

Perspectives on COVID-19 from Singapore: Impact on ESKD Care and Medical Education

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Singapore is a nation state in Southeast Asia with a population of approximately 5.7 million on an island of 278.6 square miles located just below peninsular West Malaysia. A major global transportation hub with >68 million travelers passing through its airport in 2019,¹ Singapore is a popular tourist destination and busy commercial port. Hence, it is vulnerable to the introduction of pandemic infectious diseases. Singapore's commitment and approach to epidemic preparedness were shaped by its severe acute respiratory syndrome (SARS) outbreak in 2003, which resulted in 228 cases and 33 deaths, including health care workers.² After the SARS epidemic, a long-term whole-of-government plan was developed.³ Substantial upgrading of infrastructure increased isolation and intensive care unit (ICU) capacity throughout public sector hospitals, and in 2019, a new purpose-built National Centre for Infectious Diseases was completed with over 300 beds, including negative pressure isolation facilities and intensive care beds. Contingencies were developed, allowing rapid expansion of national ICU bed capacity alongside creation of stockpiles of drugs, personal protective equipment, and medical equipment, including ventilators. Formal platforms were established to enable better intragovernment coordination,

and disaster simulations were carried out regularly. Training of health care workers is a major focus, and strategic planning extended into the academic arena. When Duke-NUS Medical School was founded in 2005, one of its basic research programs was specifically focused on emerging infectious diseases. Indeed, researchers from this program have made substantive contributions to the recent national response to coronavirus disease 2019 (COVID-19).⁴

Shortly after the first reports of atypical pneumonia caused by a novel coronavirus from Wuhan, China in December 2019, Singapore began to prepare for potential spread of this new virus.⁵ The first documented case of COVID-19 was identified on January 23, 2020 in a recent arrival from Wuhan. A number of containment measures were rapidly instituted, including patient isolation, vigorous contact tracing and quarantine, border controls, and active community education. On February 7, 2020, soon after the first cases of community transmission were recognized, the Singapore Ministry of Health (MOH) raised the Disease Outbreak Response Condition (DORSCON) from yellow to orange, indicating the outbreak was considered to have a moderate to high public health effect. Public health interventions were stepped up with effective containment

of this first COVID-19 wave, while allowing schools and most businesses in the country to remain open.

Early March 2020, there was a second wave of infections triggered by returnees from Europe, North America, and elsewhere around the world where COVID-19 had been rapidly spreading. In view of the sharp rise in imported cases, mandatory quarantines of all individuals arriving from COVID-19-affected areas were instituted. Despite this and active containment measures, in late March the number of community cases was rising, and infections began to appear in the population of foreign workers housed in dormitories around the city. In response, the government instituted a “circuit breaker” on April 7, 2020, closing schools and all nonessential businesses and asking citizens to remain largely confined to their homes. These restrictions were further tightened on April 22 because of rapidly rising numbers of

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cases among foreign workers. Many resources have been concentrated on the outbreak in foreign worker dormitories, including aggressive testing, strict quarantine, and expansion of onsite medical care.

As of July 5, 2020, Singapore has had a total of 44,774 patients with COVID-19 (7855 per million population), 40,441 who have recovered with 4333 active cases of whom 210 were in hospital and two in ICU. To date, there have only been 26 deaths attributed to COVID-19 infection, and the ICU bed requirement has only exceeded 30 per day on a small number of occasions. The very low mortality and ICU requirement are likely to be due to a number of factors. More than 90% of the total patients are young and healthy foreign workers, with a low likelihood of severe illness or mortality. Because of aggressive case finding, many diagnosed patients had few or no symptoms. The health system is functioning at full capacity, and the ICUs were not overburdened at any point in time. With the institution of the circuit breaker measures, community transmission fell to very low levels, and the outbreaks in the foreign worker dormitories are currently controlled. In early June, some of these restrictions were lifted, and many businesses and schools have reopened. Although the COVID-19 outbreak in Singapore is still evolving, we will briefly discuss its effect on care of patients with ESKD and on medical education.

The latest 2018 registry data reported 1256 patients on incident dialysis and 7405 patients on prevalent dialysis in Singapore.⁶ Their median age was 64 years, with diabetic nephropathy (55%) as the predominant etiology of ESKD, and most (86%) were on hemodialysis. Chronic hemodialysis is almost exclusively administered in 119 outpatient centers, whereas the predominant home-based therapy is peritoneal dialysis. Almost two-thirds of Singapore's patients on hemodialysis are treated in the large charity centers supported by a mixture of basic national insurance (MediShield Life), government subsidies, and philanthropy. The remainder of patients

in the smaller private centers do not receive government subsidies and rely on private insurance and personal funds to pay for their dialysis. Around 60% of the private centers are operated by a large dialysis organization.

The first reports of coronavirus infections in Singapore rekindled memories of the SARS epidemic among the older generation of renal physicians, and a number of protective measures were rapidly instituted for the vulnerable population of patients with ESKD. Along with other measures in place across the health system, dialysis centers instituted processes to reduce contact between patients, such as permanently assigning patients to specific dialysis shifts to avoid crosscontamination and controlling patterns of patient flow during shift changes. Mandatory mask wearing was instituted for patients throughout dialysis sessions, well before broader requirements for wearing masks by nonhealth care workers was required by the government. Temperature checks and screening questionnaires were instituted, including travel history, history of contact with a COVID-19–positive patient, and presence of COVID-19–like symptoms such as fever, sore throat, runny nose, cough, shortness of breath, or anosmia. As in the United States, it is typical for a single nephrologist to care for patients across multiple dialysis centers. With DORSCON Orange, travel of health care workers between clinical sites was drastically limited to avoid spread of infection between hospitals and clinics, which had been a problem during SARS. Thus, most clinics quickly adopted teleconferencing systems for routine patient evaluations in the dialysis centers.

As mentioned, one of the pillars of Singapore's mitigation efforts has been intensive contact tracing and strict quarantine. Accordingly, protocols were rapidly developed for patients with ESKD serving home quarantine to be treated in special MOH-designated centers. To date, routine SARS coronavirus 2 testing is not done for patients on dialysis. Instead, if they develop symptoms of acute respiratory illness, fever, or anosmia, patients are directed to designated

clinics or public hospitals where testing is done on the basis of current guidelines. As of July 5, 2020, there have been eight COVID-19–positive patients with ESKD in the community (seven on hemodialysis, one on PD), but there have been no documented infection clusters within dialysis centers. Infected patients are hospitalized and isolated until they clear the virus. Reports of COVID-19 infection rates in dialysis centers worldwide are limited, ranging from one in 1000 in Turkey⁷ to 10% in Wuhan at the peak of the outbreak.⁸ It is likely that the relatively low number of infections in Singapore is a product of the rigorous national measures described previously and the relatively low number of cases in the general community, as well as the early adoption of strict mitigation strategies by dialysis centers.

The authors' views on the effect of COVID-19 on medical education come from the perspective of an academic medical center representing a partnership between the largest public hospital cluster in Singapore and an American-style graduate-entry medical school. As a consequence of the DORSCON level elevation to orange, medical students were prohibited from entering clinical environments, and face-to-face classes with >50 students were prohibited. Faced with this circumstance, our approach to delivering medical education was rapidly reshaped. Along with medical schools and universities worldwide, e-learning solutions were instituted for preclinical, classroom training. Although patient-based studies and e-learning were also utilized for clinical training, we found that they are helpful and necessary but not sufficient. Accordingly, we pushed to maintain practical and authentic clinical experiences for our students. Working in close partnership with Singapore's MOH, public health care institutions, and the two other Singaporean medical schools, we reintroduced practical clinical training for medical students while identifying, mitigating, and managing risks in a clinical environment where COVID-19 was prevalent. Strong support by the MOH, recognizing the

need to avoid interruption of the pipeline of well-trained clinicians for the health system, was critical for this venture.

There are a number of COVID-19–positive patients in our clinical environment. For example, Singapore General Hospital, one of our primary training sites, has admitted over 1060 COVID-19–positive patients, with 173 currently in house at the time of this writing. Comprehensive control measures have been taught and deployed, including strict personal hygiene, social distancing, personal protective equipment, strict disinfection of teaching environments, and minimizing numbers of activities and participants, with focus on core clinical learning outcomes and competencies.

To facilitate these measures, small numbers of students are embedded in clinical teams where they can be closely supervised. They are not allowed to enter high-risk areas such as ICUs, emergency departments, and isolation wards. Likewise, students are prohibited from interacting with high-risk patients or carrying out risky, aerosol-generating procedures. The return of students to the clinical environment has been staggered, beginning with the most senior and experienced students. Clinical postings have been shortened to the minimum duration required to achieve key outcomes, with explicit consideration of reducing demands on overstretched clinical faculty. Efforts have also been made to maintain authenticity and validity of assessments: for example, successfully conducting practical, clinical final examinations under full COVID-19 restrictions.⁹

Along with colleagues around the world, we have leveraged e-learning, simulation, and other technologies, including Zoom-enabled team-based learning, virtual ward rounds using remote electronic medical record connections, recording stethoscopes, and virtual patient clerking using secure iPads. Although the effectiveness of these technologies for delivering clinical education is not clear, this will be rigorously monitored, and it seems likely that some of these innovations can add value in the post–COVID-19 era.

COVID-19 has also had significant effects on graduate medical education, including training of nephrologists. There are over 1000 graduate medical education trainees in our center, organized in Accreditation Council for Graduate Medical Education (ACGME) International–accredited residencies. The so-called Junior Residencies provide foundational training, similar to United States residencies for internal medicine, general surgery, and pediatrics, followed by Senior Residencies for subspecialty training, including nephrology, analogous to specialty fellowships in the United States.

As a result of the prohibition of medical staff movement between hospital campuses in DORSCON orange, some residents have been unable to complete required rotations and competency assessments. Offsite continuity clinics have also been affected. As in other countries, most teaching hospitals have drastically scaled down elective procedures, limiting opportunities for residents to complete required procedures. Furthermore, emergency departments have been faced with a sustained surge in patients with respiratory symptoms. Many residents from both medical and surgical programs have been redeployed to these areas, at the expense of training time in their specialties. There have also been delays in holding certification examinations.

These many training disruptions have created uncertainty and anxiety among residents. Many have expressed concern about infection risk and fear of transmitting COVID-19 to their family members, especially young children and elderly parents. Cognizant of the increased risks of burnout in this situation, additional hospital resources have been made available for emotional support. As some of these training obstacles may not be surmountable, extension of training durations could be required. On the other hand, there have been some positives in this dire situation. One is the practical necessity for residents to learn and experience multidisciplinary and interprofessional health care firsthand on a global scale. Moreover, the

importance and relevance of the six core ACGME competencies have been starkly reinforced. Trainees have been required to think practically about systems-based practice and practice-based learning while facing the effects of reduced resources in health systems that are being stretched. Finally, this shared experience has been a powerful crucible for forging the qualities of collegiality and resilience among our residents.

The COVID-19 pandemic is far from over. Singapore, along with countries around the world, has been relaxing some of its mitigation measures with the goal of safely restarting the economy and moving toward a more normal life for its citizens. This is an uncertain period for everyone, and no one has a perfect solution for this next phase. Singapore is fortunate to have a robust public health program, ample capacity in its health care system, and substantial testing capability for COVID-19. Steps are being taken to increase the speed and efficiency of contact tracing through innovative approaches, including the use of cell phone apps, data integration, and artificial intelligence. In parallel, Singapore continues to actively invest in COVID-19 research through special grant programs focusing on disease transmission, diagnostics, immunopathogenesis, clinical therapeutic trials, and modeling. Many of these research projects are in collaboration with global partners, aimed at improved monitoring, new approaches to therapy, and developing an effective vaccine. Indeed, emerging successfully from this pandemic will require countries around the world to work together, sharing knowledge and lessons learned.

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REFERENCES

1. Changu Airport Group: Air traffic statistics. 2020. Available at: <https://www.changiairport.com/corporate/our-expertise/air-hub/traffic-statistics.html>. Accessed May 18, 2020
2. Tan CC: SARS in Singapore—key lessons from an epidemic. *Ann Acad Med Singapore* 35: 345–349, 2006
3. Wong JEL, Leo YS, Tan CC: COVID-19 in Singapore—current experience: Critical global issues that require attention and action. *JAMA* 323: 1243–1244, 2020
4. Tan CW, Chia WN, Qin X, Liu P, Chen MI, Tiu C, et al.: A SARS-CoV-2 surrogate virus neutralization test (sVNT) based on antibody-mediated blockage of ACE2-spike (RBD) protein-protein interaction [published online ahead of print July 23, 2020]. *Nat Biotechnol* doi:10.1038/s41587-020-0631-z
5. Ng Y, Li Z, Chua YX, Chaw WL, Zhao Z, Er B, et al: Evaluation of the effectiveness of surveillance and containment measures for the first 100 patients with COVID-19 in Singapore—January 2–February 29, 2020. *MMWR Morb Mortal Wkly Rep* 69: 307–311, 2020
6. National Registry of Diseases Office: Singapore renal registry annual report 2018, 2020. Available at: <https://www.nrdo.gov.sg/publications/kidney-failure>. Accessed May 18, 2020
7. Haberal M: COVID-19 update. *Exp Clin Transplant* 18: 139–140, 2020
8. Li J, Xu G: Lessons from the experience in Wuhan to reduce risk of COVID-19 infection in patients undergoing long-term hemodialysis. *Clin J Am Soc Nephrol* 15: 717–719, 2020
9. Boursicot K, Kemp S, Ong TH, Wijaya L, Goh SH, Freeman K, et al: Conducting a high-stakes OSCE in a COVID-19 environment. *MedEdPublish* 9: 54, 2020