Original Research

Enhancing Patient Engagement and Blood Pressure Management for Renal Transplant Recipients via Home Electronic Monitoring and Web-Enabled Collaborative Care

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Abstract

Background: *Effective management of hypertension in chronic kidney disease and renal transplantation is a clinical priority and has societal implications in terms of preserving and optimizing the value of scarce organs. However, hypertension is optimally managed in only 37% of people with chronic kidney disease, and poor control can contribute to premature graft loss in renal transplant recipients. This article describes a telehealth system that incorporates home electronic blood pressure (BP) monitoring and uploading to a patient portal coupled with a Web-based dashboard that enables clinical pharmacist collaborative care in a renal transplant clinic.* **Materials and Methods:** *The telehealth system was developed and implemented as a quality improvement initiative in a renal transplant clinic in a large, 700-bed, urban hospital with the aim of improving BP in posttransplant patients. A convenience sample of 66 posttransplant patients was recruited by the clinical pharmacist from consecutive referrals to the Transplant Clinic.* **Results:** *Preliminary results show statistically significant reductions in average systolic and diastolic BP of 6.0 mm Hg and 3.0 mm Hg, respectively, at 30 days after enrollment. Two case reports describe the instrumental role of home BP monitoring in the context of medication therapy management.* **Conclusions:** *Optimizing BP control for both pre– and post–renal transplant patients is likely to benefit society in terms of preserving scarce resources and reducing healthcare costs due to premature graft failure. Connected health systems hold great promise for supporting team-based care and improved health outcomes.*

Key words: *e-health, home health monitoring, telehealth, telemedicine, pharmacy*

Introduction

Emerging health information technology and patient-facing e-health tools have created new opportunities for patients to participate actively in monitoring their health and for supporting collaborative care with providers.[1–3] As delineated in the chronic care model, improvements in healthcare quality and efficiency are predicated on having both an informed and activated patient along with a prepared, proactive team, enabled by technology.[4] One promising, patient-facing e-health tool is the use of remote patient monitoring, especially for chronic conditions such as hypertension.[5]

Home-based, remote patient monitoring for blood pressure (BP) is the recommended standard of care for improving BP control in patients with hypertension.[6] A systematic review and meta-analysis of 37 studies of home-based BP monitoring showed small but significant reductions in systolic and diastolic BP (SBP and DBP, respectively) compared with clinic-based monitoring.[7]

More substantial and sustained BP reductions have been reported when home BP monitoring is combined with telemonitoring and pharmacist comanagement in primary care.[8] Collaborative, team-based care, enabled by technology and telemonitoring, in combination with home electronic BP monitoring, has been shown to improve BP control for hypertensive patients in controlled clinical trials.[9]

The role of team-based care involving pharmacists to improve cardiovascular and renal outcomes using medication therapy management (MTM) is gaining ground given the challenges of uncontrolled BP in the context of chronic renal disease.[10] BP is optimally managed in only 37% of people with chronic kidney disease.[11] Hypertension is particularly serious in renal transplant patients, 70–90% of whom have arterial hypertension and require antihypertensive therapy.[12–14] An increase of 5 mm Hg SBP increases the risk of graft loss and death[15]; however, a decrease in SBP after renal transplant, even in patients with long-standing hypertension, is associated with improved patient and graft survival.[16] In many cases hypertension continues after successful renal transplantation and remains a focus of ongoing care. Hence, effective management of BP in the context of chronic kidney disease in renal transplant patients is a critical determinant of graft survival and outcomes.[15] Given the high costs of kidney transplantation, the growing wait list for transplant candidates, and the flat rate of organ donation, there are societal and clinical imperatives to maximize the success of kidneys that are transplanted.[16]

Many effective antihypertensives are available, but access to care and clinical inertia are main barriers to effective treatment of hypertension.[8] Additionally, nonadherence to medication therapy contributes to poor BP control and increases the potential for complications and adverse events.

This article describes a telehealth system approach and preliminary results for the management of BP in renal transplant recipients. The overriding goals of the system are to enhance patient engagement and improve adherence to medications via a collaborative care, pharmacist-based, MTM program.

Materials and Methods

TELEHEALTH SYSTEM DESIGN

A telehealth system was developed and implemented in a renal transplant clinic as a quality improvement initiative in a large, 700-bed, urban hospital with the aim of improving BP in posttransplant patients. Prior work with a similar telehealth and home electronic BP monitoring system in a patient-centered primary care medical home demonstrated high levels of both patient and provider acceptance and identified several technical issues that needed to be addressed to improve engagement and adherence to home BP monitoring.[13] Results of this previous work helped to inform the development of the renal transplant clinic approach.

HOME ELECTRONIC BP MONITORING

As part of their posttransplant follow-up with the transplant clinic pharmacist, patients are given an electronic, uploadable BP monitor (model UA-767PC; A&D Medical, San Jose, CA) with instructions in proper procedures to use in taking BP, how often and when to measure BP, and how to upload readings via USB into their home computer. BP readings are not uploaded in real time, and the patient is not able to edit the BPs. If the patient does not have a home computer, he or she is shown how to log into a kiosk (located in the Transplant Clinic) to upload BP readings and to use the Good Health Gateway® (Abacus Health Solutions, Cranston, RI) patient portal. Patients are educated about the importance of BP management for their renal and overall health, and their targeted levels for SBP and DBP are identified and discussed. Overall medication regimens are reviewed, and any barriers to medication adherence are discussed. Finally, an online tour of the Good Health Gateway patient portal is given to familiarize the patient with the interface.

CALCULATING BP VALUES

At minimum, six home-based readings within a given 30-day period were deemed necessary based on prior published research[17,18] to calculate and display an average for SBP and DBP. Graphical display of BP readings to the patient is done through the Good Health Gateway Web portal and is made available to the pharmacist via the MTM Web-based platform, described below.

GOOD HEALTH GATEWAY PATIENT PORTAL

The Good Health Gateway Web portal page shows the BP goal level tailored to each patient along with a 5-star rating to provide feedback to the patient on his or her adherence to BP monitoring in the most recent 30 days (0 stars = no monitoring; 1 or 2 stars = some, but insufficient monitoring to calculate an average; 3 stars = met minimum requirement of 6 readings; 5 stars = met ideal standard of 14 readings). Patients also receive feedback via the portal on whether they are at the BP goal that has been set for them.

Figure 1 shows the patient's personalized BP monitoring record. The patient is able to view his or her readings over a range of time periods.

GOOD HEALTH GATEWAY AND MTM PLATFORM

Figure 2 displays the Pharmacist Dashboard on an iPad® (Apple, Cupertino, CA), which enables the clinical pharmacist to closely monitor

Fig. 1. Patient's personalized blood pressure (BP) monitoring page. This page is synchronized with HealthVault. Multiple time periods are available for patients to select for viewing.

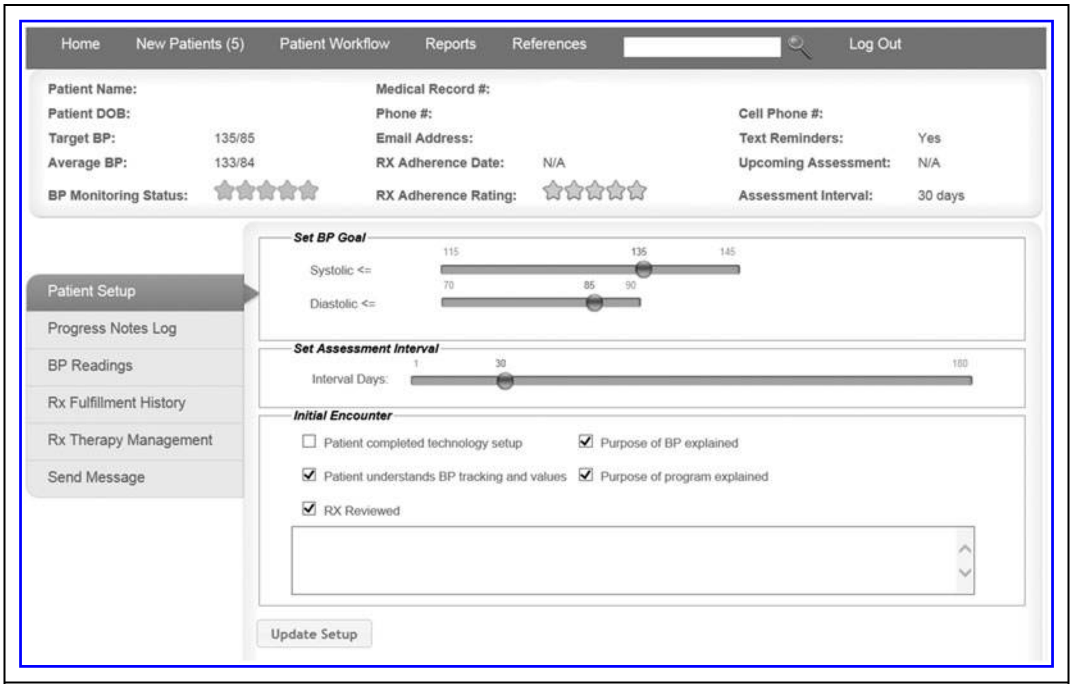

Fig. 2. Pharmacist Dashboard depicting the status of an individual patient's adherence to blood pressure (BP) monitoring and relevant parameters. The clinical pharmacist can augment the Dashboard with encounter notes. DOB, date of birth; N/A, not available; Rx/RX, prescription.

and review the patient's adherence to monitoring and the patient's home BP readings. The platform also provides a standard structure to the pharmacist in identifying and accessing patient-specific barriers to adherence to BP monitoring and medication regimens.

MESSAGING PLATFORM

Patients' BP monitoring rates are tracked via the platform. Automated feedback messages are sent to patients via mail and text to reinforce patients who are actively monitoring, whereas tailored prompts are sent to patients who are not providing sufficient readings to calculate a monthly BP average. A phone support service is also available to assist patients who may be having technical issues with the electronic monitor.

COLLABORATIVE CARE MODEL/MTM

The clinic setting where this technology is implemented incorporated a physician–pharmacist collaborative practice agreement for the management of hypertension. The clinical pharmacist, as a dedicated member of the transplant team, is responsible for providing MTM services within the transplant clinic. The established collaborative practice agreement enhances the MTM services by allowing the pharmacist to authorize medication additions, deletions, and dose changes on behalf of the physician. The MTM service within this collaborative care model also focuses on improving therapy outcomes by promoting medication adherence and reducing barriers to adhering to medications. Home BP readings are reviewed at each clinic visit and periodically in between clinic visits by the pharmacist to assess the efficacy of antihypertensive therapy. If antihypertensive therapy requires dose optimization or dose reduction, the pharmacist communicates home BP reading data to the patient's primary physician (face-to-face, facsimile, or telephone communication) and provides medication therapy recommendations for approval.

Results

A convenience sample of 66 posttransplant patients were recruited and enrolled by the clinical pharmacist (D.M.) from consecutive referrals to the Transplant Clinic. Demographics indicate that the patients were mostly white (72%), 15% African-Americans, 8% Latino, and the remaining 5% Asian or mixed race/ethnicity. Average age was 54.0 years, and 52% were female. The time since transplant was a bimodal distribution; most patients were either 3 years or greater or less than 1 year posttransplant. The sample of patients includes patients with and without established hypertension at baseline.

Paired *t* tests comparing baseline BPs with readings at 30 days after intervention were calculated for systolic, diastolic, and pulse rate, respectively. Thirty days was chosen as the primary outcome point because it allowed for sufficient time for medication adjustments, if necessary. The average change in SBP and DBP readings for the 63 patients who were monitoring at 30 days after enrollment was statistically significantly lower: 6.0 mm Hg and 3.0 mm Hg, respectively (p values <0.01). Change in pulse rate was not statistically different at 30 days so that metric was dropped from further analysis. At 180 days after enrollment, the reduction in SBP remained statistically significant (6.6 mm Hg) despite the reduced sample size at that time point ($n=23$; $p<0.05$). The change in DBP was also statistically significant for the subsample: 5.0 mm Hg ($n=23$; $p<0.5$).

Of the 66 patients enrolled, 75% monitored at least once, and 69% achieved the minimum of six readings and obtained a BP average.

CASE REPORTS

Patient A is a 63-year-old African American male with end-stage renal disease secondary to hypertension and diabetes. The patient received a transplant and had poorly controlled diabetes and continued hypertension after the procedure. Through medication review by the pharmacist, it was identified that the patient had an expired vial of insulin. The patient was instructed to obtain a new vial of insulin, and subsequent finger sticks were noted to be within the goal range, which were confirmed via a follow-up call by the transplant pharmacist. During the continued follow-up, the pharmacist was able to ensure adequate BP control (SBP <140 mm Hg and DBP <80 mm Hg) for a period of time. Over time, however, the pharmacist identified, via the MTM Web-based portal, that the patient's BP had started to increase, reaching a monthly average SBP of 145 mm Hg and DBP of 77 mm Hg, and the patient subsequently required a dosage change in one of his antihypertensive medications; this resulted in improvement of the patient's BP. Throughout follow-up, the patient still had variable blood sugar levels, ranging from 100's-200's mg/dL, and the pharmacist facilitated referral to the medical primary care clinic for further diabetes management.

Currently, the patient feels well, has excellent graft function, and his blood sugar levels are better controlled. The latest available home BP readings at the patient's 9th month in the program indicate SBP = 124 mm Hg and DBP = 61 mm Hg, decreases of 21 and 16 mm Hg in SBP and DBP, respectively.

Patient B had received a deceased donor kidney transplant over 30 years ago. During a routine follow-up visit, it was noted that her BP was elevated; however, the patient reported normal BP at home. Through participation in the electronic BP monitoring program, it was noted that her BP is within goal, and the elevated BP reading in the office was likely a reflection of white coat hypertension. To date, she is not taking any antihypertensive therapy; however, through speaking with her pharmacist and physician she is well aware of nonpharmacologic methods for preventing high BP such as exercise and a healthy diet. As part of the program, the patient will continue to be monitored closely, and her home BP readings will be reviewed on a daily basis to ensure that her BP remains at goal.

Discussion

Achieving adequate BP control for renal transplant recipients is crucial for promoting longevity of the graft and avoidance of renal and cardiovascular complications.[19,20] These early results for the telehealth system with post–renal transplant patients show promise in the management of BP and promoting engagement in this high-risk population. These findings are consistent with results from studies in primary care that used a collaborative care, Web-based platform with remote BP monitoring,[21] but this is the first instance to our knowledge that deployed such a telehealth system in a specialty renal clinic. Although the levels of patient adherence to ongoing BP monitoring to date are modest, the iterative engagement approach using multichannel messaging and enhanced patient–provider communication and support are promising strategies.

Barriers that were identified in prior research by the research team and addressed in this study included the following

a. *Lack of computer access*. This was addressed through making a kiosk available.
b. *Limited computer literacy*. Telephonic support and technical assistance was provided to guide members through the registration and set-up process.
c. *Patient forgetfulness, apathy, or motivational decline over time*. Regular tracking of patients and monitoring activities followed by telephonic outreach helped to increase engagement.
d. *Obesity*. A specialized cuff was used for arm width up to 26 inches.
e. *Lack of understanding of importance of BP management*. The educational component of MTM was coupled with physician visits with the patient.

This telehealth system, although at an early stage, has potential major societal implications for organ donation and preservation. Over 5,000 patients die each year because of a lack of viable donor kidneys, and $42.5 billion were spent in the treatment of end-stage chronic renal disease in 2009.[22] Optimizing BP control for both pre– and post–renal transplant patients is likely to benefit society in terms of preserving scarce resources and reducing healthcare costs due to premature graft failure.

Renal transplant recipients typically take multiple medications and are often on complex regimens, which require careful monitoring and titration. The clinical pharmacist is ideally suited to provide this support in the context of a structured and evidence-based MTM program. As illustrated in the two case reports, the clinical pharmacist, enabled by the MTM dashboard, was able to assess the extent of medication challenges for each patient and intervene to improve the patient's BP status as well as avoid potential complications.

The pharmacist collaborative care model is emerging as a viable approach to leveraging expertly trained clinical pharmacists as active team members in renal clinics.[10] Given the rapid movement toward accountable care, hospitals are seeking ways to leverage valuable clinical resources such as clinical pharmacists to increase efficiencies and optimize health outcomes.

Providing patients with a portal to view their BP readings over time is one method of promoting self-management and increasing activation. By reviewing fluctuations in BP, patients are able to associate undesirable increases in BP to changes in medication use and lifestyle indiscretions. This process can enhance awareness of factors that influence BP and potentially personal accountability for improved BP management.

The Million Hearts campaign[23] undertaken by the Centers for Disease Control and Prevention are promoting self-measured BP monitoring as one strategy that can be implemented in communities to reduce the risk of disability or death due to high BP. They cite the addition of Web-based tools as added support to enable home BP monitoring. Connecting patient-generated BP readings through a telehealth system with a provider can further enhance BP management.

Limitations include the lack of a comparison group, the small sample size, and the lack of measures of adherence. It is also uncertain as to whether or not this system could be replicated in other clinics that are not integrated or that do not have a pharmacist co-management model.

A next step in evaluating the telehealth system will be to incorporate a wait-list comparison group by identifying transplant recipients who are eligible to participate but have yet to be enrolled and using a matching algorithm to control for relevant variables that could explain any difference between the two groups. The trajectory of BP values for patients using the telehealth system can then be compared with clinic BP values for those patients in the control group.

Future studies of telehealth systems in renal clinics should include both pre- and posttransplant patients as well as integrate the data into the electronic medical record. Connected health systems such as described in this study hold great promise for supporting team-based care and improving health outcomes.

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Disclosure Statement

E.W.A., M.J.F., and D.K.A. are equity stakeholders of Abacus Health Solutions. T.M. is an employee of Abacus Health Solutions. D.M. declares no competing financial interests exist.

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