Telemedicine to Promote Patient Safety: Use of Phone-Based Interactive Voice-Response System to Reduce Adverse Safety Events in Pre-dialysis CKD

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CKD patients have several features conferring on them a high risk of adverse safety events, which are defined as incidents with unintended harm related to processes of care or medications. These characteristics include impaired kidney function, polypharmacy, and frequent health system encounters. The consequences of such events in CKD can include new or prolonged hospitalization, accelerated kidney function loss, acute kidney injury, ESRD, and death. Health information technology administered via telemedicine presents opportunities for CKD patients to remotely communicate safety-related findings to providers for the purpose of improving their care. However, many CKD patients have limitations that hinder their use of telemedicine and access to the broad capabilities of health information technology. In this review, we summarize previous assessments of the pre-dialysis CKD populations' proficiency in using telemedicine modalities and describe the use of interactive voice-response system to gauge the safety phenotype of the CKD patient. We discuss the potential for expanded interactive voice-response system use in CKD to address the safety threats inherent to this population.

Key Words: Chronic kidney disease, Telemedicine, Patient safety, Self-care, Health care disparities

INTRODUCTION

CKD affects approximately 10% of the adult population worldwide.[1] Along with the expanding number of CKD patients are an increasing proportion of patients who are elderly and have multiple comorbidities requiring many prescription medications. These complex medical regimens may only have marginal benefits, but in the context of decreased kidney function, can lead to adverse safety events, defined as unanticipated complications of medical treatment.[2] Identifying and reducing adverse safety events in CKD patients have the potential to improve the outcomes of this disease population. In this review, we discuss current telemedicine applications in pre-dialysis CKD patients. We describe a role for interactive voice-response system (IVRS) in evaluating patient-reported safety outcomes and the need for more research to implement this technology in the care of CKD patients.

THE SAFETY PHENOTYPE OF CKD

In addition to hospitalization and death, CKD-specific adverse safety events can include hypoglycemia, hyperkalemia, dizziness, falls, acute kidney injury, and medication errors.[3-5] These events occur frequently in both outpatient and inpatient settings and can lead to accelerated kidney function loss, acute kidney injury, and ESRD.[6] Evaluations of the medication regimens of CKD patients have revealed a substantial medication burden, which is a likely contributor to adverse safety events unique to this disease. Studies have reported a median number between 8 and 10 medications daily necessitating 25 pills or more per day.[7,8] Fraser and colleagues[9] found approximately 20% of patients aged 70 years and older reported taking 10 or more medications. Patients have difficulty adhering to these sizable regimens that often come with complex instructions.[10] Nonadherence, in turn, has been shown to be a significant threat to patient safety increasing the risk of adverse events in CKD.[4] Solutions are needed to facilitate medication reconciliation, adherence, and monitoring of adverse effects related to the heavy medication burden.

TELEMEDICINE AS AN ADJUNCT TO CHRONIC MEDICAL CARE

Telemedicine, defined as the ability to provide healthcare from a distance, is increasingly being developed in pursuit of improving ambulatory chronic disease management and may offer a new opportunity to address the high frequency of adverse safety events observed in CKD.[11] Telemedicine technologies provide a framework for the introduction of health information technologies (IT) to enhance patient self-management, education, and access to provider communication and consultation.[12-14]

Telemedicine technology based on expanded wireless telecommunication and fiber optic networks has become increasing available to consumers in recent years; 85% of American adults use the Internet.[15] As of October 2014, 64% of American adults owned a smartphone and at least 90% of American adults owned a cell phone with 81% using their phone for text messaging.[16] Smartphones are becoming a standard tool for instantaneous access to the Internet with 7% of US population relying solely on their smartphone for Internet connection, particularly individuals in minority and lower income populations, many of whom are at increased risk for developing CKD and ESRD.[17,18] These powerful communication conduits provide enormous potential to introduce a vast array of

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health IT to patients. However, few studies have investigated the use of health IT in the pre-dialysis CKD population (see Table 1), with most existing studies addressing the monitoring and treatment of the dialysis population.[27]

PROMISE AND LIMITATIONS OF TELEMEDICINE IN CKD

As developers and investigators turn their attention to use of telemedicine modalities and health IT in pre-dialysis CKD, it will be important to incorporate interactive elements into new applications as this has been reported to increase the likelihood for successful use in chronic disease populations.[28] The iNephro study demonstrated how sustained use of health IT applications are a challenge in CKD. iNephro investigators distributed a free smartphone application to German-speaking CKD patients to assist them in medication adherence and documentation of blood pressure (BP).[25] After 11,688 smartphone users downloaded the application and demonstrated initial engagement, significant drop-off in use of the application was reported at 2 months. Less than 1% (10 of 1095) used the application at least weekly 1 year after download. Multiple explanations were offered for the attrition rate. Users may have found a different application or found the application difficult to use or of limited value after mastering their medication regimen. Another explanation for the decline in application use was that participants sought out more interpersonal interactions. For example, permitting participants either to look up information about the safety or dosing of medications to share with their provider or to use the application in conjunction with visits to their doctor may have enhanced the application's use.[29] Other studies in the CKD population have incorporated interactive elements to better engage patients but have not necessarily shown significant improvement in outcomes.[30]

CLINICAL SUMMARY

- CKD patients experience many safety events related to complex medication regimens and decreased kidney function.
- Health information technology administered via telemedicine in pre-dialysis CKD is in the early stages of development and requires more investigation for the appropriate roles telemedicine can have in reducing important clinical outcomes, such as mortality and hospital admissions.
- Interactive voice-response system, a widely accepted health information technology, have been underused in CKD and can be used to elicit patient-reported outcomes related to safety.

Studies evaluating blood pressure control show limited improvement in treatment goals. Rifkin and colleagues[24] conducted a 6-month trial randomizing CKD patients into an arm using a Bluetooth-enabled sphygmomanometer with BP readings transmitted to health care providers regularly vs usual care where participating patients recorded BP readings at home, which they shared with providers. Participants whose remotely transmitted BP readings were above goal were contacted for treatment modifications. The authors found improvement in BP in both groups with no statistical differences. Participants using the home-based tele-monitoring device transmitted significantly more readings to their providers than the usual care participants reported at clinic. The intervention was well received by both participants and clinicians and was determined to be cost effective. Margolis and colleagues[23] reported on a cluster-randomized trial of home BP tele-monitoring (8 clinics) vs usual care (8 clinics) of hypertensive patients followed at each center. This study included patients with and without CKD. They found not only significantly improved BP control in the intervention group but also hypotension-related events in CKD and diabetic patients with more stringent BP goals.

In a diet assessment pilot project by Murali and colleagues,[22] participants with CKD independently used an online program that calculated adherence to disease-specific nutrition recommendations from a 24-hour meal history. Participants brought a printout of the results to regular nephrology appointments for discussion. Confidence in diet self-management did not improve after 6 weeks of access to the program and may have been related to the perception of some participants that their diet was not adequately discussed. Specifically, patients who felt alerts from the diet program were de-emphasized if laboratory results were within normal ranges. Such patient feedback can help to enhance future health IT applications designed for nutrition or physical measurement assessments and could help to improve the utility of the conveyed health information.

The first sizable randomized control trial evaluating a comprehensive CKD intervention was recently published.[21] Ishani and colleagues[21] randomized 601 veterans with CKD to a tele-monitoring system with direct management by an interdisciplinary team vs usual care. The interdisciplinary team was charged with managing and evaluating BP, volume status, proteinuria, diabetes, cholesterol, depression, health literacy, and patient activation. With a 12-month study duration, there was no significant difference between groups for the primary composite outcome of death, hospitalization, emergency department visit, and nursing home admission.[21,30] The study findings failed to show a benefit to aggressive monitoring and management, even with successful patient participation (only 3.8% failed complete the year of monitoring). However, it is important to note that the evidence for the effectiveness of aggressive CKD management is relatively limited. Additionally, the authors have pointed out that control group participants may have received more aggressive therapy than expected through new Veteran Affairs initiatives starting at the time of the study and limiting the potential treatment effect of the intervention.[21,30]