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ORIGINAL ARTICLE

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Going to war on COVID-19: Mobilizing an academic nephrology group practice

Martin B.-H. Lee | Horng R. Chua | Weng K. Wong | Gek C. Chan | Christopher C. H. Leo | A. Vathsala | Boon W. Teo

Division of Nephrology, Department of Medicine, National University Health System, Singapore

Correspondence
Dr Martin B.-H. Lee, Division of Nephrology, Department of Medicine, National University Health System, 1E Kent Ridge Road, Singapore 119228.
Email: martin_lee@nuhs.edu.sg

Abstract

Aim: The COVID-19 pandemic poses unprecedented operational challenges to nephrology divisions in every country as they cope with COVID-19-related kidney disease in addition to regular patient care. Although general approaches have been proposed, there is a lack of practical guidance for nephrology division response in a hospital facing a surge of cases. Here, we describe the specific measures that our division has taken in the hope that our experience in Singapore may be helpful to others.

Methods: Descriptive narrative.

Results: A compilation of operational responses to the COVID-19 pandemic taken by a nephrology division at a Singapore university hospital.

Conclusion: Nephrology operational readiness for COVID-19 requires a clinical mindset shift from usual standard of care to a crisis exigency model that targets best outcomes for available resources. Rapid multi-disciplinary efforts that evolve flexibly with the local dynamics of the outbreak are required.

KEYWORDS

COVID-19, nephrology, operational, pandemic, response

The Division of Nephrology, National University Hospital, Singapore, is a 17-attending doctor academic group practice spanning two campuses, that collaborates with a regional general hospital and a network of primary care clinics as part of the publicly funded health-care system serving the west of Singapore. In a typical year, we attend to 25 000 outpatients and 2300 inpatients who stay >20 000 days in hospital. We manage more than 200 prevalent peritoneal dialysis (PD), 1200 haemodialysis (HD) patients and 600 kidney transplant (KTx) recipients. We deliver more than 20 000 inpatient HD sessions and our doctors perform monthly rounds at nine community HD centres. Our interventional nephrologists perform more than 150 native and transplant kidney biopsies, and insert 550 HD and 40 PD catheters. At any one time, we conduct more than 10 clinical trials and clinical research studies, and have at least six nephrology trainees.

In early April 2020, Singapore had 1189 COVID-19 cases, six deaths and a rising incidence of local transmission. By end-April, the number of cases had surged to over 16 000 and continues to rise despite a nationwide stay-home restriction. Since the incidence of acute kidney injury (AKI), AKIN3 AKI and intensive care unit (ICU) dialysis in COVID-19 infected patients has been reported as 5.1% to 7%, 2% and 23%, respectively,[1,2] we were concerned that the number of patients needing hospital and intensive care treatment may exceed capacity. Our division's responses are described below and we discuss adjustments that will be needed if the number of COVID-19 cases continues to rise. We cannot emphasize enough the importance of unified and strong support from hospital senior management, nursing, facilities and operations management for these measures and contingency plans.

1 | METHODS

Nephrologists in our division described the COVID-19 operational responses for specific clinical services.

2 | RESULTS

2.1 | General changes in manpower deployment

To contain the spread of COVID-19 and ensure continuity of medical services, routine services were reduced to essential patient care. As far as possible, doctors and nurses were segregated by work and job scope, inpatient and outpatient settings and by teams (Figure 1). This was a strategy developed after Singapore experienced SARS in 2003, and it allows teams who contract COVID-19 to be placed in quarantine without crippling patient services. Doctors could also be redeployed to the emergency department and hospital pandemic ward teams to care for COVID-19 patients. Division staff and education meetings and social interactions were reduced, and all meetings conducted remotely. In subsequent weeks, potential manpower attrition due to infection, quarantine and possibly death will require us to be flexible and proactive to reduce non-urgent care, revise workflows and accept realistic clinical outcome indicators, while striving to deliver quality care.

SUMMARY AT A GLANCE

A valuable experience and operational response to COVID-19 pandemic threat by a nephrology division at a Singapore university hospital. This article gives good example of shift of clinical mindset from usual standard of care to a crisis exigency model that targets best outcomes for available resources.

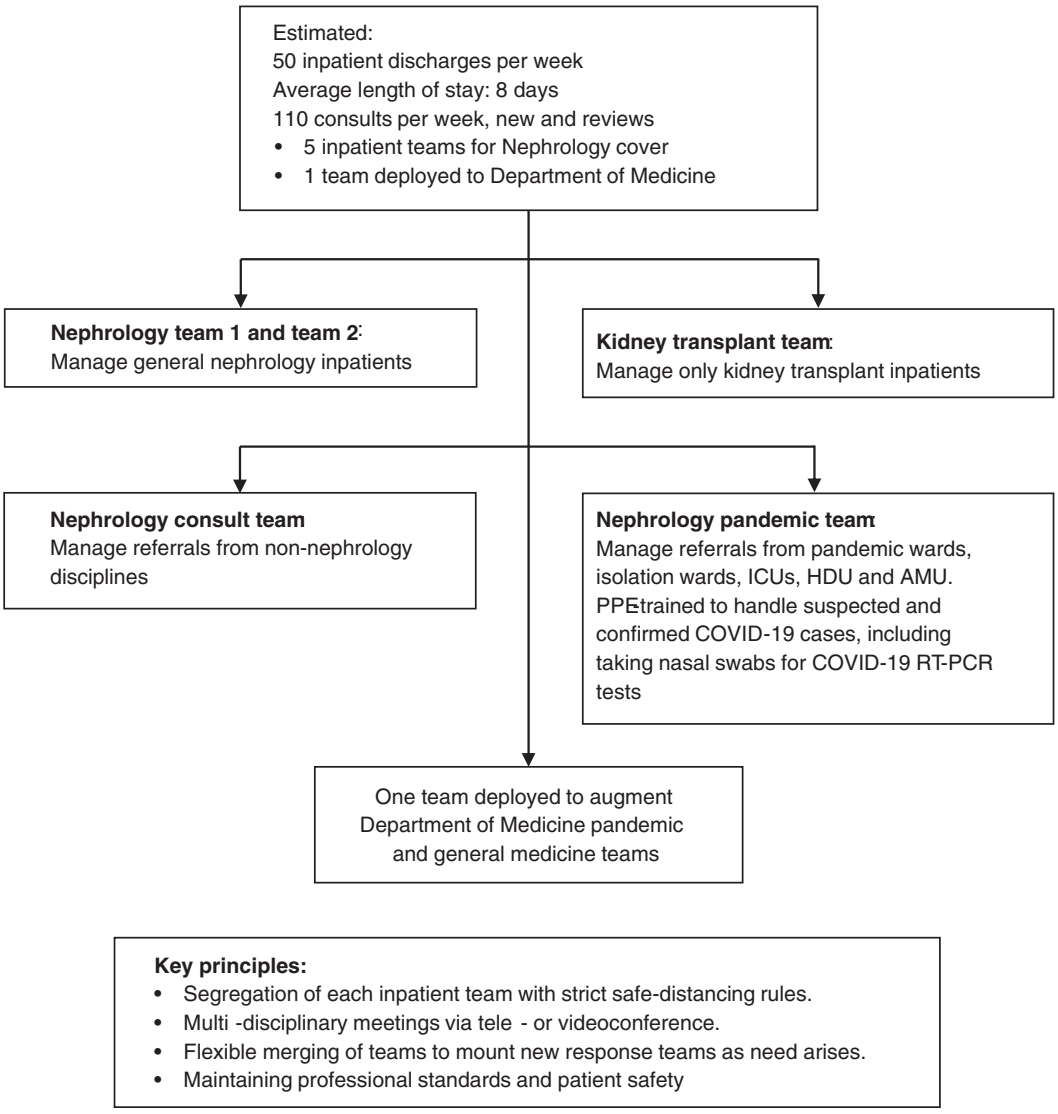

FIGURE 1 Inpatient nephrology service segregation. AMU, acute medical unit (newly admitted patients from emergency awaiting ward bed); HDU, high dependency unit; ICU, intensive care unit; PPE, personal protective equipment

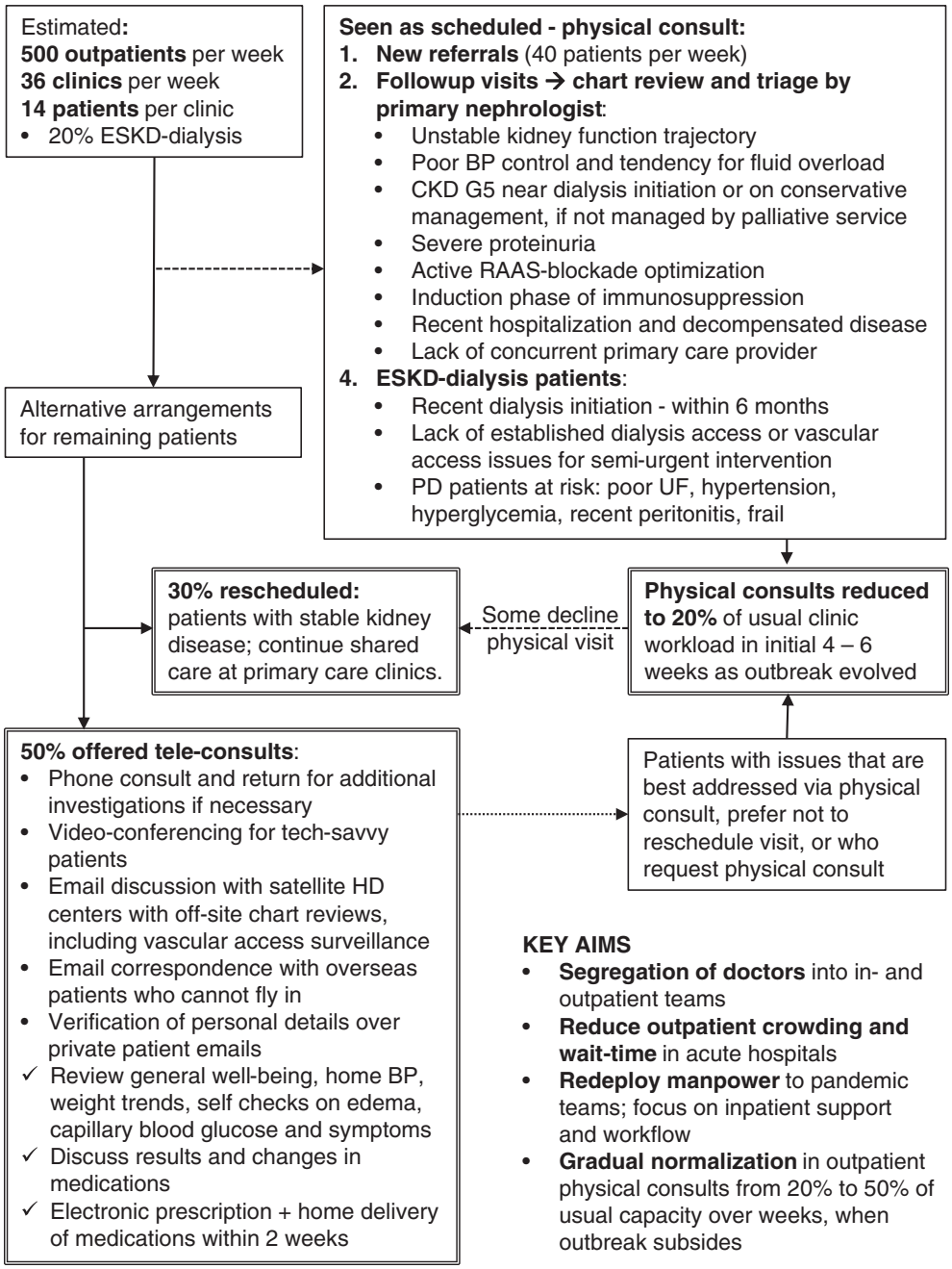

FIGURE 2 Outpatient general nephrology service and patient triage. BP, blood pressure; CKD, chronic kidney disease; ESKD, end-stage kidney disease; HD, haemodialysis; PD, peritoneal dialysis; RAAS, renin-angiotensin-aldosterone-system

2.2 | Outpatient continuity care

Outpatient care posed severe challenges due to the large number of patient attendances and new consultations. The knowledge required to manage subspecialty chronic patients, for example, interventional nephrology, point-of-care imaging and stone prevention, implied that total segregation of doctor teams would invariably affect care. The Division attends to 5000 unique patients a year and sees 1000 new referrals. As chronic kidney disease (CKD) and end-stage kidney disease (ESKD) patients are at higher risk for viral infections,[3] outpatient attendances were triaged and rescheduled by the patients' primary nephrologists according to urgency (Figure 2) to curb virus transmission by reducing patient numbers in clinic and pharmacy waiting areas. Patients were managed remotely using telemedicine (telephone and video calls) and given longer intervals between follow-up tests and consultations. The current funding model for patient care is based on piecemeal fee for service. Reducing outpatient visits will reduce revenue of the group, but the impact is mitigated by revenue from electronic visits, dialysis provision, and increasing the proportion of group doctors in direct clinical care.

2.3 | Inpatient care

We rostered our doctors to five strictly segregated teams according to degree of exposure to COVID-19 inpatients in order to minimize virus transmission to doctors, uninfected patients and nursing staff

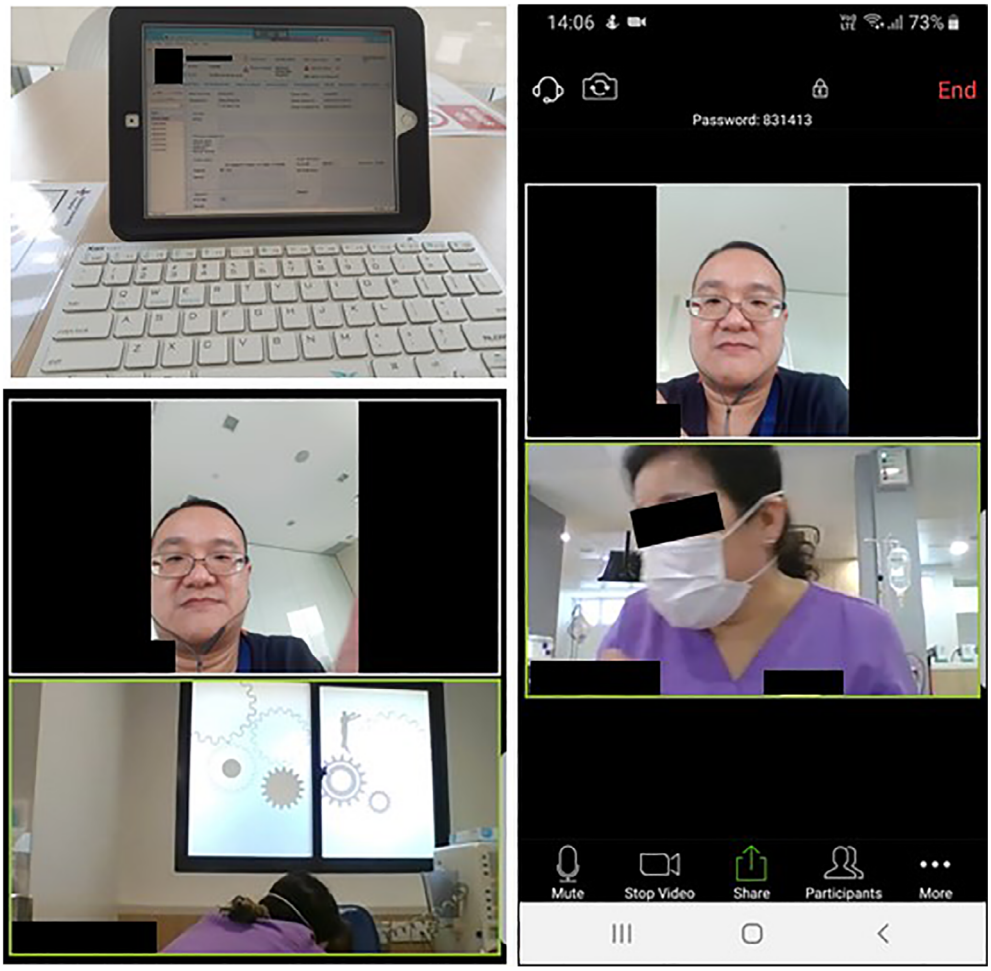

FIGURE 3 Telemedicine community dialysis rounds. Hospital nephrologist and dialysis centre nurse carry out telemedicine rounds for patients on haemodialysis. Top left panel: Secure network tablet displays patient electronic dialysis record. Bottom and right panels: Concomitant smartphone videoconferencing allows patient visualization, remote examination and consultation. Patients and identifiers were not shown and the nurse and centre deidentified to protect their identities. The nephrologist is one of the authors, W. K. W. and gave consent for his image to be shown

(Figure 1). Transplant doctors were never rotated to the general nephrology or pandemic teams. Elective admissions were deferred to preserve bed capacity for a surge of COVID-19 admissions. COVID-19 disease may be asymptomatic or mildly symptomatic[4-7] and our knowledge of the clinical presentation of COVID-19 in CKD and transplant patients is still evolving. Therefore, our doctors had a low threshold for screening for COVID-19 disease in CKD and ESKD patients admitted for fluid overload, respiratory and non-respiratory symptoms,[8] in order to identify COVID-19 cases for immediate isolation to prevent infection within the hospital and its inpatient dialysis centre.

HD for confirmed and suspect COVID-19 patients was provided separately in existing and newly converted isolation wards. This required the rapid installation of in-room water supply and dialysate effluent drainage for mobile HD using portable reverse osmosis units. Early planning, continual reassessment and close coordination between nephrology and the hospital's facilities management and operations departments was critical in meeting this need. In ICU, continuous renal replacement therapy (CRRT) and sustained low efficiency dialysis (SLED) for COVID-19 patients was performed using dedicated machines. In event of a shortage of machines, sessions or consumables, we will prescribe dialysis with greater clinical discretion and strict adherence to target weights to maximize HD slots. If HD capacity is overwhelmed, we will fall back on acute PD[9] or hybrid dialysis where appropriate. We started training additional HD nurses in preparation for a surge of COVID-19 patients requiring dialysis.

For PD inpatients who are in isolation for suspected or confirmed COVID-19, we will preferentially do automated PD (APD) instead of continuous ambulatory PD (CAPD) in order to reduce patient contact and infection risk to PD nurses, and halve the use of personal protective equipment (PPE). PD effluent from COVID-19 patients will be bleach disinfected[9] before discarding in the en-suite toilet bowel or ward dirty utility sluice, following hospital biohazard precautions. Non-COVID-19 inpatients on APD will be converted to CAPD if cyclers are fully deployed for COVID-19 patients. Additional nurses will be trained in APD disconnection and CAPD to increase PD nurse strength.

2.4 | Community haemodialysis

A major challenge is the prevention, early detection, and management of COVID-19 infection in community HD centres.[10-14] All centres screened patients for travel history, symptoms and fever before entry. In centres run by the largest public-sector provider, the National Kidney Foundation of Singapore (NKF), patients from different shifts

were temporally and physically segregated, one shift leaving completely before the next shift's patients were allowed into the centre from a holding area. Changing of shifts for non-essential reasons was disallowed and extra iso-UF sessions minimized where safe to do so.

Unstable or ill COVID-19 HD patients were admitted to the National Centre for Infectious Disease which has a dedicated COVID-19 dialysis facility, or other hospitals. On discharge, these patients may require segregation from uninfected patients for a period of time, especially in view of reports of relapse of COVID-19 test positivity.[15]

Mildly symptomatic but stable patients dialyzing with the NKF were transferred to a dedicated centre and dialyzed on the last shift of the day. Asymptomatic patients with COVID-19 contact or travel history dialyzing at private sector or NKF centres were required to move to a dedicated private centre, or to a dedicated NKF centre respectively, to be isolated and observed for symptoms.

Since the outbreak began, our doctors have been using tele- and videoconferencing for their monthly community dialysis rounds and management of non-acute dialysis issues. The infrastructure for this had previously been established by the NKF, which equipped its centre nephrologists with secure-network tablets and shared laptops that connect with the provider's electronic medical system (Figure 3).

Outpatient HD is reimbursed by national and private medical insurance with co-payments from the patients' mandatory medical savings. Low-income patients receive subsidized dialysis from the NKF, which is therefore able to segregate COVID-19 positive patients without affecting reimbursement. Smaller private sector providers could consolidate their patients to a single shift or centre, necessitating changes in reimbursement flow.

2.5 | Peritoneal dialysis

The COVID-19 pandemic rapidly resulted in a shortage of masks and hand sanitizers for use during PD exchanges, causing patient anxiety. Some patients fell victim to mask purchase scams. We revised our practice and gave patients the option to not wear a mask during PD procedures,[16] but they had to avoid talking, or to switch to scarfs or reusable masks. Our hospital pharmacy and materials department procured dedicated supplies of hand sanitizer for our patients to supplement supply from PD vendors. Importantly, we reemphasized to patients the importance of good PD technique and hand hygiene in preventing infections, to counter over-emphasis on mask use in the prevention of PD infections.

We reduced physical PD clinic patient visits by at least 70% using the same principles as for other clinics (Figure 2). We rescheduled stable patients and refilled prescriptions to be home-delivered free by the pharmacy to reduce crowding in clinics and pharmacies. We adopted measures in the ISPD COVID-19 guideline[9] such as pre-clinic telephone screening and triage disposition for patients with symptoms, travel or contact with COVID-19.

To reduce avoidable hospitalizations, we sought to pre-empt volume overload or depletion by reviewing target weights, setting upper and lower weight thresholds and blood pressures (BP), and instructing patients on contingency PD regimens if their weight or BP went out of range.

Initiation of PD for new ESKD patients continued as usual, with stable patients doing outpatient urgent start intermittent PD in order to increase hospital bed capacity. Home visits for new or prevalent patients with significant issues such as recent peritonitis were continued, but routine visits were suspended to reduce potential virus transmission.

Finally, we communicated closely with the PD vendors to ensure uninterrupted and adequate PD supplies for both prevalent patients and surge demand, including acute PD in ICU to supplement CRRT and SLED. If resources become limiting during a surge of COVID-19 admissions, we will redistribute dialysate between hospitals and may be forced to conserve dialysate by reducing PD volumes for stable inpatients with residual kidney function.

2.6 | Quality of care and the need for advocacy

Before the pandemic, our division was operating near maximum clinical capacity. The epidemic has restricted our usual workflows and care capacity, potentially compromising quality metrics. For example, as elective admissions for creation of arterio-venous fistulae were reduced, catheter-related blood stream infections may increase, but this has not yet been observed. If anything, infection rates have remained stable, likely due to heightened hand and general hygiene. To maintain a high standard of care and reduce hospital admissions, we advocated for CKD and ESKD patients by clearly articulating their needs to hospital operations and management. For example, seemingly elective admissions for early HD initiation or PD catheter placements were recategorized as essential because they pre-empt emergent admissions, ICU utilization and longer hospitalizations resulting from late dialysis initiation.

2.7 | Kidney transplant

Given Singapore's compact size, the vast proportion of KTx recipients return to the transplant centre for their post-transplant follow-up. Our transplant team cares for over 600 post KTx recipients and evaluates ESKD patients for live donor (LDKT) or deceased donor kidney transplant (DDKT). Plans for KTx recipients have evolved with each phase of the COVID-19 pandemic.

In the first few weeks, given the uncertainties about diagnosis of COVID-19 infection, LDKT and DDKT were ceased. Inpatient and outpatient transplant teams were functionally separated. Only prevalent KTx transplanted within the preceding 6 months or those deemed unstable were seen in clinic. Repeat prescriptions of medications were home-delivered for the remainder.

In the next phase, a positive COVID-19 RT-PCR nasal swab formed the crux of diagnosis for COVID-19 infection in symptomatic

individuals. Separate management protocols for immunocompromised infected patients had been established at our hospital. Clusters of COVID-19 infections were identified nationally by aggressive contact tracing. This allowed resumption of KTx with potential donors and recipients who had tested negative for COVID-19 on two occasions. KTx patients without contact with COVID-19 clusters were triaged and given priority for transplant clinic visits.

However, by the third month of the pandemic, with increasing numbers of imported cases and community spread, we had entered a new phase in KTx care. Telephone or video consults predominated, with direct patient visits restricted to the small minority with unstable allograft function or recent hospital discharge. Only DDKT were deemed urgent enough to proceed, provided both potential donor and recipient tested COVID-19 negative prior to transplant. Thus, from a transplant perspective, the major lesson learnt in this pandemic has been to evolve care with the dynamics of the infection in the community while remaining committed to managing prevalent KTx.

2.8 | Research

Research is time-sensitive and expensive. For clinical studies, the pandemic severely affected patient recruitment, study visits, sample collection and protocol adherence, with consequences for publication, drug discovery and clinical application.[17,18] Our university hospital and research institutions had to ensure the safety of study participants, coordinators and investigators. We used remote study locations and encrypted interviews where feasible to reduce physical hospital visits. Trial recruitment continued with safe distancing and participants and staff in PPE. We collected samples when participants returned for clinic visits instead of at separate study visits. Study drugs were home-delivered. Researchers worked from home on devices with secure access to electronic medical records.

In basic research, laboratories were less productive because of disrupted reagent supply chains and staff locked down at home, necessitating partial culling of animal colonies and cryopreservation of derived cell lines, with the risk that they may not behave reproducibly when thawed after the pandemic. Safe distancing measures required staggered use of facilities and equipment and segregating workers. Careful planning of experiments helped conserve reagents to be ready for a quick start after the pandemic when global reagent demand rebounds.

2.9 | Medical education

All in-person education sessions were discontinued in favour of online meetings. Advantages included safe distancing as the speaker and participants were segregated, while still allowing video presence. Online functions enabled greater audience participation using pointers, screen or video sharing, live whiteboard and file sharing. Participants in any location could join the session on their device, making education more accessible for those on the move or in between clinical tasks. Inter-institutional learning was enhanced.

However, online platforms are vulnerable to security breaches and lack the human "touch," an essential part of learning from seniors and colleagues. Online procedural skills training is inferior to practicums, but may improve with future virtual 3D-rendering technology. Nonetheless, in this extraordinary time, tele-education has emerged as a new cornerstone for medical education.

2.10 | National unity and mobilization

Since the outbreak began, all heads of hospital nephrology units were in constant communication to adopt a unified, clear and decisive approach for patient management. We will record, share and derive consensus documents for improved response to future pandemics. The Singapore Society of Nephrology and the Chapter of Renal Medicine, Academy of Medicine Singapore served as channels for outreach and mobilization of nephrologists.

2.11 | Economic perspectives

It is likely that the measures taken for COVID-19 will become the new normal.[19] Economies will need to incorporate and pay for safe distancing, enhanced environmental hygiene and a much larger health budget. As societies restructure economically after the pandemic, physicians should advocate to redress deficiencies and build resources for health and social services.[19]

3 | DISCUSSION

Our division's operational preparedness and ongoing response to the COVID-19 threat has required us to shift our clinical mindset from usual standard of care to a crisis exigency model that targets best outcomes for available resources. Rapid multi-disciplinary efforts that evolved flexibly with the local dynamics of the outbreak were required.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

AUTHOR CONTRIBUTIONS

M. B.-H. L was lead author and contributed the abstract, sections on Inpatient Care, Peritoneal Dialysis and References. H. R. C.: Figure 2, Outpatient Continuity Care. W. K. W.: Figures 1 and 3, Inpatient Care and Community Haemodialysis. G. C. C.: Research. C. C. H. L.: Medical Education. A. V.: Kidney Transplantation. B. W. T.: paper conceptualization, Introduction, Manpower Deployment, Outpatient Continuity Care, Quality of Care, Advocacy, National Unity and Economic perspectives.

ORCID

Martin B.-H. Lee https://orcid.org/0000-0002-4809-3088

REFERENCES

1. Cheng Y, Luo R, Wang K, et al. Kidney disease is associated with in-hospital death of patients with COVID-19. *Kidney Int*. 2020;97:829-838.
2. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*. 2020;395:497-506.
3. Soni R, Horowitz B, Unruh M. Immunization in end-stage renal disease: opportunity to improve outcomes. *Semin Dial*. 2013;26:416-426.
4. Gandhi M, Yokoe DS, Havlir DV. Asymptomatic transmission, the Achilles' heel of current strategies to control Covid-19. *N Engl J Med*. 2020;382:2158-2160.
5. Huang L, Zhang X, Zhang X, et al. Rapid asymptomatic transmission of COVID-19 during the incubation period demonstrating strong infectivity in a cluster of youngsters aged 16-23 years outside Wuhan and characteristics of young patients with COVID-19: a prospective contact-tracing study. *J Infect*. 2020;80:e1-e13.
6. Li G, Li W, He X, Cao Y. Asymptomatic and presymptomatic infectors: hidden sources of COVID-19 disease. *Clin Infect Dis*. 2020;ciaa418. https://doi.org/10.1093/cid/ciaa418
7. Pung R, Chiew CJ, Young BE, et al. Investigation of three clusters of COVID-19 in Singapore: implications for surveillance and response measures. *Lancet*. 2020;395:1039-1046.
8. Ferrey AJ, Choi G, Hanna RM, et al. A case of novel coronavirus disease 19 in a chronic hemodialysis patient presenting with gastroenteritis and developing severe pulmonary disease. *Am J Nephrol*. 2020;51(5):1-6. https://doi.org/10.1159/000507417
9. Brown EA, De Arteaga J, Chow J, Dong J, Liew A, Perl J. *International Society of Peritoneal Dialysis: Strategies Regarding COVID-19 in PD Patients*. Brussels, Belgium: International Society of Peritoneal Dialysis; 2020. https://ispd.org/wp-content/uploads/ISPD-PD-management-in-COVID-19_ENG.pdf
10. Ikizler TA. COVID-19 and dialysis units: what do we know now and what should we do? *Am J Kidney Dis*. 2020;76:1-3.
11. Kliger AS, Silberzweig J. Mitigating risk of COVID-19 in dialysis facilities. *Clin J Am Soc Nephrol*. 2020;15:707-709.
12. Watnick S, McNamara E. On the frontline of the COVID-19 outbreak: keeping patients on long-term dialysis safe. *Clin J Am Soc Nephrol*. 2020;15:710-713.
13. 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*. 2020;15:717-719.
14. Burgner A, Ikizler TA, Dwyer JP. COVID-19 and the inpatient dialysis unit: managing resources during contingency planning pre-crisis. *Clin J Am Soc Nephrol*. 2020;15:720-722.
15. Lan L, Xu D, Ye G, et al. Positive RT-PCR test results in patients recovered from COVID-19. *JAMA*. 2020;323:1502.
16. Li PK, Szeto CC, Piraino B, et al. ISPD peritonitis recommendations: 2016 update on prevention and treatment. *Perit Dial Int*. 2016;36:481-508.
17. Eisen MB, Akhmanova A, Behrens TE, Weigel D. Publishing in the time of COVID-19. *Elife*. 2020;9:e57162. https://doi.org/10.7554/eLife.57162
18. Weissgerber T, Bediako Y, de Winde CM, et al. Mitigating the impact of conference and travel cancellations on researchers' futures. *Elife*. 2020;9:e57032. https://doi.org/10.7554/eLife.57032
19. Agarwal R. The aftermath of coronavirus disease of 2019: devastation or a new dawn for nephrology? *Nephrol Dial Transplant*. 2020;35:904-907.

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