Early Impact of COVID-19 on Solid Organ Transplantation in the United States

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Background. The regional impact of coronavirus disease 2019 on solid organ transplantation in the United States has not been fully evaluated. Methods. A retrospective analysis of month-to-month trends on waitlist additions, waitlist deaths, and transplant surgeries between all United Network for Organ Sharing (UNOS) regions was performed. A linear regression model trained on historical data was used to estimate anticipated transplantation volume. Results. All UNOS regions reported a decrease in total waitlist additions and transplant surgeries. The largest decreases in total transplants were identified in regions 1, 2, 6, and 9, with regions 2, 7, 8, and 9 noting the largest decrease in waitlist additions. Six of the 11 regions noted increases in waitlist deaths, with UNOS regions 9, 1, and 2, all located within the Northeast, noting the highest percent increase in waitlist deaths at 170%, 89%, and 54%, respectively. The largest reductions in solid organ transplantation and waitlist deaths were seen in kidney and lung transplantation. Current transplantation volume is significantly lower than the low range of the 95% confidence interval derived from the linear regression model (2182 versus 3110; P < 0.05). Conclusions. Significant decreases in total waitlist additions and transplant surgeries with increases in waitlist deaths were noted in the majority of US transplant domains. The impact was especially prevalent in areas with high burden of coronavirus disease 2019 infection. National and regional strategies aimed at minimizing disruptions in transplantation are needed.

INTRODUCTION

Preliminary reports detail significant decreases in solid organ transplantation (SOT) in France and the United States secondary to the ongoing coronavirus disease 2019 (COVID-19) pandemic.1 However, wide geographic heterogeneity in US transplant center practices has also been reported, and it is unclear if the decreases in SOT are driven by regional reductions (related to concurrent COVID-19 disease burden) or represent a more national phenomenon.2 Our aim was to evaluate the regional impact of COVID-19 on waitlist additions, waitlist deaths, and transplant surgeries for all SOT within each US transplantation region.

MATERIALS AND METHODS

Utilizing data provided by United Network for Organ Sharing (UNOS) registry, we evaluated month-to-month trends on waitlist additions, waitlist deaths, and transplant surgeries for all SOT (heart, heart-lung, intestine, kidney, kidney-pancreas, liver, lung, and pancreas) in the United States from January 1, 2019, through April 30, 2020.3 Geographic variation in trends were evaluated within the 11 UNOS regions. The average number of waitlist additions, waitlist deaths, and transplant surgeries performed from January and February 2020 were compared with counts during the entire month of April 2020. To limit confounding from regional variation in the adoption of shelter-in-place statutes, data from March 1, 2020, through...
March 31, 2020, were excluded from comparisons. A linear regression model trained on historical transplantation data from 2011 to 2019 was additionally performed to estimate anticipated monthly transplantation volumes. All statistical analysis was performed in R-studio version 3.5.3 (Boston, Massachusetts).

RESULTS

National Trends

Month-to-month trends in SOT in the United States for waitlist additions, waitlist deaths, and total transplantations are shown in Figure 1. Compared with the monthly

FIGURE 1. Month-to-month trends in solid organ transplantation in the United States from January 1, 2019, through April 30, 2020. Trends further delineated by organ type, including heart, liver, lung, and kidney. A, Month-to-month trends in waitlist additions or initial waitlist registration; B, month-to-month trends in waitlist deaths; and C, month-to-month trends in transplant surgeries performed.
averages observed in 2020 (January and February 2020), the number of transplants in April 2020 decreased by 35.9% (2182 versus 3404) with the largest reduction seen in kidney and lung transplants (Kidney: 42.9%; Lung: 40.4%; Heart: 26.0%; Liver: 20.7%). A similar pattern was seen in the number of total waitlist additions, which decreased by 23.3% (Lung: 34.3%; Heart: 34.2%; Kidney: 25.1%; Liver: 10.2%). Conversely, total waitlist deaths increased by 26.2% with the largest increase seen in kidney waitlist deaths (Kidney: 43.0%; Lung: 11.8%; Liver: 7.7%; Heart: 33.8%).

**Regional Trends**

Figure 1 demonstrates trends on waitlist additions, waitlist deaths, and transplant surgeries between all UNOS regions. Relative changes from January and February 2020 to April 2020 in waitlist additions, waitlist deaths, and transplants stratified by organ type for each UNOS region are shown in Figures 1 and 2. Table S1 (SDC, http://links.lww.com/TP/B973) depicts concurrent total COVID-19 disease burden by population. In April 2020, all UNOS regions reported a decrease in total waitlist additions and transplant surgeries, with the largest decrease in total
transplants observed within the Northeast and Northwest (regions 1, 2, 6, and 9). Regions 2, 7, 8, and 9 experienced the largest decrease in waitlist additions. Six of the 11 regions noted increases in waitlist deaths, with UNOS regions 9, 1, and 2 (all located within the Northeast) noting the highest percent increase in waitlist deaths at 170%, 89%, and 54%, respectively. Of note, kidney waitlist deaths increased by over 2-fold in region 9 (25 deaths to 87 deaths).

A linear regression model trained on historical total transplantation historical data (2011–2019) predicted a 12-month transplantation volume of 39,449 (95% confidence interval [CI], 37,324-41,574; multiple R-squared, 0.9196) with a predicted median monthly transplantation volume of 3,287 (95% CI, 3,110-3,465; Figure S1, SDC, http://links.lww.com/TP/B974). The total transplant volume of April is significantly lower than the low range of the 95% CI derived from the linear regression model (2,182 versus 3,110; P<0.05).

CONCLUSIONS
The impact of the current pandemic on SOT is unprecedented, with early data showing a significant reduction in total waitlist additions and transplant surgeries across all transplant domains, with an increase in waitlist deaths for kidney, liver, and lung transplantation. In an regression model, the current transplantation volumes are approximately 40% lower than the estimated 95% CI.

States with high burden of COVID-19 would be expected to have reductions in transplant volume secondary to the increased demand and utilization of hospital resources imposed by COVID-19. However, in a national survey of transplantation centers, over 75% of centers noted full suspension of living donor transplantation practices along with the majority of centers noting restrictions in deceased donor transplantation regardless of concurrent COVID-19 disease burden. Our findings suggest that these restrictions have significantly impacted the ability to perform transplantation across the United States.

Because of limitations with currently available UNOS data, we were unable to evaluate specific patient and donor (offers and acceptances) characteristics including COVID-19 status, which are crucial to decision-making for transplant programs.

As the pandemic continues, transplant centers will need to develop strategies to address challenges in the various sectors of SOT to improve outcomes, particularly among those requiring urgent, life-saving intervention.

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