Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

have COVID-19 can strain health care systems beyond capacity. In the United States, this has been magnified by the high prevalence of COVID-19 in nursing homes and rehabilitation facilities, resulting in prolonged hospitalizations and greater inpatient demands for dialysis. Even beyond a surge, dialysis providers must ensure sufficient availability of resources and vigilance regarding COVID-19 risk as dialysis-dependent patients transition across health care settings.

In conclusion, the studies published in this issue of *KI* highlight not only the high risk of developing COVID-19 among patients receiving in-center hemodialysis but also the severe consequences of COVID-19 in this population, with 20% mortality among patients receiving maintenance dialysis who have COVID-19. Until the pandemic is controlled, the kidney community needs to aggressively pursue infection control and appropriate resource management to optimize outcomes in this vulnerable population.

DISCLOSURE

DEW is a medical director at Dialysis Clinic, Inc., Boston. He is a member of the American Society of Nephrology's Dialysis COVID Task Force. The views expressed here are his own. All the other authors declared no competing interests.

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A *Kidney International* "journal of the COVID-19 year" in kidney transplantation

P. Toby Coates[1]

The global coronavirus disease 2019 pandemic's impact on kidney transplant recipients and transplantation programs in the calamitous months of February to June 2020, spring to summer in the Northern Hemisphere, is represented in articles published in the December issue of *Kidney International*. Writing about another pandemic in the year of 1665 over 300 years ago, the author Daniel Defoe[1] describes the same period of time in London and gives a remarkably familiar description of how a pandemic affects populations, including the unproven treatments, epidemiology of infection, and human response to restrictions on freedom of city lockdowns that occurred during that time. The risks, outcomes, epidemiology, and potential treatments for the kidney transplant population worldwide during the past 12 months have been thankfully studied in detail by multiple investigators and form the subject of papers in *KI* this month.

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see basic research on page 1502 and clinical investigations on pages 1540, 1549, 1559, and 1568

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First, from Europe comes the registry experience of Calliard *et al.*[2] who describe the clinical presentations of 279 kidney transplant recipients reported to the French nationwide registry of Solid Organ Transplant COVID Recipients. Risk

factors for hospitalization with coronavirus disease 2019 (COVID-19) were median age of 61 years with comorbidities of hypertension, diabetes, and cardiovascular disease. This report, like earlier reports published in *KI*, also shows groups of patients may be managed successfully at home.[3] Early experience with a variety of treatments including dexamethasone and tocilizumab was provided from the Brescia group in Italy, suggesting a potential role for early use of anti-inflammatory treatments in patients with COVID-19–related pulmonary syndromes who received transplants.[4]

The effect of COVID-19 on mortality in the European dialysis and kidney transplant recipients is also provided in this issue of the *Journal* from the European Renal Association—European Dialysis and Transplant Association (ERA-EDTA) Registry. Population-based mortality data provided on 4298 patients from Spain and France were reported to the registry covering the period from February 1, 2020, to April 30, 2020. In the kidney transplant recipients, crude mortality was highest in those over the age of 75 years and highest in those with a primary underlying disease of diabetes mellitus. The probability of death was greater in Spain than in France during this period.[5]

A second report in this issue of the *Journal* uses the French Cristal Registry in combination with the COVID-19–specific registry—Impact of the COVID-19 Epidemic on the Mortality of Renal Transplant Recipients and Candidates: a French Nationwide Registry Study (IMPORTANT)—to provide a more detailed insight to COVID-19 in France.[6] Over 42,000 kidney transplant recipients and 16,000 patients who are wait-listed are studied in this report that covers the peak of the first wave of the pandemic in Europe between March 1 and June 1, 2020, and differences between the outcomes of transplant recipients and patients who are wait-listed in low and high viral prevalence regions of France. Insightful data on the kinetics of infection showing no significant difference between patients on the transplant wait list and transplant recipients are provided. From March 1, to June 1, 2020, there were 275 deaths in transplant recipients, 44% of which were associated with COVID-19 infection. In the same period, there were 144 deaths in transplant candidates in France. Both recipients and candidates for transplantation who died were older, more often diabetic, and had cardiovascular comorbidities. When high viral risk areas and low viral risk areas in France were compared, death for transplant candidates and recipients were comparable in high risk areas, but in low risk areas, death for the wait-listed candidates greatly exceeded that of those who received a kidney.

From across the Atlantic, in the United States, Azzi *et al.*[7] summarize important clinical and antibody findings in the epicenter of the New York pandemic and provide important data on high-risk African American and Hispanic populations from the Bronx. In their patient cohort of 1475 patients who received transplants, prevalence of COVID-19 infection was 16% of those who presented to hospitals. Like the European reports, older (median age 59 years) kidney transplant recipients with diabetes and cardiovascular disease were more likely to be infected with the virus. This study also provides unique data on the development of antibody responses to COVID-19. First, 80% of those who were diagnosed with COVID-19 by polymerase chain reaction developed a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) IgG response using the Abbott SARS-CoV-2 IgG antibody test (Abbott Park, IL). What is needed, however, are (i) data regarding the duration of the antibody response and, (ii) with close follow-up of these patients who received kidney transplants, whether these antibodies prevented future COVID infections. Second, these antibody studies also show up to 20% of renal transplant recipients may develop COVID-19 infection without developing symptoms. These patients were typically younger, with better graft function, and are less likely to be diabetic.

These 4 current clinical studies[2,5–7] published in this issue of *KI* confirm the observation that diabetes and hypertension are significant risk factors for COVID-19 infection. Insight into the pathogenicity of the COVID-19 virus in the kidney is also provided in this issue by the work of Menon *et al.*[8] Single-cell RNA sequencing was applied to investigate the angiotensin-converting enzyme 2 (ACE2) cellular expression in healthy living kidney donors and in diabetic kidneys. The proximal tubules were shown to be the principal site of the ACE2 receptors and in this study to be the main cell types involved for SARS-CoV-2 infection in the kidney. The upregulation of diabetic kidney disease–related ACE2 and associated viral pathways were identified, including genes and processes connected to RNA splicing and viral biology. By comparison to proximal tubule cells derived from patients with active COVID who required hospitalization, a common set of SARS-CoV-2 genes and diabetic kidney–related ACE2 genes were identified. Functional *in vitro* studies suggest that gene expression profiles active in the proximal tubular cells in diabetic kidneys could interact with viral infections, such as SARS-CoV-2 infection, and modulate host responses.

How will the transplant community respond to the pandemic through the Northern Hemisphere's winter months and coming into the spring again in 2021? These papers all provide very useful pieces of knowledge to inform general and transplant nephrologists caring for these patients. From these studies we learn the following:

(i) The patients at greatest at risk for COVID-19 infection and death are patients with primary disease as diabetic nephropathy.[2,5–7]

As this association, with plausible molecular mechanism via the ACE2 receptors in the proximal tubules,[8] exists in both renal transplant recipients and wait-listed candidates, targeted interventions in this higher risk group may be made. As social isolation and distancing are effective at reducing COVID-19 infection as shown by the Australian experience, identification of

these at-risk populations may reasonably prevent more infection.[9]

(ii) The disproportionate impact of COVID-19 on waiting list mortality compared with transplantation mortality in low viral risk areas strongly support the maintenance of transplant programs wherever possible.[5]

Hospitals and administrators should fully support transplant programs based on the demonstration of patient survival.

(iii) Kidney transplant recipients infected with COVID-19 produce IgG antibodies in 80% of those who are diagnosed by reverse transcriptase polymerase chain reaction.[7]

These findings are critical to the field as patients who received transplants in general are poor responders to vaccination and thus the demonstration of a humoral response to the SARS-CoV-2 virus in the immunocompromised individual is heartening. Although it is unknown whether these antibodies are protective and for what duration they exist, evidence of an immune response in patients who are immunocompromised also justifies their potential inclusion in clinical trials.

(iv) Demonstration of asymptomatic transmission and development of antibody responses to COVID-19 in transplant patients.[7]

This observation is critical for the care of patients who received transplants because it provides reassurance that a minimally infective or asymptomatic infection may occur without devastating consequences. Coupled with evidence of safe home management of mild cases in patients who received transplants,[2,3] the diagnosis of COVID-19 infection does not necessarily require inpatient management and the risks inherent in hospitalization.

What will happen in the next period is unknown, but taking all these papers together allows the highest risk groups of patients who received kidney transplants to be identified and strategies to protect this vulnerable group of patients can be generated. Clearly strict public health measures based on these and other epidemiological studies should be maintained, especially in the high-risk populations (older transplant recipients, with diabetes and cardiovascular comorbidities). However, the high rate of patients who received transplants becoming infected with COVID-19 coupled with data suggesting that an antibody immune response can be generated in patients who are immunosuppressed and received transplants argue strongly for their inclusion in first vaccine trials. The easy transmission of COVID-19 infection to transplant recipients and their poor outcomes also suggests that the health of immediate close contacts of transplant recipients should also be considered as candidates for early vaccination trials in the hope that this strategy might mitigate risk to the more vulnerable population.

In December at the end of Defoe's *Journal*,[1] a sense of cautious optimism for the future is described, a point at which sadly today's world has not yet reached with the current pandemic. Nevertheless, in December 2020, at the end of this first year of the pandemic, the clinical, epidemiological, and basic science advances described here in *KI* and elsewhere provide a framework to develop strategies to protect and treat patients who received transplants from the worst effects of the COVID-19 virus.

DISCLOSURE

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