CASE STUDY

Achieving blood pressure control among renal transplant recipients by integrating electronic health technology and clinical pharmacy services

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Purpose. The implementation and outcomes of a program combining electronic home blood pressure monitoring (HBPM) and pharmacist-provided medication therapy management (MTM) services in a renal transplantation clinic are described.

Summary. Patients enrolled in the program were provided with a computer-enabled blood pressure monitor. A dedicated renal transplantation pharmacist was integrated into the renal transplantation team under a collaborative care practice agreement. The collaborative care agreement allowed the pharmacist to authorize medication additions, deletions, and dosage changes. Comprehensive disease and blood pressure education was provided by a clinical pharmacist. In the pretransplantation setting, the pharmacist interviewed the renal transplant candidate and documents allergies, verified the patient's medication profile, and identified and assessed barriers to medication adherence. A total of 50 renal transplant recipients with at least one recorded home blood pressure reading and at least one year of follow-up were included in our analysis. A significant reduction in mean systolic and diastolic blood pressure values were observed at 30, 90, 180, and 360 days after enrollment in the program ($p < 0.05$). Pharmacist interventions were documented for 37 patients. Medication-related problems accounted for 46% of these interventions and included dosage modifications, regimen changes, and mitigation of barriers to medication access and adherence.

Conclusion. Implementation of electronic HBPM and pharmacist-provided MTM services implemented in a renal transplant clinic was associated with sustained improvements in blood pressure control. Incorporation of a pharmacist in the renal transplant clinic resulted in the detection and resolution of medication-related problems.

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Hypertension is a well-known risk factor for the development of cardiovascular diseases and compromised graft survival among renal transplant recipients.[1-3] An estimated 70–90% of renal transplant recipients develop hypertension or require at least one antihypertensive agent to maintain goal blood pressure values in the postoperative period.[4,5] In this population, an increase of 5 mm Hg in systolic blood pressure (SBP) has been associated with an increased risk of graft loss and death, while a reduction in SBP and diastolic blood pressure (DBP), maintained over a four-year period after renal transplantation, has been associated with a significant improvement in graft survival.[6] Pharmacists can play an important role in managing blood pressure among renal transplant recipients. The integration of pharmacist-provided medication therapy management (MTM) services in a renal transplantation clinic has been associated with substantial improvements in SBP and DBP, improved patient satisfaction, a reduced risk of adverse drug reactions, and increased healthcare-associated cost savings.[7-10]

Problem

Rhode Island Hospital (RIH) is an urban academic multidisciplinary hospital affiliated with the Warren

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Alpert Medical School of Brown University and a member of the Lifespan Healthcare System in Providence, Rhode Island. The hospital is a 719-bed tertiary care institution with a pediatric division and multispecialty ambulatory care clinics. In response to the need to optimize blood pressure among renal transplant recipients, a program combining electronic home blood pressure monitoring (HBPM) and pharmacist-provided MTM services was developed and implemented in the renal transplantation clinic of RIH.

Analysis and resolution

Enrollment in the electronic HBPM and pharmacist-provided MTM program was available for all renal transplant recipients, regardless of transplantation date. As part of a clinical pharmacist encounter, patients are provided with a computer-enabled blood pressure monitor (model UA-767PC, A&D Medical, San Jose, CA). This device was previously shown to enhance patient engagement in blood pressure management in an ambulatory care setting.[11,12] The clinical pharmacist provides patients with training on the proper procedure to use the device, recommended frequency and timing of blood pressure monitoring, and methods to upload blood pressure readings to a dedicated online patient portal (Good Health Gateway, Abacus Health Solutions, Cranston, RI). Patients cannot edit blood pressure readings, and the upload of these readings does not occur in real time.[12] A computer kiosk, located in the transplantation clinic, is available for patients who do not have access to a personal computer for the purpose of uploading their blood pressure readings during clinic visits. A maximum of two readings are recorded in a 24-hour period, and a minimum of six home-based readings in any given 30-day period are necessary to calculate mean SBP and DBP during this period.

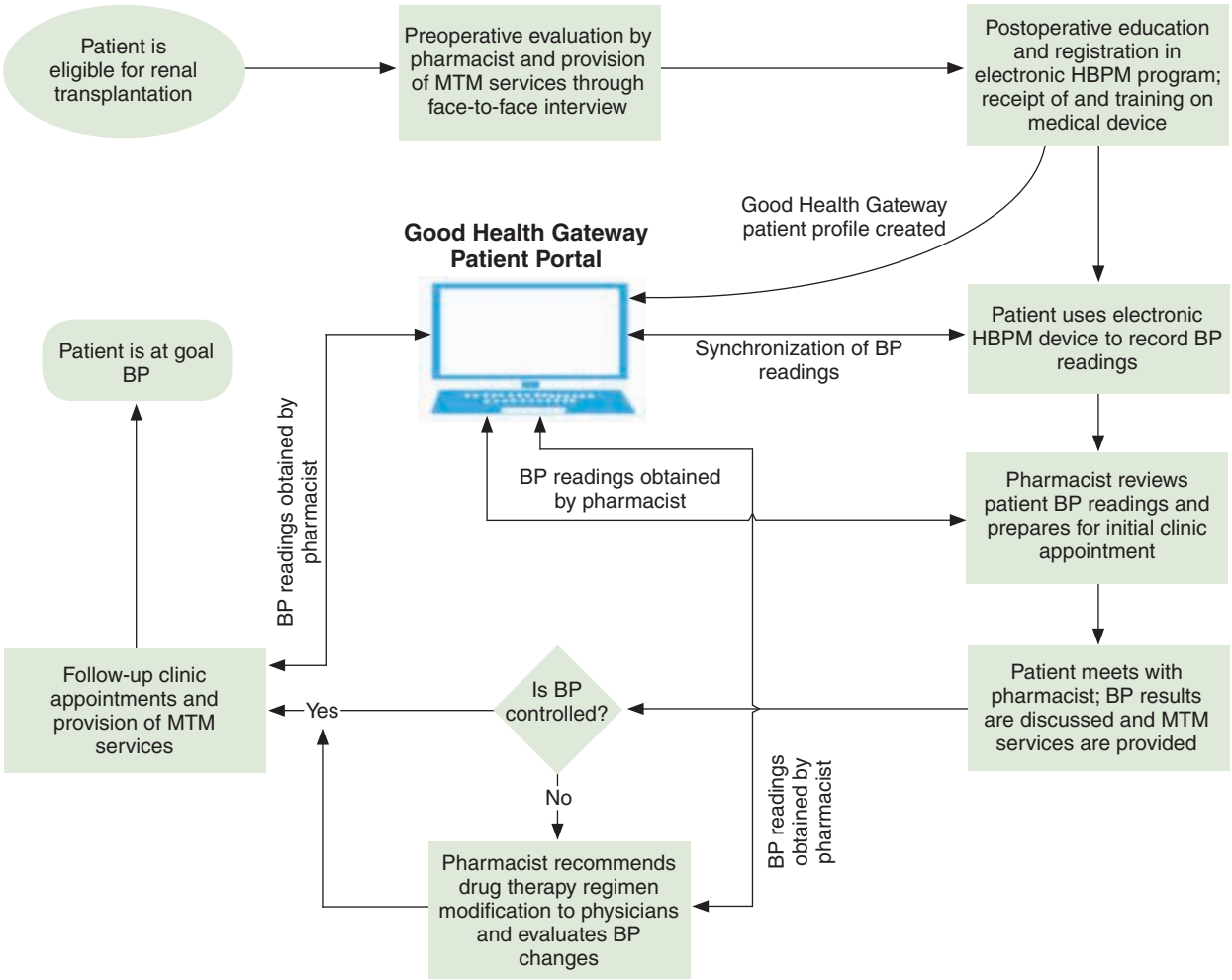
A diagram outlining the blood pressure control care delivery model is presented in Figure 1. A comparison of the pharmaceutical care delivery model before and after the implementation of the electronic HBPM and MTM program is presented in Table 1. Both interventions incorporated the services of a dedicated renal transplantation pharmacist who was integrated into the renal transplantation team under a collaborative care practice agreement. The collaborative care agreement allows the pharmacist to authorize medication additions, deletions, and dosage changes. In the pretransplantation setting, the pharmacist interviews the renal transplant candidate and documents allergies, verifies the patient's medication profile, and identifies and assesses barriers to medication adherence. Before the implementation of this program, a patient's medication history was obtained only through medical records, and the limited presence of a clinical pharmacist on the renal transplant care team precluded consistent evaluation of renal transplant candidates for medication-related issues. After renal transplantation but before hospital discharge, the clinical pharmacist provides patients with training and education on the use of the electronic HBPM device, registers the patient in the online patient portal, provides detailed medication education, ensures that the proper medications are prescribed, and educates the patient on the importance of blood pressure management. In the ambulatory care setting, the clinical pharmacist reviews the trend of SBP and DBP readings of individual patients since the last MTM visit via a dedicated Web portal. The pharmacist uses the recorded home blood pressure readings to guide antihypertensive therapy optimization.

Experience with the program

We identified 84 patients who enrolled in the electronic HBPM and MTM services program from October 1, 2012, through December 31, 2013; enrolled after renal transplantation; and had at least one documented SBP and DBP reading using the electronic HBPM device. A total of 34 patients had less than one year of follow-up. The baseline characteristics of all 84 renal transplant recipients and those with at least one year of follow up ($n = 50$) are presented in Table 2. There were no significant differences in any of the reported variables between the overall renal transplant population and the subset with at least one year of follow-up. The etiology of end-stage renal disease in 38% of patients was due to diabetes mellitus, hypertension, or a combination of diabetes and hypertension. Additionally, 54% of the renal transplant cohort with at least one year of follow-up had a renal transplant within six months before enrollment in the electronic HBPM program compared with 46% of patients who had a renal transplant more than six months before program enrollment. The mean ± S.D. number of pharmacist-provided MTM visits for the subset of patients with at least one year of follow-up was 1.6 ± 0.9.

We compared SBP and DBP values of the patients with at least one year of follow-up at baseline and at 30, 60, 90, 180, and 360 days after enrollment in the program using repeated measures analysis of variance by ranks. When compared with baseline values, patients' mean SBP and DBP values were significantly lower at 30, 90, 180, and 360 days after program enrollment ($p < 0.05$). There were no significant differences among mean SBP and DBP values at 30, 90, 180, and 360 days postenrollment. Clinically meaningful reductions in the mean SBP were observed at 30, 90, 180, and 360 days (reductions of 5, 11, 12, and 9 mm Hg, respectively). Clinically meaningful reductions in the mean DBP at 30, 90, 180, and 360 days

Figure 1. Process flow diagram of integrated electronic home blood pressure monitoring (HBPM) and pharmacist-provided medication therapy management (MTM) to achieve blood pressure (BP) control in a renal transplant clinic.



(reductions of 2, 5, 6, and 6 mm Hg, respectively) were also observed.

Pharmacist-provided MTM services allowed for the comprehensive evaluation and identification of medication- and disease-related problems. Clinically relevant interventions were documented for 37 patients. Medication-related problems were documented for 17 patients, representing 46% of total pharmacist interventions. Medication-related problems included subtherapeutic drug dosing (identified in 14 patients) and lack of adherence (identified in 3 patients). Nonmedication-related problems were documented for 20 patients, representing 54% of total pharmacist interventions. These interventions included lifestyle and dietary counseling (e.g., smoking cessation, encouraging physical activity, reducing salt content in diet).

Discussion

This quality-improvement initiative combined telemonitoring in the form of electronic HBPM and pharmacist support using MTM services to optimize blood pressure control among renal transplant recipients. The use of electronic HBPM ensures higher sensitivity in detecting poor blood pressure control compared with office blood pressure measurement.[13,14] Patient enrollment in the program has grown over the past two years and includes renal transplant recipients at different times after renal transplantation.

We observed early and clinically relevant reductions in mean SBP and DBP values of renal transplant recipients after program enrollment. These reductions were principally attributable to the lowering of SBP and DBP values in patients with uncontrolled hypertension. There was

Table 1.
Comparison of Pharmaceutical Care Delivery Model Before and After Electronic HBPM and Pharmacist-Provided MTM Services[a]

Variable	Before Implementation	After Implementation
Pretransplantation		
Source of patient medication history	Medical records	Face-to-face interview and review of medical records, outpatient pharmacy
Assessment of barriers to medication adherence	Limited	Extensive
Medication-related problem identification	Limited	Extensive
Health professional who performed service	Renal transplant pharmacist—limited involvement	Renal transplant pharmacist
Posttransplantation		
Amount of predischarge medication education provided	Limited	Extensive
Method of monitoring BP postdischarge	NA	Electronic HBPM
Location where BP values are recorded	Patient diaries or journals	Online patient portal
Education regarding importance of maintaining goal BP	Limited	Extensive
Identification of modifiable risk factors for patient lack of adherence	Limited	Extensive
Feasibility of real-time identification of patients not at BP goal for focused intervention	Not feasible	Feasible

[a]HBPM = home blood pressure monitoring, MTM = medication therapy management, BP = blood pressure, NA = not available.

an incremental benefit associated with the use of electronic HBPM and MTM services, as 71% of renal transplant recipients showed a clinically relevant reduction in SBP and DBP 1 month after program enrollment, compared with 87% and 94% at 6 and 12 months after program enrollment, respectively.

Interestingly, the use of electronic HBPM and pharmacist-provided MTM services provided similar effects on blood pressure management among renal transplant recipients, regardless of their renal transplant history. This suggests that the use of self-measured blood pressure management with pharmacist support is a robust intervention for blood pressure optimization in this population. In addition, patient access to pharmacy clinical services in the renal transplantation setting has resulted in the ability of pharmacists to provide MTM services, including adjustments to antihypertensive medications (e.g., additions, deletions, dose modification), thereby reducing therapeutic inertia.[15]

It is often difficult for patients to perceive the benefits of blood pressure control, as hypertension is not something the patient can feel or identify. With the use of the online patient portal, patients can recognize whether their blood pressure is at goal. The purpose of this program is to prompt patients to seek medical advice when their blood pressure is inadequately controlled. However, approximately one half of the patients enrolled in the program do not have a home computer, so these patients do not receive such feedback until they visit the clinic. This disadvantage is compounded by the fact that transplant recipients are followed less frequently as time passes from the date of transplantation. Eventually, transplant recipients will follow up only annually with the transplantation clinic, which may result in extended periods of poorly controlled blood pressure if these patients do not have computer access at home. This limitation has stimulated a refinement of the electronic HBPM program. Patients without computers now receive a new blood pressure monitoring device that transmits their readings via a wireless device. This new device allows feedback in the form of regular follow-up telephone calls from the transplantation pharmacist. We have observed markedly increased numbers of blood pressure readings with the wireless device compared with those entered into the kiosk.

Another lesson learned from our initial experience with using the electronic HBPM intervention and scheduling MTM visits was the time needed

Table 2.
Baseline Characteristics of Renal Transplant Recipients Using Electronic HBPM With Pharmacist-Provided MTM Services[a]

Variable	Renal Transplant Recipients (*n* = 84)	Renal Transplant Recipients With ≥1 Yr of Follow-up (*n* = 50)
Age at renal transplant, yr		
Mean ± S.D.	48 ± 15	52 ± 14
Median (range)	48 (13–72)	51 (16–72)
Sex, no. (%) patients		
Male	46 (55)	28 (56)
Female	38 (45)	22 (44)
Race, no. (%)		
Caucasian	59 (70)	35 (70)
Black	11 (13)	7 (14)
Hispanic	8 (10)	4 (8)
Unidentified or other	6 (7)	4 (8)
Etiology of end-stage renal disease, no. (%) patients		
Polycystic kidney disease	12 (15)	5 (10)
Diabetes mellitus	11 (13)	8 (16)
Hypertension	11 (13)	6 (12)
Diabetes mellitus and hypertension	10 (12)	9 (18)
Other	40 (47)	22 (44)
Renal transplants, no. (%)		
1	69 (82)	41 (82)
2	13 (15)	7 (14)
3	2 (2)	2 (4)
Current immunosuppressive therapies, no. (%) patients		
Tacrolimus, mycophenolate, and prednisone	54 (64)	31 (62)
Cyclosporine, mycophenolate, and prednisone	5 (6)	4 (8)
Sirolimus, mycophenolate, and prednisone	5 (6)	3 (6)
Sirolimus, azathioprine, and prednisone	5 (6)	2 (4)
Sirolimus and prednisone	4 (5)	3 (6)
Other (includes missing data)	11 (13)	7 (14)
Time from renal transplantation to program enrollment, no. (%) patients		
≤6 mo	39 (46)	27 (54)
>6 mo	45 (54)	23 (46)
No. blood pressure measurements using electronic HBPM technology		
Mean ± S.D.	125 ± 113	176 ± 116
Median (range)	92 (1–450)	158 (23–450)
No. pharmacist-provided MTM visits		
Mean ± S.D.	1.6 ± 0.9	1.6 ± 0.9
Median (range)	1 (1–4)	1 (1–4)

[a]HBPM = home blood pressure monitoring, MTM = medication therapy management.

to meet with patients to review their past blood pressure values, provide education, and review medication- and disease-related problems. During high-volume clinic days, the pharmacist had less time to conduct a thorough MTM visit. Transplant recipients typically require at least 10 medications, making abbreviated MTM sessions undesirable. We have responded to this challenge by increasing our pharmacist staffing levels in the clinic to accommodate patient visits, especially during high-volume clinic days. To ensure that the transplant pharmacist has adequate time to meet with each patient for thorough medication review and therapy management, a dedicated examination room within the transplantation clinic was established.

Conclusion

Implementation of electronic

HBPM and pharmacist-provided MTM services implemented in a renal transplant clinic was associated with sustained improvements in blood pressure control. Incorporation of a pharmacist in the renal transplant clinic resulted in the detection and resolution of medication-related problems.

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