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A Postpartum Remote Hypertension Monitoring Protocol Implemented at the Hospital Level

Alisse Hauspurg, MD, Lara S. Lemon, PharmD, PhD, Beth A. Quinn, RN, Anna Binstock, MD, Jacob Larkin, MD, Richard H. Beigi, MD, Andrew R. Watson, MD, Hyagriv N. Simhan, MD

Department of Obstetrics, Gynecology and Reproductive Sciences, UPMC Magee-Womens Hospital, University of Pittsburgh School of Medicine, and UPMC Magee-Womens Hospital and the Departments of Clinical Analytics and Surgery, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania.

Abstract

OBJECTIVE: To evaluate the feasibility, acceptability, and compliance of a remote blood pressure monitoring protocol implemented as a quality improvement measure at the hospital level for management of hypertension in postpartum women after hospital discharge.

METHODS: This is an ongoing quality improvement project that included women admitted to the postpartum unit of a single tertiary care hospital. We designed nursing call center-driven blood pressure management and treatment algorithms which were initiated after hospital discharge until 6 weeks postpartum. Women are eligible to participate if they have a diagnosis of chronic hypertension, superimposed preeclampsia, gestational hypertension, preeclampsia, or postpartum hypertension and have access to a text messaging-enabled smartphone device. After identification by an obstetric care provider, women are enrolled into the program, which is automatically indicated in the electronic medical record. Maternal, obstetric, and sociodemographic data were obtained from the electronic medical record.

RESULTS: Between February 2018 and January 2019, we enrolled 499 patients. Here we report on the first 409 enrolled patients. Participants include 168 (41%) with gestational hypertension, 179 (44%) with preeclampsia with no history of chronic hypertension, 49 (12%) with chronic hypertension with superimposed preeclampsia, and 13 (3%) with postpartum preeclampsia. One hundred seventy-one (42%) participants had antihypertensives initiated or titrated through the program. Three hundred forty women (83%) continued the program beyond 3 weeks postpartum, and 360 (88%) attended an in-person 6-week postpartum visit. Two hundred thirty-five out of 250 women who completed a postprogram survey (94%) reported satisfaction with the program.

CONCLUSION: In this study, we detail results from an ongoing remote blood pressure monitoring program. We demonstrate high compliance, retention, and patient satisfaction with the program. This is a feasible, scalable remote monitoring program connected to the electronic medical record.

Corresponding author: Alisse Hauspurg, MD, UPMC Magee-Womens Hospital, Pittsburgh, PA; janickia@upmc.edu.

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Recent evidence suggests that maternal morbidity and mortality are increasing in the United States, with the majority occurring in the postpartum period.¹ The etiology of this rise is likely multifactorial, including advancing maternal age and increased prevalence of obesity with concomitant medical comorbidities. Hypertension complicates 10–20% of pregnancies in the United States and is a significant contributor to maternal deaths worldwide, with 14% of global maternal mortality directly related to hypertension.² However, the majority of management recommendations are focused on antepartum blood pressure goals and surveillance.³ Significantly less attention has been paid to the postpartum period, despite prior studies showing that hypertensive disorders of pregnancy are the most common etiology of postpartum readmissions with a significant associated cost burden.^{4,5} In prior observational studies of women with hypertensive disorders of pregnancy, worsening of hypertension was noted between days 3–6 postpartum.^{3,6,7} This increase in blood pressure is typically seen after discharge from the hospital and is associated with serious morbidity, including seizure, stroke, and rarely death.⁸

Recognizing the underutilization of postpartum care and the increasing morbidity in this period, the American College of Obstetricians and Gynecologists (ACOG) recently updated their guidelines to reflect the importance of appropriate postpartum care and to propose a new paradigm for management in this period.⁹ With the recommended changes in the scope of postpartum care and redefining this period as the “fourth trimester,” incorporation of innovative interventions for risk reduction in this population was recommended. However, translation of the ACOG guidelines into clinical practice constitutes an ongoing challenge.

The American College of Obstetricians and Gynecologists and others have suggested the use of telemedicine or remote health care interventions to facilitate care in the “fourth trimester.” The capability of telemedicine has been significantly expanded with the consumer electronics market and the ability to use patient’s cell phones as secure and compliant clinical endpoints. These interventions have been successful in nonobstetric populations at improving blood pressure control and reducing both inpatient and outpatient visits.^{10–12} In small pilot trials, these have shown to be effective at improving short-term follow up and patient satisfaction.^{13,14} The objective of this study was to describe the feasibility, acceptability, and compliance of remote blood pressure monitoring for management of hypertension in postpartum women after hospital discharge.

METHODS

This is an ongoing quality improvement project that included women admitted to the postpartum unit of a single tertiary care hospital (University of Pittsburgh Medical Center, UPMC Magee-Womens Hospital). Eligible women have one of the following hypertension-related diagnoses: chronic hypertension, chronic hypertension with superimposed preeclampsia, gestational hypertension, preeclampsia, eclampsia, or new onset postpartum hypertension. Women must be English-speaking and are also required to have access to a text messaging-enabled smartphone device. Diagnoses are made by the clinical care team according to ACOG criteria.³ (Regardless of diagnosis, hypertension is defined as blood pressure 140 mm Hg or above systolic or 90 mm Hg diastolic). Maternal, obstetric, and sociodemographic data are obtained from the electronic medical record. The program was

approved by the University of Pittsburgh Medical Center Quality Improvement Review Committee. Review of follow up data was approved by the University of Pittsburgh Institutional Review Board.

The University of Pittsburgh Medical Center created a remote patient monitoring platform that leveraged Vivify Health as its core vendor. The monitoring platform was integrated with electronic health records for both ordering and results, with a goal of increasing education, engagement, and blood pressure monitoring in the postpartum period. Patients are enrolled in the program by their primary obstetric care provider while on the postpartum unit or after a readmission postpartum. After identification and verification of eligibility, the health care provider places an order in the electronic medical record with the patient's phone number, which automatically generates a text message to enroll the patient. The computerized physician order entry triggers a health level 7 message to an enterprise master patient index, which then sends an automated message to Vivify to enroll the patient. Vivify then adds a service level for the postpartum hypertension program in the patient medical record. The patient is enrolled into one of two groups based on whether or not they were taking oral antihypertensive medications at the time of discharge.

The platform involves a "bring your own blood pressure device," either through insurance coverage, patient purchase, or hospital provision. The patient is trained on use of the blood pressure device by a nurse educator before discharge from the hospital. Before discharge from the hospital, nursing staff record blood pressure on both the home blood pressure monitoring device and the hospital device to confirm accuracy. We use the Drive Medical BP 3600 automatic upper arm blood pressure monitor. Both groups of the program are managed through a nursing-staffed University of Pittsburgh Medical Center call center with documentation of calls and blood pressures directly into the electronic medical record.

We designed nursing call center-driven blood pressure management and treatment algorithms (Fig. 1). These algorithms were developed by local expert stakeholders, consistent with national guidelines on goals for hypertension management postpartum.¹⁵ Briefly, after discharge from the hospital, women are prompted to check their blood pressure 5 days per week for the first week of the program, and, if they require antihypertensive medication, to continue to check blood pressures 5 days per week throughout the program as long as they remain on medications. In both groups, if all blood pressures are at goal, the 1-week postpartum in-office blood pressure check appointment is canceled. Women with blood pressures exceeding the goal who are asymptomatic are encouraged to keep their postpartum office visit. In that case, the call center contacts the on-call physician for possible initiation of an antihypertensive medication and the patient is moved into the medication group. The initial choice of antihypertensive agent is dictated by the clinical care team while the patient is inpatient. After hospital discharge, titration of medication or in the case of medication initiation, selection of the antihypertensive agent is based on clinical judgment from the call center physician as there are no standardized management guidelines for specific antihypertensive agents or parameters for medication titration in the postpartum period.¹⁶

The primary feasibility outcomes in this study were engagement and retention through 42 days postpartum. Patient acceptability was assessed via a postprogram survey administered through the telehealth platform. Patients were prompted to complete the survey through the telehealth platform beginning on day 35 of the program. The survey included questions regarding comfort with the technology, knowledge of health condition and satisfaction with the program (Box 1). All items were measured using a 5-item Likert response scale, with a score of 1 indicating strong disagreement, a score of 3 indicating neutral, and a score of 5 indicating strong agreement. Engagement was assessed via the proportion of women who continued the program at each week postpartum.

Data frequencies and descriptive statistics were completed using Stata IC 15.

RESULTS

Between February 2018 and January 2019, we enrolled a total of 499 patients into our remote hypertension monitoring program from one site. We report here on the first 409 women completing the program through January 2019 (Table 1). The remainder of the participants (n590) are still actively enrolled in the program.

Participants included 168 (41%) with gestational hypertension, 179 (44%) with preeclampsia with no history of chronic hypertension, 49 (12%) with chronic hypertension with superimposed preeclampsia, and 13 (3%) with postpartum preeclampsia. During their hospitalizations, 164 (40%) women received magnesium sulfate; 106 (26%) were enrolled in the medication group at the time of hospital discharge, with the remaining 303 (74%) in the nonmedication group of the program (Table 2). During the program, 168 (41%) of participants had antihypertensives initiated or titrated through the program. Obstetric outcomes stratified by the use of antihypertensive medication in the program are shown in Table 3. Of our cohort, 60 women (15%) had a readmission postpartum, most commonly secondary to severe hypertension.

Compliance with the program was high. Based on the protocol, 177 (43%) women did not require the previously scheduled in-office blood pressure check at 1-week postpartum, the majority (112; 63%) were in the no medication group. Of the 232 women who required a blood pressure check based on the protocol, 198 (85%) women attended the visit. Of the 409 women who have completed the program to date, 340 (83%) continued the program beyond 3 weeks postpartum and 302 (74%) continued the program beyond 4 weeks postpartum (Fig. 2). Among women enrolled in the program, 360 (88%) attended a 6-week postpartum visit, compared with a historical background rate of 60% attendance among all deliveries and 66% attendance among women with a hypertensive disorder of pregnancy in the year before implementation of the program (2017). An ongoing goal of the program is to bridge care from obstetricians to primary care physicians; currently 87 (21%) participants have established care with a primary care physician postpartum, with an additional 42% reporting that they have scheduled an appointment with their primary care physician.

A total of 250 (61%) women completed the postprogram survey to date (Box 1). Overall, 235 patients (94%) reported that they were satisfied with their experience in the remote

monitoring program, 232 (93%) would recommend the program to others, 239 patients (96%) reported that they are comfortable using new technology, and 221 women (88%) did not worry about their privacy with the technology. A total of 205 women (82%) expressed feeling more comfortable knowing a nurse was checking their health every day.

DISCUSSION

In this study, we detail results from an ongoing remote blood pressure monitoring program implemented at the hospital level. We demonstrate feasibility, high engagement, retention, and patient satisfaction with the program as well as high compliance with postpartum visits. This is a scalable remote monitoring program connected in Health Insurance Portability and Accountability Act-compliant fashion to the electronic medical record, which allows for documentation, communication, and the ability to prescribe and adjust medications through a nursing call center protocol.

The traditional 6-week face-to-face postpartum visit is poorly attended, with prior studies showing that as many as 40% of women are not seen in follow up after delivery.⁹ This underscores the need for development of innovative models to expand care and accessibility for these women, many of whom may be high-risk.^{17–20} However, identification of innovative interventions and implementation of these recommendations at the hospital level has not been well detailed. Within the context of small randomized trials or research studies, text message-based postpartum hypertension monitoring programs have been shown to increase patient engagement and improve compliance with blood pressure follow-up.^{13,14} One such study compared a text-based remote monitoring protocol for postpartum hypertension compared with usual care in a small cohort of women. They demonstrated increased compliance with having a single blood pressure value recorded in the first 10 days postpartum in the text messaging group compared with the standard of care group.¹³ In the standard of care group, 43.7% of women had a blood pressure measure within the first 10 days postpartum compared with 92.2% in the text-based monitoring group. Similar to our findings, the authors demonstrate improved attendance at the traditional 6-week postpartum visit in the text message group. Our findings also confirm those of smaller studies in terms of women's attitudes towards telehealth.^{21,22} Patients were comfortable using the technology and were not worried about their privacy with the use of the application to track their health. Women also felt more comfortable knowing that a nurse was checking on their health every day. Previous studies similarly demonstrate participants' views of telehealth as a secure and easy monitoring technique.

Remote hypertension monitoring improves compliance with ACOG recommendations surrounding blood pressure assessment within the first 3–10 days postpartum and may identify women with otherwise unrecognized blood pressure elevations requiring medication in this period.^{3,9} The study by Hishberg, et al found that additional treatment was required in 16.5% of women in the remote monitoring group. Within our cohort, 106 (26%) women were discharged on an antihypertensive medication and 171 (42%) patients had blood pressure medication titrated (either initiated, up-titrated, or down-titrated) through the program. A further benefit of our protocol is a systematic method of medication titration. The recently published SNAP-HT trial demonstrated that systematic titration of

antihypertensive medications in the postpartum period not only shortens the duration of antihypertensive therapy, but also has a longer-term benefit on blood pressure that persisted up to 6 months postpartum.²³ The authors hypothesized that this beneficial effect is secondary to more favorable cardiovascular remodeling. Thus, it is possible that remote hypertension monitoring postpartum with systematic medication titration may provide additional long-term benefits to women with hypertensive disorders of pregnancy and may improve long-term cardiovascular health. The American Heart Association and ACOG have identified hypertensive disorders of pregnancy as risk factors for later-life cardiovascular disease, however, effective evidence-based interventions have not yet been adequately studied or implemented.^{24–26} Prior studies have shown that postpartum care after a hypertensive disorder of pregnancy is often fragmented, with no cohesive transition from the obstetrician to internist or cardiologist.²⁵ An ongoing goal of our program is to facilitate care handoffs from the obstetrician to the primary care physician; as such, 21% of enrolled women have already been seen by their primary care physicians, and 42% report that they have scheduled an appointment with their primary care physician.

Despite the strengths of this preliminary report, there are some notable limitations to our data. Because only 250 women completed the postprogram survey, results demonstrating satisfaction may be subject to reporting bias. Furthermore, as this program is in its nascent stage, we are unable to assess long-term benefits such as reduction in maternal morbidity or mortality, and clinical benefits associated with remote blood pressure monitoring, along with generalization and full scalability at this point. However, integration into the electronic medical record is promising and facilitates an easier and quicker expansion. The program requires that women were English-speaking and have access to a text-messaging enabled smartphone. Prior studies have shown that approximately 92–96% of reproductive-aged women have access to a smartphone.²⁷ However, it is possible that a larger proportion of high-risk women may not have access to a text-messaging enabled smartphone, thus the applicability of our findings to a broader population within the United States may be limited. Within our study period, two women (0.5%) declined to participate because of not owning an appropriate device. Finally, it is possible that patients who were enrolled in the program were self-selected and more motivated than a general patient population, which could have contributed to our observed engagement, satisfaction, and compliance rates. Further, we are unable to address unintended negative consequences that may result from the use of remote hypertension monitoring.

This study details the use of telehealth to improve postpartum hypertension care and patient engagement. For remote monitoring in the postpartum period to be implemented in a broader fashion in accordance with ACOG recommendations, key criteria must be met. The system must be scalable, it needs to be incorporated into the electronic medical record system, and it must have the ability to be implemented at the hospital level. Early studies of remote monitoring for hypertension care in the postpartum period have shown promising results in terms of patient engagement and satisfaction as well as improving blood pressure control. Further study is needed to evaluate whether such monitoring actually reduces maternal morbidity and mortality.

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Box 1.**Postprogram survey questions**

I did not worry about my privacy with the new technology that was used to keep track of my health.

I felt more comfortable knowing a nurse was checking my health every day.

I know the names of the medications I am taking, if any.

I know what kind of health condition I have.

I know why it is important to check my vital signs such as my blood pressure and pulse.

I was comfortable using the new technology.

I would recommend this program to others.

Learning to take care of my health condition with the remote monitoring program and devices did not take too much time.

Overall, I am satisfied with my experience in the remote monitoring program.

Fig. 1.

Overview of hypertension remote monitoring protocol. Week 1 (**A**) and weeks 2–6 (**B**). BP, blood pressure; HR, heart rate.

Hauspurg. Postpartum Remote Hypertension Monitoring. *Obstet Gynecol* 2019.

Fig. 2.

Proportion of cohort (N=5409) continuing the program through weeks 2–5 and beyond postpartum.

Hauspurg. Postpartum Remote Hypertension Monitoring. *Obstet Gynecol* 2019.

Table 1.

Demographic Characteristics (N=409)

Characteristic	Value
Maternal age (y)	31.0 (27.0–35.0)
Race	
Caucasian	305 (75)
African American	87 (21)
Asian	8 (2.0)
Other	9 (2)
Predelivery BMI (kg/m ²)	27.8 (23.6–34.6)
Insurance status	
Private	274 (67)
Public	128 (31)
Other	7 (2)
Primiparous	156 (38)
Tobacco use *	44 (11)
Pregestational diabetes *	9 (2)
Gestational diabetes *	45 (11)

BMI, body mass index.

Data are median (interquartile range) or n (%).

* Missing for seven patients.

Table 2.**Obstetric Outcomes (N=409)**

Outcome	Value
Hypertension diagnosis	
Chronic hypertension with superimposed preeclampsia	49 (12)
Gestational hypertension	168 (41)
Preeclampsia without severe features	136 (33)
Preeclampsia with severe features	43 (11)
Postpartum preeclampsia	13 (3)
Mode of delivery *	
Cesarean	80 (20)
Vaginal	322 (80)
Birth weight (g) *	3,010 (2,635–3,415)
Gestational age at delivery (wk) *	37.7 (36.9–39.1)
Received magnesium sulfate *	164 (40)
Seen for 4–6-wk postpartum appointment	360 (88)

Data are n (%) or median (interquartile range).

* Missing for seven patients.

Table 3.

Obstetric Outcomes by Medication Usage in the Program

Outcome	Did Not Receive Antihypertensive Medication (n=241)	Received Antihypertensive Medication (n=168)
Hypertension diagnosis		
Chronic hypertension with superimposed preeclampsia	10 (4)	39 (23)
Gestational hypertension	134 (56)	34 (20)
Preeclampsia without severe features	78 (32)	58 (35)
Preeclampsia with severe features	14 (6)	29 (17)
Postpartum preeclampsia	5 (2)	8 (5)
Mode of delivery *		
Cesarean	44 (19)	36 (22)
Vaginal	192 (81)	130 (78)
Birth weight (g) *	3,100 (2,800–3,485)	2,845 (2,220–3,260)
Gestational age at delivery (wk) *	38.0 (37.1–39.3)	37.3 (35.6–38.9)
Received magnesium sulfate *	64 (27)	100 (60)
Seen for 4–6-wk postpartum appointment	210 (87)	150 (89)

Data are n (%) or median (interquartile range).

* Missing for seven patients: five in the nonmedication group, and two in the medication group.