Title
Remote Patient Monitoring (RPM) For Postpartum Hypertensive Disorders of Pregnancy (HDP)

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Publication Date
2022

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA

Los Angeles

Remote Patient Monitoring (RPM) For Postpartum Hypertensive Disorders of Pregnancy (HDP)

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Nursing Practice

by

Leah Maurine Spiro

2022

ABSTRACT OF THE DISSERTATION

Remote Patient Monitoring (RPM)

For Postpartum Hypertensive Disorders

of Pregnancy (HDP)

by

Leah Maurine Spiro

Doctor of Nursing Practice

University of California, Los Angeles, 2022

Professor Wei-Ti Chen, Chair

Objectives: To establish adherence to- and satisfaction with RPM and follow-up program in the management and care of patients with HDP after hospitalization for delivery. **Background**: Pregnancies complicated by HDP account for 2.5-4.6% of postpartum readmissions within six weeks of delivery, compared to 1% of deliveries in normotensive patients; 60% of readmissions occur in the first seven days postpartum. Standardization of HDP management can improve outcomes through optimized postpartum blood pressures. RPM has established safety, patient outcomes, financial benefit, and increased adherence, though few institutions currently utilize standardized protocols for HDP. **Methods**: Participants (n=13) received access to an application and a Bluetooth enabled blood pressure cuff that automatically uploaded to a provider monitored

portal. Participants had a telehealth visit with a provider at 48 hours post discharge, with additional visits as needed. Adherence and satisfaction were measured through adherence with program requirements through ten days postpartum and participant surveys. Secondary outcomes included readmission through six weeks postpartum, incidence of out-of-range blood pressures, and recommendations for antihypertensive medication titrations to primary obstetricians. **Results**: Consent rate of 72% (13 of 18 approached), overall retention/adherence of 100%, as measured by adherence to study specifications, and stated satisfaction of 93.6% in post-participation surveys. No Readmissions amongst participants were documented. **Conclusions and Implications***:* Validated utilization of RPM will indicate a feasible strategy in the management of HDP and reduction of cardiovascular sequelae. Blood pressure optimization and standardized care of HDP may decrease cardiovascular disease in women with subclinical risk factors.

The dissertation of Leah Maurine Spiro is approved.

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2022

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EDUCATION

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CERTIFICATIONS

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Basic Life Support for Healthcare Providers (BLS)	American Heart Association (AHA)	Exp: 2023
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Member, interdisciplinary team to improve maternal outcomes related to VTE, PPH and HTN

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2022- present American College of Cardiology, Affiliate Member

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RESEARCH PAPERS – PEER REVIEWED (IN PROGRESS)

1 **Spiro, L**., Minissian, M., Burwick, R. (2022). Remote patient monitoring and follow-up for postpartum hypertensive disorders of pregnancy: A review of literature. *Journal for Women's Health.*

CLINICAL PRACTICE PAPERS

1 **Spiro, L**., Scemons, D. (2018, Aug 31). Management of chronic and gestational hypertension of pregnancy: A guide for primary care nurse practitioners. *The Open Nursing Journal*, *12*, 180-183. 10.2174/1874434601812010180

SCHOLARLY WORK

In Progress *Remote Patient Monitoring (RPM) for Hypertensive Disorders of Pregnancy (HDP).* [DNP Scholarly Project, UCLA School of Nursing]
Chair: Wei-Ti Chen, PhD, CNM, FAAN
Committee Members: Betty Chang, PhD, FNP, FAAN; Mary Rezk-Hanna, PhD, FNP, FAHA; and Anna Gawlinski, PhD, ACNP

CHAPTER ONE: INTRODUCTION

Postpartum care that is tailored to the individual's needs can help decrease patients' long- and short-term health risks through education, evidence-based recommendations, and follow-up at variable intervals. For example, postpartum hypertension (HTN) is associated with increased morbidity (such as stroke, coronary artery disease, and peripheral arterial disease) and is a leading cause for hospital readmission during the first six weeks post-delivery (Ganapathy, et al., 2016; Hoppe, et al., 2018). Emerging research supports the feasibility and patient satisfaction of home blood pressure monitoring for postpartum women with hypertension-related pregnancy disorders (Ganapathy et al., 2016; Hoppe et al., 2018; Rhoades et al., 2017).

Patient readmission rate is a multifactorial outcome measure that is monitored in the National Database of Nursing Quality Indicators (NDNQI); NDNQI allows organizations to track nursing-specific indicators of quality care, thus offering some insight on how to potentially improve outcomes (Press Ganey, 2019). Establishing the feasibility of an evidence-based intervention, such as remote blood pressure monitoring, using quality improvement (QI) processes, is an essential step in validating best practice within a specific healthcare setting. Thus, outcome measures such as the frequency of HTN levels requiring medication titration recommendations, patient satisfaction and adherence with technology, and hospital readmission rates can be measured to determine the effectiveness of the intervention.

The implementation of a Doctor of Nursing Practice (DNP) Scholarly Project that provides telehealth for postpartum blood pressure surveillance and management, can assist hospitals to adopt innovative technologic approaches to healthcare. Implementation of an evidence-based intervention, remote blood pressure monitoring, for blood pressure surveillance and management may improve patient outcomes (increased frequency of identifying HTN levels

requiring medication titration recommendations, increased patient satisfaction and adherence with technology, and reduced hospital readmission rates).

Problem Statement

Pregnancies complicated by HDP account for 2.5-4.6% of postpartum readmissions within 6 weeks of delivery, compared to 1% of deliveries in normotensive patients (Mogos et al., 2018). This population is highly vulnerable to potentially morbid sequelae (such as stroke, coronary artery disease [CAD], peripheral arterial disease, and mortality; Ganapathy et al., 2016, Hoppe et al., 2018). Mogos and associates (2018) noted that about 60% of hospital readmissions occur within the first 7 days postpartum, primarily due to HDP. These data provide an opportunity for improvement and standardization in care for HDP during the immediate postpartum period, and the addition of evidence-based interventions to the current standard of care. In the institution where this project will be implemented, there is no current protocol for the management of postpartum HDP. Management of postpartum HDP is primarily based on individual clinicians' knowledge and skills using traditional in person patient clinic appointments and/or virtual visits.

Poor management of HDP can result in the development of essential hypertension and increased risk for negative cardiovascular sequelae, including cerebrovascular disease (CVD), peripheral arterial disease (PAD), and cardiovascular-related mortality (Giorgione et al., 2020). Patients with a diagnosed HDP have a 28.4% chance of being diagnosed with essential chronic hypertension within two years of delivery, as compared with 9.1% of women in the healthy control group. Additionally, the risk of developing hypertension is considerably higher in the first six months postpartum compared with 6-12 months or 1-2 years later (odds ratios of 18.33, 4.36, and 7.24 respectively). The early diagnosis and close follow-up after delivery can impart significant benefit to long-term cardiovascular health. Thus, it is integral that women with HDP

maintain vigilance in their follow-up in the immediate postpartum period. Preventative medicine can delay and possibly prevent cardiovascular disease in women with subclinical risk factors (Giorgione et al., 2020). Optimized blood pressure management through the close follow-up and monitoring afforded by RPM can potentially decrease long and short-term cardiovascular risk (Ganapathy et al., 2016; Giorgione et al., 2020; Hauspurg et al., 2019; Hoppe et al., 2018; Rhoads et al., 2017; Thomas et al., 2021; Wen et al., 2019).

The assessment of care and processes for follow-up of patients with HDP in the Maternal-Fetal Care Unit (MFCU) of the institution of the study revealed that with the implementation of a formal follow-up program for patients with HDP, patient satisfaction and adherence with recommendations and health maintenance can be positively impacted. Readmissions for HDP has an estimated hospital cost of $50,000 per patient. In 2020, the hospital had approximately 70 readmissions for HDP and about 6000 total deliveries. With a reduction in readmissions by 20%, there is a potential for savings of $700,000 (J. Astasio, personal communication, September 1, 2020). Boulet et al. (2020) estimate that 5-10% of all deliveries are affected by HDP, including patients with preeclampsia and hypertension. If 10% of deliveries, or 600 patients, are enrolled in VyTrac programming, the approximate cost would be $129,000, resulting in a conservative net gain of $571,000 (see Appendix A for budget).

PICOT Question

The PICOT question for the DNP Scholarly Project aimed at addressing this QI concern is as follows: In postpartum women with hypertension (P), does utilization of an RPM program for blood pressure monitoring (I), compared to current follow-up practice of no RPM utilization (C), affect patient satisfaction with, and adherence to the RPM program (O) from discharge until six weeks postpartum (T)? Secondary outcomes include measuring the frequency of out-of-range

blood pressures (mild and severe range), medication titration recommendations, and hospital readmissions.

CHAPTER TWO: THEORETICAL FRAMEWORK

Doctorally prepared nurses can be most impactful in enriching patients' lives between, rather than during, acute events through employing Lydia Hall's Care, Core and Cure model to inform exceptional nursing practice (Gonzalo, 2019). Within this model, the patient is considered the core. In this model, the healthcare provider explores gaps in patients' knowledge and their education regarding management of postpartum hypertension. Healthcare providers are involved in the "cure," and form an interdisciplinary team that utilizes alternate modalities of care (including virtual monitoring) for management of HDP. The care component specifically addresses the role of the nurse in nurturing the patient, identifying risk factors and specific needs that may lead to delayed resolution of the acute state and potential hospital readmission related to their HDP.

All three components of the model (care, core, and cure) incorporate a holistic approach to patient-centered care. This creates an individually tailored plan of care to manage hypertension and avoid potential long-term sequelae related to HDP. Hall also emphasizes the significance of the nursing role in preparing and stabilizing the patient post-acute event (Gonzalo, 2019). The nurse then has the largest impact on health maintenance, bonding with and becoming the patient's advocate. The theory of the "Three Cs of Lydia Hall," emphasizes the totality of the patient, and the nurse's role to support, educate, and facilitate patients moving forward after a potentially life-altering event (Petiprin, 2020). Implementation of RPM for postpartum patients with HDP reflects the "care" phase of Hall's model, as the DNP student implements an evidence-based intervention. The "cure" phase of the model is depicted by the

potential for this intervention to improve patient outcomes (for example, reduced risk associated with HDP and short and long-term cardiovascular risk; Ganapathy et al., 2016, Hoppe et al., 2018).

The assumption of this mid-range change theory is that providing patients with tools to take a more active role in their healthcare and health maintenance post-acute event will result in more universal healing (Petiprin, 2020). RPM in the postpartum period allows the implementation of evidence-based change after the acute event of hospitalization for delivery of a newborn. During this period, one can facilitate health maintenance and preventative medicine best, as the patient is eager and open to change and health resolution. Specifically, for patients with HDP, optimized blood pressures in the immediate postpartum period may result in decreased short and long-term cardiovascular risks (Rhoads et al., 2017; Wen et al., 2019).

DNP Essentials

Hall's model aligns with the American Association of Colleges of Nursing's (AACN, 2006) DNP Essentials for practice. Essential I, scientific underpinnings for practice, outlines human behavior during acute care situations, compared with patterns throughout normal life events. Utilization of knowledge from physiological, psychological, and therapeutic science helps the DNP student to identify best practices for implementation. Translation of the best evidence is applied to the DNP student's clinical problem through the synthesis of nursing science that supports the RPM intervention. This scholarly DNP project provides an opportunity for improvement in patient outcomes through translation of evidence.

Timing is key, and patients are more likely to undertake active roles in their health, changing existing behaviors, during the post-acute period. This juxtaposition of human behavior during acute events versus normal life activities directly reflects Hall's model and the nurse leader's ability to impact significant change by shifting the focus of care towards a holistic and

preventative approach. QI that focuses on accessibility through alternate modalities of providing care, such as RPM, and health promotion results in stronger patient engagement, possibly leading to increased adherence with follow-up recommendations from their provider. RPM improves access, outcomes, and engagement, while decreasing costs, morbidity, and mortality (Ganapathy et al., 2016; Giorgione et al., 2020; Hauspurg et al., 2019; Hoppe et al., 2018; Rhoads et al., 2017; Thomas et al., 2021; Wen et al., 2019). Hall's theory supports the identification of opportunities for interventions to promote health maintenance post-hospitalization (acute event).

Quality Improvement Framework

The Institute for Healthcare Improvement (IHI) Plan-Do-Study-Act (PDSA) process improvement can concurrently be applied to this DNP scholarly project. The PDSA process is utilized institutionally at the site of project implementation. This framework aligns with core institutional values, allowing for a more seamless implementation of a new innovation within this clinical environment. This process allows users to assess the goals for improvement, how positive change can be evaluated or measured, guiding how that change can be made (IHI, 2021). First, current practice must be established and analyzed to decipher where improvement can be made. Specifically, the planning phase includes identifying the intervention that can support a protocol for RPM in the evaluation and management of HDP. The "do" phase is where change can be implemented, followed by a formal evaluation ("study") of the efficacy of that change. Subsequently, if outcomes are achieved, change can be spread beyond the pilot setting ("act") and established as an actual improvement in quality healthcare. Future PDSA cycles can be determined by the efficacy of cycle one.

More than half of all readmissions occur within the first 10 days postpartum, illustrating a need for more diligent monitoring in the immediate post-discharge period for patients with HDP

(Wen et al., 2019). RPM has been shown to be cost-effective technology that can aid providers in disease management and prevention, specifically from discharge until 10 days postpartum. The PDSA cycle is a quality control program to constantly redesign interventions, allowing for improvement that results in change that can be applied to a wider set of circumstances. The PDSA cycle provides a framework that allows for continuous process improvement, team involvement, and effective final intervention for this project, potentially resulting in practice change institutionally. The PDSA model fosters interprofessional collaboration and incentive to execute successful QI programming.

CHAPTER THREE: REVIEW OF LITERATURE

Search Strategy

For an effective and inclusive literature review, several databases were utilized, including CINAHL Complete, PubMed, EMBASE, Web of Science and Google Scholar. Search terms or keywords included the following mesh terms: “postpartum” OR “pregnancy” AND “hypertension” OR “high blood pressure” OR “elevated BP” OR “preeclampsia” AND “readmission” AND “follow-up.” Additional terms included “cardiovascular disease prevention” AND “postpartum” OR “pregnancy” AND “hypertension.” Data related to telemedicine/virtual appointments was compared to traditional follow-up, employing terms such as “postpartum” AND “follow-up” AND “virtual” OR “telemedicine.” This yielded approximately 68 full-length articles. After careful review of each text, five articles accurately addressed the clinical question, providing evidence that virtual appointments and RPM are as, if not more, effective than the existing standard of care and provide standardization (Ganapathy et al., 2016; Giorgione et al., 2020; Hauspurg et al., 2019; Hoppe et al., 2020; Rhoads et al., 2017; Thomas et al., 2021; Wen et al., 2019).

Literature Review

A single-cohort, prospective study out of a large rural hospital sought to determine differences in health outcomes and participant perceived barriers to care between women who did and did not utilize RPM for HDP (Rhoads et al., 2017). Primary outcomes included examining the utility of RPM in reducing hospital readmissions and reducing healthcare costs. Additionally, the authors evaluated whether RPM increased compliance and adherence through increasing accessibility with RPM utilization.

Participants included 48 women, 18 years or older, English speaking, at the University of Arkansas for Medical Sciences (UAMS) diagnosed with preeclampsia that were hospitalized during the postpartum period. Upon enrollment, participants completed baseline surveys regarding perceptions of technology and demographics. Users were given Bluetooth enabled vital sign monitoring devices and educated on utilization of the technology. Data was transmitted to a secure, nurse-monitored portal. For 24 hours prior to discharge, vital signs were monitored by both the inpatient nursing team and the RPM technology to ensure adequate patient education and adherence. Participants were informed to check their blood pressure twice daily and their weight daily. Nurses that were monitoring the portal called patients when vital signs were out-of-range or symptoms were identified. Through a phone conversation, the nurse then established if the patient needed follow-up over the phone with a provider, in person at the clinic or at the emergency department.

Amongst these 48 women (25 full RPM users and 23 non-users), the authors established no significant difference in health outcomes (such as readmission, stroke or even death) between the RPM and non-RPM users, indicating that RPM does not represent inferior healthcare. Additionally, the authors found no differences between the demographics of users and non-users. Users showed significantly higher measures related to technology, including facilitating

conditions (access to resources, knowledge, and assistance), perceived benefits (RPM would help mitigate risk, best/most efficient option for postpartum monitoring), and perceived barriers (time, lack of knowledge, privacy concerns, ease of use).

There was no difference between groups related to technology anxiety. The authors did establish that RPM was significantly less costly than standard of care, especially when postpartum readmissions were reduced, without sacrificing outcomes. Statistical analyses included chi-squared test, Fisher's exact test, and a two-sample independent t test. The authors illustrated a statistically significant increase in participants returning to the medical facility for follow-up care amongst nine users (42.9%), compared to zero non-users (0%; p=0.0046). Participants were able to recognize out-of-range blood pressures and identify symptoms earlier, thus seeking care from a provider earlier, decreasing risk associated with HDP. This further supports RPM in optimizing postpartum care. Users of the RPM program displayed decreased perceived barriers to care and higher compliance with provider follow-up recommendations compared to non-RPM users. RPM allowed participants and their providers to monitor blood pressures more closely, resulting in earlier detection and treatment of concerning results.

Some limitations included a small budget, resulting in a small sample size. Additionally, this study only evaluated RPM for postpartum women, excluding antepartum patients. The authors support early detection and optimized management of HDP utilizing RPM. The authors support the RPM technology utilization in the management of HDP, as these women are more prone to premature cardiovascular and ischemic heart disease, such as atherosclerotic cardiovascular disease, chronic hypertension, and stroke.

One limitation to close follow-up in the postpartum period is the requirement for in-person visits. RPM and telehealth visits may be an alternative to improve postpartum follow-up for women with HDP. A prospective, single-center study primarily evaluated the ease of use,

efficacy, benefits, and feasibility of telehealth follow-up in the immediate postpartum period (48 hours after discharge) and secondarily established incidence of out-of-range blood pressures, hospital readmission rates, and participant satisfaction (Hoppe et al., 2018).

Participants included 55 women, 18 years or older, admitted to labor and delivery with hypertension in pregnancy who agreed to telehealth intervention for blood pressure management after discharge through six weeks postpartum. Participants received a tablet computer device and equipment for vital sign monitoring, which transferred data to a central, nurse-monitored call center. Nurse-driven telehealth follow-up appointments were scheduled at 48 hours after discharge and as needed. Patients with symptoms, including headache, visual disturbance, abdominal pain, and shortness of breath, will be directed to the emergency department for evaluation. Participants were instructed to keep routine postpartum follow-up appointment with their primary obstetrician at 4-6 weeks postpartum. A 37-question self-administered questionnaire (SAQ) was created via Qualtrics and distributed at the end of participant enrollment. Descriptive analyses with mean (standard deviation) and frequency (percentage) was done utilizing Statistical Analysis System (SAS) software, version 9.4.

When asked about the ease of use, quality of care, mental effort, time and overall satisfaction with this telehealth approach, participants valued it highly with a satisfaction rate of 86% and retention rate of 52 (95%), indicating feasibility. According to collected data, 38 participants (84%) stated that they preferred telehealth to in-person follow-up methods due to decreased stress, ease, and quality of care; 39 participants (87%) were “very/extremely” satisfied with the program. The incidence of severe hypertension after discharge was 16% (9 participants) and 53% of participants required treatment for postpartum hypertension, but none were readmitted to the hospital (0%). Fourteen participants (25%) had their antihypertensive medications titrated, and 11 participants (20%) were started on antihypertensive medications; 6

participants (11%) were referred to the emergency department for evaluation. These results indicate that telehealth is a potentially effective strategy in reducing hospital readmission rates.

Limitations include a small sample size related to a single-site study. The investigators discussed observations that patients often experienced an initial drop in blood pressure, followed by a subsequent increase 3-6 days postpartum. This supports the need for close follow-up in the first few days after hospital discharge to reduce the risk for serious maternal morbidity, mortality, and postpartum readmission. The secondary outcome of this QI project will also investigate incidence of severe range blood pressures, recommendation of titration of antihypertensive medications, and postpartum readmissions.

The authors address American College of Obstetrics and Gynecology (ACOG) guidelines that state that patients with HDP are at the highest risk for stroke and death in the first 72 hours after delivery and should have close outpatient follow-up within 7-10 days postpartum (ACOG, 2018). The highest risk is after 72 hours, but often before 7-10 days due to physiological changes that occur in the early postpartum period. Close follow-up enables providers to promptly recognize impending severe hypertension and treat patients without concerning symptoms immediately, avoiding readmission. Additionally, the authors found that RPM decreased costs dramatically, due to decreased hospital readmissions and cost of RPM compared to clinic visits. This QI project will utilize RPM technology that uploads blood pressures in real-time via a Bluetooth enabled blood pressure cuff to a central portal that providers can access. Providers can set alerts within the application for dangerous readings that will create push notifications directly to the provider's mobile device through the VyTrac application. Antihypertensive medications can then be titrated to avoid risks associated with HDP and hospital readmission. In emergent situations when symptoms of potential HDP worsening are present, the patient will be directed to return to the hospital for evaluation.

Similarly, Thomas et al. (2021) conducted and validated a cross-sectional, post-participation web-based self-administered questionnaire (SAQ) to ascertain participant experiences and engagement with RPM devices and technology. Specifically, the survey evaluated participants perception of care, ease of use, perception of effective orientation, perceived security, and problems encountered.

Participants included women admitted to the University of Wisconsin inpatient obstetrics unit for delivery of their neonate with a diagnosed HDP. The survey evaluated the perception of the quality of care, ease of use, orientation efficacy, perceived security, and concerns that arose. Descriptive analyses on all responses with regression analyses on relevant questions were performed and evaluated. The 41-item survey was administered at six weeks postpartum, to 195 participants out of the 214 that were enrolled after participation in the RPM program was complete.

Of those who received the Qualtrics Survey, 128 people completed it (66%). 80% of participants felt the technology easily fit into their lifestyle with minimal effort. 95% of participants preferred RPM to traditional models of care, while only 4.7% said they would prefer traditional follow-up methods, 91% indicating that they would recommend RPM to others. 84% of participants were extremely satisfied with the program overall, appreciating that it eased the burden of- and access to care. Limitations of the study included connectivity issues and a homogenous and small sample size. The authors illustrate that, traditionally, 50-70% of women do not attend postpartum follow-up and RPM has proven to be a feasible, safe, and preferred solution.

Ganapathy, Grewal and Castleman (2016) also assessed ease of use, suitability, and safety of their new RPM device. The authors randomly selected 50 pregnant women who were admitted to a city inpatient obstetrical unit for various reasons and administered the Bluetooth

device and blood pressure monitor, and education on usage. Participants were instructed to take their blood pressures when alerted by the device. Device parameters were individualized per provider preference.

The application changed color based off the recommendation for next steps. A green screen indicated results within range. Amber signified a mild range result and a suggestion to recheck the blood pressure in four hours. If the blood pressure was still mildly elevated after four hours, the participants were advised to contact their providers directly. When blood pressures were within a severe range, the application turned red and advised patients to go directly to the hospital. The application then alerted providers of out-of-range results that warranted follow-up. Descriptive analysis was done post-implementation.

The authors found that the technology provided accurate results when compared to hospital blood pressure monitors. Because the readings uploaded in real-time, providers were able to detect elevated readings earlier and intervene accordingly. The color coding on the application was accurate 100% of the time, thus ensuring proper guidance on next steps. Over 90% of women stated that the technology was simple to use and 78% preferred RPM to traditional models of care. Additionally, RPM was found to reduce healthcare costs, increase access to care by reducing geographical restrictions, and allow earlier detection of concerning blood pressure readings. The authors also indicated that the results were more accurate related to a reduced incidence of white-coat hypertension. The study was limited in that blood pressure readings required interpretation by a provider. Risks associated with HDP were difficult to stratify based on geographical location and resources.

Hauspurg and associates (2019) also discussed the feasibility, reliability and validity, accessibility, and compliance with RPM and nurse-driven algorithms to manage and treat

postpartum hypertension. The authors also established an ongoing goal of bridging care between obstetricians and primary care providers after participation.

In an ongoing QI project, the authors observed 409 patients within a single center (University of Pittsburgh Medical Center, or UPMC) with HDP over the course of one year. Once eligibility was confirmed, the inpatient provider could place an order for enrollment in the RPM program. Participants were then educated on utilization and usage of personal blood pressure cuffs. One day prior to discharge, participants measured their own blood pressures in conjunction with inpatient care, to validate devices. Participants were instructed to record their blood pressure five days a week and attend a follow-up visit in-person one week post-delivery. Readings were recorded directly into the electronic medical record (EMR), and in an RPM platform called Vivify Health and monitored through a nurse-staffed call center with algorithms consistent with national guidelines.

Participants were able to cancel their appointment if blood pressures remained within a specified range all the time (88% of women ultimately attended appointments). Medication management was at the discretion of the call-center physician. Data frequencies and descriptive statistics were done using Stat IC 15 software. One hundred and sixty-eight participants (41%) had an antihypertensive medication initiated or titrated through enrollment in the program utilizing a dedicated treatment algorithm. Two hundred and fifty participants (61%) completed the post-participation survey and 235 women (94%) reported satisfaction with RPM; 232 (93%) would recommend RPM to others, 239 (96%) felt comfortable with the technology, 221 (88%) did not worry about their privacy related to RPM technology. A documented rate of 60 participants (15%) required readmission for hypertensive crises; 177 participants (43%) did not require a one-week clinic visit. Three hundred and forty participants (83%) were engaged beyond

three weeks postpartum, and 302 participants (74%) were engaged beyond four weeks postpartum.

Of participants that met criteria for a one-week clinic visit, 360 (88%) were compliant. RPM improved the care that women received for postpartum hypertension and improved patient involvement and compliance with their condition, compared with a historical compliance rate of 60%. Two hundred and five participants (82%) were more comfortable knowing that their blood pressures were being overseen by a nurse.

The authors found that RPM greatly improved postpartum blood pressure surveillance and increased adherence to ACOG guidelines, as compared with a traditional approach. Women were able to have their antihypertensive agents titrated more closely, thus reducing their risk for postpartum readmissions. Secondarily, 87 participants (21%) established care with a primary physician after enrollment, and an additional 42% endorse already having an appointment scheduled. The study is limited by its lack of long-term data, as it is still in early stages. Additionally, participants were English speaking only with access to smartphone devices, thus potentially decreasing generalizability.

Early recognition and treatment of postpartum hypertension may have long-term cardiovascular benefits, though further studies are needed. Hauspurg et al. displayed tangible benefits of systematic and standardized care for patients with postpartum HDP, supporting the intervention of this proposed Scholarly Project. Likewise, this project will utilize an antihypertensive titration recommendation protocol (see appendix B) based on ACOG criteria and guidelines (ACOG, 2018). The Centers for Disease Control (CDC) also supports the utilization of RPM and recommends that as much care as possible be provided via telehealth platforms to maintain newborn and postpartum patient safety and infection control for the foreseeable future, regardless of an improvement in Covid-19 caseload (CDC, 2020).

Synthesis of Literature Review

The literature supports early follow-up in the immediate postpartum period following hospital discharge among patients with HDP, as compared with the routine postpartum follow-up at 4-6 weeks for uncomplicated pregnancies (Ganapathy et al., 2016; Giorgione et al., 2020; Hauspurg et al., 2019; Hoppe et al., 2018; Rhoads et al., 2017; Thomas et al., 2021; Wen et al., 2019). Moreover, accumulating data indicates that RPM with a follow-up program, plus virtual/telemedicine appointments are preferred to in-person follow-up in the postpartum period and may reduce morbidity, mortality, and hospital readmissions (Ganapathy et al., 2016; Giorgione et al., 2020; Hauspurg et al., 2019; Hoppe et al., 2018; Rhoads et al., 2017; Thomas et al., 2021; Wen et al., 2019).

Given that literature suggests that telemedicine appointments may be more effective, less costly, and preferred by patients over in-person appointments, there is evidence to support implementation of a telemedicine option for women that require close blood pressure monitoring after delivery. Telemedicine increases access to care, compliance with postpartum vital sign monitoring and follow-up recommendations (Ganapathy et al., 2016; Giorgione et al., 2020; Hauspurg et al., 2019; Hoppe et al., 2018; Rhoads et al., 2017; Thomas et al., 2021; Wen et al., 2019). RPM provides integral data to providers to aide in identifying out-of-range blood pressure values that require titration of antihypertensive medications, potentially decreasing cardiovascular risk related to stroke, short and long-term morbidity, mortality and hospital readmission (Ganapathy et al., 2016; Giorgione et al., 2020; Hauspurg et al., 2019; Hoppe et al., 2018; Rhoads et al., 2017; Thomas et al., 2021; Wen et al., 2019).

There remains a gap in knowledge regarding how differences in the recognition and treatment of postpartum hypertension specifically impacts long-term cardiovascular health (Hauspurg et al., 2019; Hoppe et al., 2018; Rhoads et al., 2017). The American Heart

Association (AHA) and the ACOG have established that HDP is associated with long-term cardiovascular disease, however obstetricians lack guidance on effective, evidence-based research for standardization of care, leading to disparate medical management strategies and often poor transition of care from the obstetrician to an internist or cardiologist (ACOG, 2018; Hauspurg, 2018). Additionally, the research lacks differentiation on how increasing access through RPM can specifically improve care for minority populations. Implementation of an evidence-based telehealth program for RPM standardizes care for patients with HDP and can potentially improve maternal outcomes and reduce existing healthcare disparities.

Leadership and Interdisciplinary Practice

Developing a systems-level approach to quality and safety improvement in healthcare is an integral factor in transformational leadership (Zaccagnini & Pechacek, 2021). Doctoral level nurses possess the scientific knowledge, leadership aptitude, and command of QI frameworks to facilitate functional and maintainable change within and throughout the healthcare system (Armstrong & Baus, 2020). Advanced practice registered nurses (APRNs) are uniquely positioned to apply evidence-based, transformational, and translational science towards practice change, improving the patient experience. Oftentimes, best practice is not utilized due to factors such as a lack of science-based knowledge, poor leadership and support, system failures and administrative issues (Zaccagnini & Pechacek, 2021). The discrepancy between evidence and practice paves the way for motivated DNP-prepared leaders with the ability, knowledge, creativity, and management skills to be positive change agents within the healthcare infrastructure. The DNP-prepared leader can identify areas of underutilized best practices and implement evidence-based interventions while integrating science-based knowledge and leadership to improve patient safety. This QI project focuses on a power shift from providers to patients, involving patients more holistically in their care. It provides a solution to the largely

unaddressed disparity of postpartum access to care through utilizing more widely available and alternate modalities, such as RPM.

Ethical Considerations

Ethical considerations for this QI project include maintaining patient safety and privacy with all protected health information. According to the CDC (2018), a main goal of the Health Insurance Portability and Accountability Act of 1996 (HIPAA) is to ensure that patient information is protected while maintaining a seamless flow of information. VyTrac is fully HIPAA compliant, and data is entered and shared by the patient, eliminating some HIPAA concerns. Information flows directly from the patient to the provider, and the application is fully encrypted, offering safety and privacy of sensitive health information. This DNP scholarly project has undergone a full review under the Institutional Review Board (IRB) at the facility of implementation (Study #00001570). Additionally, an IRB approval through a reliance agreement was established at the University of California, los Angeles (Study #22-000030). This QI project has been registered with www.clinicaltrials.gov, identifier number NCT05124327.

CHAPTER FOUR: METHODS

Project Design

This QI initiative was a single-center, single-cohort, prospective, descriptive project utilizing the PDSA process. The purpose of this project was to investigate adherence to- and satisfaction with RPM for management of HDP. Secondary outcomes included measuring the frequency of mild and severe-range blood pressures (mild range: systolic blood pressure 140-159 mm Hg, diastolic blood pressure 90-109 mm Hg; severe range: systolic blood pressure ≥160 mm Hg, diastolic blood pressure ≥110 mm Hg), antihypertensive medication titration

recommendations, and hospital readmissions. This project served as cycle one in the PDSA improvement model (IHI, 2021).

Sample and Setting

The project population included _____ participants (n). This volume of participants was established based on realistic goal setting by key stakeholders and investigators within the institution of the study that supported the QI pilot project, with the option to expand based on preliminary findings. Key stakeholders include obstetricians, including maternal-fetal medicine specialists, cardiologists, hospital administrators, and all medical professionals within the setting of implementation.

Inclusion criteria were (a) postpartum hypertensive women; (b) aged 18 years or older; (c) in the hospital after delivery; (d) current diagnosis of HDP made during pregnancy or postpartum period (i.e. preeclampsia, gestational hypertension, chronic hypertension, or new-onset postpartum hypertension, with or without lab abnormalities, at any gestational age); and (e) English-speaking with current access to a smartphone device. Diagnosis of hypertension was made by the clinical care team utilizing ACOG criteria of systolic blood pressure of 140 mm Hg or greater or diastolic blood pressure of 90 mm Hg or greater on two measurements greater than four hours apart.

Exclusion criteria were (a) patients with eclampsia; (b) patients requiring a massive transfusion protocol (MTP); (c) patients who underwent hysterectomies; (d) patients that were admitted to the intensive care unit (ICU) after delivery; and (e) patients who experienced fetal demise. Convenience sampling involved patients within one MFCU in a large academic hospital in an urban setting within Los Angeles, California. This 12-bed unit manages complex obstetrical patients before and after delivery of their neonates. The institution is an 886-bed tertiary care center.

Power Analysis

A 95% confidence interval for a proportion would be the widest if the observed proportion is at 0.5. A sample size of 30 participants would give a width of 0.374 for a 95% confidence interval around 0.5, with limits of 0.313 to 0.687. The width around a proportion of 0.7 would be 0.347 (0.506 to 0.853) for the same sample size, and around 0.9 would be 0.244 (0.735 to 0.979). A sample size of 30 achieves 80% power to detect a difference of 0.249 using a one-sided exact binomial test assuming the null proportion of 0.5 with a 0.025 significance level.

Instrumentation

This QI project established a formal remote patient follow-up and blood pressure monitoring program, utilizing VyTrac as the primary technology. VyTrac is a Utilization Review Accreditation Commission (URAC) accredited organization in its infancy, exploring validation amongst diverse patient populations, such as obstetrics. Because of this, the VyTrac application and Bluetooth technology has been donated by the organization. VyTrac has the capability to synchronize with the EMR utilized by the institution (C-S Link, an iteration of Epic), however this feature will not be utilized in establishing feasibility during this pilot project due to cost prohibitions. VyTrac will give participants access to an application on their personal smartphone devices and Bluetooth-enabled blood pressure cuffs that automatically upload data to their portal.

Providers can link to participant's portals and gain access to their blood pressure readings in real-time. Emergency alerts within desired parameters were set for participant's blood pressure measurements, and other vital signs via the provider portal within the VyTrac application. This allowed the provider to address out-of-range findings in a timely fashion. Data was reviewed by one of three providers prior to the 48-hour follow-up appointment or as needed for out-of-range results. If symptoms or blood pressure readings were deemed urgent to address by the provider, patients were notified to schedule a virtual visit earlier than 48 hours post

hospital discharge. Participants were also encouraged to contact their primary provider, the DNP project lead, or present to the emergency department for evaluation of out-of-range blood pressure readings or symptoms, such as headache, visual disturbance, abdominal pain, or shortness of breath (SOB).

A post-participation survey, displaying Likert-style questions (see Appendix C) was developed utilizing validated questions from the 41-item SAQ developed by Thomas and associates (2021). Though this specific survey has not been validated, the larger SAQ has been, and relevant questions have been extracted. This may pose a potential threat to internal validity. Because the SAQ in its entirety was validated, though not the individual questions, this validity concern is minimal.

Intervention

Participants were consented and enrolled with VyTrac after eligibility was confirmed by the DNP project lead. Participants received verbal, one-on-one education by the project lead on how to properly use VyTrac technology, application download, expectations, instructions, and virtual visit. Participants were then prompted to check their vital signs twice daily (morning and night) or more per primary obstetrician preference, beginning immediately on discharge. Automated reminders prompted participants at 9am and 9pm to take their blood pressures, if they had not already done so. The timing of the alert can be individualized to participant preference.

Data may be accessed via the portal by the practitioner at any time. Data was most frequently evaluated when the provider is alerted of out-of-range readings and prior to the 48-hour follow-up visit. The project lead received flags or alerts through the VyTrac app, which then triggered an email notification to ensure receipt of information. Data upload continued to automatically transmit to the VyTrac application until the end of the enrollment period- 10 days postpartum. At this point, the provider reviewed all the data once again to ensure in-range blood

pressures (values mostly below 140/90 mmHg and never above 160/110 mm Hg) and evaluated any need for further evaluation (Appendix D: Gantt chart and timeline). The patient was then discharged from the VyTrac program.

Participants were scheduled for a virtual appointment with a provider at 48 hours post-hospital discharge for blood pressure and other vital sign evaluation and optimization, recommending antihypertensive therapy titration to primary obstetrician as necessary (see appendix B for titration protocol). Recommendations were sent to providers via the messaging system, utilizing the "inbox" feature on C-S Link. Messages included vital sign readings and were linked directly to the patients' chart, ensuring streamlined care.

If a 48-hour visit was not possible due to scheduling conflicts, the appointment was scheduled up to 72 hours after discharge. According to ACOG (2018), follow-up is recommended within 72 hours of discharge for patients with severe hypertension (systolic blood pressure >160 mm Hg or diastolic blood pressure >105-110 mm Hg), as significant morbidity is associated with the immediate postpartum period, and more than half of all postpartum strokes occur within 10 days of delivery (Wen et al., 2019). Blood pressure and antihypertensive medication optimization will be based on ACOG criteria, with a goal of always maintaining values below 140/90 mm Hg (ACOG, 2018). The initial usage of antihypertensive therapy will be in accordance with the participant's care team as an inpatient.

This project aimed to empower patients to take a more active role in their healthcare, demonstrating Hall's theoretical framework. As a nurse-driven initiative, this project streamlined care for all demographics of patients and arms them with tools to maintain situational awareness after the acute event of labor with the diagnosis of HDP. It motivated patients to take concrete steps towards healing and health maintenance to reach equilibrium and prevent long-term health sequelae (Petiprin, 2020).

Data Collection and Analysis

Outcomes

Maternal sociodemographic data was collected from the EMR after enrollment to analyze for trends in age, ethnicity, or type of HDP. The primary outcome for this study was adherence of participants to the program or protocol over ten days postpartum and participant satisfaction at completion, ten days postpartum. Specifically, adherence to project guidelines of at least 90%, and participant satisfaction of at least 80% (see Appendix C for satisfaction survey). Adherence was defined as participants uploading at least two blood pressures 80% of the enrolled days or more until 10 days postpartum, with one reading between 6am and 11am, and the other between 6pm and 11pm. If the participant met adherence criteria, then they counted as having completed the full program. Satisfaction was analyzed through post-participation surveys displaying Likert-scale style questions. If participants failed to adhere with project guidelines, the DNP project lead contacted them via email after one day of non-adherence. If non-adherence persisted for another day, the DNP project lead contacted participants via phone. If participants were still unable to upload blood pressures as specified after two points of contact, an additional participant was recruited into the project to maintain validity.

Data was collected on how often participants had mild or severe range blood pressures, how many times medication titrations were recommended, and how many readmissions occurred amongst participants. The proportion of postpartum hospital readmissions for hypertensive emergencies was calculated and compared to the previous year's proportion from the population of women who were diagnosed with HDP. Maintaining internal validity, benchmark readmission rates were taken from the same months in the year prior with this specific population within this institution, as childbirth has a seasonal component. Weekly readmission rates for hypertension was tallied over three months (12 values) and those values were compared with the same three

months one year prior. A histogram was created to establish any outliers and ensure a normal distribution pattern. A one sample, one-sided exact binomial test was calculated to assess feasibility, compared to a proportion of 0.5 (50%) and a confidence interval for the proportion of people who successfully complete the study. A significance level of 0.05 was used for a one-sided test. These values indicated that the proportion of participants that completed the study was statistically significant.

CHAPTER FIVE: RESULTS

Amongst women that delivered Between March 6 and April 6, 2022, 18 women with an HDP were approached for this study. Of the 18, 13 participants gave informed consent, resulting in a consent rate of 72%. Most often, women who declined participation stated that they were overwhelmed by new motherhood and the postpartum period or did not feel that they would benefit from the program. Over the course of the 10-day program, 100% of participants completed the program, with a adherence rate of 93.2% to program guidelines, specifically BP measurements twice daily. The overall satisfaction rate, established via a Likert-style survey, was 93.6%. There were no readmissions to the hospital in all 13 participants.

Baseline demographics of participants at the time of recruitment and consent are summarized in Table 1. Amongst enrolled participants, the mean maternal age was 36 years old, and the mean gestational age was 36 weeks and 6 days. Of participants, 7 were white (53.8%), 1 was Black or African American (7.7%), and 3 were Asian (23.1%), with 2 participants listing their race as none/other. 7 participants stated their ethnicity as non-Hispanic (53.8%), 5 stated their ethnicity as Hispanic (38.5%), while 1 declined to respond.

The type of HDP was also stratified into 23% gestational hypertension (3), 23% chronic hypertension (3), and 54% preeclampsia (with or without severe features; 7).

Outcome data is summarized in Table 2. Overall, 46% (5 participants) were discharged on at least one antihypertensive medication. Throughout participation in the program, medication titration recommendations occurred 5 times on 30.8% (4) of participants. A total of 49 mild-range and 0 severe-range blood pressures were documented. The study coordinator acknowledged a total of 15 occurrences of contact with participants for non-compliance with program requirements and guidelines.

Table 1: *Maternal Demographic Information*

MATERNAL DEMOGRAPHIC INFORMATION	**N = 13**
MEAN MATERNAL AGE	36 years old (26 - 43 y.o.)
MEAN GESTATIONAL AGE	36w6d (28w4d – 39w6d)
RACE	
WHITE	53.8% (7)
BLACK / AFRICAN AMERICAN	7.7% (1)
ASIAN	23.1% (3)
NONE/OTHER	15.4% (2)
ETHNICITY	
NON-HISPANIC	53.8% (7)
HISPANIC	38.5% (5)
DECLINED	7.7% (1)
TYPE OF HYPERTENSION	
GESTATIONAL HYPERTENSION	23% (3)
CHRONIC HYPERTENSION	23% (3)
PREECLAMPSIA	54% (7)

Table 2: *Maternal Outcomes*

MATERNAL OUTCOMES	**N = 13**
PARTICIPANTS DISCHARGED ON ANTIHYPERTENSIVE MEDICATIONS	46% (6)
LABETALOL	7.7% (1)
PROCARDIA	23.1% (3)
BOTH	15.4% (2)
OUT-OF-RANGE BLOOD PRESSURE READINGS	
MILD-RANGE	49 occurrences (out of 193, 25.4%)
SEVERE-RANGE	0 occurrences
MEDICATION TITRATION RECOMMENDATIONS	5x on 4 participants (30.8%)

CONTACTS FOR NON-COMPLIANCE	15
OVERALL ADHERENCE RATE	93.2%
OVERALL SATISFACTION RATE	93.6%
HOSPITAL READMISSIONS	0% (0)

CHAPTER SIX: DISCUSSION

Limitations

The specific design strategy for this QI project resulted in a lack of randomization, as participant involvement will depend, in part, on participant willingness, primary obstetrician authorization, and eligibility based on specific maternal criteria. Additionally, because the study design was quasi-experimental, causality was difficult to ascertain. The developed satisfaction tool has not been validated, thus presenting potential internal validity concerns. Questions were derived from previously validated tools, thus minimizing concerns (Hoppe et al., 2018; Thomas et al., 2021). Additionally, IRB requirements severely impacted the recruitment time for this study. As such, the goal of 30 participants was unable to be reached. Instead, data was collected on 13 participants.

Another potential threat to internal validity included the impact of the Covid-19 pandemic, including modifications to standard postpartum follow-up to avoid exposure or changing attitudes and preferences of participants and providers alike regarding in-person care. This validity concern is minimized due to the planned comparison of readmission rates month-to-month from one year prior. Participants may be more likely to prefer RPM due to Covid-19, but would, however, prefer a traditional appointment not within the context of a global pandemic, thus potentially threatening external validity. The Center for Disease Control, (CDC, 2020) recommends that as much care as possible be provided utilizing RPM to maintain newborn and patient safety and infection control for the foreseeable future, regardless of an improvement

in the Covid-19 caseload. Due to geographical location and significant population homogeneity, this project may lack racial/ethnic diversity.

Future studies may focus on recruiting a more diverse population. Limitations always exist when statistical analyses are done. This includes mathematical errors, a lack of appreciation for qualitative factors, and misuse of statistical data. Because no statistical analyses will be done to compare the intervention of this project to the same population before the intervention, it will be difficult to ascertain an improvement directly correlated with implementation of RPM in the management of HDP, possibly limiting validity.

Another potential threat to external validity was the participant's literacy with technology, impacting the generalizability of the data. This, too, was a minor threat, as the technology has been previously tested on large groups of individuals with a diverse range of ages, education levels, and socioeconomic status. RPM was proven to provide ease of use and was generally preferred to in-person management (Ganapathy et al., 2016; Giorgione et al., 2020; Hauspurg et al., 2019; Hoppe et al., 2018; Rhoads et al., 2017; Thomas et al., 2021; Wen et al., 2019). Studies indicate that about 92-96% of women of childbearing age have access to a smartphone device (and are therefore competent to use them). However, minority populations that are historically more high-risk may have a disproportionate lack of access to such technology, thus potentially skewing generalizability (Pew Research Center, 2019).

The clinical strengths of this project included the early identification of out-of-range blood pressures requiring treatment, and the potential to reduce short- and long-term complications associated with HDP. Additional strengths included the project's ability to be self-funded and profitable annually, though perhaps not initially. The program addressed gaps in care for vulnerable populations and increases access to that care, thus improving patient outcomes. Weaknesses may stem from the large nature of the facility, leading to administrative and

budgeting barriers. Recruitment for participants and buy-in from the providers was needed to successfully implement any new project.

Some opportunities presented from addressing the mission of the organization, improving access to care through increasing programming. The potential cost savings are associated with decreasing readmissions. Streamlining clinical care can potentially result in better outcomes, fewer errors, and appropriate management for all demographics. Threats to the success of this program were influenced by high staff turnover rate and hesitancy of newer members to engage in research while getting acclimated to a new clinical environment (see Appendix E: SWOT Analysis).

Implications for Practice and Research

This project validated the feasibility of RPM for patients with HDP, which may potentially lead to increased adherence, satisfaction, and accessibility, resulting in more vigilant management of postpartum HDP and improved long-term cardiovascular health and short-term morbidity and mortality. AHA and ACOG have established that HDP is associated with eventual cardiovascular disease, however obstetricians lack standardization and guidance on effective, evidence-based research for standardization of care. This has led to subsequent disjointed medical management with much room for error in transitioning from obstetrician to internist or cardiologist (Hauspurg et al., 2018). Additionally, further research is needed to determine the most effective follow-up program to use in conjunction with RPM technology. Thus, implementing and establishing adherence to- and satisfaction with an RPM and follow-up programming provides support in addressing and eradicating these gaps and standardizing management of HDP. As such, this project has prospective future applicability for a highly vulnerable population, ensuring buy-in from key stakeholders through improved patient outcomes and proven cost savings for the institution.

Maternal health and wellbeing have substantial links with cultural and racial factors. Black women are three times as likely to have morbid outcomes related to gestational complications, specifically HDP (Jain et al., 2018). Historically, minority populations have experienced inferior access to care due to concerns related to transportation, healthcare insurance, or provider accessibility and distrust, resulting in diminished adherence with follow-up and negative health sequelae (Miranda et al., 2010). Future research is needed to establish benefits of RPM that specifically address racial gaps in the healthcare system and potentially improves access for underserved populations.

CONCLUSION

This QI project aided in providing an alternative method for BP monitoring and standardizing postpartum care for HDP, resulting in a potential decrease in short- and long-term cardiovascular disease, including CAD, CVD, PAD, and CV-related mortality due to subsequent development of essential hypertension (Giorgione et al., 2020). Additionally, this program has the potential to save the institution over half a million dollars, imploring conservative estimations, through decreased readmissions for HDP in the postpartum period (see appendix A). The implementation of RPM in the management and care of postpartum HDP acts as an initial step towards improved BP monitoring and treatment of blood pressures, that result in improved patient outcomes. In addition, there is a potential for increased access through the utilization of alternative, cost effective modalities of care. Translating validated evidence-based recommendations into tangible guidelines to promote health maintenance through QI is fundamental to the practice and leadership of the DNP-prepared nurse.

APPENDICES

Appendix A
Budgets

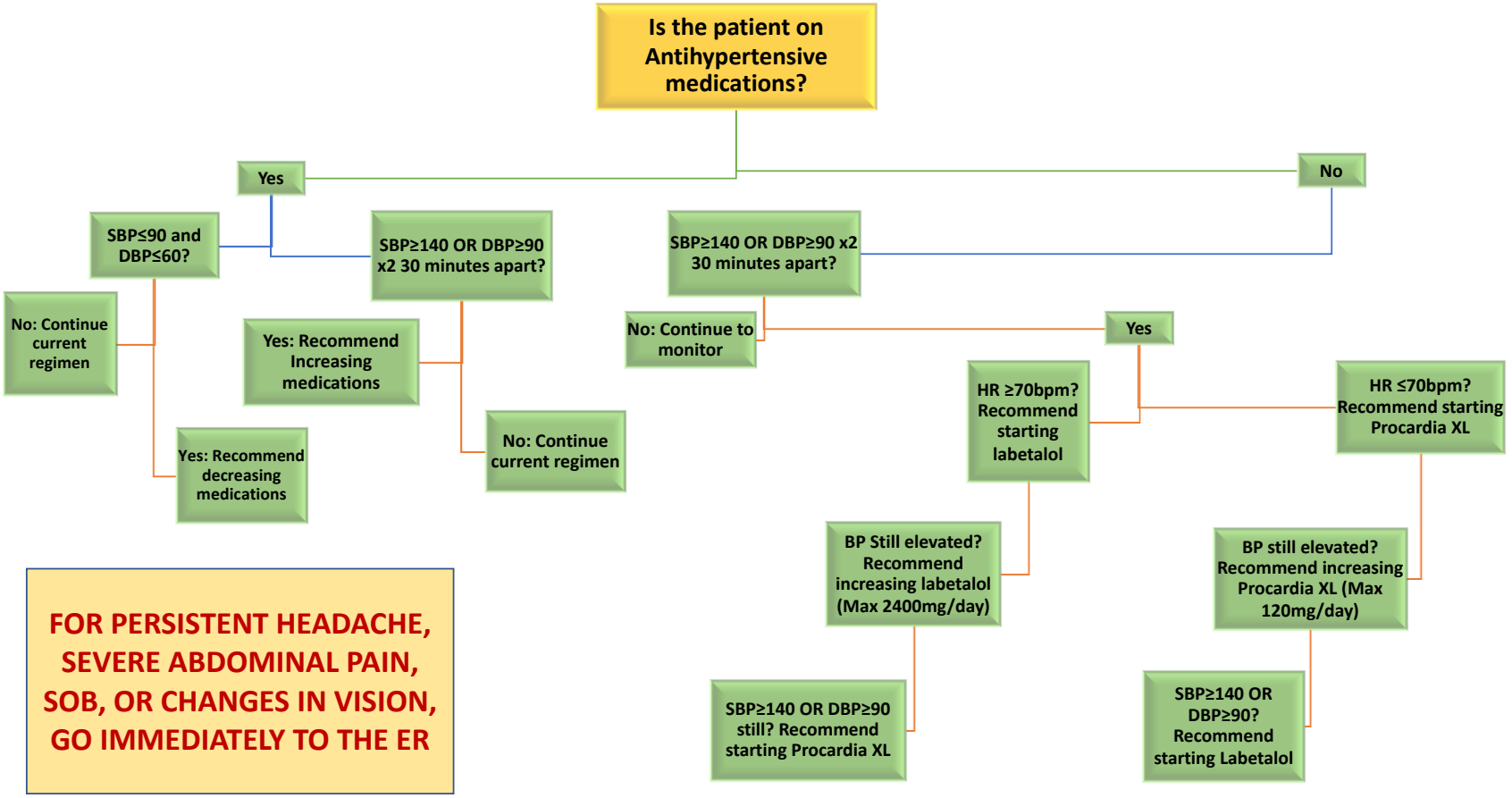
Annual Budget: Postpartum Follow-Up Program					
	Cost per item (savings)	**Quantity**	**Monthly Cost**	**Annual Cost**	**Assumptions**
Initial onboarding *ONE TIME FEE	$5,500	1	NA	$5,500 (once)	N/A
Private-label mobile application *ONE TIME FEE	$4,500	1	NA	$4,500 (once)	Optional, assuming utilization
Health Record Integration *ONE TIME FEE	$20,000	1	NA	$20,000 (once)	Optional, assuming utilization
Software Licensing Fee	$1,000	1	$1,000	$12,000	-Includes technical support, appointment scheduler, billable timer for rendered services, and online resources -Developer assistance: additional $125/hour -Billing Consultant: additional $250/hour
Per Clinician Per Month (PCPM)	$250	10	$2,500	$30,000	-10 providers enrolled -One sub license included
Per Member Per Month (PMPM)	$95	600	variable	$57,000	-600 members / patients enrolled -1 device per member
Readmission cost	($50,000)	70	variable	$3,500,000 20% = (700,000)	-Based on 2020 data -Assumes 20% reduction in readmissions
Practitioner Hours	In-Kind	900 hours (1.5 hours per patient including consult + case review)	In-Kind	In-Kind	-Programming with improve postpartum care, ultimately decreasing time spent and adding an additional source of revenue (billing for remote services)
Annual Total:	Cost: $129,000 Savings: $700,000 Net savings: $571,000				

90 DAY FEASIBILITY PROJECT BUDGET

ITEM	COST/SAVINGS	
VYTRAC TECHNOLOGY AND UTILIZATION	Complimentary / proof of concept	
READMISSION REDUCTION	70/year ~5.8/month X3/20% ($50,000/patient)	-Assumes reduction of readmissions by 20%
200 PRACTITIONER HOURS	In-Kind	
TOTAL	$175,000 potential cost savings over 3-month project period	

Appendix B

Antihypertensive Titration Recommendation Protocol



(ACOG, 2018; Hauspurg et al., 2019; Hoppe et al., 2018)

Appendix C

Satisfaction Survey

1. Overall, how satisfied are you with the quality of care you received through this program?
    a. [ ] Very satisfied
    b. [ ] Satisfied
    c. [ ] Neutral
    d. [ ] Dissatisfied
    e. [ ] Very dissatisfied
2. How easy was the program to use and complete?
    a. [ ] Very easy
    b. [ ] Easy
    c. [ ] Neutral
    d. [ ] Difficult
    e. [ ] Very difficult
3. Do you feel that this program was more or less convenient than your expectation?
    a. [ ] Much more convenient
    b. [ ] More convenient
    c. [ ] Neutral
    d. [ ] Less Convenient
    e. [ ] Much less convenient
4. How satisfied do you feel with the orientation / enrollment? Do you feel it adequately trained / explained the program to you?
    a. [ ] Very satisfied
    b. [ ] Satisfied
    c. [ ] Neutral
    d. [ ] Dissatisfied
    e. [ ] Very dissatisfied
5. Do you feel that your personal information is secure?
    a. [ ] Very secure
    b. [ ] Secure
    c. [ ] Neutral
    d. [ ] Unsafe
    e. [ ] Very unsafe
6. Would you prefer the traditional model of in-person care at variable intervals?
    a. [ ] Very much prefer traditional model
    b. [ ] Prefer traditional model
    c. [ ] Neutral
    d. [ ] Prefer this model
    e. [ ] Very much prefer this model
7. Do you feel that you received better care with this remote vital sign monitoring and follow up program?
    a. [ ] Very much feel that I received better care with this program
    b. [ ] Feel that I received better care with this program
    c. [ ] Neutral
    d. [ ] Feel that I would have received better care without this program
    e. [ ] Very much feel that I would have received better care without this program
8. How much would you recommend this method of follow up to other people in your same circumstance?
    a. [ ] Very much recommend this method
    b. [ ] Would recommend this method
    c. [ ] Neutral
    d. [ ] Would NOT recommend this method
    e. [ ] Very much would NOT recommend this method
9. How difficult was it to use the Bluetooth enabled cuff and VyTrac program?
    a. [ ] Very difficult
    b. [ ] Difficult
    c. [ ] Neutral
    d. [ ] Easy
    e. [ ] Very easy
10. Do you feel satisfied with the time commitment of this program?
    a. [ ] Very satisfied
    b. [ ] Satisfied
    c. [ ] Neutral
    d. [ ] Dissatisfied
    e. [ ] Very dissatisfied

(Hoppe et al., 2018; Thomas et al., 2021)

Appendix D

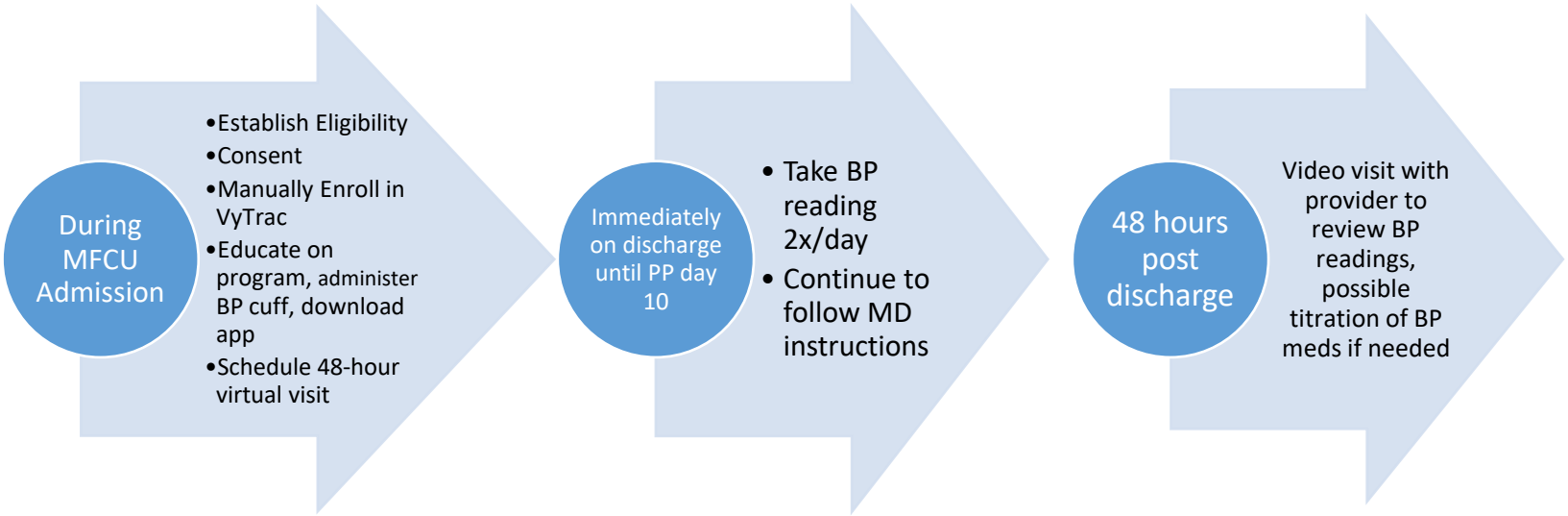
Gantt Chart and Timeline

Decreasing PP Readmits

Cedars Sinai Medical Center
Leah Spiro

Project Start: Mon, 11/1/2021
Display Week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
November 2021 - March 2022- PDSA Cycle 1				
Apply for CSMC and UCLA IRB	Leah	0%%	11/1/21	11/30/21
Meet with Michelle Souza and Nicole Schwartz	Leah	0%	12/1/21	12/15/21
Establish committee and hold meeting, develop algorithm	Leah and Margo	0%	12/15/21	12/31/21
Meet with VyTrack	Leah / Margo	0%	1/1/22	1/7/22
Jan Recruits x10	Leah / Margo / Simona	0%	1/8/22	1/31/22
Feb Recruits x10	Leah / Margo / Simona	0%	2/1/22	2/28/22
March Recruits x10	Leah / Margo / Simona	0%	3/1/22	3/31/22
Monitor Outcomes thus far (inc. ROI)	Leah / committee	0%	3/15/22	3/31/22
April - May 2022				
Finalize data of all 30 participants, including statistical analyses and comparisons	Leah / committee	0%	4/1/22	4/30/22
Post-Implementation				
PDSA Cycle	Leah	0%	5/1/22	6/1/22



Appendix E

SWOT Analysis

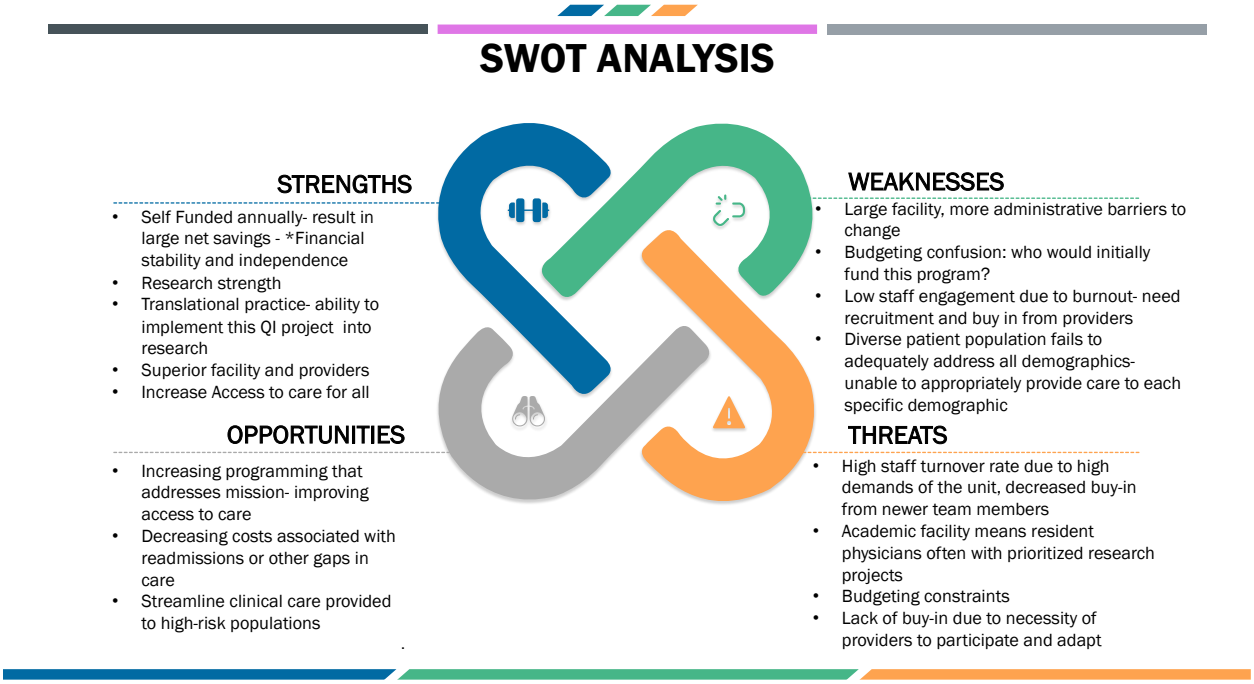


TABLE OF EVIDENCE

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS Design, Intervention, Measures)	RESULTS	DISCUSSION, INTERPRETATION, LIMITATIONS
Ganapathy, R., Grewal, A. & Castleman, J. S. (2016). Remote monitoring of blood pressure to reduce the risk of preeclampsia related complications with an innovative use of mobile technology. *Pregnancy Hypertension*, *6*(4), 263-264. https://doi.org/10.1016/j.preghy.2016.04.005.	**Primary Outcomes:** -Assess feasibility/ usage of RPM in OB patients -Includes ease of use, suitability, and safety of new device	**Sample:** -n=50 -pregnant women who were admitted for obstetric reasons -No identifiable patient information was collected to avoid confidentiality breech concerns. **Setting:** -A city hospital inpatient obstetrics unit	-Feasibility study -Designed a new kit to overcome barriers to early detection of HDP. -Kit includes Bluetooth enabled BP monitor and cellphone-automatically upload to a portal -Application changes color depending on the BP reading, alerting patients on next steps (green = recheck in a week, amber = recheck BP in four hours, if still amber, call your doctor, and if red= go to the hospital) -alerts can be individualized -Application also notifies provider of patients that require immediate attention **Statistical Analysis**: Descriptive statistics post-intervention	-Technology gave accurate results compared to standard BP machines -Transfer of data in real-time via Bluetooth technology -color coding was accurate 100% of the time -technology reduced time to detect severe blood pressure -Most women were English speaking (66%), and the rest were mixed (which represented the hospitals population). -over 90% of women said the technology was very simple to use, and 78% of women said they prefer RPM to clinic visits /traditional model	-RPM technology resulted in reduced healthcare costs -Geographical restrictions / remote locations limit access to care for patients with HDP / high risk pregnancies -RPM allows practitioners to diagnose women with pathologically elevated BPs remotely. -Early detection decreases morbidity and mortality -RPM by the patient gives more accurate readings as the patients were relaxed **Limitations**: Readings require interpretation, risks are difficult to stratify based off geography / linked to direct resources

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS Design, Intervention, Measures)	RESULTS	DISCUSSION, INTERPRETATION , LIMITATIONS
Hoppe, K. K., Williams, M., Thomas, N., Zella, J. B., Drewry, A., Kim, K. M., Havighurst, T. & Johnson, H.M. (2018). Telehealth with remote blood pressure monitoring for postpartum hypertension: A prospective single-cohort feasibility study. *Pregnancy Hypertension*, *15*, 171-176. https://doi.org/10.1016/j.preghy.2018.12.007.	**Primary Outcomes:** -Establish feasibility of telehealth and remote vital sign monitoring through 6-weeks postpartum -Evaluate efficacy of postpartum follow up appointments at 48 hours in decreasing readmission rates postpartum -recruitment, consent, and retention through 42 days postpartum **Secondary Outcomes:** Incidence of severe hypertension (≥160/110- either one) and readmission rates, as well as patient satisfaction	**Inclusion:** -n=55 -Women 18 years or older admitted to labor and delivery with hypertension (chronic, gestational, Preeclampsia or eclampsia with SBP ≥ 140 mmHg or DBP ≥ 90 mmHg on two separate occasions, at least 4 hours apart. **Exclusion**: -Women readmitted to labor and delivery postpartum **Setting:** -Single center -University of Wisconsin -Patients maintained follow up with obstetrician at 6 weeks, and enrollment in the program / study then ended.	-Prospective study **Intervention**: -Tablets with remote participant monitor, blood pressure cuff, weight scale, and pulse oximeter. -equipment training provided to patients and data was transmitted to a central system daily -follow-up appointment with nurse at 48 hours, who had algorithm for early detection and treatment of severe blood pressure management. -Patients with symptoms (headache, visual disturbance, abdominal pain, shortness of breath) were directed to the hospital. -patients participated in a routine 6-week postpartum visit at the clinic at the study endpoint, management then assumed by primary care provider -maternal and obstetrical sociodemographic data collected (parity, age, race, insurance, BMI and gestational age at delivery) -Retention included participants involved through 42 days -37-question self-administered questionnaire (SAQ) created and given at conclusion- Qualtrics **Statistical analyses:** -descriptive analysis with mean (standard deviation), and frequency (percentage) -SAS version 9.4 used	-SAQ including ease of use, quality of care, mental effort, time effort, overall satisfaction utilizing Likert scales -consent rate of 44% (declined due to be overwhelming, inability to return equipment) -Retention rate of 52/55 participants (95%) -NO hospital readmissions -81% response rate for the satisfaction survey, 38 (84%) preferred telehealth over in person appt, 39 (87%) were "very/extremely" satisfied with the program -9 (16%) of participants developed severe HTN. -14 (25%) of participants were prescribed increased antihypertensives and 11 (20%) were started on antihypertensives -6 (11%) were referred to ED for evaluation of symptoms	-Confirmed that blood pressure does increase after discharge -Identified severe blood pressure early, provide treatment, and eliminate hypertension -related readmissions in the 42-day postpartum period. -Participants were satisfied with telehealth and even preferred it. -Methods decrease costs dramatically. -Non-steroidal anti-inflammatory drug (NSAID) use did not have a significant impact on blood pressures and should be used at obstetrician's discretion -Established a need for further research on postpartum blood pressure management **Limitations**: single-site study and small sample size.

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Hauspurg, A., Lemon, L., Quinn, B .A., Binstock, A., Larkin, J., Beigi, R. H., Watson, A. R. & Hyagriv, S. N. (2019). A postpartum remote hypertension monitoring protocol implemented at the hospital level. *Obstetrics & Gynecology, 134*(4), 685-691. 10.1097/AOG.0000000000003479.	**Primary:** -Evaluate feasibility, efficacy, and compliance of remote blood pressure monitoring for management of postpartum hypertension through 42 days postpartum -engagement (surveys, % of women still involved weekly in program) and retention through 42-days postpartum **Ongoing Goal:** -bridge care to primary provider	**Sample** -patients in postpartum unit -Includes diagnosis of chronic hypertension, superimposed preeclampsia, gestational hypertension, preeclampsia, or postpartum hypertension -access to a smartphone with texting. -n=409 patients; 168 gestational hypertension, 179 preeclampsia, 49 superimposed preeclampsia, 13 postpartum preeclampsia. -40% received Magnesium Sulfate, 26% discharged with antihypertensive meds **Setting:** -University of Pittsburgh Medical Center- UPMC Magee-Women Hospital Single-center -Took place over the course of one year (Feb 2018-Jan 2019)	-Ongoing Quality Improvement project -Utilizing algorithms that are nurse driven to manage and treat postpartum hypertension. -Initiated on discharge until 6 weeks postpartum -RPM platform called Vivify Health as core vendor -Once eligibility is confirmed, an order is placed for RPM while inpatient, which then texts patient and enrolls them in the system -patient is enrolled in a group based off if they are taking antihypertensives or not -Utilizes a bring your own blood pressure cuff system (from insurance, purchase, or provided from the hospital). Personal cuff is validated while inpatient to ensure accurate readings -patient education on use of blood pressure cuff prior to discharge -Women are instructed to check blood pressures 5 days/week -Readings are monitored through a nurse-staffed call center and readings go directly into the EMR- utilize a nurse-driven algorithm consistent with national guidelines -If blood pressure is within goal, can cancel 1 week in person appt, if not and patient is asymptomatic- encouraged to go to appointment -Medication management is per discretion of call-center physician **Statistical Analyses:** -Data frequencies and descriptive statistics using Stata IC 15	-168 patients (41%) had an antihypertensive initiated or titrated through enrollment in the program -250 (61%) completed survey, 235 (94%) women who completed a survey reported satisfaction with the program, 232 (93%) would recommend to others, 239 (96%) were comfortable with technology, 221 (88%) did not worry about privacy. 205 (82%) were more comfortable knowing a nurse was overseeing her BPs -60 women (15%) had a postpartum readmission, most commonly due to postpartum hypertension. -Patients expressed comfort and security with knowing that they were being checked on more frequently by a nurse, and that they did not fear for a breech in confidentiality -Patients felt comfortable using the technology -Compliance: 177 (43%) did not require 1-week office visit -Engagement: 340 (83%) continued beyond 3 weeks postpartum, 302 (74) continued beyond 4 weeks postpartum -Of participants that met criteria for needing an appointment, 360 (88%) attended, compared with historic rate of 60% amongst all deliveries and 66% amongst those with HDP. -87 (21%) participants have established care with a primary care physician in the postpartum period, 42% report having an appointment scheduled	-High compliance, retention, and satisfaction -Feasible, scalable, and reliable option for postpartum hypertension management. -Further benefit is an implementation of a systematic method of medication titration leading to improved long-term cardiac effects. -Much higher compliance with this program than the traditional 6 week follow up appointment (historically 60%) **Limitations:** study in early stages, limited data on long-term benefits. Required women to be English speaking and have access to smart phones with text, which may exclude some high-risk populations.

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS Design, Intervention, Measures)	RESULTS	DISCUSSION, INTERPRETATION, LIMITATIONS
Rhoads, S. J., Serrano, C. I., Lynch, C. E., Ounpraseuth, S. T., Gauss, C. H., Payakachat, N., Lowery, C. L. & Eswaran, H. (2017). Exploring implementation of m-health monitoring in postpartum women with hypertension. *Telemedicine Journal and E-Health*, *23*(10), 833-841. 10.1089/tmj.2016.0272.	**Primary outcomes:** -Examine the utility of home blood pressure monitoring in reducing hospital admission time resulting in healthcare savings -to evaluate if remote monitoring increases compliance / adherence by increasing accessibility -describe patient experience related to RPM technology	**Sample:** -postpartum hypertensive women who elected to participate -patients who delivered a baby during the time of the study period, and had a pregnancy complicated by preeclampsia -18 yrs or older and English speaking -n=50 -2 participants excluded due to a lack of adherence, so total n=48 -25/48 chose to enter user cohort, while 23 elected for non-user cohort -convenience sampling -non-randomized controlled study **Setting:** -one rural hospital- University of Arkansas for Medical Sciences	-Prospective, single cohort study -Participants were given technology for home BP monitoring for 2 weeks and given instructions on how to use the system -satisfaction surveys taken 2 weeks after enrollment -measured blood pressure, weight, and pulse-ox via Bluetooth enabled devices that uploaded to a portal in real-time -nurses monitored home vitals and determined if the patient needed additional care over the phone, at the clinic, or at the emergency department. Measures: Surveys evaluating technology risks and benefits, satisfaction. **Statistical analyses** -chi-squared test, Fisher's exact test and a two-sample independent t test.	-Chi-squared test, Fisher's exact test and a two-sample independent t test did univariate analyses of characteristics of enrolled participants: No differences in terms of demographics in users and non-users -two sample t-test compared adherence between used of RPM and non-users and determine differences in outcomes: no differences in outcomes significant difference between users and non-users: p=0.0046- 9 users returned for care -two-sample independent t test compared full users (23 values or more over enrollment) and partial users (22 values or less over enrollment) in terms of satisfaction: no difference	-study only looked at postpartum women, not antepartum -women with preeclampsia are more prone to developing premature cardiovascular disease and ischemic heart disease and morbidity and mortality in the immediate postpartum period -early detection and proper management of HDP -women who do not use RPM have greater perceived barriers to care **Limitation**: small sample size

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS Design, Intervention, Measures)	RESULTS	DISCUSSION, INTERPRETATION, LIMITATIONS
Thomas, N. A., Drewry, A., Passmore, S. R., Assad, N. & Hoppe, K. K. (2021). Patient perceptions, opinions and satisfaction of telehealth with remote blood pressure monitoring postpartum. *BMC Pregnancy Childbirth, 21*: 153. 10.1186/s12884-021-03632-9	**Primary Outcomes:** -post participation survey for participants that experienced remote monitoring and telehealth for HDP -Validates survey related to telehealth (self-administered questionnaire or SAQ). -Planned secondary analysis	**Sample**: -inclusion: women admitted for delivery of neonate with HDP -Survey administered at 6 weeks postpartum when equipment from parent study was returned. -195 participants out of 214 enrolled participants completed the study, and 128 completed the survey -non-randomized control trial of RPM for HDP **Setting:** -Single center -University of Wisconsin	-Cross-sectional, post-participation web-based survey -secondary analyses of a non-randomized control trial of telehealth with remote BP monitoring for HDP in the postpartum period -41 item web-based survey evaluating 1. Perception of quality of care, 2. Ease of use, 3. Effective orientation, 4. Perceived security, 5. problems encountered -Qualtrics Survey Service -participants received a pack of diapers and $15 gift card at conclusion of intervention. -types of hypertensions divided into chronic, gestational, preeclampsia without severe features and everything else. -Also looked at outcomes / health parameters and neonatal outcomes **Statistical Analyses:** -Planned secondary analysis of a non-randomized controlled trial of RPM for HDP compared to standard outpatient monitoring -descriptive analysis on all responses and then performed regression analysis on some questions	-66% of respondents completed the survey -Overall, participants felt the technology was easy to use and required minimal effort. They felt that they it fit into their lifestyle and help was available if needed (80%). -95% preferred RPM to traditional models of care -only 4.7% said they preferred in person visits to RPM. -91% would recommend this to other women -84% were overall very or extremely satisfied with the program -Women felt that RPM eased the burden of care. -Participants felt RPM increased their satisfaction and access to care	-50-70% of women do not follow up postpartum -ACOG discusses telehealth to include RPM and virtual visits. -RPM has been proven to be feasible in obstetrical patients and result in high patient satisfaction as well as low privacy concerns. **Limitations:** connectivity issues, scheduled data collection at 9am was stressful for some and resulted in alerts that may increase BP. Participants would have liked to have access to historical data. Parent study: single site, homogenous and small sample.

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