Telenephrology: An Emerging Platform for Delivering Renal Health Care

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Electronic-based health care delivery systems are gaining popularity among patients and clinicians because of convenience. Importantly, telemedicine, the delivery of health care and/or health information using electronic systems, can deliver primary and specialized health care to geographically isolated patients, who account for nearly 20% of the US population. In nephrology, where a growing discrepancy exists between the geographic location of nephrologists and patients with kidney disease, telenephrology can bridge distance and deliver renal care and education to the isolated. Large nationalized health care systems, for which incentives are aligned to innovate and implement new platforms to deliver cost-effective care, have been at the forefront of telenephrology. These systems include synchronous direct physician-patient care through clinical videoconferencing, and asynchronous modalities such as electronic consultation and video telehealth to educate internists about specialized clinical topics. Large health care organizations are adopting these platforms as standalone services; however, expansion into the private health care system has been limited by reimbursement, regulations, and other issues. Though telenephrology is patient centered, studies are needed to rigorously test its clinical efficacy and cost-effectiveness. Nonetheless, growing patient demand for patient-centric health care will continue to expand the telenephrology space.

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Note from Editors: This *AJKD* Core Curriculum focuses on electronic-based health care delivery and its role in the care of patients with kidney disease. It provides information on the type of patients who might benefit from this young technology and discusses some of the ethical, legal, and technological barriers to its widespread adoption. We point out a complementary Policy Forum Perspective from Lew and Sikka in the July 2019 issue of *AJKD* that offers practical how-to advice important to practicing nephrologists who are considering using telehealth as part of their practice. We believe these 2 articles together provide valuable information on the potential use of telehealth in improving the care of patients with kidney disease.

Barriers to Chronic Kidney Disease Care

Classic Barriers

Chronic kidney disease (CKD) is a worldwide ailment that increases the morbidity and mortality of those affected and is disproportionately costly to society. The pervasiveness of diabetes and obesity will likely contribute to future increases in CKD and kidney failure with replacement therapy (KFRT). Preventing the progression of CKD to KFRT will be critical to rein in the high costs of kidney replacement therapy. Early and frequent access to CKD care is a key strategy for reducing morbidity and mortality and minimizing cost.

Many barriers impede the delivery of renal care and contribute to poor renal outcomes. These barriers can be divided into 2 large categories: system centric and patient centric. System-centric barriers include poor recognition and understanding of CKD by primary care providers (PCPs), late referrals to nephrologists, suboptimal distribution of nephrologists relative to the density of patients with kidney disease, and a for-profit private health insurance system that limits access to nephrologic care. Patient-centric factors include limited literacy, cultural/language barriers, low socioeconomic status, frailty, and geographic distance from nephrologists.

Geographic Access as an Underrecognized Barrier

Most kidney diseases are due to secondary causes, such as diabetes and hypertension, and are frequently accompanied by comorbid conditions such as neuropathy and retinopathy that restrict mobility. Geographic isolation and rurality can compound medical isolation. In the United States ~19% of the population and ~36% of veterans enrolled in the Veterans Affairs (VA) health care system reside in rural communities. However, nephrologists disproportionately reside in urban locales, often embedded in populations with a modest prevalence of CKD. As demonstrated in the 2015 Workforce Report prepared for the American Society of Nephrology, nephrology training programs are not located in regions with the greatest prevalence of kidney failure, leaving many rural regions underserved (Fig 1). Moreover, fewer residents are choosing a career in nephrology,

The Core Curriculum aims to give trainees in nephrology a strong knowledge base in core topics in the specialty by providing an overview of the topic and citing key references, including the foundational literature that led to current clinical approaches.

exacerbating the disparity between supply and demand for renal services.

Patients with CKD who live far from a nephrology practice may be less adherent to renal clinic visits and receive less CKD treatment compared with patients who live closer. Not only are processes of care compromised, but also geographically isolated patients are hospitalized more frequently and experience higher mortality than patients who live in close proximity to a nephrology practice. As distance increases, the negative health effects become more pronounced and thus health care delivery platforms are needed to bridge the distance.

Among the US dialysis population, Thompson et al showed that the mortality of patients who lived more than 100 miles from their dialysis units was 21% higher than for those who reside close to their unit. Studies performed in China and Australia corroborated these findings. In a Chinese cohort, Zhang et al noted that rural patients, at their first visit to a renal clinic/dialysis unit, had lower estimated glomerular filtration rates than their urban counterparts, implying less access to care. Peritoneal dialysis patients who lived in rural communities had higher mortality compared with urbanites.

Though not all studies of geographic remoteness illustrate poor renal outcomes, the preponderance of evidence suggests that geographic isolation affects CKD outcomes. A study by Ayyalasomayajula et al reports the feasibility of a geographic information system software to optimize the location of clinics so as to minimize patient travel while maximizing patient access. Nonetheless, a major unmet need remains and telemedicine/telenephrology is a technology that can bridge the geographic gap.

Additional Readings

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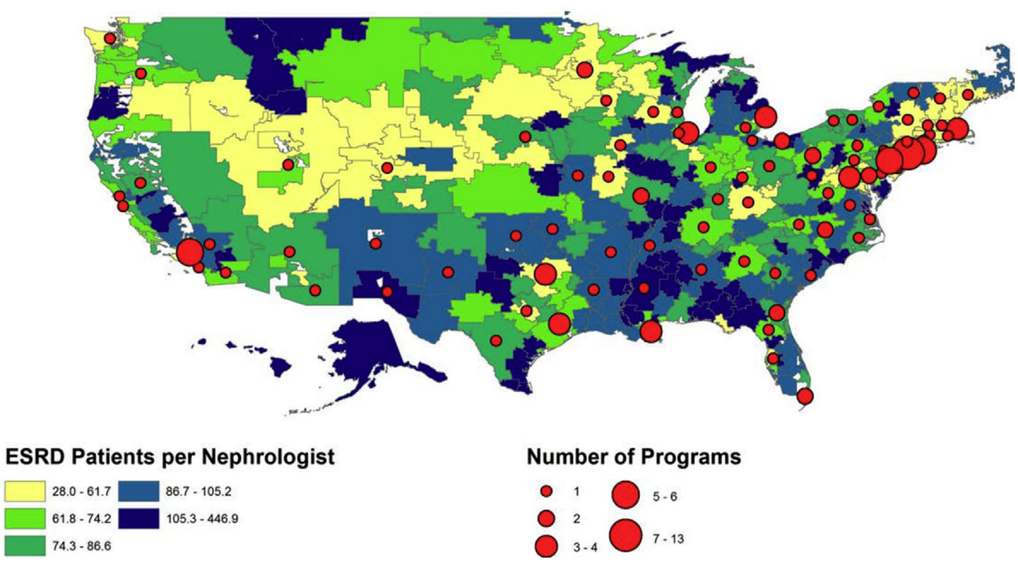

Figure 1. Number of patients per nephrologist by US hospital referral region, along with location of nephrology fellowship training programs. Abbreviation: ESRD, end-stage renal disease. Reproduced with permission from American Society of Nephrology from The US Nephrology Workforce 2015: Developments and Trends. Geographical Distribution of Nephrology Fellowship Programs and ESRD Patients per Nephrologist by Hospital Referral Region, 2011.

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Telemedicine and Telenephrology: Modalities to Increase Access

Telemedicine, as defined by the World Health Organization, is:

> […] the delivery of health care services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities.

Large nationalized health care systems are at the forefront of developing telehealth networks to deliver care remotely because their priorities are aligned to maximize resources for the most cost-effective care. In the United States, where private health insurance dominates, large health care systems such as the VA and Kaiser Permanente (KP) have led investment in and development of robust telehealth programs.

Historically, large health care organizations had been organized around medical centers for which the goal was to deliver complex care to the sick. However, as health care changed to a preventive and long-term care model located in the clinic, organizations needed a means to deliver care at greater distances from the medical centers and developed 2 main types of health care delivery platforms. Asynchronous telehealth transmits medical data and information between providers to be reviewed at their convenience. Synchronous telehealth services establish direct communication between patient and provider to permit patient care. For example, Clinical Video Telehealth (CVT), a VA initiative, uses videoconferencing on a high-speed line connected with peripheral devices that can aid the nephrology provider in a virtual examination of a patient at another site. With the aid of a technician on the patient side, peripheral equipment such as a stethoscope, digital camera, and ultrasound can be positioned to examine the heart, lungs, skin, and dialysis access. Consistent with a patient-centric focus, these platforms allow care to be delivered during or outside of business hours. Box 1 describes many of the modalities of telenephrology that have been adopted worldwide to improve access to care.

Additional Readings

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Box 1. Various Modalities of Telenephrology Used for Renal Health Care and Education

1. **CVT**[a]
Office-based and home-based: CVT delivers nephrologic expertise using high-speed internet lines to connect patients and nephrology providers.
2. **e-Consultation**
Enables the PCP to request nephrology consultation through the EHR about a focused question that does not require an in-person evaluation.
3. **SCAN-ECHO**[a]
A provider-to-provider video conferencing platform with the primary purpose of real-time linking of PCPs in rural or geographically remote clinics with nephrologists at tertiary-care hospitals.
4. **e-Kidney Clinic**[a]
Web-based nephrology education at a 5th to 6th grade reading level divided into various basic learning modules (eg, "Nutrition" and "Social Work Services") in written and graphic format and supplemented by narrative video vignettes.
5. **Kidney Mobile/Smartphone Applications**
Mobile technology using internet and smartphones can be used by patients to access educational websites; check health data (eg, blood pressure, pulse, blood glucose, and weight); and set up medications, clinical reminders, and other health alerts. The data can be presented as graphs and with the health care provider to assist in renal management.

Abbreviations: CVT, Clinical Video Telehealth; EHR, electronic health record; PCP, primary care provider; SCAN-ECHO, Specialty Care Access Network—Extension for Community Health Care Outcomes; VA, Veterans Affairs.
[a]Currently a VA-specific program.

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Lessons From Nationalized Health Care Systems

Large countries with nationalized health care systems such as Canada and Australia have long-standing experience with telehealth. In the mid-1990s, Australia established telenephrology coordination services in the Northern Territory, a remote region with an aboriginal populace that experiences a high burden of CKD. In 1997, Mitchell et al reported a 2.5-year telemedicine experience that linked 3 satellite dialysis units to the renal unit at Queens Elizabeth Hospital. They were able to perform routine renal outpatient consultation, infectious disease evaluations, and referrals for surgery, illustrating the ability to deliver complex care remotely. In a follow-up report in 2000, Mitchell et al described successful use of home video teleconferencing over a modem connection for home dialysis, demonstrating the potential to bring complex care into the home. A retrospective analysis of a pediatric video-teleconferencing–based practice that successfully performed 318 consultations for 168 patients over approximately 10 years estimated a savings of approximately AU $505 per consultation, indicating its cost-effectiveness while improving access.

In Canada, remote management of hemodialysis has been ongoing since the late 1980s. In 2010, Bernstein et al reported their experience of remotely managing 12 hemodialysis units and comparing the clinical outcomes with local routine in-person hemodialysis care. This was done before the availability of high-speed internet and videoconferencing, so the nephrologist would make telephone rounds with the local hemodialysis nurse. On a weekly basis, dialysis treatment summaries, medication lists, and laboratory tests would be faxed to the nephrologist for review before making telephone rounds. The 1-year and 2- to 5-year survival rates were equivalent and even slightly better in the remotely managed group compared with the routine care cohort. Sicotte et al compared routine in-person dialysis care with videoconferencing in which the nephrologist would either: (1) make direct "telerounds" with the patient or (2) round with the primary dialysis nurse and internist to review each case. In this small study of 19 patients, no difference in processes of care or clinical outcomes was detected between the 2 modalities. Larger systematic studies are lacking; however, these small nonrandomized observational studies illustrate feasibility and the potential to deliver comparable care remotely.

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The US Experience With Telenephrology Modalities

In the United States, telemedicine and telenephrology have principally been developed and adopted by large private or public health care organizations. Part of the growth is due to consumer demand, but also because faster access to care may reduce emergency department visits, hospitalizations, and morbidity and mortality, thus reducing overall health care costs. Organizations that integrate the financing with the delivery of health care, such as KP and the VA, are aligned in developing cost-effective telemedicine networks that enhance access. Recent legislative changes affecting the VA, specifically the Mission Act and the 2014 Choice Act, broaden veterans' access to the private health care system but also place greater pressure on VA physicians and administration to innovate to retain veterans within the VA system. Telemedicine and telenephrology are tools used by the VA to assist with patient access and retention.

In 2014, KP, a private health care organization, began its patient-provider video telemedicine program. This program grew from fewer than 5,000 video visits per quarter in 2015 to more than 25,000 video visits per quarter in 2017. Seventy-four percent of patients use smartphones for their visit, with the rest using either a desktop computer or tablet. Though no specific telenephrology program has been reported at KP, they instituted a kidney stone telemedicine program organized by urology and implemented by a trained clinical pharmacist in which metabolic workup and dietary counseling occurred by telephone on a quarterly basis. Of 536 potential patients, 500 (93.3%) enrolled in the program and 80% of patients completed a metabolic workup within 1 year, illustrating the clinical success of the program.

To deliver specialty care to uninsured patients, KP in Colorado created an electronic consult (e-consult) system for primary providers. In this system, PCPs could generate e-consults to specialists who could review and respond to the question or request face-to-face evaluation. In the 20 months that the program was operational, 602 e-consults were generated, which led to 81 face-to-face appointments with specialists. More than 50% of the PCPs used this system and thereby improved access to specialty recommendations.

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Provider-to-Patient Telehealth Interactions (Clinical Patient Management)

Case 1: *A 72-year-old veteran lives in a town 125 miles away from the closest tertiary-care VA medical center (VAMC). He has a history of diabetes, hypertension, coronary artery disease, stroke, and CKD requiring nephrology follow-up. He receives his primary care at a local VA community-based outpatient clinic (CBOC) 10 miles from his house, and due to poor vision, he cannot drive long distances. He heard about a new system at the local VA CBOC in which specialists see patients using the computer. He prefers to use that system rather than have his son drive him to the VAMC to see a nephrologist.*

Office-Based Telehealth

In 2002 the VA adopted CVT as a health care delivery platform to reach geographically remote veterans. Renal CVT is a form of telemedicine that delivers nephrologic expertise using virtual high-speed connections between veterans and nephrology providers. This technology platform delivers nephrology care through several types of provider-patient physical settings, including hospital to hospital, hospital to clinic, and hospital to home. Renal CVT appointments have also been used to provide multidisciplinary care associated with nephrology, including nutritional counseling and surgical and interventional radiologic evaluation.

In many centers, the initial visit is in-person at the VAMC to complete a physical examination and develop trust, critical for a successful long-term patient-provider relationship. As physicians' and patients' experience and comfort levels increase with CVT, the initial in-person evaluation may become unnecessary.

The goals of our renal CVT programs at the James J. Peters (Bronx) VAMC and John Cochran (Saint Louis) VAMC were to improve attendance at renal clinic visits, reduce travel times and costs, improve patient satisfaction, and of course, deliver outstanding clinical care. Some of the potential benefits were nicely illustrated through the renal CVT program at the Bronx VAMC in collaboration with the Hudson Valley VAMC in New York. A retrospective review by Tan et al showed that the program reduced round trip travel for patients from 127 ± 4.4 to 57.3 ± 4.2 miles. Before instituting telenephrology, when patients needed to travel to the Bronx VAMC from upstate New York, 53.1% of scheduled visits were either "no-show" or cancelled. However, after telenephrology was implemented and patients traveled to their local VAMC, just 28.5% of visits were no-show or cancelled, a nearly 50% reduction. Moreover, during a 2-year follow-up of telenephrology patients with CKD ($n = 112$) versus local Bronx VAMC patients with CKD followed up in the renal clinic ($n = 116$), no difference in the composite outcome of death, KFRT, or doubling of serum creatinine level was detected. Though the study was underpowered (in number and follow-up time) to detect small differences in outcome, it illustrates the potential equality of telenephrology to routine in-person care. Rigorous randomized multicenter studies are needed to test whether renal CVT improves patient outcomes in geographically isolated patients.

Additional Reading

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Case 2: *A 45-year-old woman is admitted with rhabdomyolysis after a motor vehicle accident and is found to have acute kidney injury with hyperkalemia and metabolic acidosis. Although her injuries have been adequately managed, the hospitalist is uncomfortable managing the acute kidney injury. Nephrologists are unavailable at the hospital and patients with kidney disease are routinely transported to a tertiary-care hospital 60 miles away. The patient is reluctant to transfer that far from her family.*

Acute Inpatient-Based Telehealth

Face-to-face inpatient teleconsultation is routinely used in intensive care medicine and treatment of stroke. Reports from private nephrology practices in Missouri and Arizona have illustrated the potential to care for hospitalized patients with kidney disease in the same manner.

Sanderling Renal Services in Missouri used FaceTime, web-enabled electronic stethoscopes, ubiquitous deployment of electronic medical records, and NxStage dialysis machines to deliver complex renal care to patients in rural Missouri hospitals. They received 427 inpatient consults, of which 193 pertained to acute kidney injury and 186 involved KFRT patients who had been admitted. They performed 405 hemodialysis and 70 peritoneal dialysis treatments remotely.

When the nephrologists at Summit Healthcare in Arizona retired, the hospital closed its dialysis unit and no longer provided nephrology services. At first, all patients requiring dialysis were airlifted to a metropolitan hospital, costing ~$42,000 per flight. Later, the hospital contracted with a larger nephrology group to provide inpatient telenephrology services. From October 2017 to January 2019, a total of 426 renal inpatient consults were performed, of which 263 dialysis treatments were completed, representing a transportation cost savings of ~$2.76 million.

Telenephrology platforms are likely to expand to other categories of patients, such as those who are unable to travel. Likewise, patients who frequently travel may also benefit by maintaining telemedicine visits with their longstanding provider instead of fragmenting their care with physicians with whom they have little familiarity.

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Case 3: *A 62-year-old man with kidney failure due to autosomal dominant polycystic kidney disease just started home hemodialysis. He works full time and wants to minimize clinic appointments. He is at your office inquiring about the option of using telemedicine services for his home dialysis care.*

Home-Based Telehealth

To provide medical services to patients at home, the VA deployed a home telehealth program in 2003. This was initially implemented in primary care but was later adapted for specialty care, including nephrology. In 2015, the VA adopted the national disease management protocol for veterans with CKD in which regular telephone lines, cellular modems, or cell phones capture vital signs and home blood glucose levels which are transmitted to the electronic health record. The system also provides veterans with training in using home telehealth devices. Ishani et al compared telehealth and interprofessional case management with usual care and found high patient and provider engagement in the home telehealth group compared with controls. Although the study did not demonstrate differences in the primary outcome (composite of death, hospitalization, emergency department visits, and admission to a skilled nursing facility) during the 12-month follow-up period, it noted a trend toward benefit for rural patients in the home telehealth group. The ongoing eNephro study in France is being performed to assess the cost-effectiveness, clinical impact, and patient perception of home telehealth for patients with CKD. Results from this study should provide more data on whether telehealth technologies for CKD can lower costs and affect outcomes.

As described earlier, in Australia and Canada, home-based dialysis with telenephrology support has been in practice for years; there is now growing interest in the United States to develop these platforms for home dialysis programs. Home dialysis telehealth potentially can improve the patient's quality of life with fewer clinic visits and with greater treatment adherence and confidence in self-management, as reported by Wallace et al. The disadvantages, like other aspects of telemedicine, include the inability to examine patients in person and the costs associated with the home telehealth infrastructure. Not all technology systems improve the patient experience with home dialysis and therefore studies are needed to identify which platforms best support self-care and self-management and which can increase selection of home dialysis in the future.

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Asynchronous Telemedicine Technologies

Case 4: *A 51-year-old man with CKD stage 3, diabetes, hypertension, and congestive heart failure has poor blood pressure (BP) control with thiazide, metoprolol, and lisinopril. The PCP is unsure which antihypertensive should be added to his regimen. The patient is otherwise unchanged, with stable glomerular filtration rate and low-grade proteinuria. The PCP wants to avoid a renal consult that would require significant patient travel and the patient is also hesitant about seeing multiple providers.*

Provider-to-Provider Communication: Electronic Consultation

The electronic consultation (e-consult) enables the PCP to request a specialist's evaluation about a focused question that may not require in-person evaluation. e-Consults increase access to expert opinion, reduce time to evaluation and implementation, and optimize the specialist's time. Typical nephrology e-consults include workup of hematuria, proteinuria, BP management, electrolyte and acid-base problems, and management of renal anatomic issues such as cysts and stones.

e-Consults can be billed on a system of time-based units associated with proportionate relative value units, as implemented at the VA. Moreover, because PCPs remain integral in implementing the recommended plan, they also gain further expertise that enhances PCPs' confidence in managing similar problems. Non-VA studies of e-consultation corroborated VA data illustrating greater PCP satisfaction, shorter nephrology wait times, and greater referral completion rates.

In the Netherlands, a web-based nephrology e-consultation program was piloted and reported by Scherpbier-de Haan et al. In response to a clinical question and relevant data transmitted by a PCP, the nephrologist could respond in 1 of 3 ways: (1) provide a recommendation, (2) ask the PCP to gather more clinical or laboratory data and then re-consult, or (3) request the patient to be evaluated in person. The nephrologist spent less than 10 minutes on average for each consultation and the average response time was 1.6 days. In addition, PCPs were asked if they would have referred the patient to nephrology in the absence of an e-consult system. PCPs indicated that 43 of 122 (35.3%) of their e-consults would have been referred for a face-to-face evaluation by nephrology. When nephrologists were asked how many of these 43 patients they believed needed to be seen in-person, they indicated that only 7 of 43 (16%) e-consult patients needed in-person evaluation. Interestingly, of the remaining 79 (64.7%) e-consults for which PCPs did not consider in-person nephrology evaluation necessary, 10 were judged by nephrologists to require in-person evaluation. Therefore, e-consultation efficiently increases access to nephrologists who can identify patients who will benefit most from their assessment. A large study is underway in the Alberta Kidney Care in Canada to investigate the feasibility and effectiveness of nephrology e-consultation in improving access to care for patients with CKD.

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Box 2. Topics in the SCAN-ECHO Curriculum

- Diabetic kidney disease
- Hypertension guidelines
- Resistant hypertension
- Nephrolithiasis workup and management
- AKI in the outpatient setting
- Proteinuria
- Sodium and kidney disease
- Primary care of the KFRT patient
- Anemia in CKD
- Hematuria
- Hyponatremia
- Glycemic management in CKD
- Glomerular disorder workup
- Hyperkalemia

Abbreviations: AKI, acute kidney injury; CKD, chronic kidney disease; KFRT, kidney failure with replacement therapy; SCAN-ECHO, Specialty Care Access Network-Extension for Community Health Care Outcomes.

► Scherpbier-de Haan ND, van Gelder VA, Van Weel C, Vervoort GM, Wetzels JF, de Grauw WJ. Initial implementation of a web-based consultation process for patients with chronic kidney disease. *Ann Fam Med.* 2013;11(2):151-16. ★ESSENTIAL READING

Case 5: *A primary care clinic wants to set up a protocol for the use of angiotensin-converting enzyme inhibitors and angiotensin receptor blockers in patients with early diabetes to prevent nephropathy. They have typically referred their patients, even with mild proteinuria, to nephrologists.*

Provider Education: Specialty Care Access Network-Extension for Community Health Care Outcomes

Specialty Care Access Network-Extension for Community Health Care Outcomes (SCAN-ECHO) is a provider-to-provider video conferencing platform that links PCPs in rural clinics to specialists at tertiary-care hospitals. At multiple VAMCs throughout the country, the VA has adopted the SCAN-ECHO system, which consists of weekly meetings between PCPs located at their CBOCs and specialists at their affiliated VAMCs. The session begins with a didactic presentation and is followed by PCP presentation of clinical cases and discussion with the nephrologist.

Initially, the Kidney SCAN-ECHO administrative team visits the CBOCs to introduce the program to PCPs. They provide continuing medical education credits to incentivize PCP participation. Educating PCPs should reduce the number of unnecessary nephrology consultations and enhance provider satisfaction. In addition, a national curriculum targeting nephrology-specific knowledge gaps for PCPs has been created (Box 2).

The Kidney SCAN-ECHO program has been expanded into the VAMC inpatient arena where in-house nephrologists are unavailable. Hospitalists follow a nephrology curriculum that has been developed by their affiliate VA with input from the hospitalists themselves. A recent study by Stevenson et al identified improving educational material, establishing an audit and feedback program, and identifying local leadership to champion the program as areas to improve the SCAN-ECHO system.

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Case 6: *A 60-year-old woman, married with a supportive husband, has long-standing diabetes, hypertension, and progressive CKD and is now close to requiring kidney replacement therapy. The frequency of clinic visits will increase and she will need to meet multiple providers for various aspects of KFRT education. She had a recent hip fracture and has had difficulty attending the clinics. She is quite anxious about dialysis and wants more education to help in decision making.*

Patient Education: e-Kidney Clinic

Low health literacy and specifically low kidney disease literacy are common in patients with CKD and are associated with adverse outcomes. Patients have reported communication issues with their nephrologists, resulting in poor insight into their illness. Office visits are inadequate as the sole source of patient education due to the time-limited nature, demands to manage disease, and differences in expectations of physician versus patient. Nonetheless, patient education and engagement are critical to generate the best clinical outcomes.

The VA-based e-Kidney Clinic, a web-based program (http://ckd.vacloud.us/), educates patients with all stages of CKD. The e-Kidney Clinic is divided into 6 basic learning modules: "Kidney Info," "Nutrition," "Laboratory," "Social Work Services," "Pharmacy," and "Treatment." Patient education is provided in written and graphic format with video vignettes. The format is geared toward addressing practical questions that face patients with CKD. The e-Kidney Clinic can be used as an educational tool during clinic waiting periods or at home between follow-up visits because of its on-demand nature and free access. Since its launch in 2013, the website traffic in the VA e-Kidney Clinic has tripled, demonstrating demand for web-based education platforms.

Many patients receiving dialysis report poor understanding of various aspects of dialysis before its initiation. Technology-augmented education is being developed to enable patients' access to on-demand education material to enhance insight into clinical issues underlying kidney failure and its therapies.

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Kidney Mobile/Smartphone Applications

The use of technology varies widely by age, with younger patients preferring smartphones over computers. Mobile technology use is associated with younger age, higher educational level, and normal cognitive functioning. Mobile applications (apps) are able to assist in clinical management such as with diet and medication management. In addition, using peripheral devices, patients can measure physiologic parameters such as BP, pulse, weight, and finger blood glucose level, and these data can be graphically represented to identify trends. Ideally, data can also be shared with the PCP to assist in management decisions. In the VA, the e-Kidney Clinic mobile app can be used for this purpose.

In a randomized clinical trial (Medication Adherence Improvement Support App For Engagement-Blood Pressure [MedISAFE-BP]) of 411 patients, the use of the smartphone app was associated with improved self-reported medication adherence; however, no difference in systolic BP was found. Hayashi et al developed a Self-management and Recording System for Dialysis (SMART-D) mobile app to enable self-monitoring of weight and serum potassium and serum phosphorus levels. In a small feasibility study, the 9 enrolled participants reported that the app was user friendly; however, its effect on health outcomes were not tested. A mobile app for Apple iPhones, UrApp–Nephrotic Syndrome Manager, permits the smartphone camera to read the urine test strip to monitor proteinuria.

Smartphones are also being applied in transplant nephrology. In collaboration with Facebook, Kumar et al developed a mobile app that enables wait-listed transplant candidates to create a Facebook post about their experience with organ failure and their need for a living donor and showed that the app increased the likelihood for accessing a living donor. Recently the "Talking About Live Kidney Donation Social Worker Intervention (TALK-SWI)" program for patients seeking a living donor kidney transplantation was successfully adapted into a smartphone app.

Smartphone apps have also been used by clinicians to improve their clinical management. Singh et al identified 28 current nephrology-related apps in the US Apple App Store (iOS) and Google Play Store (Android). They found a poor correlation between patient and provider impressions to their consumer ratings. The investigators caution that the reliability of these apps is unknown; for example, BP sensors have been reported to generate unreliable recordings. Though peripherals (eg, sphygmomanometers) are not regulated by the US Food and Drug Administration or other federal agency, in the future these devices may need to undergo testing and federal oversight if they are used in clinical practice. Future studies are needed to test the applicability of these apps in clinical practice and their impact on health outcomes before they can be used as part of routine care of patients with kidney disease.

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Barriers to Widespread Adoption of Telenephrology

Although telenephrology is likely to be a major component of nephrology practice in the future, there are significant barriers to adoption, some common to all aspects of telemedicine and some specific to nephrology. These limitations can be categorized into 4 categories of issues: (1) reimbursement, (2) clinical, (3) legal, and (4) societal.

Reimbursement

In countries such as the United States, where health care reimbursement is private insurance based, incentives to encourage the development of telemedicine platforms are not present. Health insurance companies want to ensure that the return on investment leads to a net increase in profit. Demonstration projects that illustrate fewer hospitalizations, fewer emergency department visits, reduced rehospitalizations, and/or capturing new patient populations are needed to encourage private payers to invest in telemedicine infrastructure.

Meanwhile, the Centers for Medicare & Medicaid Services has been changing its reimbursement policies to permit telemedicine. Recently, modifier codes have been developed for telemedicine services. Prior policy stated that telenephrology services could only be provided if the Medicare beneficiary resided in a government-designated rural community; however, the policy excluded non–hospital-based dialysis facilities. The US Bipartisan Budget Act of 2018 extended Medicare coverage to include dialysis facilities and the patient's home as the originating center, which permits physicians to bill for services rendered in these facilities. Nonetheless, reimbursement limitations exist in this case too. The dialysis faciltity providing the home dialysis care will not be permitted to collect the facility fee, which may limit dialysis facility participation.

Legal

Every state and health care facility has its own procedure for telemedicine licensure and credentialing, respectively. If the services are provided across state lines and/or health care facilities, licensure and credentialing, respectively, will need to be obtained for each state and facility. Issues of liability remain a concern for physicians because there is little legal precedent to base tort risk. Another barrier is the question of whether malpractice insurance will cover telemedicine or increase malpractice rates.

Privacy is another important concern. Because images, videos, and data are stored electronically and transmitted across long expanses, issues of how to protect patient privacy and confidentiality become paramount. This is true not only for the physiologic data gathered, but also for the financial information required for billing. It will become necessary to obtain informed consent before each encounter to ensure that patients understand their rights and the risks.

Clinical

Close physician-patient relationships are founded on in-person communication and direct examination, and there is concern that telenephrology could erode the quality of this bond. Telemedicine and telenephrology evaluations can and have been performed without any long-standing relationship between the patient and physician, which leads to further fragmentation of health care, especially if these visits are not recorded within an accessible electronic health record. There is also a concern of overuse of services, for example, contributing to inappropriate prescription of antibiotics or narcotics.

Box 3. A Summary of Advantages and Disadvantages of Telenephrology Compared With Traditional Methods of Renal Health Care and Education

Advantages of telenephrology (modality)

1. Improved access to care for patients in rural areas (CVT)
2. Improved access to care for frail disabled patients, especially those with transportation issues (CVT)
3. Self-management of home dialysis (CVT)
4. Timeliness and ease of nephrology consult for PCPs (e-consult)
5. Nephrology education of PCPs (SCAN-ECHO)
6. Comprehensiveness and ease of patient education about kidney disease (e-Kidney Clinic)
7. Greater engagement of younger patients in their renal health care (mobile apps)
8. Improved patient knowledge and confidence in kidney disease management

Disadvantages of telenephrology

1. Lack of long-term outcomes data comparing telenephrology with conventional systems
2. Inability to examine the patients completely
3. Potential detrimental impact on provider-patient relationship (tele-based vs in-person)
4. Unproven reliability of smartphone apps
5. Greater patient confidentiality risks
6. Costs and lack of availability of equipment
7. Lack of expertise in handling equipment
8. Issues with reimbursement of providers and facilities
9. Barriers due to medical legislation

Abbreviations: CVT, Clinical Video Telehealth; PCP, primary care provider; SCAN-ECHO, Specialty Care Access Network-Extension for Community Health Care Outcomes.

Societal

Provider and patient beliefs and acceptance of telenephrology platforms versus traditional interactions may also pose a significant impediment. Older patients who are less familiar and comfortable with technology may prefer traditional in-person care, whereas younger patients may feel at ease with these technology-dependent platforms. Physicians may also prefer routine in-person care because of familiarity and work flow, leading to only a few physicians performing telemedicine. Nonetheless, this culture is likely to change with greater involvement of technology and the internet in health care.

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Conclusions

Telenephrology is an emerging area of nephrology practice that will expand worldwide in parallel with rapid advances in information technology. Box 3 provides a summary of the potential advantages and disadvantages associated with telenephrology. The pressures on nephrology to expand its management repertoire to accommodate patient's demands for rapid and efficient access to renal care will only grow, as has been observed in other sectors of the economy. In addition, there is growing demand from health care systems (ie, hospitals and insurers) to manage patients efficiently while also improving clinical outcomes. Many of these electronic platforms will seek to enhance patient engagement to facilitate self-management, while other platforms will permit nephrologists to reach and manage patients hundreds of miles away. With the growth of these platforms, there an increasing demand for rigorous scientific evidence showing that these technologies can deliver patient-centric care that not only satisfies the consumer (the patient) but also leads to the efficiencies and outcomes demanded by physicians, hospitals, and insurers.

Article Information

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