transplant, candidate insurance type, race, previous transplant for candidates, candidate urbanicity, and waiting time (years).

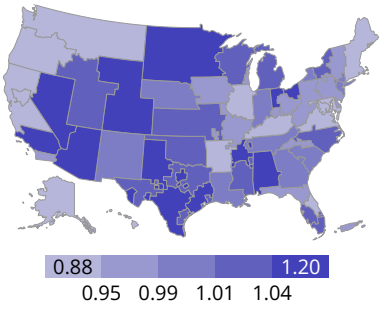

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Figure COV 13: Difference in risk adjusted kidney all-cause graft failure hazard ratio before to after COVID-19 by OPO. Graft failure hazard ratio is the difference in the organ procurement organization's (OPO's) hazard ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Model adjusted for blood type, ethnicity, sex, candidate insurance type, race, donor age (years), donor ethnicity, donor hypertension status, donor race, donor sex, recipient age (years), body mass index, cold ischemia time (hours), primary diagnosis, diabetes status, years of dialysis, miles between recipient and program, donor diabetes status, donor serum creatinine, donor type, number of HLA mismatches, donor kidney donor profile index, multiorgan transplant, calculated panel reactive antibody, recipient had a previous transplant, recipient urbanicity, type of kidney transplant, and miles between donor and program.

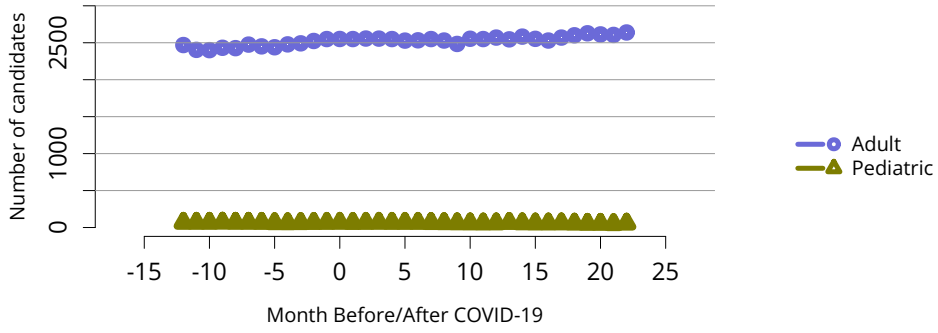

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Figure COV 14: Number of prevalent pancreas candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.

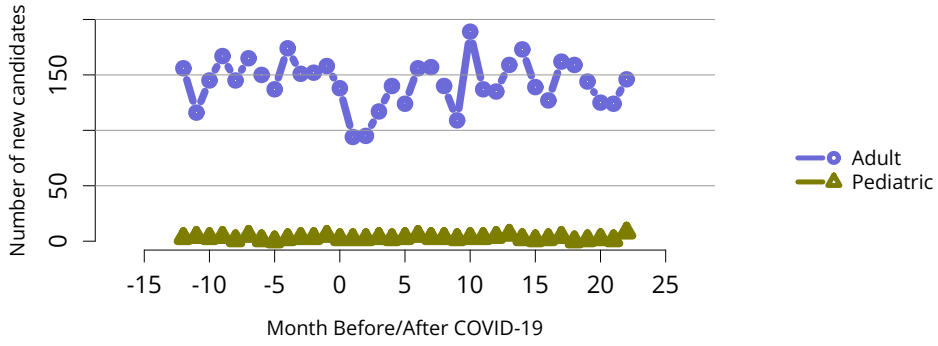

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Figure COV 15: Number of new pancreas candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.

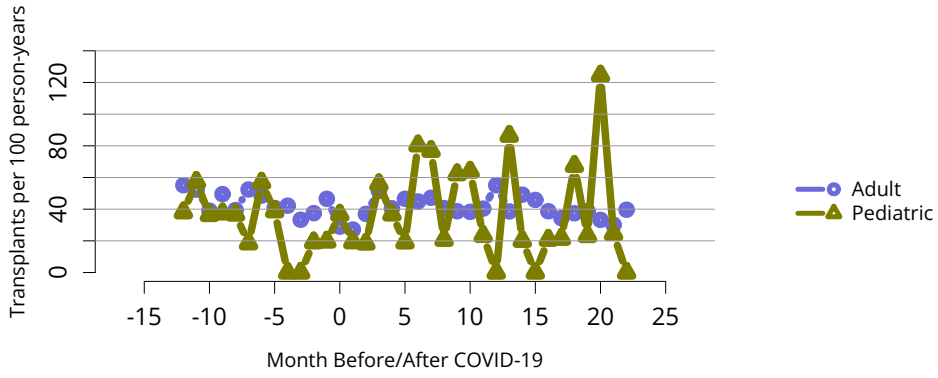

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Figure COV 16: Deceased donor pancreas transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given month. Individual listings are counted separately.

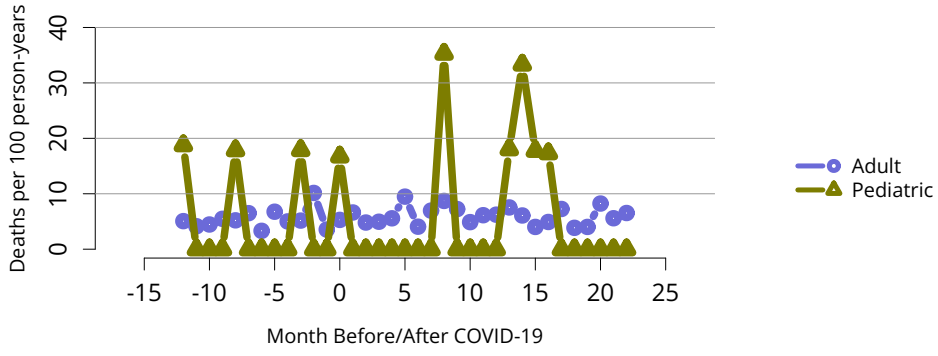

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Figure COV 17: Pancreas waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

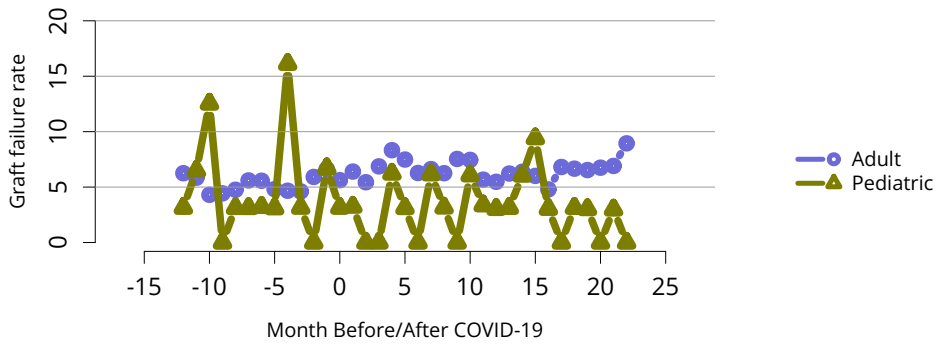

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Figure COV 18: Pancreas all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

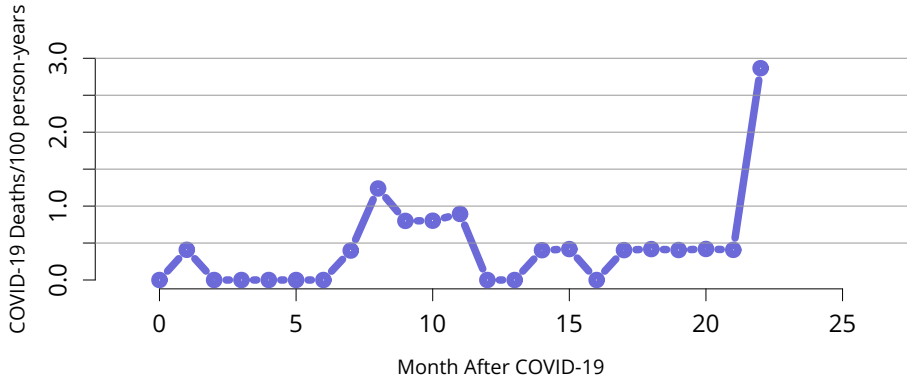

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Figure COV 19: Pancreas post-transplant COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

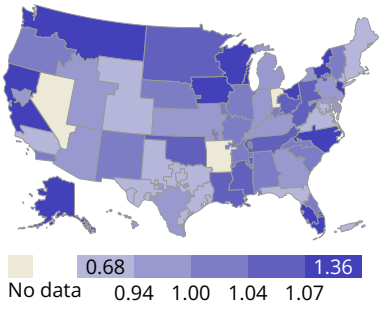

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Figure COV 20: Difference in risk adjusted pancreas waitlist mortality hazard ratio before to after COVID-19 by OPO. Waitlist mortality hazard ratio is the difference in the organ procurement organization (OPO's) hazard ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. 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. Model adjusted for blood type, age in years, body mass index, primary diagnosis, duration of dialysis, miles between candidate and program, ethnicity, sex, type of pancreas transplant, candidate insurance type, race, previous transplant for candidates, candidate urbanicity, and waiting time.

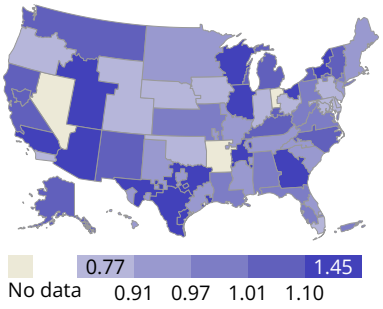

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Figure COV 21: Difference in risk adjusted pancreas transplant rate before to after COVID-19 by OPO. Transplant rate ratio is the difference in the organ procurement organization's (OPO's) rate ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Individual listings are counted separately. Model adjusted for blood type, age in years, body mass index, primary diagnosis, duration of dialysis, miles between candidate and program, ethnicity, sex, type of pancreas transplant, candidate insurance type, race, previous transplant for candidates, candidate urbanicity, and waiting time.

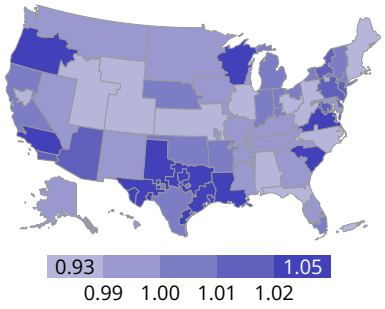

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Figure COV 22: Difference in risk adjusted pancreas all-cause graft failure hazard ratio before to after COVID-19 by OPO. Graft failure hazard ratio is the difference in the organ procurement organization's (OPO's) hazard ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Model adjusted for blood type, ethnicity, sex, candidate insurance type, race, donor age (years), donor ethnicity, donor hypertension status, donor race, donor sex, recipient age (years), body mass index, primary diagnosis, years of dialysis, miles between recipient and program, donor type, recipient urbanicity, and miles between donor and program.

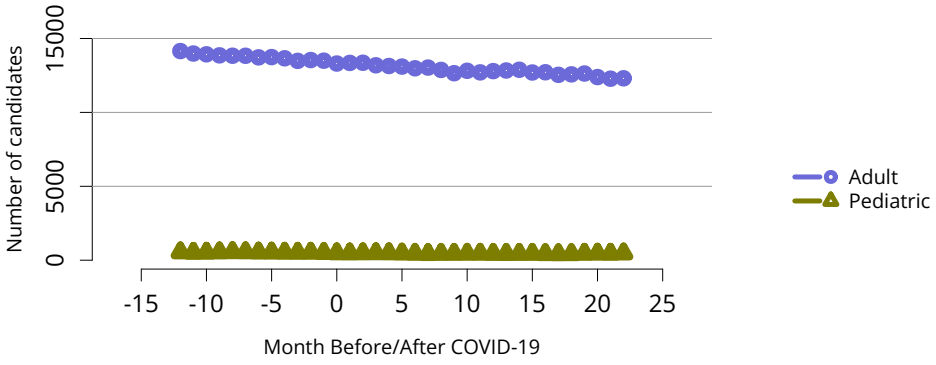

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Figure COV 23: Number of prevalent liver candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.

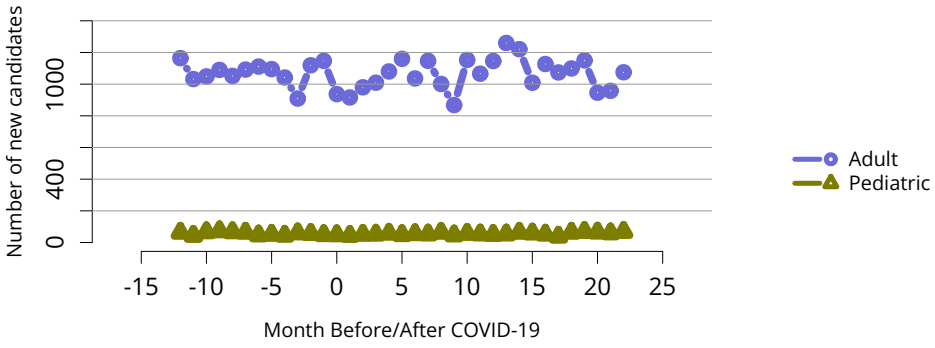

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Figure COV 24: Number of new liver candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.

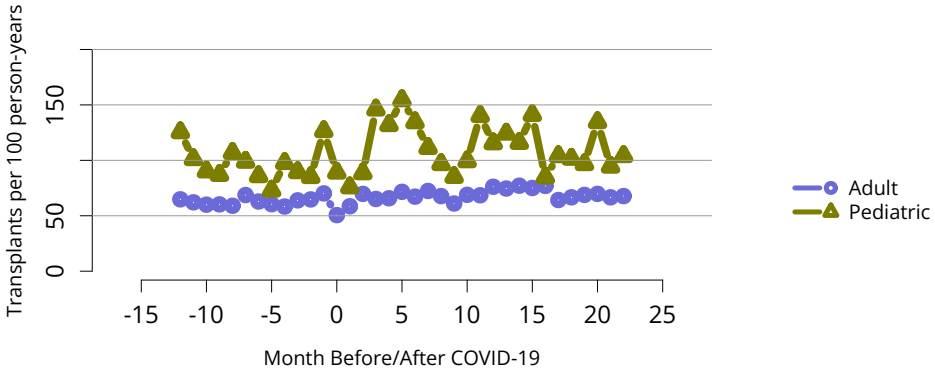

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Figure COV 25: Deceased donor liver transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given month. Individual listings are counted separately.

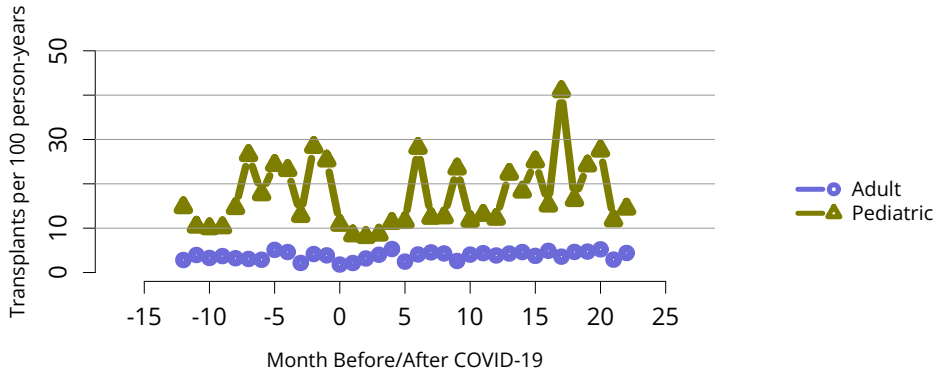

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Figure COV 26: Living donor liver transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of living donor transplants per 100 patient-years of waiting in a given month. Individual listings are counted separately.

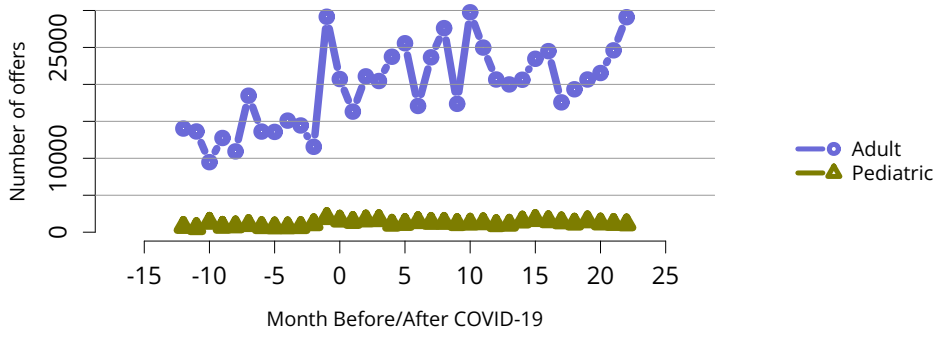

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Figure COV 27: Number of liver offers. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

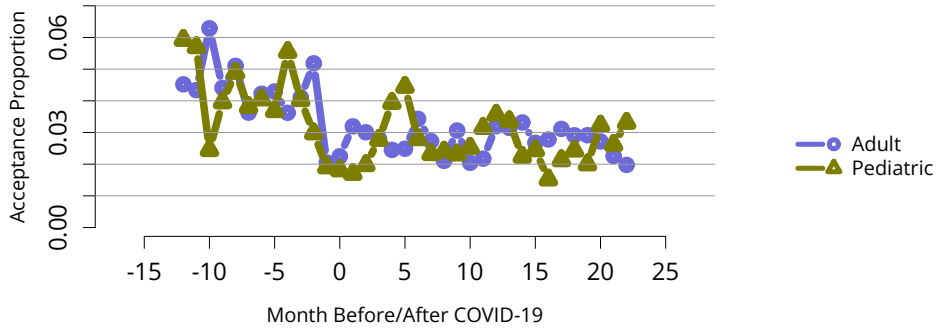

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Figure COV 28: Liver offer acceptance rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

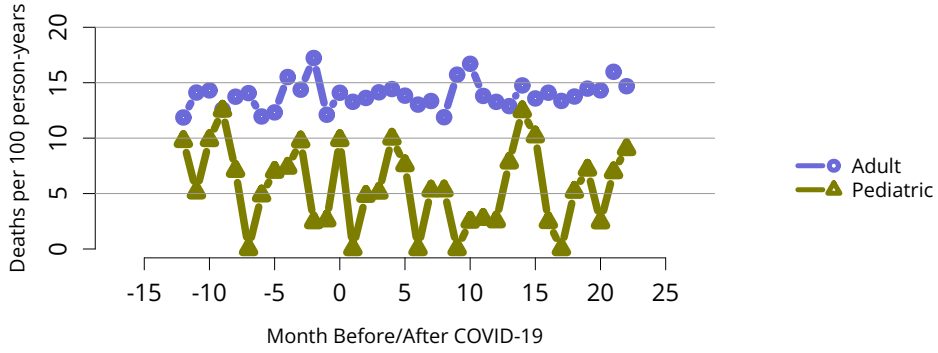

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Figure COV 29: Liver waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

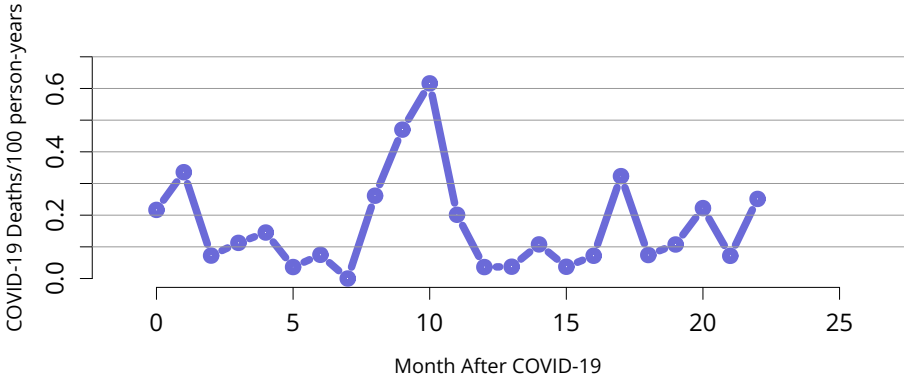

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Figure COV 30: Liver waitlist COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

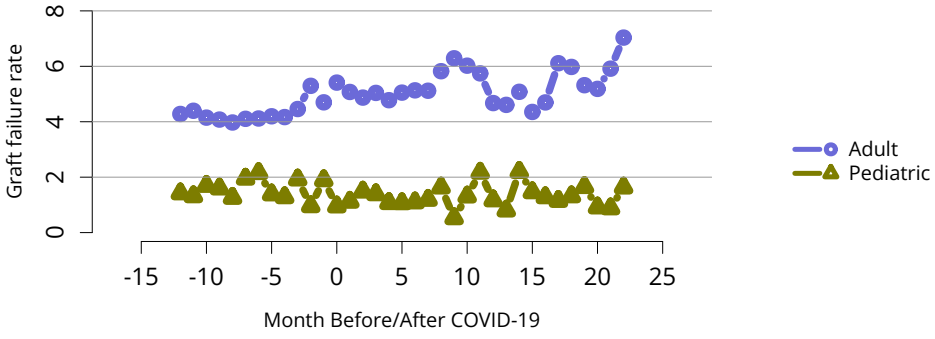

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Figure COV 31: Liver all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

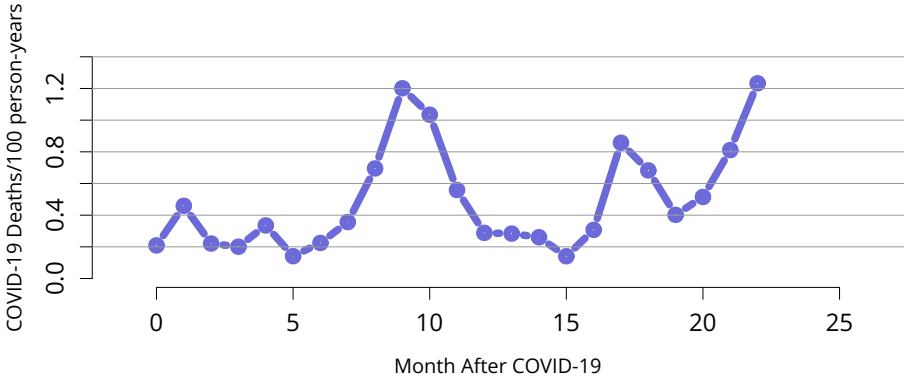

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Figure COV 32: Liver post-transplant COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

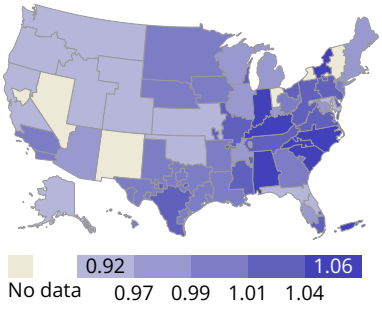

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Figure COV 33: Difference in risk adjusted liver waitlist mortality hazard ratio before to after COVID-19 by OPO. Waitlist mortality hazard ratio is the difference in the organ procurement organization's (OPO's) hazard ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. 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. Model adjusted for blood type, age in years, body mass index, primary diagnosis, miles between candidate and program, ethnicity, pediatric end-stage liver disease (PELD)/model for end-stage liver disease (MELD) score, sex, hepatocellular carcinoma status, candidate insurance type, race, previous transplant for candidates, candidate urbanicity, and waiting time.

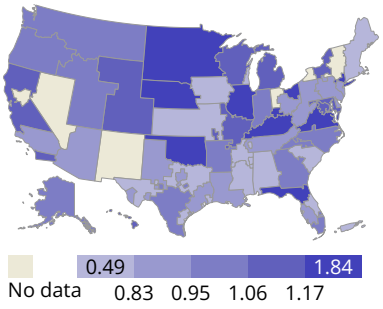

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Figure COV 34: Difference in risk adjusted liver transplant rate before to after COVID-19 by OPO. Transplant rate ratio is the difference in the organ procurement organization's (OPO's) rate ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Individual listings are counted separately. Model adjusted for blood type, age in years, body mass index, primary diagnosis, miles between candidate and program, ethnicity, pediatric end-stage liver disease (PELD)/model for end-stage liver disease (MELD) score, sex, hepatocellular carcinoma status, candidate insurance type, race, previous transplant for candidates, candidate urbanicity, and waiting time.

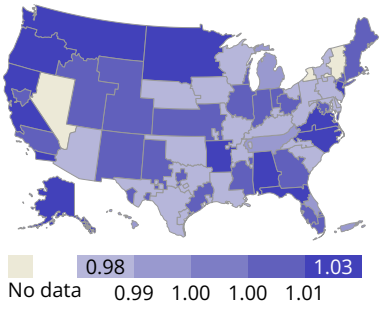

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Figure COV 35: Difference in risk adjusted liver all-cause graft failure hazard ratio before to after COVID-19 by OPO. Graft failure hazard ratio is the difference in the organ procurement organization's (OPO's) hazard ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Model adjusted for blood type, ethnicity, sex, candidate insurance type, race, donor age (years), donor ethnicity, donor hypertension status, donor race, donor sex, recipient age (years), body mass index, cold ischemia time (hours), primary diagnosis, miles between recipient and program, donor diabetes status, donor type, recipient hepatocellular carcinoma status, number of HLA mismatches, laboratory model for end-stage liver disease (MELD) at transplant, multiorgan transplant, recipient had a previous transplant, recipient urbanicity, miles between donor and program, and type of liver transplant.

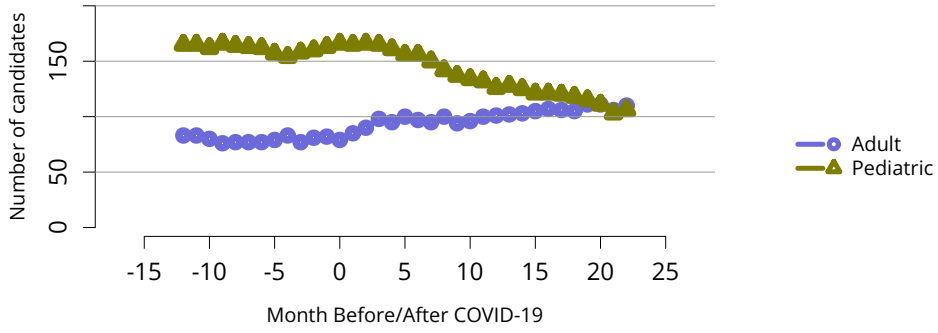

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Figure COV 36: Number of prevalent intestine candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.

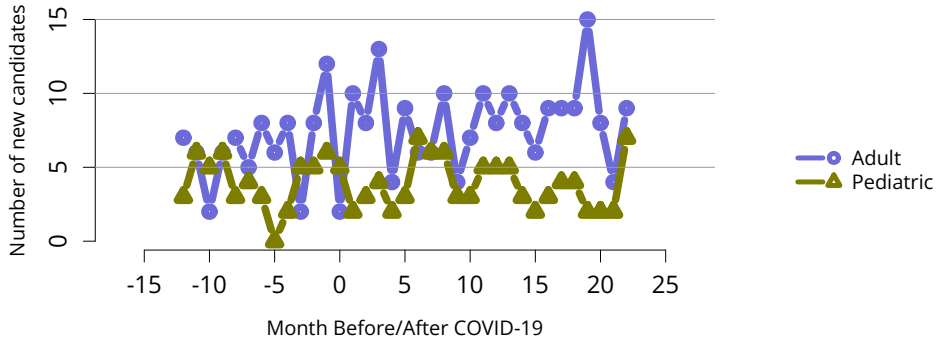

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Figure COV 37: Number of new intestine candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.

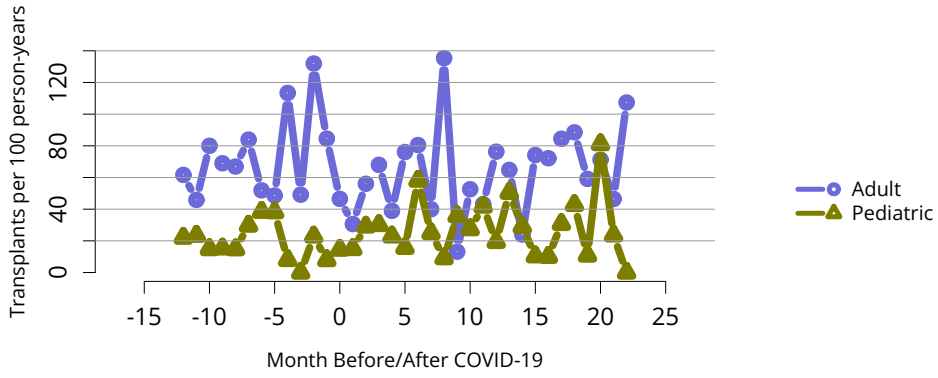

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Figure COV 38: Deceased donor intestine transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given month. Individual listings are counted separately.

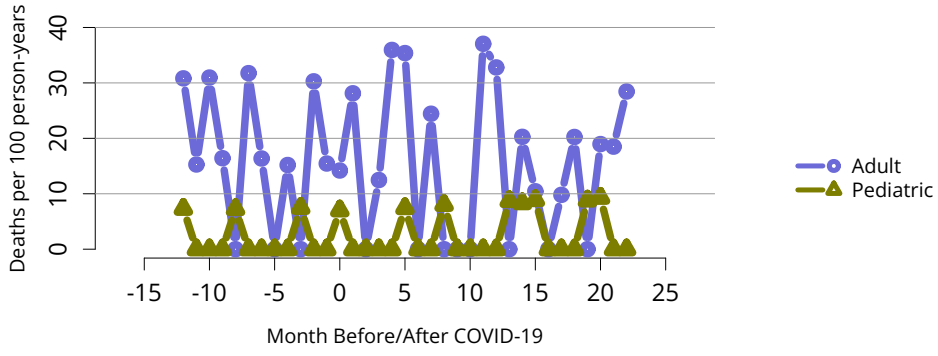

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Figure COV 39: Intestine waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

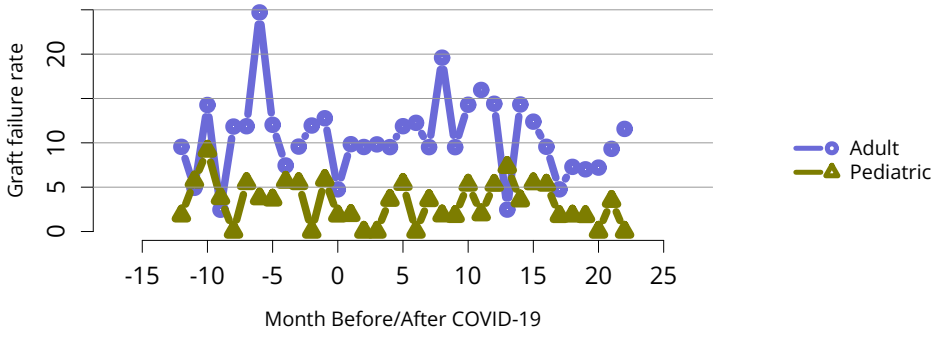

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Figure COV 40: Intestine all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

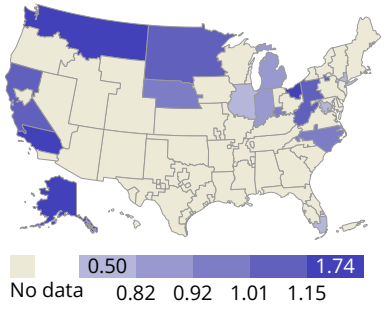

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Figure COV 41: Difference in risk adjusted intestine transplant rate before to after COVID-19 by OPO. Transplant rate ratio is the difference in the organ procurement organization's (OPO's) rate ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Individual listings are counted separately. Model adjusted for blood type, age in years, body mass index, primary diagnosis, miles between candidate and program, ethnicity, sex, intestine listing type, candidate insurance type, race, previous transplant for candidates, candidate urbanicity, and waiting time.

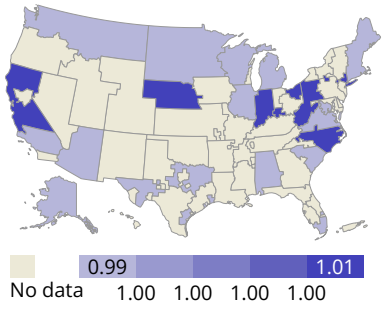

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Figure COV 42: Difference in risk adjusted intestine all-cause graft failure hazard ratio before to after COVID-19 by OPO. Graft failure hazard ratio is the difference in the organ procurement organization's (OPO's) hazard ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Model adjusted for ethnicity, sex, candidate insurance type, race, donor age (years), donor diabetes status, donor hypertension status, recipient age (years), body mass index, primary diagnosis, miles between recipient and program, intestine transplant type, recipient had a previous transplant, recipient urbanicity, and miles between donor and program.

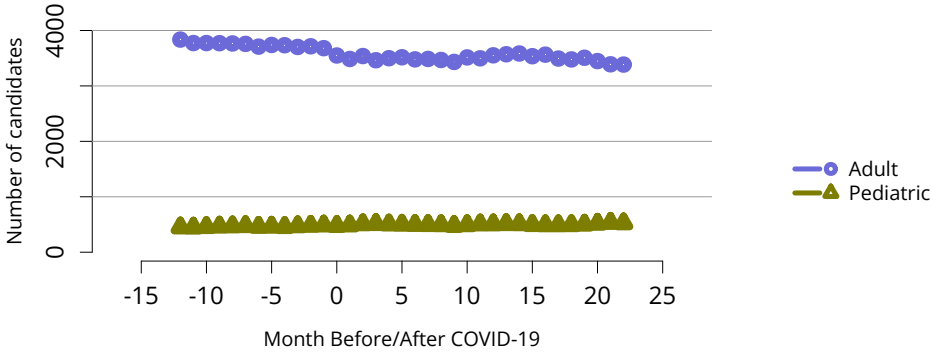

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Figure COV 43: Number of prevalent heart candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.

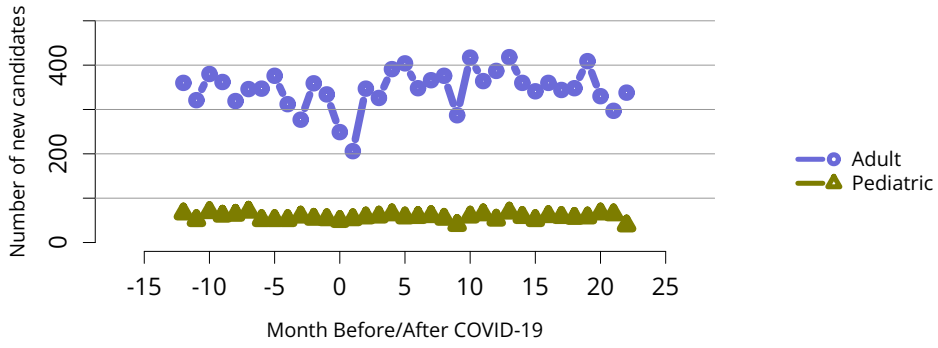

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Figure COV 44: Number of new heart candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.

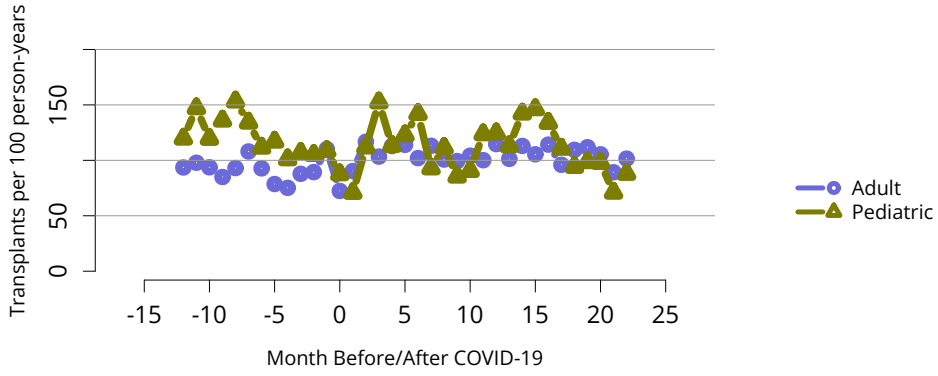

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Figure COV 45: Deceased donor heart transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given month. Individual listings are counted separately.

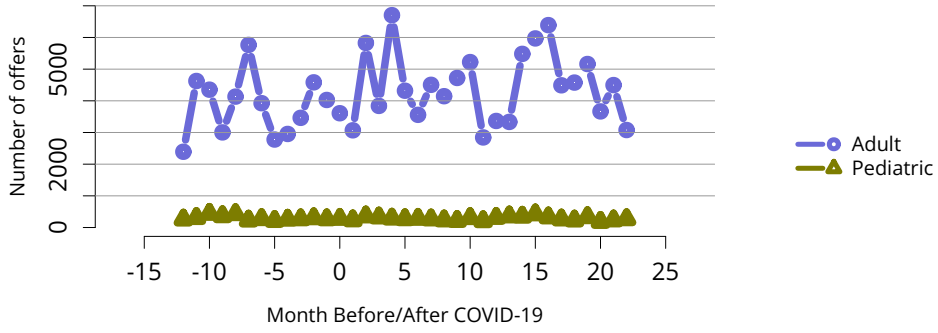

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Figure COV 46: Number of heart offers. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

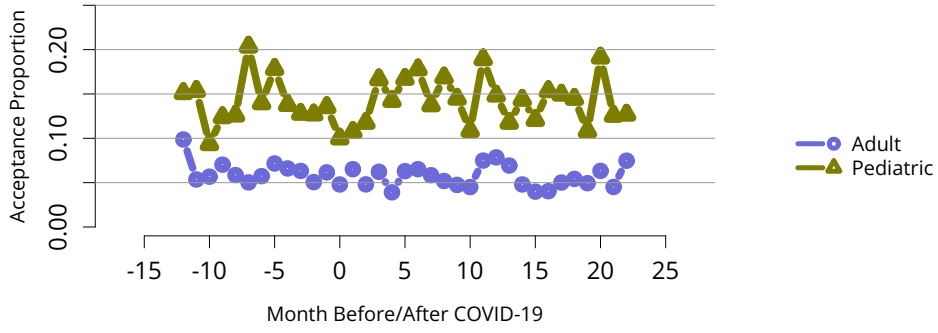

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Figure COV 47: Heart offer acceptance rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

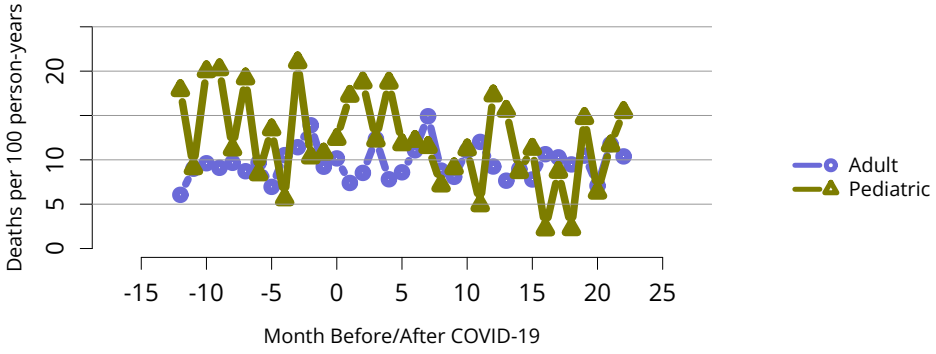

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Figure COV 48: Heart waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

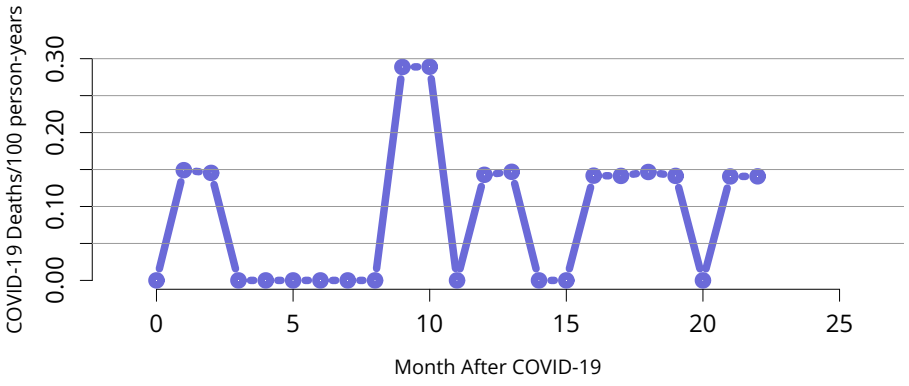

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Figure COV 49: Heart waitlist COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

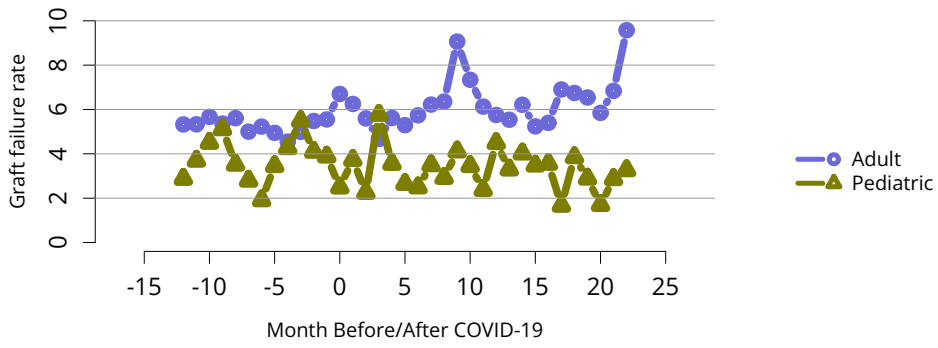

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Figure COV 50: Heart all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

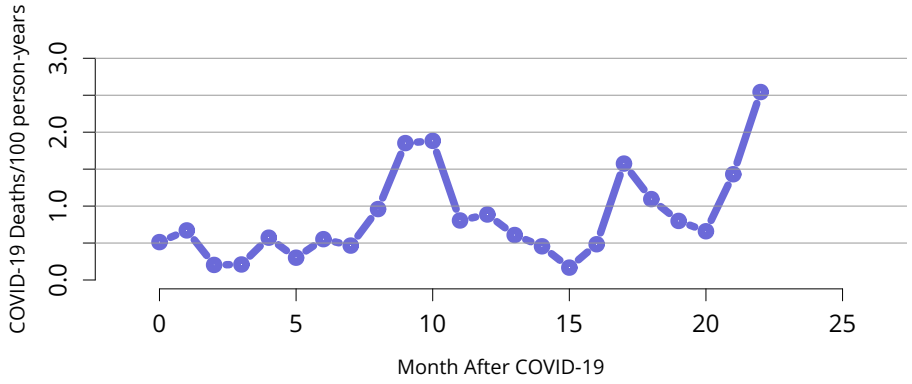

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Figure COV 51: Heart post-transplant COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

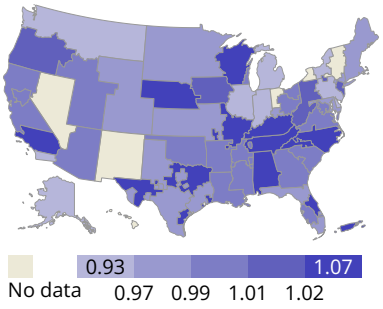

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Figure COV 52: Difference in risk adjusted heart waitlist mortality hazard ratio before to after COVID-19 by OPO. Waitlist mortality hazard ratio is the difference in the organ procurement organization's (OPO's) hazard ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. 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. Model adjusted for blood type, age in years, body mass index, primary diagnosis, miles between candidate and program, ethnicity, sex, height at listing (cm), candidate insurance type, race, previous transplant for candidates, candidate urbanicity, ventricular assist device status at listing, and waiting time.

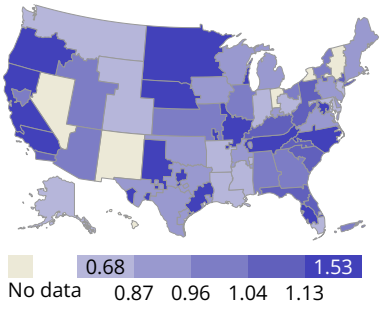

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Figure COV 53: Difference in risk adjusted heart transplant rate before to after COVID-19 by OPO. Transplant rate ratio is the difference in the organ procurement organization's (OPO's) rate ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Individual listings are counted separately. Model adjusted for blood type, age in years, body mass index, primary diagnosis, miles between candidate and program, ethnicity, sex, height at listing (cm), candidate insurance type, race, previous transplant for candidates, candidate urbanicity, ventricular assist device status at listing, and waiting time.

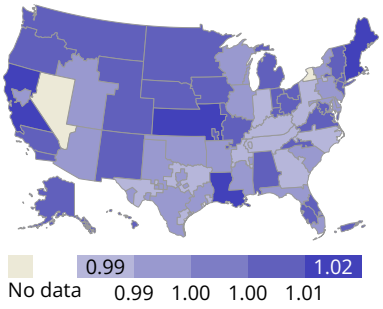

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Figure COV 54: Difference in risk adjusted heart all-cause graft failure hazard ratio before to after COVID-19 by OPO. Graft failure hazard ratio is the difference in the organ procurement organization's (OPO's) hazard ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Model adjusted for blood type, ethnicity, sex, candidate insurance type, race, donor age (years), donor diabetes status, donor ethnicity, donor hypertension status, donor race, donor sex, recipient age (years), body mass index, primary diagnosis, miles between recipient and program, number of HLA mismatches, allocation tier, height at transplant (cm), multiorgan transplant, recipient had a previous transplant, recipient urbanicity, ventricular assist device at transplant, and miles between donor and program.

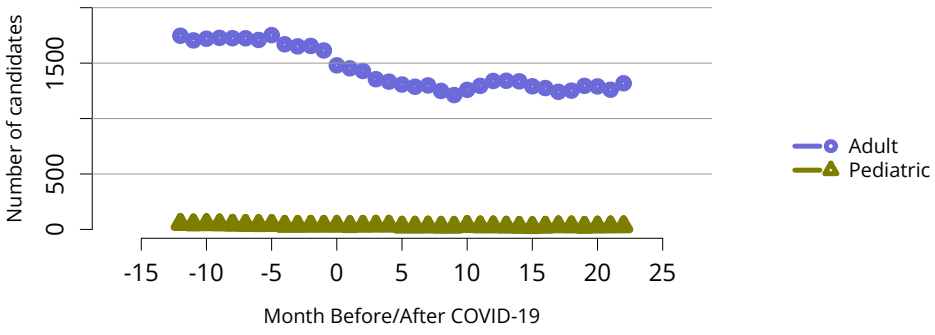

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Figure COV 55: Number of prevalent lung candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.

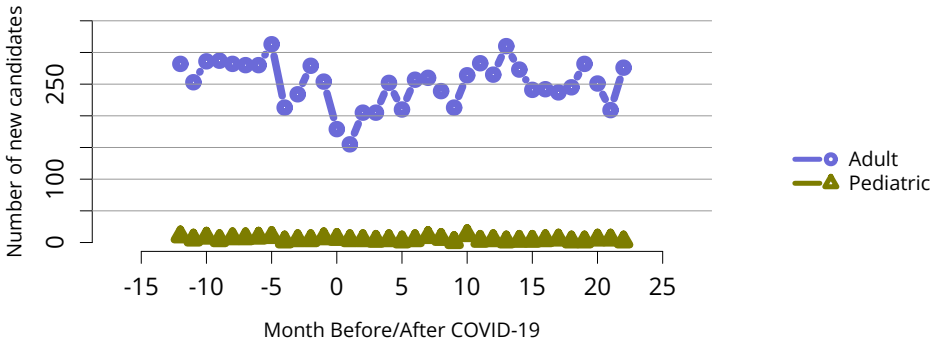

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Figure COV 56: Number of new lung candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.

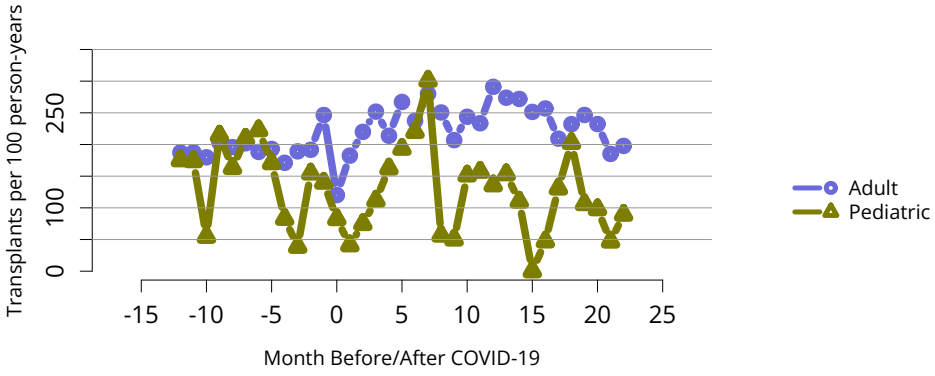

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Figure COV 57: Deceased donor lung transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting in a given month. Individual listings are counted separately.

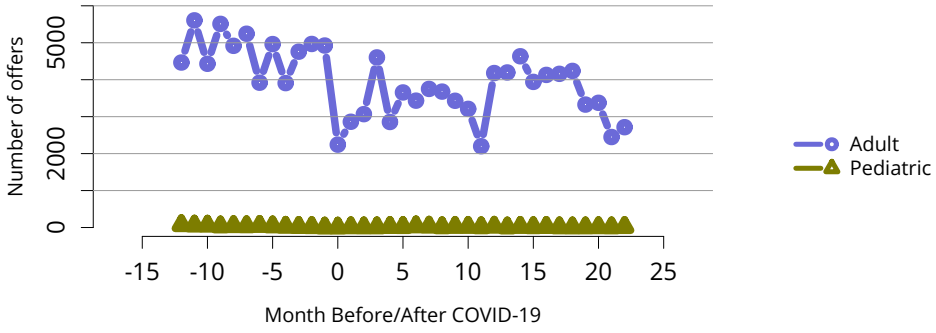

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Figure COV 58: Number of lung offers. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

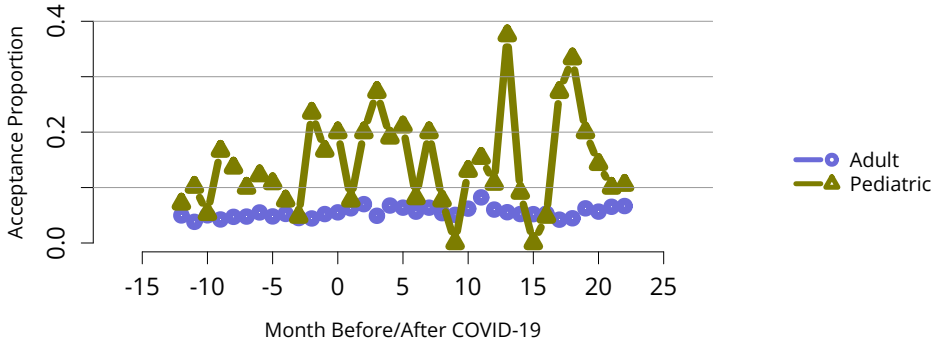

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Figure COV 59: Lung offer acceptance rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

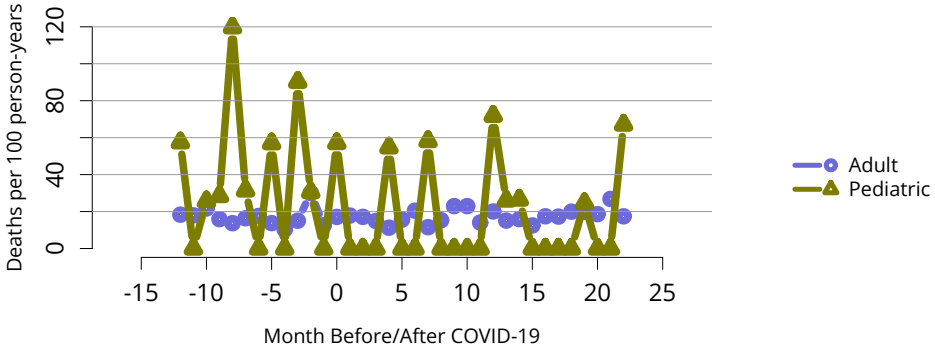

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Figure COV 60: Lung waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

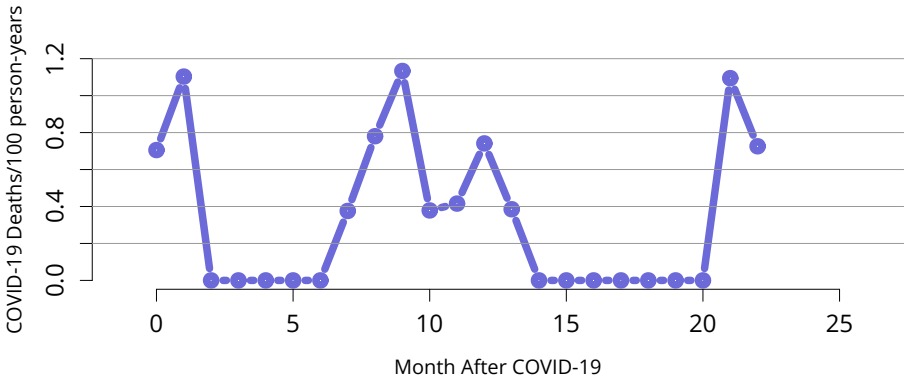

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Figure COV 61: Lung waitlist COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

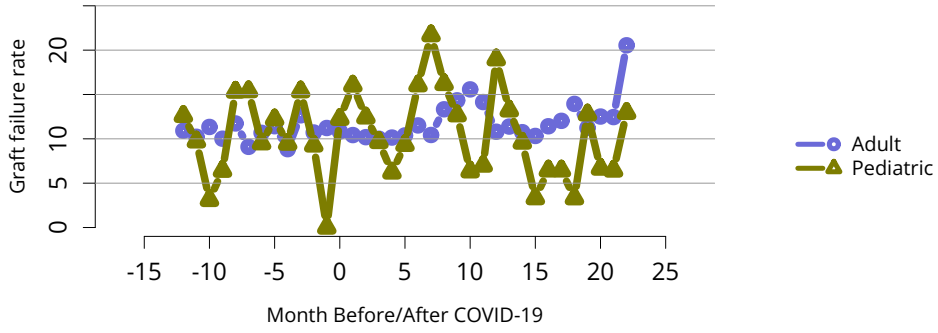

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Figure COV 62: Lung all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

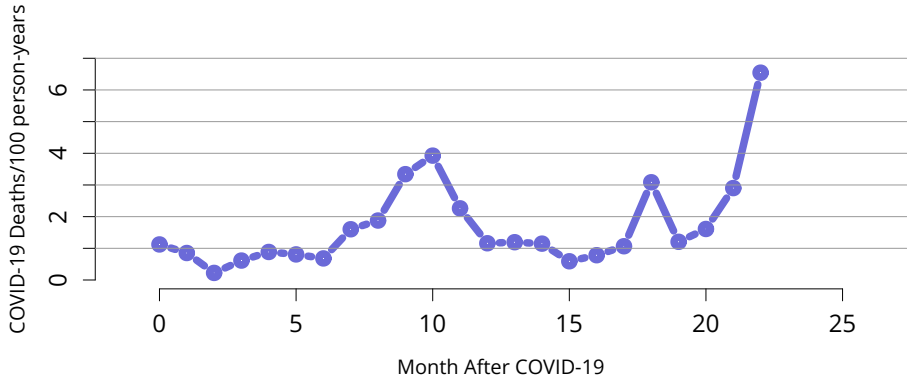

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Figure COV 63: Lung post-transplant COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

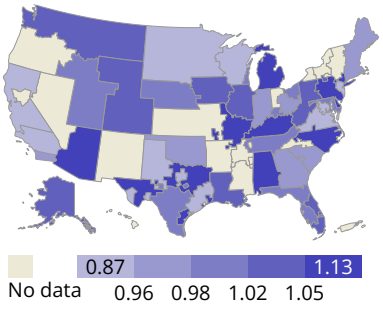

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Figure COV 64: Difference in risk adjusted lung waitlist mortality hazard ratio before to after COVID-19 by OPO. Waitlist mortality hazard ratio is the difference in the organ procurement organization's (OPO's) hazard ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. 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. Model adjusted for blood type, age in years, body mass index, diagnosis group, pediatric diagnosis group, miles between candidate and program, ethnicity, sex, height at listing (cm), lung allocation score category, candidate insurance type, race, previous transplant for candidates, candidate urbanicity, and waiting time.

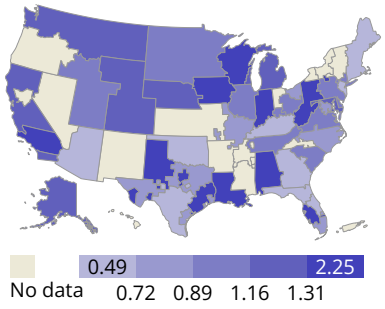

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Figure COV 65: Difference in risk adjusted lung transplant rate before to after COVID-19 by OPO. Transplant rate ratio is the difference in the organ procurement organization's (OPO's) rate ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Individual listings are counted separately. Model adjusted for blood type, age in years, body mass index, diagnosis group, pediatric diagnosis group, miles between candidate and program, ethnicity, sex, height at listing (cm), lung allocation score category, candidate insurance type, race, previous transplant for candidates, candidate urbanicity, and waiting time.

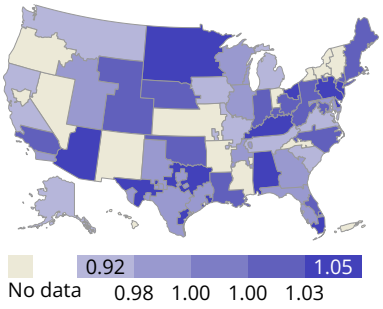

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Figure COV 66: Difference in risk adjusted lung all-cause graft failure hazard ratio before to after COVID-19 by OPO. Graft failure hazard ratio is the difference in the organ procurement organization's (OPO's) hazard ratio compared to the nation as a whole in the 12 months after the onset of the COVID-19 pandemic as compared to the 12 months before the onset of the pandemic. Model adjusted for blood type, ethnicity, sex, candidate insurance type, race, donor age (years), donor diabetes status, donor ethnicity, donor hypertension status, donor race, donor sex, donor smoked more than 20 packs per year, recipient age (years), body mass index, diagnosis group, miles between recipient and program, donor type, number of HLA mismatches, height at transplant (cm), lung allocation score at transplant, multiorgan transplant, recipient had a previous transplant, recipient urbanicity, and miles between donor and program.