

ARTICLE

Rapid Transition to a Telemedicine Service at Singapore Community Dialysis Centers During Covid-19

Clara Lee Ying Ngoh, MbChB, MRCP, FAMS, Weng Kin Wong, MBBS, MRCP, FAMS, FRCP, Christopher Cheang Han Leo, MbChB, FAMS, FRCP, Thong Tiong Choo, , Behram Ali Khan,

Vol. No. | May 27, 2020

DOI: 10.1056/CAT.20.0145

When community spread of the coronavirus became apparent in Singapore, leaders at National University Hospital and the country's National Kidney Foundation coordinated on a new telemedicine model that eliminated physician rounding at dialysis clinics. The transition was swift, but not without some challenges and minor setbacks. Still, one month after full deployment, leaders now expect that the model will be adopted as the new normal in a post-Covid-19 environment.

The rapid escalation of Covid-19 in Singapore prompted a local community hemodialysis (HD) practice to implement elements of telehealth in its care delivery model.

To put things in perspective, Singapore's health care system is structured on universal health care coverage using a dual philosophy of affordable care via government subsidies and deliberate market regulation, as well as an emphasis on individual responsibility through mandatory medical savings (*MediSave*) and insurance coverage programs (*MediShield*), private insurance schemes, and patient co-payment.¹ Renal dialysis is partially covered by *MediShield* via a deductible system, but remains heavily subsidized for low- and middle-income patients, in partnership with community dialysis centers. Singapore's [National Kidney Foundation](#) (NKF) is the largest local provider of community HD care for needy patients.

The traditional model of care in community dialysis is nephrologist-driven. Locally, rounding nephrologists at dialysis centers (DC) have overarching responsibilities for patient clinical, laboratory outcomes, and preventive health and safety standards in accordance with NKF guidelines. Frequent in-person rounds at DCs were mandatory before the Covid-19 pandemic. A medical director appointed by NKF has administrative oversight over all DC facilities and is responsible for infection control and staff welfare. Inpatients at regional hospitals are reviewed

by separate attending nephrologists. While telehealth services for renal disease is established in countries such as Canada and Australia with rural communities and home dialysis programs, the impetus for uptake in small city-states like Singapore has been low.^{2,3}

Our Nephrology division is an academic practice at the National University Hospital of Singapore (a 1,160-bed tertiary hospital serving more than 670,000 outpatients and 49,000 inpatients a year) and practices a collaborative service model with NKF. Seven nephrologists perform monthly rounds on 960 HD patients across seven satellite community dialysis centers (DCs). Here we describe the urgent transition at satellite community DCs to a telehealth service, which was compressed into a 10-week timeline.

Our Experience and Timeline for Going Virtual

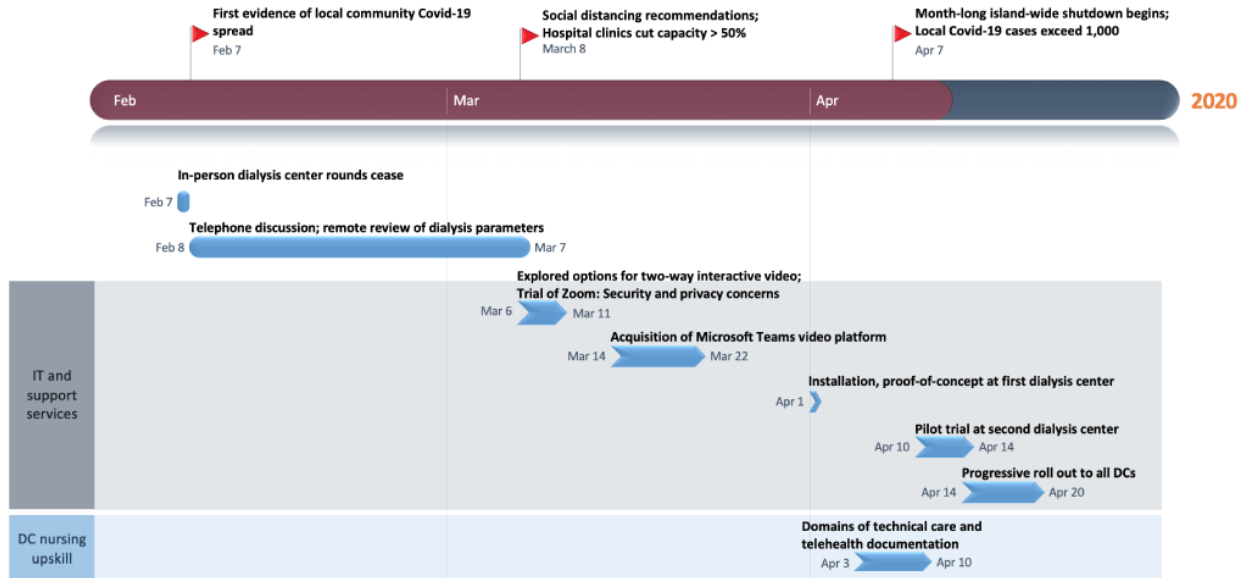
In November 2018, NKF established an electronic medical record (EMR) for each HD patient, with integrated computerized physician order entry and task management tools. Physicians were given remote access via password-secured virtual private networks (VPN) on tablet computers, but many preferred paper documents.

On February 7, 2020, after local authorities raised the risk posture of Covid-19, in-person dialysis rounds were ceased. This was replaced a day later with remote review of dialysis treatment records and telephone discussion with dialysis nurses for all patients (Figure 1).

FIGURE 1

Overview of Telemedicine Implementation for Dialysis Clinic Patients

In February, the day after the decision was made to halt in-person rounding at dialysis clinics, remote review of records and telephone consultation was initiated. A full roll-out of telemedicine technology was completed in April.



Source: The authors

NEJM Catalyst (catalyst.nejm.org) © Massachusetts Medical Society

A complete telemedicine practice was not possible, as on-site nurses were required for connecting patients to dialysis and monitoring purposes. This in-person interaction created concerns for infection control. Protocols were hence devised where patients entering the DC submitted health declarations pertaining to respiratory symptoms and travel history; mask wearing became compulsory for DC staff and patients; and patients and staff were placed in segregated shifts for dialysis and work respectively. The VPN network was occasionally unstable and documentation using a tablet was laborious.

We became increasingly concerned that local HD patients would have low acceptance of telemedicine, because of cultural perceptions and low prior exposure to this mode of care delivery. Rosner, et al., have described real-time two-way interactive video as a way of facilitating open communication between patients on home HD and the physician, which also was shown to improve patient satisfaction.³ Videoconferencing was adopted four weeks later, when it became clear that social distancing measures would have to remain in the foreseeable future. While health care organizations will have varying requirements, important considerations in choosing a corporate consultation platform include the number of participants supported, infrastructure security and data privacy, and costs of installation, particularly if the organization has no plans to continue telehealth in the longer term.^{4,5} We realized only in hindsight that the chosen video platform was

unable to link with the DC electronic medical record due to data privacy concerns, which impeded information connectivity. That delayed implementation by about one week.

Installation and trial runs were performed on April 1, 2020 in one DC. Videoconferencing was subsequently piloted on April 10, 2020 in a second DC, before being progressively rolled out to the other five DCs by April 20, 2020 (Figure 1, 2).

FIGURE 2

Telemedicine Using Screens for Medical Records and Patient Engagement

The physicians can access the medical record on one laptop while communicating with the patient and, if necessary, the dialysis clinic nurses using another laptop.



Source: The authors

NEJM Catalyst (catalyst.nejm.org) © Massachusetts Medical Society

We did not experience significant technical issues with dropped calls or image lags, as described in other studies, because the technical support team ensured a minimum bandwidth (≈ 15 Mbps) to support videoconferencing capacity. Through trial and error, nephrologists learned

about videoconference etiquette, which include ensuring a suitable environment for privacy of consultation, as well as “websites” manners such as maintaining eye contact with the camera.⁶

However, no one had accounted for the background noise of the medical equipment in the DCs, and the muffled speech as patients were instructed to wear surgical masks during dialysis; as a result, physicians sometimes relied on a clinic nurse to relay conversations.

Benefits and Challenges of a Virtual Dialysis Clinic Practice

A number of concerns have been considered as we evaluate the telemedicine program.

Volume and dry weight titration: Nurse managers and senior NKF nurses have traditionally been adept at dry weight assessment, and many DC nurses have more than five years of experience. Bioimpedance analysis is also helpful. Nonetheless, nephrologists reviewing remotely now experience a degree of clinical uncertainty for some patients as subjective information is conveyed via another source, the nurse. Some authors have demonstrated that nurses could be taught basic lung ultrasound image acquisition, which could be interpreted remotely by nephrologists for cases with complex volume assessment.^{7,8}

Dialysis vascular access: Seven of 10 hospital admissions from our DCs are related to vascular access issues. Maintenance of a functioning vascular access becomes even more crucial during this time to minimize patient exposure to hospitals and relieve demand for hospital beds.⁹ Data from vascular access flow measurements and access pressures during each dialysis session are transmitted wirelessly into the EMR, which helps our interventional nephrologists prioritize care.¹⁰ Ultimately, patients with suspected vascular access issues will still need to be reviewed in the hospital to plan further intervention. Further system process streamlining may be possible if advanced nurse practitioners can be trained to carry out ultrasound assessment of vascular access. Intervention could then be decided based on remote images.

We are also implementing a nurse-led in-center thrombolysis protocol for dysfunctional dialysis catheters. The electronic medical record will allow for DC nurse managers to order and perform thrombolysis. Patient safety is ensured by means of remote feedback to nephrologists regarding prescription approval before thrombolysis can be administered.

“*Telecollaboration at the DC has expanded to ancillary health care services, such as podiatry, via upload of high-resolution photographs of chronic wounds.*”

Chronic wound care: Telecollaboration at the DC has expanded to ancillary health care services, such as podiatry, via upload of high-resolution photographs of chronic wounds. Camera photographs are limited by the two-dimensional state. Artificial intelligence via deep neural learning with three-dimensional capabilities to assess chronic wounds has been developed.¹¹ However, there are significant barriers, including costs related to licensure of a novel technology

and lack of proven benefit for implementation unless there is an existing infrastructure for system workflow automation.

Tele-prescribing: Email notifications to physicians are now autogenerated when medications are altered in the electronic health record by nursing staff. The nephrologist in charge is then able to remotely approve prescriptions via smartphone applications. At present, medications must be prescribed from the patient's follow-up hospital in order to obtain subsidized prices. As more than 50% of patients at our DCs have follow-ups at other hospitals, close liaison is still required with the attending nephrologist. Concerted restructured billing efforts are required for 100% tele-prescribing to become a reality.

Overall outcomes and patient satisfaction: There is a paucity of outcome data from telehealth approaches for in-center HD, and only limited studies on home HD or peritoneal dialysis programs.^{3,12-14} Here, the rapid adoption of telemedicine was driven out of a necessity to continue providing care to HD patients in this unprecedented crisis. In our experience, key biochemical performance indicators have been unaltered by reduced physician presence. Unpublished audit data in March 2020 revealed that serum hemoglobin, albumin, and dialysis dose targets continue to be achieved in 85%, 91%, and 93% of patients respectively, unchanged from 6 months pre-Covid-19 at 86%, 90% and 92% respectively. There was no significant difference in hospital admission rates for cardiovascular disease or vascular access complications. It is premature to draw any conclusions on mortality rates. However, approximately 20% more hospital referrals were logged for febrile episodes with respiratory symptoms.

Initial feedback from patients has been promising. In an informal survey of patients at one DC, most expressed satisfaction with the experience: 13 of 18 patients agreed that the telemedicine service had benefited their care, and 11 of 18 agreed that telemedicine offered a near-equivalent to in-person physician rounds. We plan to establish a more formal process to assess patient satisfaction. As our patients have become accustomed to frequent health care visits for multiple co-morbidities prior to the Covid-19 pandemic, it seemed that two-way communication platforms provided reassurance that DC physicians continued to have oversight of their care needs.

“ *The transition to a virtual DC practice has been hampered by lack of interoperability of different EMR platforms used by other health care providers across the country.* ”

Ensuring True Connectivity to a Wider Health Care System

The transition to a virtual DC practice has been hampered by lack of interoperability of different EMR platforms used by other health care providers across the country. This arose as an unexpected disadvantage of local government's efforts in fostering market competition to keep health care costs low, where different public regional clusters were encouraged to seek independent procurement processes for in-house systems. A National Electronic Health Record (NEHR) is

already in use to consolidate patient encounters across different health care institutions, but further connectivity with NKF will require financial and health regulatory priorities to align.

Billing and Clinical Governance in Virtual Medicine

The rules for telehealth payment and regulations are changing rapidly as global health systems evolve in response to a prolonged pandemic. This started in the United States with temporary rules by Medicare allowing billing for all videoconference visits.^{15,16} On March 23, 2020, the Singapore Ministry of Health (MOH) approved for physicians to run both video and phone consultations, and allowed time-limited use of Medisave for teleconsultations billing on chronic disease including diabetes and hypertension.¹⁷ Teleconsultations on chronic kidney disease, including renal dialysis, remain ineligible for Medisave billing.¹⁷ Nonetheless, we are unlikely to see a major impact on HD billing structure in Singapore because of a universal health care coverage program with significant government subsidies for dialysis. However, in countries where private insurance dominates market forces, their health systems' leadership will have to make careful regulatory decisions in order to sustain telehealth as a new model of care financially, particularly to encompass vulnerable patient groups such as the geriatric population.⁶

Medical and administrative responsibilities of DC nephrologists remain unaltered. Aspects of DC systems such as infection control and staff allocations continued to be managed via secure email channels, as in the pre-Covid-19 era. No formal training was undergone prior to transition to telehealth service due to time urgency, but nephrologists learned through trial and error. However, as the usage of telemedicine and its medico-legal implications become more widespread, we urge DCs considering transition to telehealth to perform staff training in videoconferencing, consent, documentation, and technical troubleshooting (Figure 3).

FIGURE 3

Steps in Transitioning to Telemedicine for Dialysis Center Care

The most crucial aspects to ensuring success and sustainability may be a keen understanding by leaders of the medico-legal aspects of care in telemedicine, as well as patient education and buy-in.

Support staff training	<ul style="list-style-type: none">• In-house technical training for dialysis center staff• Appoint expert end-users• Test runs and fine-tuning problems, e.g., background noise levels from HD machines
Clinician training	<ul style="list-style-type: none">• Video etiquette, and “websites” manners• Documentation requirements• Medico-legal aspects to telemedicine
Patient education	<ul style="list-style-type: none">• Crucial for longer term sustainability of any telemedicine service• Increased health ownership (for example, encouraging self-photographs of foot wounds, which are electronically transmitted to the health record)• Development of a patient satisfaction tool
Developing a care framework	<ul style="list-style-type: none">• Pre-video conference checklist, including elements on digital authentication of all participants, and ascertaining each DC patient’s details and consent• Standardized elements for monthly telemedicine HD review: Specific HD and biochemical parameters, well-being• Macro templates for documentation• Escalation protocols for HD emergencies• Billing codes and payment platform
Cyber-security	<ul style="list-style-type: none">• Create password-protected user accounts to limit access• Regular system tests, audits, and staff re-training

Source: The authors

NEJM Catalyst (catalyst.nejm.org) © Massachusetts Medical Society

Hard Questions for the Longer Term

The response of community DC nurses has been unexpected. In pre-Covid times (2007), Lehoux, et al., reported in a pilot trial of a remotely operated DC that reduced physician presence subconsciously influenced staff to adopt lower safety thresholds for referring patients to emergency department.¹⁸ During this pandemic, only nursing staff and one nurse manager are left on-site in each local DC. We saw, conversely, that the mini-vacuum created by reduced physician presence was filled by nursing leaders at the DCs, who felt compelled to “hold the fort” despite perceived lesser training, in a phenomenon also described in pandemic epicenters like Italy and the United States.¹⁹ For instance, nurses did not just highlight dialysis issues, but also begun suggesting interventions; and, on their own initiative, they checked on psychological wellbeing of DC patients vulnerable to the ill-effects of prolonged social distancing. Physicians were accepting of the increased nursing care roles, as it freed them to focus on pandemic-related efforts. In the post-

Covid-19 era, we believe physicians will continue to be receptive of empowered DC nursing roles, as they focus on the backlog of elective patient care and restart clinical services.

While we channel resources toward tertiary care hospitals in the fight against Covid-19, we will need to start challenging traditional practices. For instance, do stable HD patients with no recent hospital admissions need such frequent DC physician reviews? Some of these patients could be managed equally by experienced nurses, with ad hoc physician videoconference review. This is particularly so in the local context where all HD patients have to be seen regularly in the office by a separate nephrologist, raising questions about how to demarcate medical responsibility when physicians deliver telemedicine to DCs.

As we redesign health care models to continue care delivery as best as possible during this pandemic, some aspects of the redesign will persist. Telemedicine used to be deemed too difficult for widespread implementation, but it is likely here to stay as a *new normal* long after this humanitarian crisis is over. It will redefine traditional roles of physicians in the process. This should be viewed as a potential win-win situation on all sides, which makes for more resource-efficient and sustainable health care systems globally.

Clara Lee Ying Ngoh, MbChB, MRCP, FAMS

Associate Consultant, National University Hospital, Medicine

Weng Kin Wong, MBBS, MRCP, FAMS, FRCP

Consultant and Director of Clinical Services, National University Hospital, Medicine

Christopher Cheang Han Leo, MbChB, FAMS, FRCP

Consultant and Program Director, National University Hospital, Medicine

Thong Tiong Choo,

IT Director, The National Kidney Foundation

Behram Ali Khan,

Senior Consultant and Director of Intervention Nephrology, National University Hospital, Medicine Director of Clinical Services, The National Kidney Foundation

Acknowledgements

The authors wish to acknowledge the following people for their contributions to this effort: Alice Thandar, IT Specialist, NKF; and Koh Lee Hwee, Vascular Coordinator, NUH.

Disclosures: Clara Lee Ying Ngoh, Weng Kin Wong, Christopher Cheang Han Leo, Thong Tiong Choo, and Behram Ali Khan have nothing to disclose.

References

1. The Commonwealth Fund International Healthcare Systems Profile. *The Singaporean health care system*. The Commonwealth Fund. March 16, 2016. Accessed April 27, 2020. <https://international.commonwealthfund.org/countries/singapore/>
2. Sicotte C, Moqadem K, Vasilevsky M, Desrochers J, St-Gelais M. Use of telemedicine for haemodialysis in very remote areas: the Canadian First Nations. *J Telemed Telecare*. 2011;17(6):146-9
3. Rosner MH, Lew SQ, Conway P. Perspectives from the Kidney Health Initiative on advancing technologies to facilitate remote monitoring of patient self-care in RRT. *Clin J Am Soc Nephrol*. 2017;12(6):1900-9
4. Bieber SD, Weiner DE. Telehealth and Home Dialysis: A new option for patients in the United States. *Clin J Am Soc Nephrol*. 2018;13(6):1288-90
5. Hailey D. Telehealth in nephrology care — promises and challenges. *Am J Kidney Dis*. 2016;68(6):5-7
6. Mehrotra A, Ray K, Brockeyer DM, Barnett ML, Bender JA. Rapidly converting to “Virtual Practices”: Outpatient care in the era of Covid-19. *NEJM Catalyst*.
7. Lakhe A, Sodhi I, Warriar J, Sinha V. Development of digital stethoscope for telemedicine. *J Med Eng Technol*. 2016;40(6):20-4
8. Swamy V, Brainin P, Biering-Sørensen T, Platz E. Ability of non-physicians to perform and interpret lung ultrasound: A systematic review. *Eur J Cardiovasc Nurs*. 2019;18(6):474-83
9. Ng JJ, Ho P, Dharmaraj RB, Wong JCL, Choong AMTL. The global impact of COVID-19 on vascular surgical services. *J Vasc Surg*. 2020;71(6):2182-2183.e1
10. Lok CE, Huber TS, Lee T. KDOQI clinical practice guideline for vascular access: 2019 update. *Am J Kidney Dis*. 2020;75(6):S1-S164
11. Wang L, Pedersen PC, Strong DM, Tulu B, Agu E, Ignatz R. Smartphone-based wound assessment system for patients with diabetes. *IEEE Trans Biomed Eng*. 2015;62(6):477-88
12. Lew SQ, Sikka N, Thompson C, Cherian T, Magnus M. Adoption of telehealth: Remote biometric monitoring among peritoneal dialysis patients in the United States. *Perit Dial Int*. 2017;37(6):576-8
13. Rumpsfeld M, Arild E, Norum J, Breivik E. Telemedicine in haemodialysis: a university department and two remote satellites linked together as one common workplace. *J Telemed Telecare*. 2005;11(6):251-5
14. Bernstein K, Zacharias J, Blanchard JF, Yu BN, Shaw SY. Model for equitable care and outcomes for remote full care hemodialysis units. *Clin J Am Soc Nephrol*. 2010;5(6):645-51

15. HHS Press Release. *Secretary Azar announces historic expansion of telehealth access to combat COVID-19*. Washington: U.S. Department of Health and Human Services. March 17, 2020. Accessed April 12, 2020. <https://www.hhs.gov/about/news/2020/03/17/secretary-azar-announces-historic-expansion-of-telehealth-access-to-combat-covid-19.html>.
16. Drees J. *17 federal government updates on telehealth in response to COVID-19*. Becker's Hospital Review. April 11, 2020. Updated April 30. Accessed May 18, 2020. <https://www.beckershospitalreview.com/telehealth/14-federal-government-updates-on-telehealth-in-response-to-covid-19.html>
17. MOH Press Release. *Time-limited extension of CHAS subsidy and use of Medisave for followup of chronic conditions through video consultations in view of COVID-19*. Singapore: Ministry of Health. April 3, 2020. Accessed April 12, 2020. <https://www.moh.gov.sg/covid-19/vc>.
18. Lehoux P, Daudelin G, Poland B, Andrews GJ, Holmes D. Designing a better place for patients: professional struggles surrounding satellite and mobile dialysis units. *Soc Sci Med*. 2007;65(6):1536-48
19. Nacoti M, Ciocca A, Giupponi A. At the epicenter of the Covid-19 pandemic and humanitarian crises in Italy: Changing perspectives on preparation and mitigation. *NEJM Catalyst*.