

Chronic Kidney Disease, Queensland (CKD.QLD) Registry: Management of CKD With Telenephrology



Sree K. Venuthurupalli^{1,2,4}, Andrea Rolfe^{3,4}, John Fanning¹, Anne Cameron^{2,4} and Wendy E. Hoy^{2,4}; on behalf of the NHMRC CKD.CRE and the CKD.QLD Collaborative

¹Renal Services, Toowoomba Hospital, Darling Downs Hospital and Health Service, Toowoomba, Queensland, Australia; ²Centre for Chronic Disease, The University of Queensland, Brisbane, Queensland, Australia; and ³Renal Unit, Kingaroy Hospital, Kingaroy, Queensland, Australia

Introduction: Enabled by the Chronic Kidney Disease, Queensland (CKD.QLD) Registry, we aim to outline the structure, implementation, and outcomes of telenephrology clinics for the management of patients with chronic kidney disease (CKD) in rural, regional, and remote areas of the Darling Downs region in Queensland, Australia.

Methods: This is an observational registry-based study involving adult patients with CKD, attending specialist clinics, and residing ≥ 50 km away from Toowoomba Hospital. The telenephrology cohort (TC) included those who had their follow-up appointments via videoconference at local Queensland Health facilities, and the standard care cohort (SCC) included those who continue to have their follow-up in Toowoomba Hospital.

Results: A total of 234 patients with CKD were seen via videoconference clinics between September 1, 2011 and December 31, 2016, representing 22.2% of the CKD registry cohort from Toowoomba Hospital. The baseline characteristics and comorbid profiles of both groups were similar. The Aboriginal population was overrepresented in the TC (22.2% vs. 5.9%). As a group for each visit, the TC traveled 100,000 km less (both ways) to see a specialist physically. During follow-up, 5.1% of patients in the TC were initiated on dialysis whereas 9.9% were initiated on dialysis in the SCC ($P = 0.02$). There was lower mortality in the TC (11.1% vs. 18.2%; $P = 0.02$).

Conclusion: Telenephrology clinics were safe, economical, and efficient for the delivery of specialist care for patients with CKD living at a distance from the main referral hospital. Such care was comparable to standard care delivered at the main hospital but with clear benefits to the patients in terms of reduced travel distance, more independence, and similar outcomes.

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KEYWORDS: chronic kidney disease; telenephrology

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CKD is a significant public health problem in Australia.¹ Early referral and review by a specialist is desirable for good long-term outcomes.² However, access to specialist clinics is limited by geographical location, resources, and comorbid

conditions. Distance from the nearest nephrology service is critical to outcomes in the population with CKD, as longer distances can be associated with poor attendance to specialist renal or multidisciplinary care clinics.³ This problem of nonattendance is accentuated in the case of Aboriginal and Torres Strait Islander populations because of multitude of issues related to remoteness, cultural differences, perceived racism, and lack of family support during specialist consultations.⁴ Alternative models of care need to be explored to address these issues.

Telehealth is the delivery of health services and information using telecommunication technology. The term *telenephrology* has been gaining popularity in recent times to describe delivery of specialist care to patients with kidney disease by using telemedicine

Correspondence: Sree Krishna Venuthurupalli, Renal Services, Toowoomba Hospital, Darling Downs Hospital and Health Service, Toowoomba, Queensland 4350, Australia. E-mail: Sree.venuthurupalli@health.qld.gov.au

⁴Members of the National Health and Medical Research Council (NHMRC) Chronic Kidney Disease Centre for Research Excellence (CKD.CRE) and Chronic Kidney Disease, Queensland (CKD.QLD) Collaborative.

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applications.⁵ There are multiple ways to deliver nephrology services to remote population by these methods. Telehealth use web-based platforms and applications, and medical care can be delivered via real-time videoconference (synchronous) or transfer of health records electronically (asynchronous) for review.⁶ Videoconferencing can be between a provider and a patient where a specialist directly interacts with the patient or between a provider and another provider in which case the clinical interaction involves a specialist provider and a primary care physician.⁷ Telehealth Services in Queensland Health (QH) has expanded in recent times. There is an increasing awareness and support of the potential for these technologies to facilitate access to safe, sustainable, and appropriate health care that is simple, equitable, and timely for all Queenslanders.⁸

CKD.QLD is a statewide collaborative multidisciplinary research and practice program, conceptualized in July 2009. It encompasses a CKD registry involving all consenting patients with predialysis CKD (before renal replacement therapy [RRT]) in public renal practices in Queensland.^{9,10}

The Renal Services at Toowoomba Hospital, which is the main referral hospital within the Darling Downs Hospital and Health Service (DDHHS), was one of the earliest contributors to the CKD.QLD Registry. The DDHHS deliver clinical services to ~300,000 people from 29 facilities, which include a large regional referral hospital, medium-sized regional hub hospitals, rural hospitals, multipurpose health services, community outpatient clinics, and residential aged care facilities covering predominantly rural and regional areas in southeast Queensland.¹¹ As shown in Figure 1, the DDHHS region is a large and diverse geographical area covering ~90,000 km² and consists of RA2 to RA4 remoteness categories according to the Australian Standard Geographical Structure.¹² The purpose of this structure is to classify data from census collection districts into broad geographical categories, called *remoteness areas*. The remoteness area categories are defined in terms of “remoteness”—the physical distance of a location from the nearest urban center (access to goods and services) on the basis of population size. A primary advantage of the new classification system is that the remoteness structure is updated each census,

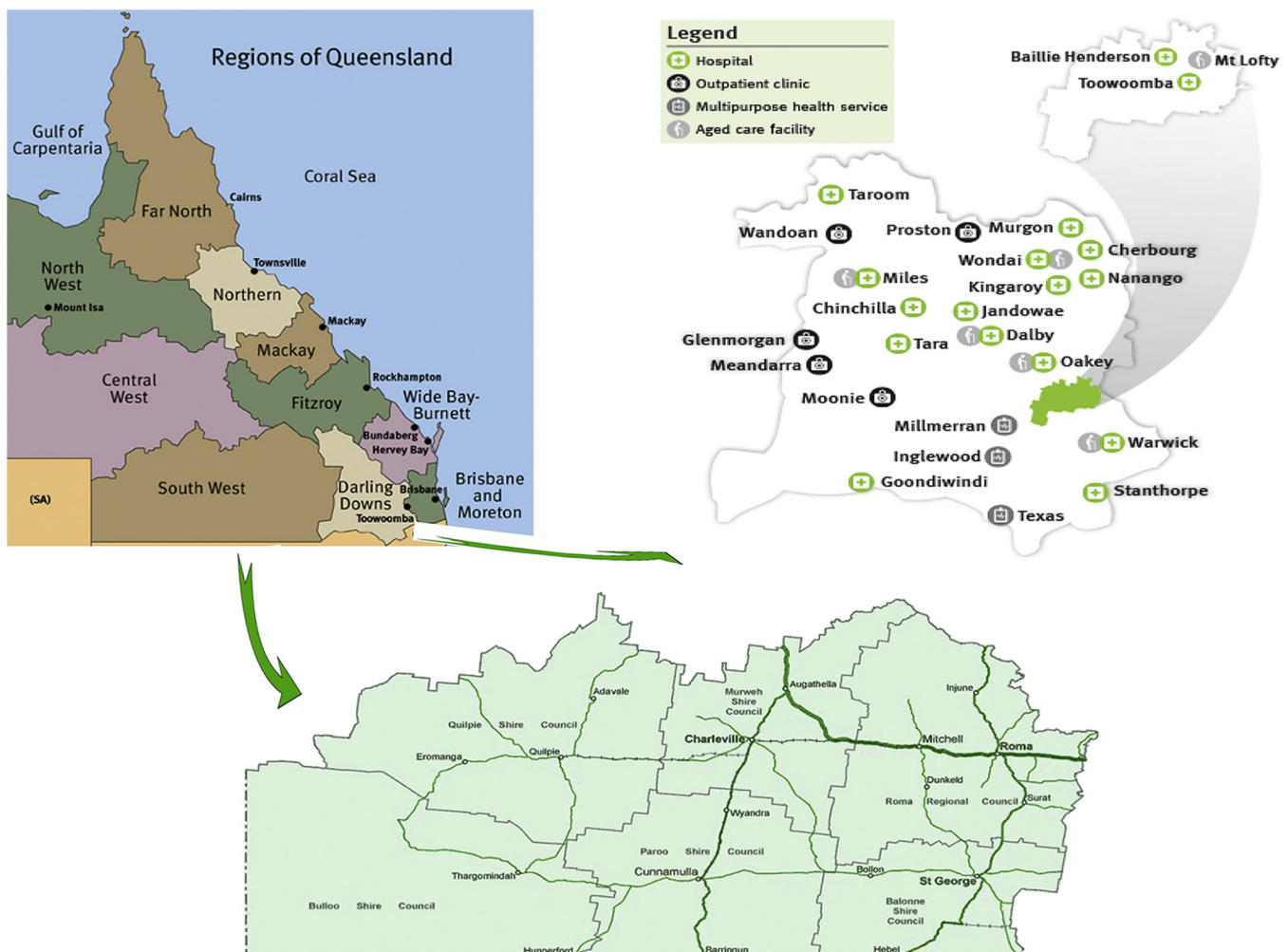


Figure 1. Geographical coverage of renal specialist clinics within the Darling Downs Hospital and Health Service. Maps not to scale.

which commenced with the census year 2001. The majority living in the DDHHS catchment area are Caucasians, whereas Indigenous Australians make up 4% of the district's population, which is 11.3% of Queensland's total Indigenous population.¹¹

Enabled by the CKD.QLD Registry, we aim to outline the implementation and outcomes, to date, of the established telenephrology clinics for the management of patients with CKD in rural, regional, and remote areas of the DDHHS. In addition, we propose to compare baseline characteristics, comorbid profiles, medical management, and outcome data between patients with CKD who had their follow-up via video-conference (TC) and those accessing in-person care in renal clinics in Toowoomba Hospital (the SCC).

METHODS

The CKD.QLD Registry methodology has been described in detail elsewhere.¹⁰ In brief, all adult patients older than 18 years with a diagnosis of CKD attending renal clinics in Toowoomba Hospital were approached for recruitment to the CKD.QLD Registry. Patients already receiving RRT were excluded, as their data are captured and reported in the Australian and New Zealand Dialysis and Transplant Registry. The demographic and clinical details of those who gave informed consent were recorded in an Excel sheet on an ongoing basis from the time of recruitment. Demographic variables include age, sex, country of birth, ethnicity, and geographical location identified by postcode. The distance traveled by

patients to access nephrology services was calculated in kilometers between postcodes of patient location and Toowoomba Hospital and reported as total distance involved both ways.

All patients attending renal clinics in Toowoomba Hospital (both prevalent and incident) were offered follow-up clinical care through telehealth, accessed at their local QH public hospital/facility. Incident patients always had their first review at Toowoomba Hospital to ascertain their clinical profile and to discuss the process. After the initial consultation, patients can choose either continuing to visit Toowoomba Hospital or moving to telehealth clinics conducted at the nearest QH facility for follow-up.

Telenephrology clinics were first started in Kingaroy (2011) and later established at Cherbourg (2013) as well as Warwick and Stanthorpe (2016). Multiple small QH locations were added from 2015 onward to cover the entire geographical area managed by the DDHHS renal service (Figure 2).

Telenephrology clinics in South Burnett district (Kingaroy and Cherbourg) are coordinated by the CKD nurse practitioner (NP). The clinics in other DDHHS hospital locations are managed by local nursing staff. Patients' health records are assembled with relevant investigations before the clinic appointment, which is coordinated by CKD clinical nurse from Toowoomba Hospital. Patients were informed of their appointments through mail, telephone, or messaging (SMS). The primary care physician looking after patients are informed of these consultations to ascertain the suitability.

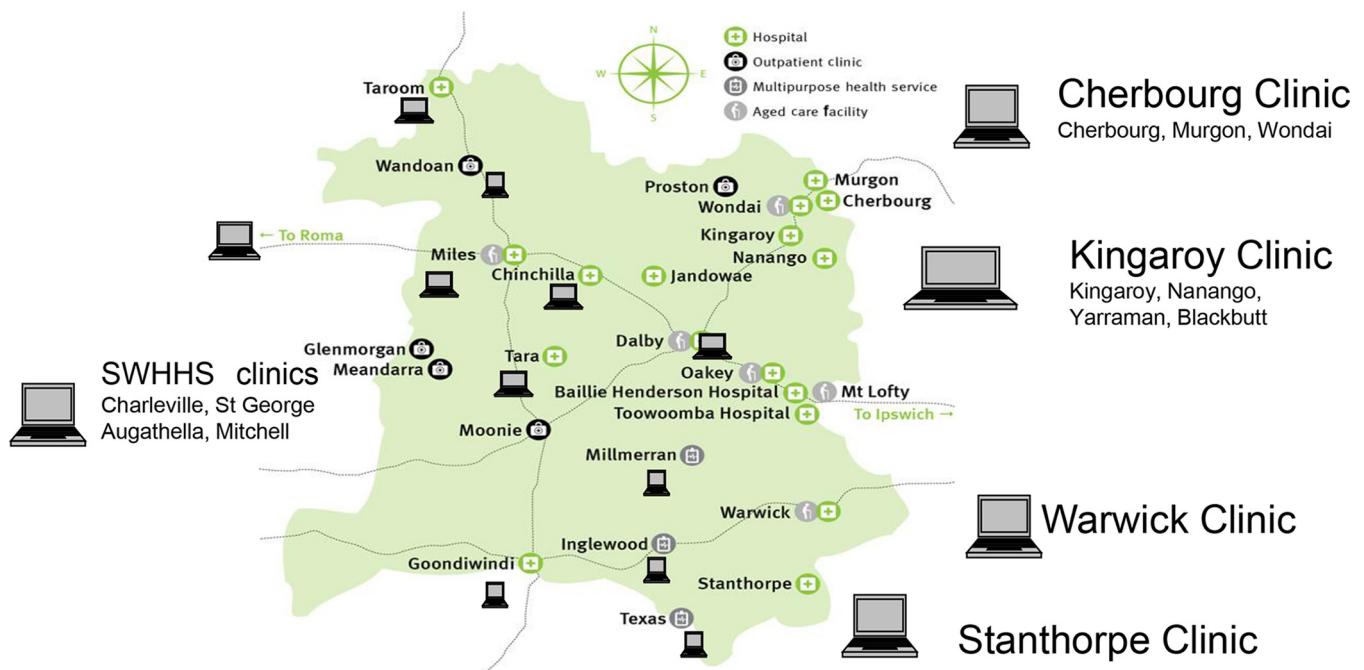


Figure 2. Location and distribution of telenephrology clinics across the health service. SWHHS, South West Hospital and Health Service. The basic map was sourced from the website of Department of Health's Primary Health Networks, with permission.

Telenephrology consultations are conducted through QH facilities using Cisco Jabber Video for TelePresence (Movi) (Cisco Systems Australia Pty Ltd., Sydney, NSW, Australia).¹³

The clinics were conducted via videoconference from an office computer in the consultant's clinic. The receiver has a videoconference system (Cisco Systems) located in a public hospital facility. In locations where CKD NP service was available (Kingaroy and Cherbourg), clinical examination including auscultation was possible. In other areas, local nursing support was available and physical examination could be performed visually but not auscultation of the chest. Health records at both ends were paper based, and vital information, investigations, and list of medications were collected by fax before the clinic appointment. However, electronic records were available for all patients within the QH system in the form of the Viewer (secure read-only online access to patient health care information from Queensland's public hospitals), which would provide data related to admissions anywhere across the state.¹⁴

The program was modified to suit the specific needs of the Aboriginal population from the Cherbourg area. Referral guidelines were changed to accept them in renal clinics at earlier stages of CKD. We liaised with Cherbourg Hospital as well as Barambah Regional Medical Services (currently known as CRAICCHS) to actively send referrals to renal services. Direct contact is established with patients to advise that they need to come to Toowoomba Hospital initially and later attend clinics at the Cherbourg Community Health Service. It was arranged that the CKD NP conduct clinics locally and be the contact person for any clinical issues. The program initially included 3 monthly specialist renal clinics via videoconference and 6 weekly NP clinics on-site. The opportunistic colocation of a dietitian, a diabetes educator, and a podiatrist on-site was encouraged to provide a multidisciplinary approach to patient care. A local aboriginal liaison officer was included in the program to organize these clinics, who happens to be a great advocate for patients with renal disease.

Information related to failure to attend clinics, RRT education, dialysis initiation, and mortality was noted from all facilities. Cost advantage was calculated in terms of distance avoided traveling to specialist clinics in Toowoomba Hospital and reduction in travel subsidy usually provided by QH. Patient satisfaction was assessed informally, and difficulties and challenges associated with conducting these clinics (both patient and provider related) were noted. At the end of each consultation, all patients were offered the choice to return to specialist clinics in Toowoomba Hospital at anytime for future follow-up.

An exit outcome from this clinic structure was defined as commencing dialysis, death, or discharge. Patients who received a kidney transplant and residing in a remote location were also included in this model of care, but were excluded from the analysis. Data were analyzed using Stata version 13 (StataCorp LP, College Station, TX).

RESULTS

A total of 234 patients with CKD were seen via telenephrology between September 1, 2011 and December 31, 2016. They represented 22.2% of the total CKD.QLD Registry cohort from the DDHHS. Fifteen others who had posttransplant follow-up through these clinics were not included.

Baseline Characteristics

The baseline characteristics and comorbid profiles of the TC and SCC are summarized in Table 1. The mean age of the TC was 65.1 years (median, 67.5 years), and

Table 1. Baseline characteristics of the telenephrology cohort versus the standard care cohort

Parameter	Telenephrology cohort ^a	Standard care cohort	<i>P</i> ^b
No. of patients	234 (22.3)	817 (77.7)	
Sex: male/female	124/110	458/359	0.40
No. of Aboriginal patients	52 (22.2)	49 (5.9)	0.001 ^b
Age at consent (yr)	65.1 ± 13.4	63.5 ± 15.6	0.36
Obesity (BMI ≥ 30 kg/m ²)	127 (54.2)	407 (49.8)	0.22
Elderly (age ≥ 70 yr)	100 (42.7)	349 (42.7)	0.99
Advanced CKD (stages 4 and 5)	77 (32.9)	313 (38.3)	0.15
eGFR at consent (ml/min per 1.73 m ²)	40.4 ± 20.8	40.3 ± 22.8	0.68
Hypertension	213 (93.1)	739 (90.4)	0.20
Diabetes	130 (55.5)	336 (41.1)	0.001 ^b
Smoking status	146 (62.3)	458 (56.0)	0.08
Diabetic nephropathy	83 (35.4)	198 (24.2)	0.001 ^b
Cardiac disease	106 (45.3)	334 (40.8)	0.22
Coronary artery disease	63 (26.9)	198 (24.2)	0.40
Cerebrovascular disease	28 (11.9)	103 (12.6)	0.79
Peripheral vascular disease	23 (9.8)	72 (8.7)	0.75
Cancers	47 (20.0)	197 (24.1)	0.37
Psychiatric disorders	14 (5.9)	48 (5.8)	0.86
Depression	47 (20.0)	161 (19.7)	0.86
Gastroesophageal reflux	53 (22.6)	147 (17.9)	0.24
Gout	61 (26.0)	188 (23.0)	0.47
Arthritis	74 (31.6)	185 (22.6)	0.01 ^b
Metabolic bone disease	19 (8.1)	81 (9.9)	0.61
Musculoskeletal problems	44 (18.8)	130 (15.9)	0.50
Joint replacement	19 (8.1)	54 (6.6)	0.63
Thyroid disorders	35 (14.9)	107 (13.1)	0.66
Eye disorders	28 (11.9)	79 (9.6)	0.30
Chronic lung disease	42 (17.9)	116 (14.2)	0.15
Obstructive sleep apnea	27 (11.5)	109 (13.3)	0.66

Data are mean ± SD or n (%).

BMI, body mass index; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

^aThe telenephrology cohort has more Aboriginal patients, diabetes, diabetic nephropathy, and arthritis.

^bSignificance: *P* < 0.05.

the mean age of the SCC was 63.5 years. Sex distribution was equal between the 2 groups. The Aboriginal population was overrepresented in the TC (22.2% vs. 5.9%). Significantly more patients with diabetes and diabetic nephropathy were seen via telenephrology, and more patients had arthritis and gout. Most comorbid conditions were more common in the TC.

Distance and Cost

Collectively, the TC traveled a distance of 97,513.6 km (both ways) for their first visit to the renal clinics in Toowoomba Hospital. The shortest distance involved was 50 km (Dalby), and the farthest was 838.4 km (Blackall). The Patient Travel Subsidy Scheme of QH spent AUD\$29,254.08 in the form of fuel subsidy for travel alone for their first appointment for the entire TC, with additional costs of accommodation and rail, bus, or air travel. In addition to these direct costs, other travel-related costs include work leave for a carer or family member to drive patients to specialist clinics in Toowoomba, as well as childcare or pet care arrangements.

Outcomes

There was a high level of acceptance and retention in the TC; >98% preferred to continue with these clinics. Increased referrals from primary care physicians asking for review via telenephrology were noted. More than 90% of consultations involved a family member or carer. There was significant improvement in attendance rates, reaching 90% in TC clinics from all locations and >80% in TC clinics from Cherbourg, where it used to be <80% and <50%, respectively, for follow-up visits in the past. The mean number of admissions per patient in the TC was 1.63 compared with 2.25 per patient in the SCC. However, the mean length of days as inpatients was more for the TC (5.5 days vs. 4.0 days). Most admissions at Toowoomba Hospital from the TC were for construction of vascular access. There were similar levels of use of renin-angiotensin-aldosterone system inhibitors and lipid-lowering drugs in both groups. Some important outcomes are reported in Table 2.

All patients in the TC had their initial assessment, education, family meetings, and decision for RRT via these clinics before they attended Toowoomba Hospital for dialysis access creation. During a follow-up period of 2790 patient-years (5.9 years), the rate of RRT was 2.0 cases per 100 patient-years in the TC as compared with 3.5 cases per 100 patient-years in the SCC. None of the Aboriginal patients from the Cherbourg area were presented at the Renal Services at Toowoomba Hospital for emergency dialysis since the start of these clinics.

There was lower mortality in the TC (4.5 cases per 100 patient-years vs. 5.3 cases per 100 patient-years); of

Table 2. Important clinical outcomes in the 2 cohorts

Outcome	Telenephrology cohort	Standard care cohort
RAAS blockers	176 (75.2)	578 (70.5)
Lipid-lowering drugs	170 (72.6)	541 (66.2)
Clinic attendance rate (%)	90	93
Hospital admissions (per patient)	1.63	2.25
Mean length of stay (d)	5.5	4.0
Renal replacement therapy	12 (5.1)	81 (9.9) ^o
Overall mortality	26 (11.1)	149 (18.2) ^o

Data are n (%) unless indicated otherwise.
RAAS, renin-angiotensin-aldosterone system.
^oSignificant.

those 26 patients from the TC who died during follow-up, 9 (34.6%) had been identified for conservative management and had been examined by the community palliative care service and >90% died at a local health care facility.

DISCUSSION

Telenephrology has been widely used in Australia for various disease conditions.¹⁵ We established telenephrology as an alternative model of care of delivery of specialist renal care for patients living in rural, regional, and remote areas in the Darling Downs region in Queensland. Our telenephrology model of care showed that specialist renal care could be delivered safely and economically to the population with CKD living 50 km away from the main referral hospital.

We demonstrated multiple benefits of this model. The first and foremost is the travel distance to Toowoomba to attend the clinics. Each patient needed to travel an average distance of 416 km from their home to specialist renal clinics in Toowoomba Hospital per single visit both ways included. The distance alone emerged as the critical factor for the high level of acceptance of these clinics. Depending on the severity of the clinical condition, each of them may be seen 3 to 4 times in a year by a specialist and the distance to travel gets multiplied that many times. But for the provision of telenephrology clinics, the distance travelled would be recurrent, as patients need to attend renal clinics multiple times for follow up. In a study related to travel time and distance to access health services, Kelly *et al.* concluded that a relationship between longer distances and adverse health outcomes could not be ruled out.¹⁶ Travel distance should be considered within the health care service delivery model. In addition, the median age of the cohort was 67.5 years and the majority had 2 to 3 associated comorbidities. Although 80% drive locally, this level of travel is beyond their capacity and thus they needed assistance of a family member or carer. The presence of arthritis and musculoskeletal problems did not help the journey either.

The economic advantages are multiple too. QH provides financial assistance to help with transport and accommodation costs for patients required to travel >50 km from their nearest hospital to attend specialist medical appointments.¹⁷ This patient travel subsidy scheme covers only part of the total expenditure incurred by patients, and most patients avail fuel subsidy only, as they preferred to travel by private vehicle. This model not only saved direct costs to QH in the form of fuel subsidy, accommodation, and travel arrangements, but numerous additional cost savings were also noted. High clinic attendance rate, less CKD-related transfers/admissions to Toowoomba Hospital, and provision of terminal palliative care locally all have enhanced economic and social benefits. These costs would be recurrent, but for the provision of telenephrology clinics.

Involvement of a family member or carer during the telenephrology clinic visit improved communication. Participation of a CKD NP, who could prescribe medication and order pathology tests, in the telenephrology clinic sessions, added an additional dimension of care. There was an immediate contact with the primary care physician and pharmacy to inform of any changes in care plan and medications. The NP later followed these patients in clinics locally to address any concerns or issues identified during the telenephrology session.

We chose to conduct these clinics in QH facilities only as compared to delivering specialist care at their general practices. Apart from the separation of nephrologists and patient by distance and presence of a computer interface, this model is the closest to the standard care provided in Toowoomba Hospital. Both groups received allied health support as required. Clinic letters were sent to the primary care physician. An unexpected additional benefit was the greater familiarity with the complex needs of these patients acquired by local medical and nursing staff, who then became confident in managing these patients and admitting them locally rather than choosing to transfer them to Toowoomba Hospital. This became more evident, especially in those patients who chose not to have RRT.

Although the rate of RRT in the TC was low as compared with that in the SCC, we did not consider this a disadvantage. Lack of suitable dialysis facilities in remote areas might have contributed to this disparity; it did not translate into higher mortality. In fact, the mortality was lower in the TC than that in the SCC. It is well known that elderly patients may not have survival advantage on RRT as compared with patients who remain on medical management only.¹⁸ As shown in [Table 1](#), the baseline characteristics and comorbid profiles of both groups were similar, indicating no selection bias toward patients seen via telenephrology. Similar

levels of use of renin-angiotensin-aldosterone system inhibitors and lipid-lowering drugs suggest comparable levels of clinical care ([Table 2](#)).

These clinics had a dramatic effect on the delivery of specialist renal care to the Aboriginal community from Cherbourg. “Failures to attend (visits)” were fewer. Patients were seen at much earlier stages of CKD than usual and received CKD education, RRT planning, access review, and initiation of dialysis through these clinics. It should be emphasized that patients with no known (or unknown) CKD from Cherbourg presented for emergency dialysis during this interval. Patients could begin their dialysis locally (Kingaroy unit) or transferred back to the local unit quickly. CKD NP-coordinated clinics in Cherbourg played a major role in the management and follow-up of these patients and improved communication with the local health staff significantly.

There are some inherent limitations of our report. This study is observational in nature, and patients are recruited on an ongoing basis. All patients who resided ≥ 50 km away from Toowoomba Hospital were offered the choice of telenephrology clinics, and the uptake was close to 100%. As the distance was the only variable differentiating these 2 groups and almost all patients who stay at a distance accepted the choice of telenephrology clinics, it was not possible to conduct a randomized controlled trial. Data from the TC could be compared only with historical data. We did not analyze the cost-benefit associated with hospital admissions, which could be an important measure of economic and health-related outcomes. We did not report data on some clinical and laboratory parameters such as blood pressure and blood sugar control (hemoglobin A_{1c}) in the registry to compare the level of clinical care between the 2 groups. Patients who were seen via telenephrology clinics had additional prompts to attend clinics from both renal service and local hospital facility so as not to waste the clinic resources, which might not be case with the SCC. Despite these limitations, our study is the first of its kind to report on patients with predialysis CKD from regional Australia.

There were some challenges with the provision of telehealth, some of which have been reviewed by Gordon *et al.*¹⁹ Technology-related issues, poor Internet connectivity, and lack of local staff to arrange these clinics, especially at small QH facilities, were some of the problems noted. The main patient-related factors were hearing impairment, which required indirect communication through family or nursing personal. The presence of a CKD NP in these clinics (Kingaroy and Cherbourg) made communication better, not only with the patient and family but also with local pharmacy and primary care physician. This level of communication is still a challenge in smaller clinic locations.

Summary and Conclusion

We demonstrated a safe, economical, and efficient model of delivery of specialist renal care for patients with CKD living at a distance from the main referral hospital. Provision of specialist care for patients with renal disease via telenephrology was noninferior and comparable to standard care delivered at the main hospital but with clear benefits to the patients in terms of reduced travel distance, more independence, and improved satisfaction. Face-to-face clinic consultations delivered locally may be considered as the criterion standard, but in the current situation with resource constraints, telenephrology provides a viable and alternative model of care of delivery of specialist renal care in regional and remote Australia.

DISCLOSURE

All the authors declared no competing interests.

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The CKD.QLD Registry study was approved by the Queensland Health Human Research Ethics Committee (HREC approval: HREC/10/QHC/41) in November 2010. Later the approvals were handed over to HREC, Metro North Hospital and Health Service [HREC reference number (MNHHS): HREC/15/QRBW/294], as of June 2015. Also, it was simultaneously approved by the University of Queensland's Human Research Ethics Committee (No.: 2011000029) All participants are required to sign a consent to participate. The CKD.QLD Registry data are managed as per legislated requirements including the Information Privacy Act 2009 and as per the National Health and Medical Research Council's 2007 National

Statement on Ethical Conduct in Human Research (updated May 2015).

REFERENCES

1. Australian Institute of Health and Welfare. *An Overview of Chronic Kidney Disease in Australia, 2009*. Canberra, Australia: Australian Institute of Health and Welfare; 2009. Cat. No. PHE 111.
2. Luxton G. Timing of referral of chronic kidney disease patients to nephrology services (adult). *Nephrology*. 2010;15:S2–S11.
3. Rucker D, Hemmelgarn BR, Lin M, et al. Quality of care and mortality are worse in chronic kidney disease patients living in remote areas. *Kidney Int*. 2011;79:210–217.
4. Bello AK, Hemmelgarn B, Lin M, et al. Impact of remote location on quality care delivery and relationships to adverse health outcomes in patients with diabetes and chronic kidney disease. *Nephrol Dial Transplant*. 2012;27:3849–3855.
5. Askew D, Brady J, Brown A, et al; Kanyini Qualitative Study Investigators. *To Your Door: Factors That Influence Aboriginal and Torres Strait Islander Peoples Seeking Care*. Newtown, Australia: The Georgia Institute for Global Health; 2014. Kanyini Qualitative Study Monograph Series No. 1. Available at: <http://www.kvc.org.au/wp-content/uploads/2014/12/Paper-Mono-1-CD-20130624-v42-Submitted.pdf>. Accessed November 25, 2017.
6. Osman MA, Okel J, Ikechi G, et al. Potential applications of telenephrology to enhance global kidney care. *BMJ Global Health*. 2017;2:e000292.
7. Narva AS, Romancito G, Faber T, et al. Managing CKD by telemedicine: the Zuni Telenephrology Clinic. *Adv Chronic Kidney Dis*. 2017;24:6–11.
8. Queensland Health, Queensland Government. Telehealth. Available at: <https://www.health.qld.gov.au/telehealth>. Accessed November 27, 2017.
9. Venuthurupalli SK, Hoy EW, Healy GH, et al. CKD.QLD: chronic kidney disease surveillance and research in Queensland, Australia. *Nephrol Dial Transplant*. 2012;27(Suppl 3):iii139–iii145.
10. Venuthurupalli SK, Hoy EW, Healy GH, et al. CKD.QLD: establishment of a chronic kidney disease [CKD] registry in Queensland, Australia. *BMC Nephrol*. 2017;18:189–190.
11. Profile of local Darling Downs Hospital and Health Service. Available at: <https://www.health.qld.gov.au/darlingdowns/pdf/ddhhs-strategicplan.pdf>. Accessed August 17, 2018.
12. Department of Health, Australian Government. Australian Standard Geographical Classification - Remoteness Area (ASGC-RA 2006). Available at: <http://www.health.gov.au/internet/otd/publishing.nsf/content/ra-intro>. Accessed November 27, 2017.
13. Cisco. Cisco Jabber for Windows and Mac: Enterprise Collaboration Made Simple Data Sheet. Available at: <https://www.cisco.com/c/en/us/products/collateral/unified-communications/jabber-mac/datasheet-c78-740458.html>. Accessed June 18, 2018.
14. Queensland Health, Queensland Government. Health Provider Portal (HPP). Available at: <https://hpp.health.qld.gov.au/>. Accessed June 18, 2018.
15. Rohatgi R, Ross MJ, Majoni SW. Telenephrology: current perspectives and future directions. *Kidney Int*. 2017;92:1328–1333.

16. Kelly C, Hulme C, Farragher T, et al. Are differences in travel time or distance to healthcare for adults in global north countries associated with an impact on health outcomes? A systematic review. *BMJ Open*. 2016;6:e013059.
17. Queensland Government. The Patient Travel Subsidy Scheme (PTSS). Available at: <https://www.qld.gov.au/health/services/travel/subsidies>. Accessed June 18, 2018.
18. Foote C, Kotwal S, Gallagher M, et al. Survival outcomes of supportive care versus dialysis therapies for elderly patients with end-stage kidney disease: a systematic review and meta-analysis. *Nephrology (Carlton)*. 2016;21:241–253.
19. Gordon EJ, Fink JC, Fischer MJ. Telenephrology: a novel approach to improve coordinated and collaborative care for chronic kidney disease. *Nephrol Dial Transplant*. 2013;28:972–981.