

# Postpartum remote home blood pressure monitoring: the new frontier



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There has been an alarming and substantial increase in hypertensive disorders of pregnancy, which are a significant driver of maternal morbidity and mortality. The postpartum period is an especially high-risk time, with >50% of pregnancy-related deaths and significant morbidity occurring during this period. The American College of Obstetricians and Gynecologists suggests inpatient or equivalent monitoring of blood pressures in patients with hypertensive disorders of pregnancy for the immediate 72 hours postpartum and again within 7 to 10 days postpartum. Hypertensive disorders of pregnancy significantly contribute to healthcare costs through increasing admission lengths, rates of readmissions, the number of medications given, and laboratory studies ordered, and through the immeasurable impact on the patient and society. Telemedicine is an essential option for patients with barriers to accessing care, particularly those in remote areas with difficulty accessing subspecialty care, transportation, childcare, or job security. The implementation of these programs also has potential to mitigate racial inequities given that patients of color are disproportionately affected by the morbidity and mortality of hypertensive disorders of pregnancy.

Remote blood pressure monitoring programs are generally acceptable, with high levels of satisfaction in the obstetrical population without posing an undue burden of care. Studies have reported different, but encouraging, measures of feasibility, including rates of recruitment, consent, engagement, adherence, and retention in their programs. Considering these factors, the widespread adoption of postpartum blood pressure monitoring programs holds promise to improve the identification and care of this at-risk population. These immediate clinical effects are significant and can reduce short-term hypertension-related morbidity and even mortality, with the potential for long-term benefit with culturally competent, well-reimbursed, and widespread use of these programs. This clinical opinion aims to show that remote monitoring of postpartum hypertensive disorders of pregnancy is a reliable and effective alternative to current follow-up care models that achieves improved blood pressure control and diminishes racial disparities in care while simultaneously being acceptable to providers and patients and cost-saving to hospital systems.

**Key words:** hypertension, postpartum, preeclampsia, pregnancy, remote blood pressure monitoring, telehealth, telemedicine

## Background

Remote monitoring of hypertension in nonobstetrical settings is reliable, effective in achieving improved blood pressure control, acceptable to providers and patients, and cost-saving to hospital systems.<sup>1,2</sup> Recently, obstetrical programs across the country have implemented

different variations of remote blood pressure monitoring programs for postpartum hypertension, delivering similar results. The American College of Obstetricians and Gynecologists (ACOG) suggests inpatient or equivalent monitoring of blood pressures in patients with hypertensive disorders of pregnancy (HDP) for the immediate 72 hours postpartum and again within 7 to 10 days postpartum.<sup>3</sup> In addition, the new Alliance for Innovation on Maternal Health (AIM) Severe Hypertension in Pregnancy patient safety bundle recommends blood pressure measurement and symptom assessment within 7 days of discharge in patients with HDP.<sup>4</sup>

Remote blood pressure monitoring programs can safely and effectively achieve these goals while simultaneously reducing barriers to care and improving patient outcomes.<sup>5</sup> Various telehealth strategies allowing for data transmission of blood pressures in both pregnant and nonpregnant populations have been used. Blood pressures can be obtained from the patient via manual data input or data upload from blood

pressure devices and Bluetooth-enabled wireless transmission. Data interfaces include text-based platforms, applications on handheld devices (smart phone or tablet), and dedicated websites.<sup>6</sup>

## Program feasibility and acceptability

Fundamental to the success of a new care delivery system is its clinical performance compared with that of the standard model of practice, but also its ability to be implemented into a clinical setting. Measures of successful implementation include the end result (our clinical outcomes of interest) and implementation outcomes, which are vital indicators of implementation success. Implementation outcomes evaluated for postpartum remote blood pressure monitoring programs have included patient acceptability and program feasibility.

Acceptability, as an implementation outcome, is generally defined as the “perception among implementation stakeholders [the patient in this instance] that a given treatment, service, practice, or innovation is agreeable,

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palatable, or satisfactory,<sup>7</sup> and is often measured using survey data. The most robust evaluation of patient acceptability was performed by Thomas et al<sup>8</sup> using a 41-question self-administered questionnaire designed specifically for this population. Only 4.7% (6/128) of participants preferred a hospital or clinic setting over technology at home, and 84% (107/127) reported that they were very or extremely satisfied with the program.<sup>8</sup> Their results are consistent with other patient acceptability outcomes indicating that remote blood pressure monitoring programs are generally acceptable to this population, with high levels of satisfaction (ranging from 87%–100%),<sup>9–11</sup> without posing an undue burden of care.

Feasibility refers to the “extent to which a new treatment, or an innovation, can be successfully used or carried out within a given agency or setting.”<sup>7</sup> Studies have reported different measures of feasibility, including rates of recruitment, consent, engagement, adherence, and retention in their programs, with 43% recruitment,<sup>11</sup> 93.9% to 100% adherence, and over 80% continuing the program until its completion.<sup>9,11,12</sup>

### Efficacy and impact on health outcomes

Feasibility and acceptability are critical to program success but demonstrating that the intervention effectively reduces adverse clinical outcomes is paramount. Outside of pregnancy, antihypertensive titration using self-monitored blood pressure has improved blood pressure control compared with clinic-measured readings.<sup>2,13,14</sup> Postpartum home blood pressure monitoring programs are designed to improve the detection and treatment of severe hypertension, safely reduce postpartum readmissions, and improve the detection and treatment of patients with chronic or persistent blood pressure elevations.

When comparing postpartum home blood pressure monitoring with standard office-based follow-up, participants enrolled in postpartum home blood pressure monitoring are significantly more likely to have blood pressure recorded within the first 10 days postpartum (92.2%–94.4% vs 43.7%

–60.3%;  $P < .001$ ).<sup>10,15</sup> These outcomes have been reproduced, demonstrating generalizability in clinical practice, with ascertainment rates as high as 95.5%.<sup>12</sup> Not only are patients participating in home blood pressure monitoring more likely to provide a blood pressure value within the desired postpartum time frame, but they are also more likely to provide multiple blood pressure values, allowing for improved clinical decision-making regarding blood pressure medication initiation/titration.

Remote monitoring programs have been found that rates of severe hypertension occur in 12.8% to 26.2% of their participants, and between 42% and 65.1% of participating patients have blood pressure elevations requiring medication adjustment.<sup>9,12,15,16</sup> In addition, postpartum home blood pressure monitoring programs have demonstrated success in reducing hospital readmissions compared with standard care,<sup>6,8</sup> with participants in one study demonstrating an 88% reduction (adjusted relative risk, 0.12; 95% confidence interval, 0.01–0.96) in readmission risk compared with nonparticipants.<sup>15</sup>

These immediate clinical effects are significant and could reduce short-term hypertension-related morbidity and even mortality. Equally exciting is the potential to improve the known longer-term impact that HDP and uncontrolled hypertension have on birthing people. The SNAP-HT trial<sup>17</sup> demonstrated that systematic self-titration of antihypertensive agents in the postpartum period yielded improved blood pressure measurements persisting up to 6 months after program completion. Follow-up at 3.6 years after the original trial demonstrated sustained reductions in blood pressure for those who had been randomized to self-management compared with controls (persistent reduction is diastolic blood pressure by 7 mm Hg at 3–4 years postpartum).<sup>18</sup> Given that cardiovascular disease is the leading cause of death in women,<sup>19</sup> a persistent 7- to 8-mm Hg reduction in blood pressure could have the potential to reduce cardiovascular risk by >30%.<sup>18</sup> Therefore, it is possible that remote blood pressure monitoring offers a unique opportunity not

only to reduce short-term complications related to HDP but also to mitigate risk and improve long-term cardiovascular health.

Another area of potential improvement is the identification of patients in need of ongoing blood pressure surveillance and long-term management of hypertension. Blood pressure can take up to 3 months to normalize postpartum, especially in obese (body mass index >35) and Black patients.<sup>20</sup> Upward of 50% of patients entering pregnancy without hypertension but who develop HDP will have persistent hypertension within the first year following delivery.<sup>21,22</sup> At least 1 in 3 patients with mild or relatively well-controlled hypertension in their index pregnancy progress to severe or uncontrolled hypertension within 5 to 7 years on longitudinal follow-up.<sup>23</sup> Through enhanced surveillance postpartum, there is a window of opportunity to identify patients early in a disease process and apply strategies to mitigate risk for their interpregnancy interval and beyond.

### Cost effectiveness

The standard time frame in which patients with HDP are scheduled for outpatient follow-up, combined with the expected exacerbation of their hypertension 3 to 5 days postpartum, when most patients have been discharged from the hospital, can have significant clinical ramifications if not identified and treated.<sup>15</sup> Postpartum hypertension remains the leading cause of postpartum readmissions in the United States<sup>24</sup> and significantly contributes to healthcare costs. Compared with normotensive pregnancies, HDP and its related morbidities through 42 days postpartum accounted for 800 excess hospital days and 731 million dollars.<sup>25</sup> Inpatient readmissions are expensive, costing as much as \$14,401 in 1 model.<sup>24</sup>

Remote home blood pressure monitoring has also been cost-effective and cost-saving by reducing the number of readmissions, length of admissions, medications administered, and laboratory studies performed.<sup>24</sup> In the model by Niu et al,<sup>24</sup> there was estimated cost-saving of \$93 per patient, which, if extrapolated to an estimated 333,253 pregnant patients with hypertension in

the United States per year, could reduce healthcare costs by approximately \$31 million per year with telehealth.<sup>24,26,27</sup> Similar findings have been supported by research from the United Kingdom and Belgium. In the United Kingdom and Belgium, home blood pressure monitoring was associated with reductions in the number of hospital visits, consumption of healthcare services, and costs to the patient, without a difference in the number of adverse maternal, fetal, or neonatal outcomes between groups.<sup>26,27</sup> It is critical to note the immeasurable impact of hospital readmission on the patient and society (time off work, transportation, and caregivers for other children or family members).<sup>24</sup> As home blood pressure monitoring services are more widely implemented and normalized, they are likely to become more efficient and streamlined, further reducing costs.

### Opportunities to reduce racial inequities in care

Remote blood pressure monitoring offers an opportunity to address the barriers associated with systemic racism and social determinants of health. This is important given the unacceptably disproportionate pregnancy-related morbidity and mortality rates for Black birthing people compared with their White counterparts. Black patients suffer higher rates of preeclampsia, pre-eclampsia-related readmission, and subsequent long-term cardiac disease.<sup>28</sup> Postpartum, Black women have a slower decrease in blood pressure over a 6-week remote blood pressure monitoring program compared with White women,<sup>29</sup> and overall are more likely to be diagnosed with hypertension earlier in life and suffer from more significant morbidity related to hypertension, with 4 to 5 times greater mortality compared with non-Hispanic White Americans.<sup>31</sup>

The implementation of remote blood pressure monitoring programs has the potential to mitigate these racial inequities. In 1 study, Black women attended in-office blood pressure checks half as often as non-Black women.<sup>16</sup> The option for telemedicine is a boon for patients with barriers to accessing care, particularly those in remote

areas with difficulty accessing subspecialty care, transportation, childcare, or job security. Ukoha et al<sup>32</sup> found that practitioners surveyed during the COVID-19 pandemic expressed doubts that patients with low income or without health insurance would have the necessary technology to use telemedicine. However, most patients in their study were interested in video visits. They had no barriers to this, with even more interest from non-English speaking patients who preferred the video capabilities.<sup>32</sup> Others have shown that text-message remote blood pressure monitoring had a 50% reduction in racial disparity compared with office visits alone. Text-message blood pressure monitoring also had a >90% ascertainment of blood pressure for all race groups. In another study, >20% of Black women who missed an in-office appointment were initiated on medications via remote monitoring.<sup>16,28,30</sup>

Despite its promise to improve care and access, implementation of this care delivery model must be done thoughtfully to ensure that telehealth care improves, not worsens, outcomes for marginalized communities.<sup>32</sup> Careful attention must remain on growing telemedicine while keeping efforts to dismantle systemic racism in mind. Multiple models have been proposed to address inequities at multiple levels of care, including factors at the level of healthcare delivery systems, research, individual providers, policymakers, and payers.<sup>32-34</sup> An example of one of these considerations is that many digital programs are exclusively in English, which may alienate patients who are non-English speakers from engaging fully with these programs.<sup>32,34</sup> One study from California of >84,000 patients found that patients with limited English proficiency had half the odds of telehealth use compared with proficient English speakers (4.8% vs 12.3%).<sup>35</sup> When implemented thoughtfully, however, telemedicine can overcome communication barriers for these patients instead of deepening the digital divide.<sup>32,35</sup>

### Next steps and future directions

The burden of obstetrical patients with chronic hypertension and HDP has increased significantly, with average

annual percentage changes of 4.1% and 3.6%, respectively.<sup>36</sup> This increase is alarming and affects communities of color disproportionately given that HDP are a significant driver of maternal morbidity and mortality, with Black and Hispanic patients dying at up to twice the rate of White patients.<sup>37</sup> Additionally, the cardiovascular impact of HDP is occurring earlier than previously assumed<sup>38</sup> and hypertension, specifically uncontrolled hypertension, has been identified as a leading driver of cardiovascular-related morbidity and mortality in this population.<sup>18,39</sup> The postpartum period is a well-established high-risk time, with >50% of pregnancy-related deaths occurring during this time frame.<sup>37</sup> Considering these factors, the widespread adoption of postpartum blood pressure monitoring programs holds promise to improve the care of this at-risk population.

The demonstrated success of postpartum blood pressure monitoring programs across an array of implementation and clinical practice outcomes begs the question of whether it is time for these programs to be integrated into our standard of care for the postpartum patient. Almost every published program for postpartum remote blood pressure monitoring leverages a different technology platform, uses a unique blood pressure management algorithm and asks patients to report blood pressure once or twice daily for varied program durations. There is a lack of standardization and aggregable data regarding the most evidence-based way to manage postpartum hypertension. A recent systematic review comparing these programs demonstrated improvement in blood pressure ascertainment, patient satisfaction, and a decrease in hypertension-related hospital admissions. However, there is not sufficient evidence to conclude that home blood pressure monitoring reduces severe maternal morbidity or mortality, particularly given that only 5 comparative studies have been published and none were powered to detect differences in patient outcomes.<sup>40</sup> This highlights the need to create more robust implementation guidelines within health systems for adoption and spread of these programs, and the opportunity to create national standards around

remote monitoring for postpartum hypertension. Leveraging the data and experiences of hospitals and care systems already engaged in this technology to form a consortium could be a robust way to evaluate the best care delivery mechanisms and create a national standard. The data obtained from large numbers of postpartum patients participating in home monitoring create the opportunity for a consortium to share information and develop clinical trials to answer important care delivery questions.

A key barrier to these programs' widespread implementation and adoption is related to program sustainability through third-party reimbursement. These programs have been maintained through public funding and grants. The potential cost-savings have led some programs to absorb the cost; however, transparency about the hours dedicated to reviewing blood pressures, interfacing with patients, and managing care through the program is lacking. More robust business cases are needed to advocate for insurance reimbursement for these services. It is essential that in seeking reimbursement for these services, we do not create a system that shows promise to reduce health inequities but paradoxically exacerbates them (the currently published enrollment and adherence numbers might be affected if patients begin being charged for such care, which they may not be able to afford).

This technology also holds promise for use in expanded indications. Universal blood pressure monitoring for all postpartum patients is feasible and would identify an important subset of patients with new-onset hypertension.<sup>41</sup> De novo, or delayed, postpartum preeclampsia is defined as new development of preeclampsia 48 hours to 6 weeks postpartum, and is an important contributor to hypertension-related morbidity.<sup>41</sup> This abnormal rise in blood pressure in a previously normotensive patient affects 1 in 10 women<sup>42</sup> and has been shown to cause worse morbidity and mortality than hypertension diagnosed during the antepartum and intrapartum periods. Therefore, adoption of patient-driven blood pressure monitoring may successfully allow

for earlier recognition and treatment of de novo postpartum hypertension with subsequent improvement in outcomes.

Although ACOG recognizes the increasing use of telehealth and its ability to improve patient engagement and satisfaction,<sup>43</sup> neither ACOG nor the Society for Maternal-Fetal Medicine provide guidance regarding the use of remote or self-blood pressure monitoring in the antepartum period related to the limited research in pregnant patients. Given that the literature supports the safe and effective use of blood pressure self-monitoring in a nonpregnant population,<sup>2,13</sup> expansion of its use in the antepartum period should be evaluated and considered. There may be benefit with not only postpartum monitoring, but also with increased antepartum surveillance in patients who are at high risk for developing HDP to aid in earlier diagnosis and in patients newly diagnosed with HDP to monitor for signs of worsening disease.

The advent of telehealth and its expansion into obstetrics holds exciting promise for new and innovative approaches to care delivery for our patients. Postpartum home blood pressure monitoring is safe, feasible, acceptable, and cost-saving. It holds particular promise in improving both short- and long-term outcomes related to hypertension and cardiovascular disease. National guidelines and standardized implementation models would allow for more rapid uptake and widespread integration of these systems into existing care models, with exciting potential for data sharing and collaboration to substantially improve evidence-based postpartum hypertensive care. ■

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