

Abstract

Background and Significance: Hypertensive disorders of pregnancy complicate about 10% of pregnancies and are a leading cause of maternal morbidity and mortality.

Purpose: The purpose of this quality improvement project was to evaluate a program to provide a home blood pressure monitor to all postpartum patients who had a hypertensive diagnosis and elevated blood pressure.

Methods: The program includes a blood pressure monitor, instructions for its use, education about hypertension, and a guidance grid with standardized blood pressure parameters reviewed prior to discharge from the hospital. Patients are taught about potential adverse outcomes during postpartum. Patients are instructed to follow-up with their care provider based on the parameters. A retrospective medical record review was used to evaluate clinical outcomes.

Results: Medical records of 185 patients indicated that 20% ($n = 36$) who received the home BP monitor reported one or more mild-to-severe range blood pressure(s) during postpartum. Twenty-eight percent ($n = 52$) had outpatient medication adjustments, including decreasing, increasing, starting, and discontinuing medications. Nine percent ($n = 17$) of patients returned to the obstetric triage for evaluation. There was patient overlap between those experiencing elevated blood pressures, medication adjustments, and those who returned to hospital for evaluation.

Clinical Implications: Ongoing monitoring may improve identification and management of postpartum hypertension and potentially prevent progression to hypertensive-related adverse events.

Key words: Blood pressure; Blood pressure monitors; Gestational hypertension; Hypertension; Maternal morbidity; Postpartum period; Preeclampsia.

POSTPARTUM HOME BLOOD PRESSURE MONITORING PROGRAM: IMPROVING CARE FOR HYPERTENSION DURING POSTPARTUM AFTER A HOSPITAL BIRTH

Kamilah A. Hayden-Robinson, MSN, RN, CNL, FNP-BC, CLC, and Jessica L. Deeb, MS, RN, WHNP-BC, IBCLC, LCCE

Hypertensive disorders in pregnancy are a leading cause of maternal morbidity and mortality (Ford et al., 2022; Hitti et al., 2018), and complicate about 10% to 14% of pregnancies (Ananth et al., 2021; Ford et al., 2022; Mogos et al., 2018). The exact mechanisms leading to blood pressure (BP) elevations during pregnancy and postpartum are not completely understood (Erez et al., 2022; Jung et al., 2022). The majority of those who experience postpartum hypertension will do so in the first week postbirth (Goel et al., 2015). Given the traditional schedule of postpartum visits occurring between 2 to 6 weeks post discharge, there is substantial risk of missing secondary or new elevations in BP among women who were hypertensive in pregnancy or develop new-onset hypertension during postpartum (Sharma & Kilpatrick, 2017).

Patients with hypertensive disorders of pregnancy are at higher risk for developing complications during postpartum including hypertension-related diagnoses (Horwitz et al., 2021). Stuart et al. (2018) reported an increased likelihood of developing cardiovascular disease risk factors in pregnancies complicated by gestational hypertension and preeclampsia based on data from approximately 60,000 women enrolled in the Nurses' Health Study II. These risk factors included chronic hypertension, type 2 diabetes, and hypercholesterolemia. In a cohort study of almost 500,000 primiparous women, Behrens et al. (2017) found women with a hypertensive disorder of



Close and effective monitoring may improve identification and management of postpartum hypertension and potentially prevent progression to hypertensive-related adverse events.

postpartum women have contact with their care provider within 3 weeks of birth, with a BP check 7 to 10 days post birth for hypertensive patients and within 3 days if patients had severe hypertension (American College of Obstetricians and Gynecologists, 2018). The New York State Department of Health (2013) recommends a BP check at least once, 3 to 5 days post birth for hypertensive patients.

Home BP monitoring has been shown to be beneficial in the obstetric population (Aquino et al., 2020; Kalafat et al., 2020). Aquino et al. (2020) noted benefits of home BP monitoring such as aiding in clinical decision-making, especially in between obstetric visits. However, more studies are needed to evaluate the long-term effects of home BP monitoring on maternal morbidity and mortality. In a systematic review and meta-analysis, Kalafat et al. (2020) concluded that home BP monitoring in pregnancy appears to be a safe and effective method for reducing prenatal visits, hospital admissions, and inaccurate diagnoses of preeclampsia and induction of labor in pregnancies being monitored for hypertensive disorders. Home monitoring did not

increase adverse outcomes. Thomas et al. (2021) found home BP monitoring was overall positively received by postpartum patients. There were some concerns expressed such as privacy, issues with incorrect cuff size, Bluetooth syncing and connectivity; however, most participants did not report these concerns. In another study, postpartum patients in a remote home BP monitoring program were satisfied, highly compliant, and remained in the program (Hauspurg et al., 2019). The American Heart Association and the American Medical Association endorse use of home BP monitoring in adults as an appropriate follow-up action to aid in diagnosis and treatment of hypertension (Shimbo et al., 2020). In the White House (2022) blueprint to address the maternal health crisis in the United States, dissemination of self-measured monitoring tools to pregnant and postpartum women is recommended to increase access and improve quality of care.

Available Knowledge

In 2018, the American College of Obstetricians and Gynecologists issued a committee opinion recommending

Specific Aims

After a review of the literature and based on current evidence, clinical leaders in our postpartum service created a home BP monitoring program. Each patient with a diagnosis of hypertensive disorder is given a home BP monitor with instructions on its use prior to hospital discharge. The goal of this program is to improve access to care for postpartum women diagnosed with hypertensive disorders in pregnancy.

Methods

Context

NYU Langone Health's Tisch Hospital is a large urban academic medical center in New York City, averaging 5,300 births per year. The average age of a woman giving birth at our institution is 32 years old. Over 85% of maternity patients have private insurance and they are primarily English-speaking and non-Hispanic White. The hospital has a department of maternal-fetal medicine. Providers who attend birth include obstetricians from both private and faculty group practices.

In 2019, as part of membership in an external quality and benchmarking organization, we were provided analysis of patients giving birth in our hospital. This included an analysis of maternal hypertension in our patient population for a 1-year time frame (Table 1). At that time, 11.7% of our population ($n = 705$) had a diagnosis code of hypertension; however, our data for 2021 indicated an increase to 17% ($n = 892$). Hypertension affects patients during the childbirth hospitalization and postpartum readmissions. Almost one-half of our postpartum readmissions are a result of hypertension. Through case review of the readmissions, it was noted that a significant number of patients reported concerning signs and symptoms, such as headache or measurement of an elevated BP at home. Notification of these occurrences to a provider led to evaluation in labor and delivery triage or the emergency department.

Prior to 2019, a postpartum visit was typically scheduled for 6 weeks post birth unless the patient contacted their provider with concerning symptoms. The paramet-

ters for home BP monitoring, medication management, and postpartum follow-up visits varied between our obstetric providers. Unless a home BP monitor was obtained during pregnancy or prescribed on discharge from the hospital, most patients did not independently monitor their BP post discharge. Discharge education included signs of preeclampsia and hypertension; however, this information was generalized in a written format rather than patient-specific.

Intervention

The initial step in our hospital change process is to bring a proposed clinical care program to the interdisciplinary obstetrical collaborative practice council. The committee approved the home BP monitoring program and permission was granted to move forward. A home BP monitor was approved by the hospital's value analysis team and purchased by the mother-baby unit. The chosen home BP monitor was easy to understand and operate by the mother-baby nurses. The health system has absorbed the cost of the equipment to date.

The next critical step was to standardize the BP parameters for follow-up. A home guidance grid was created with space to record a morning and evening BP reading with action steps based on the values (Figure 1). Blood pressure ranges were categorized as low, normal, mild, and severe. The proposed parameters were approved by the obstetric quality assurance committee. The complete program was brought back to the obstetrical collaborative practice council for their final approval and inclusion in the department's hypertensive protocol.

In addition to this program, the postpartum unit concurrently adopted the Association of Women's Health, Obstetric, and Neonatal Nurses' (2017) post-birth warning signs education tool (Figure 2). This tool, alongside updated hospital-based education materials, highlights the symptoms of elevated BP. The education is given in written and verbal format to all patients prior to discharge.

Interactive education was provided to the mother-baby nurses on use of the home BP monitor and guidance grid. Obstetric care providers were notified of the purpose and availability of the program via email. After diagnosis of a hypertensive disorder, any patient who does not have a home BP monitor is given one prior to discharge. The home BP monitor is assembled by the nurse and the patient provides a return demonstration of use. Patients are instructed to upload their twice-daily BPs into their patient portal, when available, or to bring their guidance grid to their next follow-up appointment. Further instructions listed on the guidance grid include when to call a provider for urgent signs and symptoms. The BP checks continue until the 6-week postpartum visit, unless directed to discontinue earlier by the provider.

Approximately 6 months after the start, an educational overview of the program was conducted at a unit-based education session for all labor and delivery and mother-baby nurses. New nurses are educated on the program during their orientation.

TABLE 1. CATEGORIES OF PATIENTS WITH A HYPERTENSION DIAGNOSIS CODE DURING BIRTH

Hypertension Categories	N = 705	Percent of Total
Gestational hypertension	318	45.1%
Preeclampsia; unspecified preeclampsia	83	11.8%
Preeclampsia with severe features	161	22.8%
Preexisting hypertension	92	13.1%
Preexisting hypertension with preeclampsia	45	6.4%
Eclampsia	4	0.6%
Unspecified maternal hypertension	65	9.2%

FIGURE 1. HOME BLOOD PRESSURE GUIDANCE GRID

Notes and/or questions for the doctor

This image shows a single sheet of white paper with horizontal blue lines, similar to standard notebook paper. The lines are evenly spaced and run across the width of the page. There is no handwriting or other markings on the paper.

Patient instructions for taking blood pressure at home after giving birth

1. Please make sure that you are seated in a chair with back support and your feet are both on the floor. Do not cross your legs.
2. Remove any thick, bulky or tight clothing from your arm.
3. Relax for 5 to 10 minutes before checking your blood pressure.
4. Do not eat, smoke or drink right before taking your blood pressure.
5. Put on the blood pressure cuff according to the manufacturer's instructions. Left arm is recommended.
6. Place your arm on a table. This way the cuff is roughly at the level of your heart (slightly below the armpit).
7. Turn the blood pressure machine on and then press the start button.
8. Record your blood pressure on your blood pressure log.
9. Check the "Home Blood Pressure Guidance Grid". Then do the action based on your current blood pressure range.
10. If you have any symptoms such as: **headache, visual disturbance, dizziness, or pain in the upper right area of your belly**, call your doctor for further instructions.

Home Blood Pressure Guidance Grid

Check your blood pressure **at least twice a day**. Check in the morning and then in the evening, preferably before dinner. Write your blood pressure numbers in your daily log.

If you have any symptoms such as: **headache, visual disturbance, dizziness or pain in the upper right area of your belly**, call your doctor for further instructions.

Doctor's Office Phone Number:

Blood pressure range	Category	Symptom	Action
Less than 90/ Less than 60	Low	None	If you are taking home medications for blood pressure, such as Labetalol or Nifedipine, hold the dose and speak with your doctor. If you are not on home medications, recheck blood pressure at the next scheduled time.
		If noted with dizziness and/or shortness of breath	Call MD for further instructions.
90-149/ 60-99	Normal	None	Recheck blood pressure at the next scheduled time.
150-159/ 100-109	Mild	None	If blood pressure is $\geq 150/100$ recheck in 15 minutes and call MD if blood pressure remains.
More than 159/ More than 109	Severe	None	Recheck blood pressure in 15 minutes. If still severe range, call MD for further instruction. If you cannot reach your provider in 15 minutes, go to emergency room or call 911.

* Top or bottom number in the blood pressure range.
For example, a blood pressure of 165/99 would be considered severe range or 100/54 would be considered in the low range.

My Blood Pressure Log

[illegible]

FIGURE 2. AWHONN'S POST-BIRTH WARNING SIGNS

SAVE YOUR LIFE:

Get Care for These POST-BIRTH Warning Signs

Most women who give birth recover without problems. **But any woman can have complications after giving birth.** Learning to recognize these POST-BIRTH warning signs and knowing what to do can save your life.

**POST-
BIRTH
WARNING
SIGNS**

Call 911
if you have:

- ☐ **P**ain in chest
- ☐ **O**bstructed breathing or shortness of breath
- ☐ **S**eizures
- ☐ **T**houghts of hurting yourself or someone else

**Call your
healthcare
provider**
if you have:

(If you can't reach your
healthcare provider,
call 911 or go to an
emergency room)

- ☐ **B**leeding, soaking through one pad/hour, or blood clots, the size of an egg or bigger
- ☐ **I**ncision that is not healing
- ☐ **R**ed or swollen leg, that is painful or warm to touch
- ☐ **T**emperature of 100.4°F or higher
- ☐ **H**eadache that does not get better, even after taking medicine, or bad headache with vision changes

**Trust
your instincts.**
ALWAYS get medical
care if you are not
feeling well or
have questions or
concerns.

**Tell 911
or your
healthcare
provider:**

"I gave birth on _____ and
(Date)
I am having _____."
(Specific warning signs)

These post-birth warning signs can become life-threatening if you don't receive medical care right away because:

- **Pain in chest, obstructed breathing or shortness of breath** (trouble catching your breath) may mean you have a blood clot in your lung or a heart problem
- **Seizures** may mean you have a condition called eclampsia
- **Thoughts or feelings of wanting to hurt yourself or someone else** may mean you have postpartum depression
- **Bleeding (heavy)**, soaking more than one pad in an hour or passing an egg-sized clot or bigger may mean you have an obstetric hemorrhage
- **Incision that is not healing, increased redness or any pus** from episiotomy or C-section site may mean you have an infection
- **Redness, swelling, warmth, or pain** in the calf area of your leg may mean you have a blood clot
- **Temperature of 100.4°F or higher, bad smelling vaginal blood or discharge** may mean you have an infection
- **Headache (very painful), vision changes, or pain in the upper right area of your belly** may mean you have high blood pressure or post birth preeclampsia

**GET
HELP**

My Healthcare Provider/Clinic: _____ Phone Number: _____
Hospital Closest To Me: _____



This program is supported by funding from Merck, through Merck for Mothers, the company's 10-year, \$500 million initiative to help create a world where no woman dies giving life. Merck for Mothers is known as MSD for Mothers outside the United States and Canada.

©2018 Association of Women's Health, Obstetric, and Neonatal Nurses. All rights reserved. Unlimited print copies permitted for patient education only. For all other requests to reproduce, please contact permissions@awhonn.org.

Reprinted with permission from the Association of Women's Health, Obstetric and Neonatal Nurses (AWHONN) (www.awhonn.org). AWHONN POST-BIRTH Warning Signs. Copyright AWHONN. To access the full PDF version of the patient handout for clinical use, visit AWHONN.org or email requests to permissions@awhonn.org

TABLE 2. OUTCOMES OF PATIENTS RECEIVING HOME BP MONITOR IN 2019

	Number of Blood Pressure Cuffs Given	Reported Mild–Severe Range BP	Postpartum Medication Adjustments	Returned to Hospital
Faculty Group Practice Patients	185	36 (19.5%)	52 (28.1%)	17 (9.2%)

Study of the Intervention

To evaluate program effectiveness, we conducted a review of medical records ($n = 185$) for patients who received a home BP monitor within our faculty group practice in 2019. These patients have complete medical records, including prenatal and postpartum care, within our facility's electronic medical record system (EMR). All phone calls and electronic messaging are documented in the EMR, allowing any outpatient medication regimen changes to be viewed. This review was conducted in 2020 by members of the nursing leadership team.

Results

The data (Table 2) from the faculty group practice indicated that 20% ($n = 36$) of patients who received the home BP monitor reported one or more mild-to-severe range BP(s) during postpartum. Twenty-eight percent ($n = 52$) had outpatient medication adjustments, including decreasing, increasing, starting, and discontinuing medications. Nine percent ($n = 17$) of patients returned to the obstetric triage for evaluation. There was patient overlap between those experiencing elevated BPs, medication adjustments, and those who returned to obstetric triage for evaluation. The program allowed for timely intervention as appropriate without an in-person visit for most participants.

Feedback to nurse leaders from patients receiving the home BP monitor has been positive. Some patients have stated that it would have been difficult to purchase a home BP monitor while recovering from birth. A portion of our patient population who observe the Jewish Sabbath may have difficulty obtaining a home BP monitor if discharged on a Friday. Strict observation of the Jewish Sabbath day does not allow for travel and exchanging money from sundown on Friday to sundown on Saturday, leaving them unmonitored during that time.

Although initially the home BP monitors were given to patients with a confirmed hypertensive diagnosis, as the project progressed providers started to include patients with borderline elevated BPs who would benefit from increased monitoring. There was interest in expanding to our labor and delivery triage unit to include antepartum and postpartum patients who were readmitted with hypertensive concerns. Physiologic differences were considered and modifications were made to the guidance grid for antepartum patients. The choice was made to not include defined parameters in the guidance grid for the normal and mild BP ranges. The patient's care provider would counsel the patient based on the individual clinical situation, writing their parameters on the guidance grid. To date, over 1,000 home BP monitors have been given to patients discharged from the mother–baby unit. Sepa-

ately, guidance grids are given to patients who already own a home BP monitor.

The program continued to work well, and perhaps improved, when New York City quickly became the epicenter of the COVID-19 pandemic. Providers began to use telehealth appointments regularly with ease (Limaye et al., 2021; Madden et al., 2020). Many patients purchased or were prescribed a home BP monitor and reported their measured values to the provider during the prenatal period. Patients became familiar with the cuff prior to their hospitalization and did not require one from the hospital. A 1-week post birth visit was easier to accomplish when done virtually.

Discussion

Hypertensive disorders in pregnancy are significant risk factors for severe maternal morbidity and mortality. Although we were not able to evaluate adverse outcomes, we found care was modified based on home BP monitoring. In 20% ($n = 36$) of the 185 patients whose charts were reviewed reported one or more mild or severe range BP(s), and almost one-third of patients ($n = 52$) had their medication adjusted. Patients most often communicated their BPs and concerns to their provider without having to schedule an in-person visit.

In a prior study (Kronish et al., 2017), providers identified the following potential barriers to home BP monitoring: physically obtaining a BP kit, the cost, possibility of incorrect use, incorrect cuff size, varied health literacy, non-compliance with the testing protocol, and patients selecting the better or incorrect BP to report to the doctor. By providing home BP monitors on our unit with education, several of the barriers noted, such as incorrect cuff size, incorrect use, cost, and ability to obtain the kit are eliminated.

Many patients are satisfied with home BP monitoring, feel telehealth is secure, and prefer telehealth over going to a hospital or clinic (Hoppe et al., 2019). Scheduling a postpartum follow-up visit can be difficult due to the unique circumstances a new parent experiences. Documented barriers to the postpartum visit include child-care, appointment availability, overall busyness in life, and travel cost and time (Henderson et al., 2016; Ruderman et al., 2021; Saad et al., 2021). Nationwide postpartum visit attendance rates can vary as much as 24.9% to 96.5% (Attanasio et al., 2022). In a study of barriers to prenatal care, Fryer et al. (2021) found Black and Latinx women were more likely to experience barriers related to transportation and insurance than their White counterparts. Our patients were able to access care without facing many of these barriers. However, it is important to note that Limaye et al. (2021) and Madden et al.

CLINICAL IMPLICATIONS

- Blood pressure home monitoring programs can be relatively easy to implement and support patient safety after discharge if the hospital or health system can cover the cost of the device.
- At home, blood pressure monitoring along with patient education can support timely and appropriate outpatient decision-making, such as medication changes, and when or if a return to the hospital is necessary.
- Patient's preferred language must be considered, and educational materials need to be provided or translated in the language they can understand.
- The program can be adapted to include antepartum patients, and is likely feasible for nonobstetric populations.
- Telehealth in conjunction with home blood pressure monitoring can address some of the barriers to returning to the clinic or office for a postpartum visit.
- Patient awareness of potential adverse outcomes during postpartum may increase likelihood of seeking medical attention.

(2020) found patients with public insurance experienced more difficulties with access to telehealth visits and our population was predominately covered by private insurance. Consideration of social determinants of health should be taken when using telehealth and home BP monitoring.

Limitations

Currently, home BP monitors are not submitted for insurance reimbursement; the cost of the BP monitor we used in this program is \$30. With a culture of quality and safety, the hospital was willing to absorb the cost of the home BP monitors in the postpartum unit's budget. This program may be difficult to replicate in other institutions who are unable to afford the purchase of home BP monitors. Another hospital in our health system bundled home BP monitors into their visiting nurse service. An alternative may be to write a prescription for the home BP monitor; however, this does not address the barriers of physically obtaining the monitor post birth, selecting the correct size, and proper use of the monitor. Hospitals could explore partnering with medical supply companies, pharmacies, or seek grants through hospital foundations.

There are several models for reporting BPs to the provider within our health system. Some patients write down the BP on the guidance grid, others call their providers directly to report the BPs. A third alternative is to send a message to the provider via our hospital-based patient messaging system. This program did not evaluate the most effective way of reporting BPs post discharge. Patients' use of the guidance grid cannot be evaluated as it is not embedded in the EMR.

More research is needed to determine if home BP monitoring decreases the risk of adverse events in the



The goal of this program is to lessen the barriers of care that a woman diagnosed with hypertensive disorders in pregnancy will experience during postpartum.

postpartum period. With the rarity of these events, we were unable to determine the impact of the program on severe maternal morbidity and mortality.

Clinical Implications

Prior to program implementation, patients were rarely given or prescribed a BP device. Removing barriers to postpartum BP surveillance through an at-home BP monitoring program allows providers to evaluate patients at risk for complications and intervene in a timely manner. Excluding financial constraints, this program was easy to implement, was well received by both patients and providers, and has been sustained for over 3 years. It is likely feasible to replicate at large academic medical centers with primarily English-speaking patients. However, it should be noted that this was easily adopted by another hospital in our health system whose patient population is not primarily English-speaking.

Home BP monitoring and individualized education may enhance the patient's awareness of hypertension and adverse events that can occur in the postpartum period. This ongoing monitoring may improve identification and management of postpartum hypertension and potentially prevent progression to hypertensive-related adverse events. ❖

Acknowledgment

The authors thank Dr. Audrey Lyndon for critically reviewing and assisting with the preparation of this manuscript.

Kamilah A. Hayden-Robinson is a Regulatory Maternal Child Newborn Screening Coordinator, Department of Nursing, Women's Services, NYU Langone Health – Tisch Hospital, New York, NY. The author can be reached via email at Kamilah.hayden@nyulangone.org