Reducing Disparities Using Telehealth Approaches for Postdelivery Preeclampsia Care

ADINA KERN-GOLDBERGER, MD, MPH, and ADI HIRSHBERG, MD

Department of Obstetrics & Gynecology, Maternal Child Health Research Center, University of Pennsylvania Perelman School of Medicine, Philadelphia, Pennsylvania

Abstract: The management of hypertensive disease of pregnancy presents an ongoing challenge after patients are discharged from delivery hospitalizations. Preeclampsia and other forms of postpartum hypertension increase the risk for severe maternal morbidity and mortality in the postpartum period, and both hypertension and its associated adverse events disproportionately affect black women. With its ability to transcend barriers to health care access, telemedicine can facilitate high-quality postpartum care delivery for preeclampsia management and thereby reduce racial disparities in obstetric care and outcomes. Here we discuss racial disparities in preeclampsia and the challenge of providing equitable postpartum preeclampsia care. We then describe the utility of novel telemedicine platforms and their application to combat these disparities in preeclampsia care.

Correspondence: Adi Hirshberg, MD, Hospital of the University of Pennsylvania, 2nd Floor Silverstein Bldg, Philadelphia, PA. E-mail: adi.hirshberg@pennmedicine.upenn.edu

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Racial Disparities in Postpartum Preeclampsia

MATERNAL MORBIDITY IN THE FOURTH TRIMESTER

Obstetric care during the postpartum period—also coined the "fourth trimester"—remains as essential as during the 3 trimesters of pregnancy. Many pregnancy complications, including preeclampsia, hemorrhage, infection, and perinatal depression, can arise specifically in the postpartum setting. Critical postpartum decisions, such as those involving contraception and breastfeeding, can have meaningful lifelong repercussions.

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As such, pregnancy research and obstetric professional organizations have centralized the postpartum period as an opportunity to optimize both short-term and long-term maternal health. Comprehensive postpartum care should involve chronic disease management and routine health maintenance, and surveillance and treatment of pregnancy-specific diseases, all of which have significant longitudinal implications for a woman's health.¹

Many obstetric complications have sequelae of lifelong disease states—for example, preeclampsia and gestational diabetes are associated with chronic hypertension, cardiovascular disease, and type 2 diabetes mellitus—and timely screening and risk assessment in the postpartum period could be advantageous for ultimate risk reduction. The postpartum care setting is also a unique opportunity to optimize preventive health with vaccination and Pap smears, and to facilitate family planning and pregnancy spacing. All of this has ramifications for a woman's general health and the health of any future pregnancies. Ultimately, assiduous postpartum care truly lays the foundation for a woman's healthy future.

However, traditional postpartum care, which at a minimum involves an inperson visit 4 to 6 weeks after delivery, involves inherent barriers to accessing necessary health services. Most postpartum patients have new infants at home requiring abundant care and attention, and this may limit their ability to attend follow-up appointments or engage in other health promotion activities. Postpartum women may also be exhausted from the physical strain of labor and delivery and the erratic infant sleep schedule, and they may be recovering from painful perineal trauma or cesarean section. This may further limit their ability to participate in health care programs. For these reasons, compliance with traditional postpartum care is generally poor with very low documented show rates for

postpartum clinic appointments.² Furthermore, these challenges are particularly acute for women without childcare assistance or who are struggling with social or economic instability.³

Understanding both the importance and the unique challenges of postpartum care is critical as trends in maternal morbidity continue to rise with a concomitant increase in postpartum complications and hospital readmissions. Research has demonstrated increased postpartum readmission rates from 1.72% in 2004 to 2.16% in 2011. These adverse events, many of which are related to preeclampsia, disproportionately affect publicly insured and black women, and women with baseline comorbidities such as hypertension and diabetes.⁴ Efforts to reduce maternal morbidity are therefore evolving to specifically address gaps in postpartum care with attention to the risk factors and etiologies of postpartum complications and the patient groups at highest risk.

POSTPARTUM PREECLAMPSIA

Chronic hypertension and pregnancy-related hypertension remain significant contributors to the overall burden of maternal morbidity, and this persists in the post-partum period as well. Postpartum onset preeclampsia, defined as a new diagnosis of preeclampsia between 2 days and 6 weeks postpartum, occurs most commonly in women with the same risk profile as antepartum preeclampsia, including those with chronic hypertension, obesity, and advanced maternal age.⁵ As these risk factors increase, preeclampsia incidence —both antepartum and postpartum—can be expected to increase in parallel.

Hypertension manifesting in the postpartum period may be a continuation of gestational hypertension or preeclampsia, worsening or persistent chronic hypertension, or new postpartum preeclampsia. However, the majority of patients readmitted with postpartum hypertension are experiencing progression of already diagnosed hypertensive disease rather than new onset preeclampsia in the post-partum period, and are typically asymptomatic, necessitating careful blood pressure monitoring even after hospital discharge.⁶

Hypertension is one of the most common etiologies of postpartum readmission, and women with pregnancy-associated hypertension are at the highest risk.⁷ Reducing hospital readmission is a quality improvement imperative for all health care institutions and is especially important in obstetrics, where maternal readmission to the hospital disrupts the care of a newborn infant. As pregnancy-related hospital admission is the most frequently coded admission diagnosis in the United States, understanding patterns of readmission in order to improve health care utilization and quality has significant public health ramifications.⁸ In addition, studies of postpartum readmissions have demonstrated disparities in demographics, with readmitted patients more likely to be black, publicly insured, and have a lower income, and higher rates of comorbidities. ⁹ Efforts to reduce postpartum complications and hospital readmission are therefore essential endeavors to promote women's health in general and the health and well-being of the most vulnerable groups of postpartum patients in particular.

It is also critical that these strategies specifically target risk-reduction for postpartum hypertension complications. In fact, ~50% of maternal morbidity and mortality takes place postpartum, one third of which occurs within the first week.¹⁰ This correlates with the time course of peak blood pressures, which typically occur in the initial 3 to 6 days postpartum, usually after patients have already been discharged from the hospital. Given the association of adverse postpartum outcomes with hypertensive disease, the American College of Obstetricians and Gynecologists (ACOG) recommends careful blood pressure surveillance in the postpartum setting. At a minimum, for women with known hypertensive disorders, this should involve blood pressure monitoring during the first 72 hours postpartum followed by an additional blood pressure assessment at 7 to 10 days postpartum because of the increased risk of preeclampsia complications in this time period, including strokes and seizures. Effective management of preeclampsia in the postpartum setting is rendered ever more crucial by the association between preeclampsia and long-term cardiovascular disease.

RACIAL DISPARITIES IN PREECLAMPSIA

Significant racial disparities across many obstetric outcomes—including severe morbidity and mortality—have been demonstrated between black and white women, many which cannot be attributed to baseline differences in socioeconomic status or underlying comorbidities. Differential access to care and implicit bias in the medical establishment have been posited as possible mechanisms, and many institutions and organizations have prioritized efforts to alleviate these disparities.¹² Black women are specifically at higher risk of preeclampsia and preeclampsia-related complications, and longitudinal cardiovascular disease, which is a known downstream complication of preeclampsia.¹³ They are also at higher risk of preeclampsia-related hospital readmission.¹⁴ Although prediction and prevention strategies for preeclampsia itself are limited, the disease burden of shortterm preeclampsia complications including stroke and acute renal failure, and longterm complications such as cardiac disease may be attenuated with appropriate clinical care. For example, timely administration of antihypertensive medication is associated with a reduction in maternal stroke.¹⁵

Numerous studies have highlighted a racial disparity in the disease burden of preeclampsia. Gyamfi-Bannerman et al¹⁶ demonstrated that among women with preeclampsia, non-Hispanic Black women were more likely to experience severe

maternal morbidity and mortality than non-Hispanic White women. Miller et al¹⁷ found that women from minority groups (Black, Hispanic) had a higher risk of stroke during delivery admissions and that this effect was more profound in women with hypertensive disease (both chronic and pregnancy-specific).

The disparity persists through the postpartum period. Several studies have highlighted race as a specific determinant of postpartum blood pressure trends and hypertension resolution, with non-Black women demonstrating faster normalization of blood pressure than Black women. Specifically, one study showed that postpartum decline of both systolic and diastolic blood pressure was significantly lower among non-Hispanic black women compared with all other races in the first 3 weeks postpartum.¹⁸ Similarly, another found that nonobese, non-Black women had a steady decrease in systolic blood pressure postpartum and shortest time to resolution, whereas other groups had peak blood pressures at 6.5 days postpartum and longer periods with persistent hypertension. The overall average blood pressure was significantly higher for black women compared with non-Black women in the 2 weeks after delivery. 19 Chornock et al²⁰ uncovered that non-Hispanic Black women with pregnancy-associated hypertension had higher rates of readmission than non-Hispanic White women with similar risk factors.

Although preeclampsia is a disease specific to pregnancy, there is an increased risk of developing chronic hypertension and cardiovascular disease, including ischemic heart disease, stroke, and heart failure, later in life. The postpartum visit represents an opportunity to transition to a primary care provider for long-term care to optimize risk reduction. Unfortunately, less than half of women present for outpatient postpartum care, with one study demonstrating that <50% of women with hypertensive disorders of pregnancy attend

a postpartum follow-up appointment with a women's health provider and <20% with a primary care provider within 6 months of delivery.²¹ In this same study, Black race was associated with a lower likelihood of postpartum follow-up with any provider.

Although the prevalence and complication rate of preeclampsia among Black women remains disproportionate, it is possible that timely treatment with antihypertensive medication and escalation of care may mitigate some of the short-term and long-term complications of this disease process. It is therefore essential to cultivate models of care to address the needs of postpartum patients with preeclampsia and other hypertensive disorders, and that these specifically alleviate barriers to care for minority women.

The Role of Telemedicine

INTRODUCTION TO TELEMEDICINE

Telemedicine is an emerging tool that can provide accessible care and improve outcomes across the health care spectrum. Defined as the exchange of patient information using telecommunication from one site to another in order to improve patient health, telehealth has become a critical adjunctive component to the US health care system, and is termed "telemedicine" when used for the purpose of patient diagnosis and treatment. Harnessing telecommunication technology to deliver health care is especially critical in situations where logistic burdens prevent access to care or when acute decision making is necessary, such as in the management of postpartum preeclampsia. It is also ideally suited in conjunction with monitoring and interventions that patients can implement themselves, such as checking blood pressure or taking antihypertensive medication.

In specific, text messaging ["Short Message Service" (SMS)] has become a pervasive technology in health care for

the purpose of reporting results, managing medications, and confirming medical appointments, among other uses. Current iterations of mobile phones are also replete with direct-to-consumer healthrelates applications (apps), an industry that is rapidly proliferating. The past decade has seen robust development in the market of mobile applications for women's health and pregnancy, representing 7% of total "apps" in 2015.²² These phenomena have recast the mobile telephone as an ideal tool for health care delivery. The vast majority of US adults, especially those of reproductive age, own a cellular phone, and use those for text messaging. This pervasiveness enables text message-based care delivery models to be convenient, economical, and patientcentered

TELEMEDICINE IN OBSTETRICS

The utilization of telehealth and telemedicine in obstetrics is becoming increasingly widespread, improving access to care and providing health information for many women. Numerous such programs have been implemented with success across the country. For example, the "OB Nest" program at the Mayo Clinic is a model of care for low-risk pregnant women involving self-monitoring tools, a texting platform, and an online community of other pregnant patients to share experiences.²³ Patients were provided with self-monitoring equipment and reported that obtaining their own measurements without the inconvenience of presenting to the clinic fostered increased confidence and a sense of control during the pregnancy. The novel coronavirus (COVID-19) pandemic has accelerated the adoption of telemedicine-based obstetric care to reduce the risk of exposure to the virus and facilitate social distancing. These programs have seen a rapid uptake in hospital systems throughout the country with models for routine and highrisk antenatal care.²⁴

Telemedicine platforms designed for specific aspects of postpartum care have also been developed and found to be effective. Research from other developed countries has demonstrated patient and provider satisfaction with telephone and video conference-based consultations in the postpartum period to facilitate early hospital discharge and to support new mothers in the home setting.²⁵ It is possible that routine postpartum care can be comprehensively retooled into telemedicine platforms to increase access given historically poor rates of postpartum follow-up in traditional settings.

HEALTH DISPARITIES AND TELEMEDICINE

It is well-known that obstetric morbidity disproportionately affects women with difficult access to care, including women from minority racial and ethnic backgrounds and low socioeconomic status. Telemedicine possesses a unique ability to transmit high-level care directly to patients in their own environments, circumventing the barriers and biases that can otherwise inhibit quality care. For example, a study of the ANGELS obstetric telemedicine program in Arkansas found a significant decrease in the rate of very low birth weight infants of patients with Medicaid insurance who delivered in hospitals without an appropriate neonatal intensive care unit.²⁶ Telemedicine can similarly serve as a powerful tool to alleviate other disparities in access to care for vulnerable populations.

TELEMEDICINE IN THE MANAGEMENT OF POSTPARTUM PREECLAMPSIA

Numerous mobile phone telemedicine programs have been developed specifically around the postpartum management of hypertensive disorders of pregnancy. These have evolved to meet the need of the many postpartum women requiring continued blood pressure monitoring

after discharge from the hospital, to reduce morbidity related to undermanaged postpartum preeclampsia, and to prevent hospital readmissions. They also specifically address the problem of inconsistent postpartum outpatient follow-up, which can be critical and time-sensitive in the setting of hypertensive disorders of pregnancy. As dangerous blood pressure elevations are often asymptomatic, compliance with ACOG's recommended surveillance is essential. And as hospital readmission is extremely disruptive to the mother-baby unit in the postpartum period, an innovative approach to increasing access to blood pressure surveillance and management for this patient population is essential.

Numerous studies have examined the feasibility, acceptability, and clinical outcomes of remote blood pressure monitoring programs for postpartum women. Hauspurg et al²⁷ evaluated a quality improvement project designed for women admitted to the postpartum unit of the University of Pittsburg Medical Center (UPMC Magee-Women's Hospital) with diagnosis of pregnancy-specific or chronic hypertension and involving a text messaged-based blood pressure monitoring program. The study found high rates of patient engagement, retention, and satisfaction with the program, and 88% compliance with the recommended 6-week postpartum office visit. The Blood Pressure Self-Monitoring in Pregnancy observational study in the United Kingdom collected qualitative data suggesting that self-monitoring of blood pressure in pregnancy is acceptable and feasible for women and that participating in a remote monitoring program increased awareness of the risks of preeclampsia.²⁸ It also promoted patient empowerment and increased reassurance. Hirshberg et al²⁹ at the Hospital of the University of Pennsylvania (HUP) randomized 206 postpartum patients with pregnancy-related hypertension to routine care (involving an in-person

blood pressure check in the clinic during the first week postpartum) versus Heart Safe Motherhood, a 2-week test messagebased surveillance program (see example in Fig. 1), and found a significantly higher rate of follow-up, defined as having a recorded blood pressure in the medical record within the first 10 days postpartum.

REDUCING DISPARITIES IN POSTPARTUM PREECLAMPSIA WITH TELEMEDICINE

As discussed above, Heart Safe Mother-hood is the postpartum text message-based

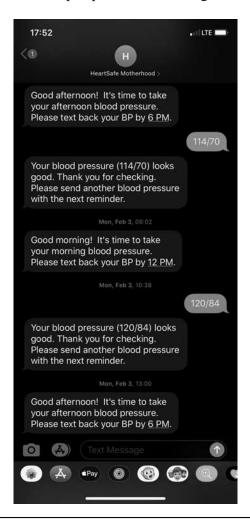


FIGURE 1. Example of patient text message interface for Heart Safe Motherhood.

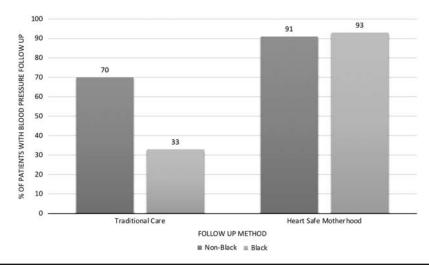


FIGURE 2. Postpartum blood pressure attainment by race. Adapted from Hirshberg et al.²⁹ Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

blood pressure surveillance program for women with hypertension in pregnancy at the HUP. Implementation of this program improved blood pressure control, reduced readmissions, and improved patient and provider satisfaction.³⁰ Institutional data from HUP demonstrated that non-Black women are twice as likely to return for an in-person blood pressure check shortly after discharge compared with black women (42.5% vs 24.1% attendance rate, respectively).30 To test the impact of a telemedicine-based follow-up program on postpartum blood pressure management, women were randomized in a controlled trial to either 2 weeks of twice daily text message-based blood pressure surveillance with home monitoring (Heart Safe Motherhood) or traditional care with an inperson office visit for blood pressure monitoring 4 to 6 days after discharge.

Of 206 women in the trial, non-Black women in the traditional management arm had 70% compliance with care, compared with 33% of Black women. In the telemedicine group, however, the rate of blood pressure measurement attainment in both

non-Black and Black women was > 90% (Fig. 2). This represents a 50% reduction in racial disparity (risk ratio 0.51, 95% confidence interval, 0.33-0.78). No women in the telemedicine arm required hospital readmission compared with 4 in the control arm, 3 of whom were black.

These data demonstrate that the use of a text message-based monitoring system resulted in significantly higher compliance among all women with no differences in blood pressure capture by race as was observed with usual care. When implemented at another institution within the same health system, blood pressure ascertainment among Black and non-Black women was again similar through use of the program, suggesting that reduction of racial disparities may be generalizable with the implementation of similar remote monitoring interventions.³¹

Given the slower decline in blood pressure among black women with hypertensive disorders of pregnancy compared with non-Black women, opportunities to reduce disparities in postpartum care have the potential to improve both short-term and

long-term morbidity related to preeclampsia. ¹⁹ Altogether, this suggests that telemedicine affords an innovative and successful platform to improve access to preeclampsia management in the critical postpartum window, during which time women from minority groups face increased barriers to accessing traditional care. It is critical, however, that implementation of telemedicine avoid inadvertently widening racial disparities and that simple, affordable, and accessible technology is prioritized.

Conclusions

The immediate postpartum period though fleeting—has many short-term and long-term implications for a woman's health. It is a challenging time to access traditional care given the responsibilities of caring for a newborn, in addition to all of the usual barriers to care that unduly affect Black women. For women with hypertensive disorders of pregnancy, the events that transpire in the first several weeks postpartum can result in hospital readmission, severe morbidity including stroke, and significant downstream cardiovascular disease. Leveraging the capabilities of telecommunication technology to expand access to care for postpartum preeclampsia has the potential to reduce maternal morbidity and mortality, decrease readmissions, improve the patient experience, and chip away at the racial disparities institutionalized by the health care system. Continued investment in growing, refining, and evaluating telemedicine programs for postpartum hypertension, with specific attention to their ability to provide equitable care, is an important step to promote obstetric and cardiovascular health for all women.

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