

2022

Leveraging Electronic Alerts and Telemonitoring for Early Detection of Maternal Hypertension

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Walden University

College of Nursing

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Philidah Seda

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Walden University
2022

Abstract[OA1]

Leveraging Electronic Alerts and Telemonitoring for Early Detection of Maternal

Hypertension

by

Philidah Seda

MSN, Medical College of Georgia, 1996

BSN, Medical College of Georgia, 1991

Project Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Nursing Practice

Walden University

November 2022

Abstract

The United States has the highest maternal mortality rate among industrialized nations, and hypertension is one of the leading causes of maternal morbidity and mortality. Given that pregnancy-related hypertension can develop anytime during the perinatal period, and complications arising from this condition can cause harm, early detection is associated with better outcomes. Best practice alerts in the electronic health record and Blue-tooth-enabled medical devices linked to health information systems can provide real-time notification of critical values to health care professionals. This project evaluated the clinical usefulness of two health care technologies—preeclampsia e-alerts and remote blood pressure monitoring—in facilitating early detection of maternal hypertension. The project was supported by the Wagner Chronic Care Model. Sources of evidence included an internal database, peer-reviewed articles, de-identified quality improvement data, and semi-structured interviews with two program coordinators. QI Macros control chart was used to analyze the preeclampsia e-alert data. Remote patient monitoring data, including acceptance rate, transmission rate, and acute hypertension protocol adherence, were reviewed to evaluate timely and evidence-based hypertension management. The analysis showed that simultaneous use of preeclampsia e-alerts and telemonitoring enables earlier detection and improved surveillance of maternal hypertension. This project substantiates that the adoption of innovative, technology-based approaches for monitoring and managing maternal hypertension has high potential to decrease hypertension-related morbidity and mortality, which can contribute to positive social change across multiple communities. [OA2]

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Dedication

This DNP project is dedicated to my parents who modeled the true meaning of hard work and perseverance. You are my greatest cheerleaders and heroes.

Acknowledgments

I would like to acknowledge my family and friends for their love, encouragement, and prayers; my DNP Chair, Dr. Courtney Nyange, for her guidance and support; and Walden University faculty for teaching me the art of change management and translation of evidence into practice.

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Section 1: Introduction

Over the last three decades, maternal mortality rates in the United States have steadily increased from 7.2 deaths/100,000 live births in 1987 to 17.3 deaths/100,000 live births in 2018 (Centers for Disease Control and Prevention, 2022). In Georgia, the rate of pregnancy-related maternal deaths is even higher at 25.1 deaths/100,000 live births in 2017, the latest year of reported data (Georgia Department of Public Health, 2022). Two-thirds of these pregnancy-related deaths were preventable. Pregnancy-related hypertension, which includes gestational hypertension and preeclampsia, complicates up to 10% of pregnancies in the United States and remains one of the leading causes of severe maternal morbidity and mortality in the nation (Bernstein et al., 2017; Lo et al., 2013). The diagnosis of hypertension in pregnancy requires a systolic blood pressure of 140 mm Hg or more, a diastolic blood pressure of 90 mm Hg or more, or both, measured on two occasions at least 4 hours apart (American College of Obstetricians & Gynecologists [ACOG], 2019b). Since pregnancy-related hypertension can develop anytime during the perinatal and postpartum period, and complications arising from this condition may progress quickly, early diagnosis is associated with better maternal and neonatal outcomes (Lavalley et al., 2018).

Coupled with clinical decision support tools in electronic health record (EHR), telemonitoring has high potential to facilitate early diagnosis of maternal hypertension. Telehealth is the use of digital technology to access health services and exchange medical information (Heuer et al., 2019). Telehealth integrates multiple information and communication technologies (ICTs) to make health care accessible from remote

locations. One form of telehealth, called telemonitoring, enables real-time information-sharing between patients and their caregivers. Telemonitoring allows patients to transmit clinical data, such as blood pressures, from a measuring device to the EHR via Bluetooth technology (Heuer et al., 2019).

This DNP project is an evaluation of the effectiveness of remote blood pressure monitoring (telemonitoring) and preeclampsia electronic alerts (e-alerts) in facilitating early detection of maternal hypertension. If these health care technologies enable earlier detection of maternal hypertension, interventions can be implemented sooner, thereby improving maternal outcomes. Findings from the project can be shared with the public through conferences and publications, with the potential to make a positive social change for mothers and babies in the community they serve and abroad.

Problem Statement

Given the high maternal and neonatal morbidity and mortality associated with pregnancy-related hypertension, a comprehensive approach to management of this condition will likely yield the best results (Walker et al., 2019). The use of electronic alerts (e-alerts) in health information systems can facilitate timely recognition of abnormal preeclampsia labs by the health care team and prevent delays in care (Bowles et al., 2015). Telemonitoring facilitates the transmission of self-measured blood pressure (BP) from a digital BP device to the EHR via a bluetooth enabled application, allowing for early diagnosis, intervention, and supervision of maternal BPs. Since BPs taken in the medical office can be affected by the “white coat syndrome” (elevated office, but normal out-of-office BP) or “masked hypertension phenomena” (normal office, but elevated out-

of-office BP), long-term BP monitoring outside the clinical environment is more reliable for early and accurate detection of high BP (Stergiou & Bliziotis, 2011, p. 123; Turk et al., 2019). The simultaneous use of these digital technologies (preeclampsia e-alerts and telemonitoring) has the potential to facilitate earlier detection and diagnosis of new onset or worsening hypertension, and in turn, reduce adverse maternal and neonatal outcomes. Given that nurses provide the majority of patient care (Swan, 2008), they are uniquely positioned to partner with information technology experts to design and evaluate technology-based interventions that support patient care. Digital technology facilitates the flow of information between patients and the health care team. Best practice alerts in the EHR enables early identification of abnormal lab values. Telemonitoring allows patients to transmit BP data to the EHR without the need to visit a medical office. Nurses can identify patients who meet criteria for remote BP monitoring and assist them with all aspects of enrollment. Nurses in medical offices can monitor BPs that are transmitted electronically and report abnormal lab values to the clinician for timely interventions. Workflows can be created that allows advanced practice nurses to receive notifications of remote BP readings so they can respond to those alerts accordingly. The ability to leverage technology to increase access to, and convenience of home BP monitoring holds significance for nursing practice as it allows nurses to provide evidence-based care that is timely and personalized.

Purpose Statement

In the last 10 years, studies on the clinical usefulness of remote BP monitoring have increased (Cairns et al., 2018; Stergiou et al., 2011), but there is limited evidence on

the added value of coupling telemonitoring with electronic alerts in the EHR to promote early detection of maternal hypertension. This project attempted to fill that gap. The purpose of the project was to evaluate the effectiveness of preeclampsia e-alerts and telemonitoring in facilitating earlier detection of maternal hypertension. The quality improvement (QI) evaluation was focused on outcome metrics that demonstrate whether concurrent use of telemonitoring and preeclampsia e-alerts supports the organization's goal of early detection of maternal hypertension. Data from this study may provide the organization with added justification to optimize the use of telemonitoring and electronic alerts for chronic disease management. Furthermore, information from this QI evaluation may illuminate the value of nurse-driven co-interventions, such as weekly outreach calls and ongoing education on self-monitoring and self-care, for management of maternal hypertension. The practice-focused question that guided this project was "Does preeclampsia e-alerts and telemonitoring of maternal BPs promote early detection of maternal hypertension in the ambulatory obstetric setting?"

Nature of the Doctoral Project

This project was an evaluation of technology-based QI initiatives; therefore, the data had already been collected. My role in the project was to analyze the existing data. The prevalence of pregnancy-related hypertension was obtained from an internal obstetric database that pulls data from hospital discharge codes and claims. Readmission rates for maternal hypertension pre- and post-implementation was reviewed. Process and outcome metrics for preeclampsia e-alert and the remote BP monitoring program were established by a multidisciplinary team of obstetric leaders and telehealth stakeholders and monitored

on a monthly basis. All metrics were reviewed and clinical leaders for the telemonitoring program (perinatal nurse practitioner and maternal child health nurse) were interviewed for additional insight. The findings were used to make recommendations to the organization for future spread.

Significance

According to the World Health Organization (2010), telehealth can address barriers to quality care. A popular and widely accepted form of telehealth is remote BP monitoring (Heuer et al., 2019). Remote BP monitoring (or telemonitoring) enables reliable assessment of out-of-office BPs for timely diagnosis and treatment of hypertension (Stergiou & Bliziotis, 2011). Evidence on the clinical usefulness of remote BP monitoring led to endorsement by the American Heart Association and American Medical Association for the diagnosis and management of hypertension and identification of white coat hypertension and masked hypertension (Shimbo et al., 2020; Xydopoulos, 2019).

Nurses can play a vital role in advancing the science and application of digital technologies in health care. Nurse-led studies on the clinical efficacy of various health care technologies can generate new knowledge or substantiate existing knowledge on the usefulness of digital technology to improve maternal outcomes. The ability to share results from technology-driven QI initiatives through publications, conferences, and workshops promotes the spread of best practices within the health system and across different communities. The transferability of best practices to different practice settings

has high potential to improve maternal outcomes on a broader scale and contribute to positive social change.

Summary

An evaluation of the clinical efficacy of preeclampsia electronic alerts and telemonitoring for early diagnosis of maternal hypertension in the ambulatory setting can provide useful information for practitioners in all obstetric settings. This DNP project was conducted to evaluate the effectiveness of two health care technologies (preeclampsia e-alert and telemonitoring) in detecting maternal hypertension in a timely manner. In addition to data review, clinical stakeholders were interviewed to determine whether they believe that these digital technologies improved the quality of care and outcomes for hypertensive mothers. Based on the data review and analysis, recommendations to the organization were produced. In the next section, existing evidence on telemonitoring of home BP measurements are summarized, along with its relevance for the obstetric population served by this organization. The role of DNP-prepared nurses in leveraging different health care technologies to improve patient care and outcomes is also discussed.

Section 2: Background and Context

Hypertension is a public health problem and a risk factor for cardiovascular disease, stroke, kidney disease, and death. In 2017, the American College of Cardiology and the American Heart Association published new hypertension guidelines categorizing hypertension into two stages; stage 1 is BP \geq 130/80 mm Hg and stage 2 is BP \geq 140/90 mm Hg (Centers for Disease Control and Prevention [CDC], 2020). Under the new guidelines, approximately 108 million adults in the United States have hypertension, but only 1 in 4 (24%) have their BP under control (CDC, 2020). This fell short of the Healthy People 2020 goal of 50% or more of Americans having controlled hypertension (Fryar et al., 2017). In 2018, hypertension was a primary or contributing cause of nearly half a million deaths in the United States, and between 2003–2014, the cost associated with hypertension-related complications averaged 130 billion dollars a year (Kirkland et al., 2018). Despite numerous public campaigns to educate Americans about prevention of high BP (e.g. low sodium diet, smoking cessation, routine exercise), the prevalence of hypertension in the United States continues to rise (Egan et al., 2021; Mills et al., 2020).

In addition to the rising rate of hypertension, hypertensive disorders of pregnancy have been a leading cause of maternal deaths in the United States for the last three decades (CDC, 2021). Significant racial/ethnic differences in the prevalence of pregnancy-related risk factors have been noted across racial groups, with non-Hispanic Black women demonstrating the highest prevalence of hypertensive disorders of pregnancy (Bornstein et al., 2020). The prevalence of hypertensive disorders of pregnancy in Black women steadily increased from 4.5% in 2007 to 8.6% in 2018. These

statistics are noteworthy, as more than 50% of the obstetric population at the project site are African American.

The purpose of this doctoral project was to evaluate whether two technology-driven interventions facilitated early detection of maternal hypertension. The practice-focused question that the project aimed to answer is whether preeclampsia e-alerts and remote BP monitoring (telemonitoring) promotes early detection of maternal hypertension in the ambulatory obstetric setting. In Section 2, the model and framework that informed this project will be summarized, along with nursing contributions in advancing technology-based care. The obstetric population demographics at the project site will be explained to contextualize the problem and project. Finally, the vital role that DNP-prepared nurses play in championing innovative, evidence-based initiatives to improve patient care and outcomes will be discussed.

Concepts, Models, and Theories

An important goal for DNP-prepared nurses is to integrate evidence-based practice models and frameworks that facilitates the adoption of clinical best practices. The Wagner chronic care model and implementation science are two frameworks that facilitate the translation of evidence-based recommendations into systems redesign. Both frameworks are relevant to this DNP project.

Early accounts of telehealth date back to the early 1900s when Einthoven, the inventor of electrocardiograph (ECG), used telephone lines to transmit ECG data from the hospital to his lab (Ramos, 2010). Electronic stethoscopes, which produce both visual and audio outputs, were used as a wireless device to transmit heart sounds for the purpose

of telecardiology and teaching. In the early 20th century, the development of broadcasting sparked an interest to apply radio communications in medicine. Radios were used by physicians at shoreline stations to assist ships at sea that had individuals with medical emergencies. In 1924, a distant examination of children with direct image was done, later defined as one of the first conceptions of diagnostic telehealth as it is used today.

In the last few decades, the use of digital technology to deliver health services increased as technological infrastructures, such as internet, WiFi, and video conference equipment, improved (Perry et al., 2021). Rapid consumption of digital health has also been influenced by innovative technologies, such as integrated EHRs, telemonitoring capabilities, wearable technology, and artificial intelligence (Bergier et al., 2021). Among privately insured individuals in the United States, annual telemedicine visits increased by 52% from 2005–2017 (Barnett et al., 2018). The global COVID-19 pandemic became another catalyst for accelerated uptake of telehealth as health care systems quickly pivoted to keep their patients and healthcare teams safe from the virus.

Today, it is hard to imagine health care without technology. Modern telehealth includes teleconsultation, telepsychiatry, virtual visits, store-and-forward imaging, and telemonitoring, to name a few (Heuer et al., 2019; Perry et al., 2021). Decision support tools in the EHR guides safe practice by alerting the clinical team of abnormal values or preventing clinicians from ordering medications that are contraindicated. Telehealth provides access to health care from the convenience of the patient's home. Telehealth includes services provided by various health professionals, including nurses, clinicians, pharmacists, case managers, social workers, and others (World Health Organization,

2010). A popular form of telehealth, called telemonitoring, enables wireless transfer of clinical data to the EHR in real time; this promotes quicker visibility of abnormal clinical values, such as BPs, by the clinician and health care team and timelier interventions.

Wagner Chronic Care Model

The Wagner chronic care model (CCM) is an important framework for health systems aimed to improve quality of care for patients and populations with chronic conditions, such as hypertension. The CCM outlines six essential elements for population health management at the community, organization, practice, and patient levels using evidence-based research (Crabtree et al., 2013; Wagner et al., 1996). These elements include patient-centered health system design, leveraging decision support and clinical information systems to support patient care, self-management support for patients, and care coordination with multiple disciplines and community partners (Wagner et al., 1998; Willemsse et al., 2014). The principle behind CCM is that a health system that endorses improvement of chronic disease management must transform their care delivery system into one that delivers evidence-based care, empowers patients to self-manage, leverages different care partners and technology to support clinical care, and connects patients with community resources (Wagner, 2019). Nurse scholars can play a vital role in leading innovative practices at any CCM level or care setting.

An important first step for health systems that plan to leverage Wagner CCM principles to optimize hypertension management is to understand the prevalence of hypertension in the population whom they serve, as well as factors related to awareness and control of hypertension. Organization-level interventions may include data collection on

community demographics and social determinants of health as well as health promotion activities for patients and staff. The ability to establish telehealth programs and infrastructures that support patient care outside of the hospital or clinic is another organization-level strategy. Practice-level interventions includes evidence-based management of hypertension and the provision of health education that encourages behavioral changes. Monitoring and treating high BP in-office and out-of-office and educating patients on healthy lifestyle, such as routine exercise, smoking cessation, and stress-management, are examples of practice-level interventions. Patient-level interventions calls for hypertensive adults to take accountability for managing their condition, including healthy living habits, attending appointments, measuring their BP, and taking BP medicine. Essentially, the Wagner CCM promotes meaningful interactions and partnerships between the health care team and patients, as well as organizational programs and infrastructures, that enables continuity of care. Telemonitoring is a patient care strategy that organizations, clinicians, nurses, and patients can leverage to improve hypertension management and patient outcomes.

Implementation Science

Implementation science (IS) provides a framework to translate evidence-based recommendations into clinical policies and practices with the goal of improving health outcomes (Nelson-Brantley & Chipps, 2021). The pathway for IS begins with discovery of evidence-based approaches to solve a problem, testing promising interventions, identifying attributes that worked or did not work well, integrating what worked well into clinical practice, and evaluating whether the intervention(s) are improving population

health and outcomes (Trinkley et al., 2020). Implementation science is rooted in behavioral change management and asserts that implementation teams must consider various factors that influence adoption and sustainability of evidence-based interventions, including acceptability, costs, feasibility, and penetration (Nelson-Brantley & Chipps, 2021). Translation of scientific evidence into practice is the cornerstone of IS, allowing for iterative changes as leaders learn what works well, for whom, and under which circumstances. An important element of IS is to engage multi-level stakeholders from beginning to end of the process and commit to several plan-do-study-act (PDSA) cycles as the team moves from exploration to full implementation (Nelson-Brantley & Chipps, 2021). This maximizes knowledge gained from each PDSA cycle. The IS framework has been applied in various disciplines, including public health, medicine, and nursing (Nelson-Brantley & Chipps, 2021), and it is a useful framework for teams who are working on novel or innovative QI initiatives, such as remote patient monitoring (RPM).

Relevance to Nursing Practice

An Accountable Care Organization (ACO) is one that takes accountability for providing high quality, coordinated, and cost-effective care for its members (Bodenheimer & Grumbach, 2016). The emergence of ACOs presented unique opportunities for professional nurses to partner with physicians and other health care professionals to lead change. One such change is better coordination of care for patients with chronic conditions. Historically, health care services in the ambulatory clinics consisted of an individual physician or group of physicians providing primary care and performing uncomplicated treatments that does not require hospitalization (American

Academy of Ambulatory Care Nurses [AAACN], 2017). Patients who needed to see a specialist were referred, as indicated. Licensed Practical Nurses or Unlicensed Assistive Personnel worked directly with physicians and performed patient care tasks in the clinic. Occasionally, this led to unlicensed assistive personnel performing activities commonly associated with professional nursing practice as many practices did not hire registered nurses (RNs). As ACOs evolved and fiscal caps for hospital care shifted, many health services previously rendered in the hospital setting moved to ambulatory care settings, creating a need for professional RNs who can assess and supervise patients with more acute and complex needs. In addition, it inspired innovation and evidence-based policies and practices that promote safe care in outpatient settings.

Primary care nurses in ambulatory settings play a critical role in the care of hypertensive patients. Typically, nurses measure BPs during office visits and educate patients on hypertension prevention and management. In some cases, a home BP measuring device is prescribed for patients with borderline or high BPs with instructions to record their BPs on a manual log and bring the log to the next office visit so the clinician can review the BPs. This is not always reliable as some patients abandon home BP measurements or forget to bring their log to the medical office. Given this, new approaches for timely detection and supervision of hypertensive patients are warranted.

When nurses incorporate the best available evidence, clinical expertise, and patient preferences into care, better outcomes are achieved (McEwen & Wills, 2019). Traditional care for pregnant women with high BP focuses on frequent visits to the medical office or hospital for BP checks and urine tests (Crabtree et al., 2013;

Xydopoulos et al., 2019). An expectant mother with new-onset or chronic hypertension, for instance, may be cared for by a team comprised of a midwife, obstetrician, perinatologist, cardiologist, and nurses, requiring multiple appointments with various caregivers. This can be anxiety-provoking and demanding in terms on transportation cost, time away from work, or childcare arrangements (Xydopoulos et al., 2019). Hospitals with home health services may send a nurse to the mother's home to check BPs and conduct teaching, but this has significant cost implications for health systems. Expectant mothers with uncontrolled BPs that require medication and close monitoring are typically admitted to the antenatal unit for inpatient care, which is costly and stressful for the family.

Given that maternal BP rises and falls throughout pregnancy, and maternal BPs taken in the medical office can be affected by white coat or masked syndrome, the best way to detect maternal hypertension earlier is to monitor BPs frequently throughout the antepartum and postpartum period. Recent studies have shown that women are willing to measure their BPs at home and take control of existing or new-onset hypertension (Heuer et al., 2019; Lavalley et al., 2018). While evidence on the clinical usefulness of technology to support hypertension management is strong, technology alone does not inspire patients to take control of their hypertension. A comprehensive, team-based approach to hypertension management is the key. Doctoral-prepared nurses can champion the design and implementation of technology-based interventions and nurse co-interventions to support hypertension management. Routine BP measurements in the medical office can be complemented by remote BP monitoring, patient education on

lifestyle changes, telephonic outreach to support self-management, and care coordination. With recent advancements in technology, self-measured BPs can now be transmitted to the patients' EHR in real-time via a bluetooth enabled smartphone. Telemonitoring, care coordination between the healthcare team, and an integrated EHR that allows the clinical team to view the mother's health history and clinical data from any location facilitates connected care.

In the last two decades, telehealth services have gained popularity and is increasingly used to supplement in-office encounters. Nurses are ideally situated to support consumers who are willing to take advantage of remote health care services. Practicing scholars can lead teams in the design and implementation of evidence-based practices that leverages clinical decision support tools, such as best practice alerts in the EHR, and other forms of digital technologies to support patient care (Wang et al., 2021). One such team can develop and implement policies, workflows, and programs for nurse-driven outreach and care coordination for patients enrolled in remote monitoring programs. Merging technology with cointerventions, such as lifestyle counseling, patient education, telephonic outreach, and care coordination can assist patients in monitoring their chronic condition and improve self-management (Spruill et al., 2015; Tucker et al., 2017). DNP-prepared leaders can collect and evaluate data on acceptability, cost, satisfaction, and adaptation of technology-based interventions prior to, and after implementation. This DNP project evaluated existing organizational data on the clinical usefulness of telemonitoring and preeclampsia e-alerts for early detection of maternal hypertension. Given the limited evidence on combining two digital technologies to

facilitate early detection of maternal hypertension, this study filled a gap while illuminating the critical role of nurses in advancing the application of clinical information technology to support maternal care. Dissemination of findings from this DNP project should be useful for any organization who aims to leverage technology to manage maternal hypertension, thereby broadening the potential for social change.

Local Background and Context

The project site is a large, multispecialty integrated health care system in a Southeastern Metro area that provides health coverage and health care to 320,000 members. The organization is part of a larger national health system comprised of eight separate but closely aligned regions with an overarching program office at the national level. The organization has a strong focus on patient-centered preventative care. Telehealth expansion is a strategic priority for the health system and the organization's virtual care platform is robust, with over half of the health services offered via text, phone, or video. Members are encouraged to register for the patient portal so they can access their personal health record (PHR) and a wide range of online health services, including appointment scheduling, messaging, prescription refills, and e-visits.

Given the shocking rate of maternal mortality in the United States, the organization supports federal, state, and local policies aimed at reducing preventable maternal deaths. The organization's government relations team lobbied for a bill which extends Medicaid coverage for up to one year postpartum. The organization also endorsed the Black Maternal Health Momnibus Act of 2021, comprised of twelve bills that offers a comprehensive approach to addressing systemic racism and social determinants of health

to improve maternal health and ensure equitable care (United State House of Representatives, 2022). The Momnibus Act promotes the use of telehealth to support maternal care, particularly for women in underserved areas. Remote patient monitoring is a telehealth benefit that meets this goal and supports the organization's mission of providing high-quality, convenient, equitable, and affordable care.

In 2019, the obstetric service line implemented two technology-based interventions - preeclampsia e-alert and remote BP monitoring. Preeclampsia e-alert was created for the obstetric department as part of a QI initiative to facilitate timely recognition of a dangerous form of maternal hypertension called preeclampsia. The aim was to establish a safety net, in conjunction with providers checking their lab results throughout the day, for patients at risk of developing preeclampsia. In late 2019, the obstetric leadership team opted into a remote BP monitoring pilot due to the prevalence of pregnancy-related hypertension (22%) in the organization. The project site has a higher percentage of African American members than other regions of the enterprise, and it is well-known that African American women have higher rates of maternal hypertension than other racial/ethnic groups (Singh et al., 2018). In 2018, sixty percent of their maternal readmissions was due to hypertension-related conditions. The aim of implementing preeclampsia e-alert and remote BP monitoring was early detection of maternal hypertension so interventions can be initiated sooner. The DNP project evaluated whether the preeclampsia e-alert and remote BP monitoring facilitated earlier detection of maternal hypertension in this ambulatory obstetric setting.

Definition of Terms

Telehealth and telemedicine are often used interchangeably, but there is a difference. Telemedicine is restricted to services delivered by physicians, while telehealth includes services provided by various health professionals, including nurses, pharmacists, case managers, social workers, and others (World Health Organization, 2010).

Telemonitoring is the transmission of clinical data from an automated medical device to the EHR using bluetooth enabled smartphones and mobile applications (Heuer et al., 2019). Electronic alerts (e-alerts), also known as best practice alerts, are clinical decision support tools used to notify the healthcare team of abnormal values or when a particular element of a patient's care needs attention (Swedlund et al., 2018). Additional operational definitions relevant to this doctoral project are included in section 3.

Role of the DNP Student

Healthcare technology is advancing at a rapid pace and nurses at every level must acquire and maintain adequate knowledge and skills to utilize these technologies effectively. Technology-based tools support nurses' ability to assess, plan, implement and evaluate patient care. The flow of information within an integrated health system facilitates communication between the patient and various caregivers. Mobile devices linked to health information systems can provide real-time notification of abnormal or critical values to health care professionals. Technology alone, however, cannot replace sound clinical reasoning or judgement when managing patients with acute or chronic disease, nor enhance technology-driven nursing practices. The expertise of nurses and nurse leaders is essential to optimize the use of technology in healthcare.

As Director of Women's Services, one of my primary responsibilities is to ensure that our clinical team delivers high quality, patient-centered care. Given that maternal hypertension is a problem in our organization, a multi-faceted approach to managing this condition offers the greatest potential of improving maternal outcomes. Best practice alert in the EHR is a clinical decision support tool that is readily available, but often under-utilized. Electronic alerts (e-alerts) are commonly used to prompt the healthcare team about drug allergies or drug-drug interactions (Breighner & Kashani, 2017), but they can be utilized for much more. In our organization, e-alerts are used to signal the healthcare team about contraindicated medications, clinical care gaps (e.g. overdue mammogram and cervical exam), and critical lab values. E-alerts can also be used to notify the healthcare team about clinically significant lab values that does not meet the criteria for critical labs, such as abnormal preeclampsia labs. As the operational leader for the obstetric service line, my motivation for partnering to implement preeclampsia e-alerts and remote BP monitoring was to facilitate earlier detection of preeclampsia so interventions can be implemented in a timely manner. Preeclampsia e-alert and telemonitoring are important components of a bundle of QI initiatives aimed at improving perinatal outcomes.

My role in the DNP project was to evaluate the effectiveness of preeclampsia e-alert and remote BP monitoring in facilitating early detection of maternal hypertension. After preeclampsia e-alert was implemented at the project site, the virtual care manager collected process and outcome data for 4 months; this data was analyzed. Outcomes data for remote BP monitoring was collected from November 2019 to November 2021, to

include total enrollment, transmission rate, number of severe range alerts, patient disposition after severe range alerts, and acute hypertension protocol adherence. Patient disposition includes same day clinic appointment for repeat BP check and management, hospital admission for expectant management or induction of labor, and postpartum readmissions for inpatient hypertension management. The RPM Coordinators (Perinatal NP and MCH RN) were interviewed to gauge their perception of the effectiveness of telemonitoring in facilitating early recognition of maternal hypertension. To control for potential bias, results of the data analysis was shared with the Perinatal Patient Safety Committee who are familiar with all aspects of the telehealth program and outputs. Several members of the perinatal patient safety committee were engaged in program planning for both initiatives, so they would readily challenge any flaws in data analysis. Based on the data review and analysis, recommendations to the organization were produced.

Summary

Delays in recognizing clinically significant preeclampsia labs can lead to poor maternal outcomes. Similarly, severe range BPs (high or low) which are not recognized and treated expeditiously can lead to maternal stroke and other adverse outcomes for the mother and baby. Preeclampsia e-alerts and remote BP monitoring has high potential to facilitate early recognition of maternal hypertension so appropriate interventions can be initiated in a timely manner. When combined, these technology-based interventions can facilitate earlier recognition of maternal hypertension and/or preeclampsia. This DNP project evaluated whether simultaneous use of these healthcare technologies led to early

detection of maternal hypertension. In section 3, plans for data collection and analysis were discussed.

Section 3: Collection and Analysis of Evidence

Complications arising from pregnancy-related hypertension are among the leading causes of maternal illness and death in the United States (Bernstein et al., 2017).

Addressing this public health crisis is a top priority for the organization. Timely recognition and appropriate treatment of maternal hypertension can mitigate harm to the mother and her unborn child. Integrated models of care, supported by patient-centered technologies, can enable earlier detection and treatment of maternal hypertension. The ability to incorporate telemonitoring and best practice alerts into established care pathways can improve quality of care, care coordination, and patient experience.

In the last decade, evidence on the clinical usefulness of remote BP monitoring has mounted. In 2019, the project site implemented a preeclampsia best practice alert (e-alert) for early detection of abnormal preeclampsia labs. A few months later, telemonitoring of maternal BP was launched to support hypertension management. The remote BP monitoring program is a convenient way to monitor maternal BPs outside the medical office as it enables automated sharing of BP values with the health care team from remote locations. The aim was early detection of maternal hypertension so interventions can be initiated in a timely manner. The purpose of this project was to evaluate whether these technology-enabled interventions promoted earlier detection of maternal hypertension. In this section, the practice-focused question and gap in practice will be reinforced and relevant operational definitions will be clarified. Sources of evidence will be discussed, as well as methods of data collection and analysis used to

evaluate whether telemonitoring and preeclampsia e-alerts enabled earlier detection of maternal hypertension.

Practice-Focused Question

Chronic illnesses, such as hypertension, poses a significant burden on those affected and health systems responsible for managing the conditions (Wootton, 2012). At the project site, the prevalence of maternal hypertension in 2018 was 22%. In the same year, 60% of maternal hospital readmissions were attributed to hypertensive-related conditions. Existent literature has confirmed that telemonitoring is a viable option for monitoring maternal BPs (Cairns et al., 2018; Stergiou et al., 2011), but there is limited evidence on the added value of e-alerts to promote early detection of maternal hypertension. The purpose of this project was to evaluate the effectiveness of combining two healthcare technologies (e-alerts and telemonitoring) for timely detection of maternal hypertension. The findings will inform whether simultaneous use of preeclampsia e-alerts and telemonitoring promotes early detection of maternal hypertension in the ambulatory obstetric setting.

Operational Definitions

Electronic alert (e-alert): A clinical decision support tool available in the EHR to bring clinician attention to abnormal values (Bowles et al., 2015). An electronic alert (also known as best practice alert) is a visual reminder tool within the EHR that allows clinicians to identify abnormal values quicker.

Telehealth: The use of digital technology to access health services and exchange medical information from distant locations (Heuer et al., 2019). Telehealth methods

include telephone or video visit, e-visits, portal-secure email messages, and telemonitoring.

Remote blood pressure monitoring: The use of health information technology to transmit BP values from a bluetooth-enabled medical device to the EHR from remote locations (Heuer et al., 2019).

Telemonitoring: Continuous or intermittent observation of clinical parameters from a distant location (Willemse et al., 2014). Telemonitoring can take place synchronously (real-time transmission of clinical data) or asynchronously (store-and-forward transmission of clinical data; Wootton, 2012).

Chronic maternal hypertension: BP \geq 140 mm Hg systolic or 90 mm Hg diastolic predating conception or identified before 20 weeks gestation (ACOG, 2019b).

Preeclampsia: A pregnancy-specific hypertensive disorder manifested after 20 weeks of gestation and consisting of new onset systolic BP \geq 140 mm Hg or diastolic BP of \geq 90 mm Hg on at least two occasions at least 4 hours apart in a previously normotensive woman combined with one of the following new-onset conditions: proteinuria (\geq 300 mg per 24-hour urine collection) or maternal organ failures, including kidney, liver, or uteroplacental dysfunction (ACOG, 2020).

Sources of Evidence

This DNP project is an evaluation of two technology-based QI initiatives that were implemented at the project site to facilitate early detection of maternal hypertension. My role in the project was to analyze existing organizational data. The preeclampsia e-alert was created as a safety net to ensure that clinically significant preeclampsia labs

were captured and reported to an OB clinician in a timely manner. A metric was established by the obstetric leadership team to measure turn-around time from preeclampsia e-alert (signifying abnormal lab) to notification of an OB clinician; the goal was < 4 hours. Data collection for the preeclampsia e-alert initiative was conducted by the virtual care manager for 4 months post-implementation and recorded on an Excel spreadsheet.

The remote BP monitoring (telemonitoring) program was implemented 3 months after preeclampsia e-alert as a regional pilot. Department-specific guidelines for management of acute hypertension, adapted from ACOG (2019a) and other specialty guidelines, were developed and disseminated to all OBGYN clinicians and nurses. Measures of success for RPM were established by the obstetric leadership and regional telehealth teams, to include total enrollment, transmission rate, number of severe range alerts, patient disposition after severe range alerts, and acute hypertension protocol adherence rate. Outcome data were collected by two RPM Coordinators (perinatal outreach nurse and perinatal nurse practitioner) and reported at the monthly Perinatal Patient Safety Committee meeting. The perinatal outreach nurse and perinatal nurse practitioner who monitors the alerts were interviewed to assess their experience with RPM and whether they believe that the technology-driven initiatives improved timely, effective, and equitable care. Based on data review and analysis, the effectiveness of preeclampsia e-alerts and remote BP monitoring were evaluated, and recommendations to the organization were produced.

Analysis and Synthesis

Data collection for preeclampsia e-alerts was conducted by the virtual care manager for 4 months post-implementation. Abnormal preeclampsia lab result time and provider notification time were documented on an Excel spreadsheet. A data analyst was retained to help organize the data for analysis using QI Macros control chart. Remote BP monitoring acceptance rate and transmission rate from November 2019 to December 2021 were reviewed to assess RPM uptake and ease of use. Data on patient disposition after severe range BP alerts and adherence to the acute hypertension protocol were reviewed to evaluate timely and evidence-based care. Postpartum readmission rate for hypertension-related complications was reviewed to determine if it increased or decreased compared to the 2019 baseline rate of 3.2%. The obstetric leadership team expected the postpartum readmission rate to increase initially due to earlier detection of maternal hypertension and timely hospital admission for patients who require inpatient management. Interviews with the perinatal nurse practitioner and perinatal outreach nurse provided additional insight on the effectiveness of these technology-based initiatives in facilitating earlier detection and appropriate management of maternal hypertension.

The preeclampsia e-alert data was sent to women's services leadership on a monthly basis. The remote BP monitoring data was reported at the monthly perinatal patient safety committee and readily available. The RPM coordinators are an integral part of the women's service line, so it was relatively convenient to interview them about the OB telemonitoring program. A site approval form for this QI evaluation was signed by the chief operating officer of the project site. The site approval form granted permission

to access clinical data that were used as a source of evidence for this doctoral project only. All organizational data were de-identified and kept strictly confidential.

Summary

Program evaluation is an important component of any QI initiative as it allows the planners to assess whether the interventions are making a difference in achieving expected outcomes (Kettner et al., 2017). An analysis of the organization's operational data on preeclampsia e-alerts and remote monitoring of maternal BPs was done to evaluate the effectiveness of two technology-driven quality and safety initiatives. The overarching goal was earlier detection of maternal hypertension so timely treatment can be initiated. The data analysis revealed whether simultaneous use of two technology-based solutions facilitated early detection of maternal hypertension. Findings from organizational data review and analysis, implications to the organization and community, and recommendations to the organization are discussed in Section 4.

Section 4: Findings and Recommendations

In 2019, the prevalence of maternal hypertension at the project site was high, and nearly a fourth (22%) of the OB population were diagnosed with one or more hypertensive disorders of pregnancy. Further, hypertension was the leading cause of postpartum readmissions. Given that undetected hypertension can lead to poor maternal and fetal outcomes, a key goal for the women's services leadership team was to detect maternal hypertension early so timely interventions could be implemented. Remote BP monitoring (telemonitoring) is increasingly used to monitor out-of-office maternal BPs, but there is limited evidence on the value of layering best practice alerts (e-alerts) in the EHR to facilitate earlier detection of maternal hypertension. The purpose of the DNP project was to evaluate whether preeclampsia e-alerts and telemonitoring of maternal BPs facilitated early detection of maternal hypertension in the ambulatory obstetric setting.

Sources of evidence for this DNP project included an internal OB database, peer-reviewed articles, de-identified QI data on preeclampsia e-alerts and remote BP monitoring (collected by a virtual care manager and obstetric leaders), and information gained by interviewing two RPM program coordinators. The women's services leadership team partnered with data analysts and statisticians to build a real-time obstetric database that included maternal demographics and other health information that informed care delivery and improvement efforts. The internal obstetric database was available to women's services leaders who were granted access, including myself; the data could be viewed at liberty. The preeclampsia e-alert data were monitored for 4 months post-implementation and sent to women's services leadership. The remote BP monitoring data

were collected by two RPM program coordinators and reported at the monthly perinatal patient safety committee meeting; I am a member of the committee. A 30-minute interview with each RPM program coordinator provided additional insight on what worked well with RPM and opportunities for improvement. A data analyst in the quality department was retained to help with data analysis.

Findings and Implications

Approval from Walden University Institutional Review Board (IRB) and project site were obtained before analysis of de-identified organizational data commenced. The internal obstetric databased revealed that from 2019–2021, the racial/ethnic mix of the obstetric population remained relatively static (50% Black, 25-30% Caucasian, 7% Asian, 5% Hispanic, and 8% other). Thirty-nine to 42% of the obstetric population had one or more high risk diagnosis. The prevalence of hypertensive disorders of pregnancy (HDP), consisting of preeclampsia, eclampsia, gestational hypertension, or chronic hypertension with super-imposed preeclampsia, was high (20-25%) and HDP was the leading causes of maternal morbidity. The database allowed the obstetric leadership team to better understand medical conditions, like hypertension and diabetes, among the racial/ethnic groups that they serve. The realization that a quarter of their obstetric clients had one or more hypertensive disorders of pregnancy, and HDP was a leading cause of maternal illness, provided a strong case for the organization to invest in technology and accompanying infrastructure to manage this condition.

Preeclampsia Electronic Alert (E-Alert)

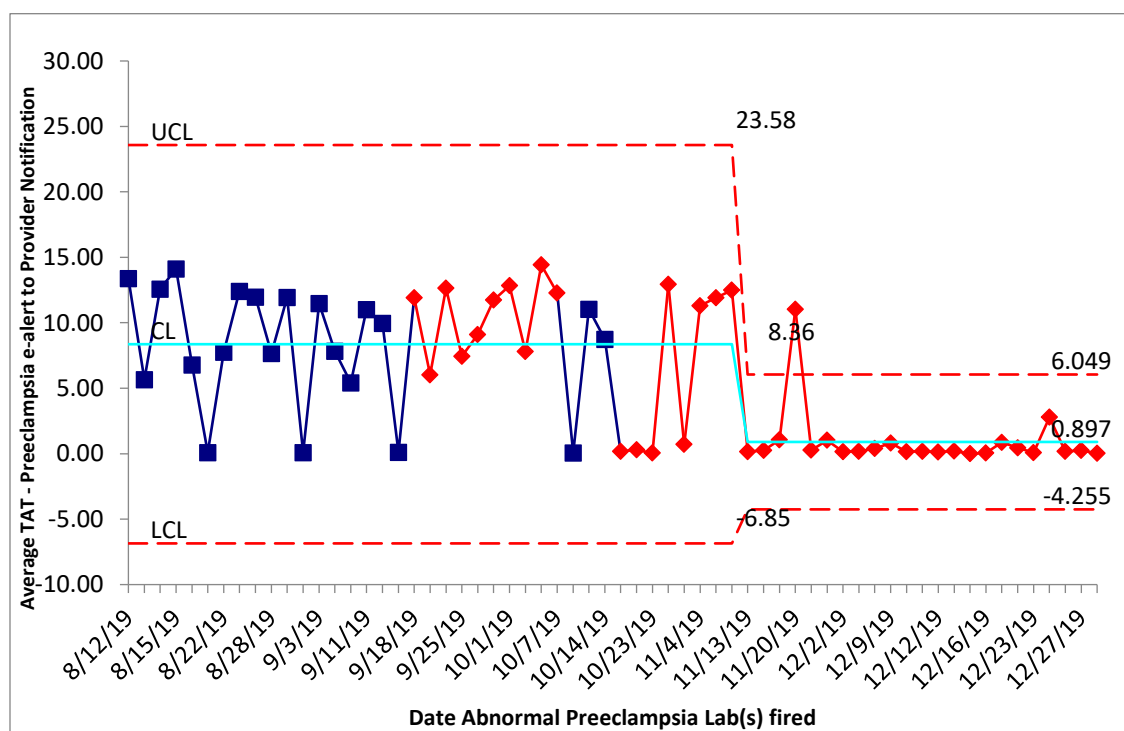
Parameters for clinically significant OB preeclampsia labs were defined by the women's services leadership team and approved by the Chief of OBGYN. A best practice alert (preeclampsia e-alert) was built in the EHR based on pre-defined preeclampsia lab parameters. Abnormal preeclampsia lab(s) "fires" an alert in the EHR and the lab routes to a "Clinically Critical Lab Results Pool." Virtual care nurses monitor the pool Monday–Sunday from 8:00a.m. to 5:30p.m. and notify the ordering or on-call OB provider of any abnormal preeclampsia lab(s) that enters the pool. Each time an abnormal preeclampsia lab routed to the Clinically Critical Lab Results Pool, the virtual care manager documented two data points on an excel spreadsheet: (a) preeclampsia e-alert time and (b) OB provider notification time. A key improvement goal for the service line was for an OB provider to be notified within 4 hours of abnormal preeclampsia lab result so interventions can be initiated in a timely manner.

A data analyst from the quality department was retained to assist with data analysis. From August 9, 2019, to December 27, 2019, 71 abnormal preeclampsia labs routed to the clinically critical lab results pool. The virtual care manager documented the preeclampsia e-alert time (signifying abnormal lab) and provider notification time on an Excel spreadsheet. After 3 months of data tracking, the mean turn-around time for OB provider notification was 8.36 hours, twice the goal of < 4 hours. A deep dive revealed that abnormal preeclampsia lab(s) that resulted before 5:30pm were reported to the OB provider within 30-60 minutes. Abnormal preeclampsia labs that resulted after 5:30pm were reported to the OB provider the next morning between 8:00a.m. and 10:00a.m. Lab

leadership reported that 70% of the labs resulted between 6:00p.m. and 9:00p.m. as they were processed as a batch (called “batch run”) during evening hours. In response, the women’s services leadership team requested that preeclampsia labs be processed upon receipt (classified as “urgent”) and hired a per diem virtual care nurse to monitor the pool Monday to Friday from 6:00p.m. to 10:00p.m.; this provided 12-hour coverage on weekdays versus the original 8 hours of coverage. After evening coverage was established in mid- November, the average turn-around time (TAT) for OB provider notification decreased to less than 1 hour and remained stable until data collection for preeclampsia e-alerts ceased on December 27, 2019 (Figure 1).

Figure 1

Average Turnaround Time from Preeclampsia E-Alert to Provider Notification



Telemonitoring

A total of 1450 members were enrolled in the remote BP monitoring program from November 19, 2019, to December 31, 2021. Maternal BP surveillance was supported by two RPM Coordinators, consisting of a Perinatal Nurse Practitioner (Perinatal NP) and Maternal-Child Health Registered Nurse (MCH RN). In the first 6 months of the program, less than 85% of enrolled mothers were transmitting daily BPs to the EHR. In August 2020, a new application (Health Ally) was introduced, and within two months, 95% of enrolled mothers were transmitting BPs daily. Both RPM Coordinators reported that the increase in BP transmission rate was attributed to the new app and troubleshooting support by the MCH RN. The total number of RPM hypertension enrollments, severe range BP alerts, and maternal disposition after severe range BP alerts between November 19, 2019 to December 31, 2021 are outlined below:

- Total enrollment = 1450
- Number of severe range alerts = 1594
- Hospital admissions for induction of labor = 75
- Postpartum readmissions = 60
- Same day office visits for repeat BP check by a nurse = 499

Expectant or postpartum mothers who enrolled in the telemonitoring program checked their BPs twice/day (morning and evening). If the BP was greater than 140/90, the patient received an automated text message to call the 24-hour advice line. The Advice Nurse reported all abnormal BP values to the on-call OB physician. The MCH RN made weekly outreach calls to all enrolled mothers to review their BP readings and

reinforce self-care, such as healthy eating and daily exercise. A high-priority alert message was sent to the surveillance clinician's In-basket for severely elevated BP, defined as systolic BP ≥ 160 mm Hg and/or diastolic BP ≥ 110 mm Hg), low systolic BP (< 90 mm Hg), 7-day average systolic BP greater than 150mm Hg, 7-day average diastolic BP greater than 100mm Hg, or no BPs transmitted in 3 days.

In the first 6 months of the RPM program (November 2019 to May 2020), the telemonitoring acceptance rate was 85-90%. The BP transmission rate was $< 85\%$ during the same timeframe. In August 2020, the remote BP monitoring acceptance rate increased to 95% and remained consistently above 95% until December 31, 2021. The high acceptance rate demonstrates that telemonitoring is well-accepted by the OB population at the project site. Between August 2020 and October 2020, the BP transmission rate increased from 85-95%. The high transmission rate enabled heightened surveillance of out-of-office maternal BPs, that in turn, facilitated early detection and timely interventions for maternal hypertension.

Interview with RPM Coordinators

A 30-minute interview with each RPM Coordinator (Perinatal NP and MCH RN) provided additional insight on the clinical usefulness of remote BP monitoring for early detection of maternal hypertension. Each interview was conducted virtually (via Teams). Three questions were posed:

- 1) Can you share what worked well with remote BP monitoring?
- 2) Can you share areas of opportunity or learnings from the remote BP monitoring program?

3) How did telemonitoring of maternal BPs support women's service line goals?

The Perinatal NP stated,

Remote blood pressure monitoring has been a game-changer in early detection of hypertension. As COVID-19 surged in 2020, some mothers were afraid to go into crowded places, like hospitals or medical offices. They appreciated the convenience of checking their blood pressures from the comfort of their home and knowing that we are keeping an eye on it. Most mothers were excited about the remote monitoring program and eager to try it. Only a handful opted out.

The MCH RN said,

I never thought that I would be providing virtual care to pregnant moms at this stage of my career. I love it. I have a unique relationship with each mom because we talk every week. The weekly call allows me to review their blood pressures and educate them about hypertension and self-care. We talk about healthy eating, exercise, keeping appointments, warning signs, social support, and anything else on their mind. I remind each mom to call the Advice Line for high or low blood pressure and to save the number in their cell phone. After a few weeks, the moms are better informed about their condition, which is the goal.

Both RPM Coordinators shared that the new Health Ally app made a big difference in maternal BP transmissions. The project site transitioned to the new app eight months after RPM was implemented due to enrollment and transmission challenges with the prior app.

The MCH RN shared,

The original app (by the same company that provides the BP devices) required seven steps to download and pair with smartphones. Some patients abandoned the program due to enrollment challenges. I spent countless hours on the phone troubleshooting transmission issues, and for some, I was never able to resolve their issue. I gave those moms a manual log to record their BPs.

The Perinatal NP stated,

I tested the new Health Ally app by enrolling myself for remote blood pressure monitoring. I followed the instructions to pair my device and was able to complete enrollment in two minutes. To be honest, our enrollment rate has exceeded my expectation and I am able to address BP issues before they become a bigger problem.

Unanticipated Limitations and Outcomes

An unanticipated outcome of the telemonitoring program was transmission issues incurred by the first app used to transmit BPs to the EHR. Despite troubleshooting support by the IT department and MCH RN, some patients were not able to enroll, so they abandoned the telemonitoring program. The organization resolved the issue by transitioning to a new app 8 months after implementation of the program. While there were costs associated with the transition, the BP transmission rate increased from 85% to > 95% within two months and it remained consistently high. Due to high acceptance rates for remote BP monitoring, the original RPM Coordinator (Perinatal NP) had to solicit additional clinician support to help monitor severe range BP alerts within the first year of the program. Access to in-office appointments was temporarily impacted when the

second clinician's schedule was changed from face-to-face care to virtual care, but the Chief of OBGYN believed that this was value-added due to known implications of poorly managed maternal hypertension.

Implications for Individuals, Organizations, and Communities

The organization's mission is to provide high quality, timely, and person-centered care. Given the prevalence of maternal hypertension for the population whom they serve, improvement efforts on hypertension prevention, detection, and management were well-supported by the executive team. Women who meet criteria for remote BP monitoring receive a free BP measuring device and enrollment support from OB nurses. Easy access to same day appointments in the medical office allowed the clinical team to validate maternal hypertension after a severe range alert so timely interventions can be initiated. The high RPM acceptance and transmission rate (> 95%) demonstrated that remote BP monitoring is well accepted by the obstetric population at the project site. Further, expectant and postpartum mothers are willing to measure and transmit their BPs from a distant location daily.

The Wagner CCM promotes meaningful interactions and partnerships between the healthcare team and patients, as well as organizational programs and infrastructures that enables continuity of care. The organization's robust telehealth infrastructure allows patients to interact with their healthcare team through various virtual platforms, including e-visits, telemonitoring, and video visits. The COVID-19 pandemic accelerated the adoption and adaptation of telehealth to support patient care. The integrated care model makes it easy for obstetric leaders to engage specialists, such as perinatologist or

cardiologist, for connected care. Information system builds for best practice alerts and evidence-based RPM protocols promotes standardized care. A commitment to evidence-based management of hypertension and provision of health education and support empowered the mothers to take better care of themselves and their chronic condition. Leveraging technology, such as preeclampsia e-alert and telemonitoring, to detect abnormal preeclampsia labs and high BPs early has resulted in timely recognition and prompt evaluation and management of hypertensive mothers.

Given the success of OB remote BP monitoring at the project site, leaders from other regions of the enterprise harvested learnings and implemented remote BP monitoring in their respective organization(s). To date, 7 of 8 regions have implemented remote BP monitoring. The project site subsequently implemented OB remote glucose monitoring in October 2020 and low risk pregnancy monitoring in early 2022. For low-risk pregnancy monitoring, a toolkit that includes a fetal doppler (to detect fetal heart rate) and Bluetooth enabled BP monitor and weight scale sends BPs and weight values directly to the mother's EHR via a smartphone app. The adoption of additional telemonitoring programs at the project site, as well as other regions of the enterprise, have spread technology-based interventions to other communities with high potential to improve maternal outcomes in those communities as well.

Implications to Positive Social Change

Walden University's mission charges DNP graduates to use the knowledge and skills acquired during doctoral studies to lead social change. Doctoral-prepared nurses can champion system-level changes that leverages technology to mitigate preventable

maternal morbidity and mortality. The practice-focused question that this project aimed to answer is whether simultaneous use of preeclampsia e-alert and telemonitoring promotes early detection of maternal hypertension. The findings suggest that using multiple technologies enabled earlier recognition of maternal hypertension. Given that hypertension is a major cause of maternal morbidity and mortality at the project site and nation-wide, applying innovative, convenient, and technology-based approaches for monitoring and managing maternal BPs offers great promise to decrease maternal mortality across multiple communities.

Recommendations

An important step for organizations that wish to improve maternal care and outcomes is to gain a better understanding of their demographics and health conditions that predisposes them to maternal morbidity and mortality. Partnering with data analysts to build a dashboard that tracks demographic information, such as maternal age, parity, ethnicity, body mass index, and prevalence of chronic conditions, can inform high-priority areas for quality improvement. Collaborating with information technology (IT) experts to understand decision support tools in the EHR, and soliciting their support for technical builds, is essential for leaders who aim to leverage health care technology to support patient care. The OB leadership team at the project site learned that best practice alerts in the EHR were available, but under-utilized. They partnered with IT to build a preeclampsia e-alert that enabled earlier detection of maternal hypertension.

The infrastructure, personnel, time commitment, and cost associated with telemonitoring programs require a strong executive and institutional commitment. At the

project site, implementation of remote BP monitoring required (a) executive approval to purchase and distribute Bluetooth-enabled medical devices to members (free of charge), (b) technical builds by the clinical information systems team, (c) development of evidence-based workflows and protocols, (d) clinician and staff education, and (e) dedicated resources to monitor and respond to preeclampsia e-alerts and severe range BP alerts. The availability of workflow consultants and educators who can develop and train staff on new protocols and workflows is essential. A dedicated resource(s) to collect data is valuable as it enables iterative changes along the way and program evaluation.

Strengths and Limitations of the Project

Strengths

Maternal hypertension is a big problem for the organization. While evidence on the clinical usefulness of remote monitoring exists, there was limited evidence on the value of layering two healthcare technologies to facilitate early detection of maternal hypertension. The OB leadership team embraced the potential to fill this gap, which is a key strength. The organization has a strong focus on preventative care, so technology-based interventions that enables early detection and management of chronic diseases are encouraged and well-supported. Given my previous role as director of women's services, easy access to preeclampsia e-alert and telemonitoring data was another strength. A final strength of the DNP project is that recommendations provided to the OB department addresses a major problem for the population whom they serve and should contribute to their multi-faceted approach to mitigate preventable maternal morbidity and mortality.

Limitations

The first limitation of the project was the timeframe that preeclampsia e-alert data was collected was 4 months. While the service line goal of provider notification within 4 hours was met and sustained during the last 45 days of data collection, four months of data collection is not long enough to generalize the findings to other organizations. Additional studies are needed to determine whether preeclampsia e-alert and remote BP monitoring would facilitate early detection of maternal hypertension in other settings. A retrospective cohort study of women enrolled in the remote BP monitoring program versus a similar cohort of women who were not enrolled would yield valuable information on the impact of telemonitoring on early recognition of maternal hypertension. In addition, a quantitative or qualitative study on nurse-led co-interventions would yield valuable data on intermediate and long-term outcomes of leveraging technology and nurse-driven interventions for management of maternal hypertension.

Section 5: Dissemination Plan

Integration of new knowledge into practice are key activities for DNP graduates. In fact, the only way that scholarly work can touch human lives is to disseminate (White, 2021). My dissemination journey for the DNP project will begin with the Perinatal Patient Safety Committee (PPSC) at the project site. PPSC is comprised of OB and quality leaders who set the direction for QI initiatives for the service line. The committee was the first to endorse telemonitoring of maternal BPs and will be interested in the results. Next, I will share findings with members of the OBGYN department. Obstetric clinicians and nurses implemented the telehealth initiatives, so it is important to share findings with the frontline stakeholders. Given that the project site is in one of eight closely aligned regions of the health system, it is important to share my findings with members of the interregional PPSC. The interregional PPSC is an important platform for sharing best practices with clinicians and nurses from other regions of the enterprise who face similar challenges with management of hypertension and other chronic conditions.

Maternal hypertension is one of the leading causes of maternal morbidity and mortality in the nation (CDC, 2021), so dissemination of findings to external health systems and interest groups is essential. This can be accomplished through local and national conferences, workshops, and publications. The first conference that I will disseminate my scholarly work is the internal nursing conference. The annual nursing conference allows frontline nurses and leaders across the enterprise to submit an abstract for a poster or oral presentation. Topics of interest includes nurse-led research, evidence-based practice, performance improvement, leadership, and excellence in quality, safety,

and care experience. One benefit of disseminating scholarly work at a nursing or specialty conference is the ability to share learnings with a broad audience of professionals. A second venue for disseminating findings from this project is to publish in one of the specialty publications. The ability to share results from technology-driven QI initiatives through publications, conferences, and workshops promotes the spread of best practices across multiple communities with great potential to make a positive social change for a broader group of mothers and babies.

Analysis of Self

Scholar

In my DNP practicums, I gained knowledge and skills in program planning, implementation, and evaluation, translation of evidence into practice, and dissemination. As a practicing scholar, I have a responsibility to share this knowledge with other health care professionals through mentorship as I continue to build my competencies in the art and science of translation and dissemination. Dissemination of findings from this DNP project will allow me to spread my learnings to other obstetric leaders who wish to leverage technology to improve maternal outcomes. As a nurse leader, mentoring others on leading with science and data will foster a culture of evidence-based practice and professional excellence.

Practitioner

Frontline nurses and nurse leaders identify problems during day-to-day practice. When solutioning the problem, it is important to engage stakeholders at every level of the problem, conduct a literature search to find the latest evidence on the topic, appraise and

summarize the evidence, and make recommendations for policy or practice changes. My doctoral education prepared me to follow this standard approach for translating evidence into practice (Fineout-Overholt, 2019). I hope to serve as a mentor for emerging nurse leaders and a valuable resource for verifying that information which guides policy or practice changes are reliable and applicable.

Project Manager

Leaders of change must be skilled in interprofessional teamwork and change management. Effective listening and communication skills are essential. When the preeclampsia e-alert and telemonitoring were implemented, I championed some of the work, which sharpened my project management and leadership skills. One of my primary responsibilities was to ensure that the clinical teams embraced the remote BP monitoring program and followed recommended guidelines and workflows. I was responsible for articulating the purpose of the program and ensuring compliance with standard workflows and protocols.

My scholarly journey has been informative and insightful, and I am thrilled that it is culminating with the completion of the DNP project. A key learning is that translation of evidence into practice relies on a leader's ability to build relationships and trust with multi-level stakeholders and inspire them to connect to the vision. The OBGYN leadership team at the project site were supportive of the project and their commitment to explore the efficacy of technology-based solutions for hypertension management made it easier to collect data. The biggest challenge was balancing work and school requirements.

Summary

The maternal mortality rate in the state of Georgia is high and hypertensive disorders of pregnancy remains one of the leading causes of maternal deaths (Georgia Department of Public Health, 2022). Given that 22% of the obstetric population at the project site had one or more hypertensive disorder of pregnancy in 2019, targeted interventions for hypertension management were warranted. Early detection and treatment of maternal hypertension can save lives. Best practice alerts in the EHR and Blue-tooth-enabled mobile devices linked to health information systems can provide real-time notification of abnormal or critical values to health care professionals. Preeclampsia e-alert and remote BP monitoring were implemented as QI initiatives for early detection of maternal hypertension.

The purpose of the DNP project was to evaluate the effectiveness of preeclampsia e-alerts and telemonitoring in facilitating early detection of maternal hypertension. The QI evaluation was focused on outcome metrics that demonstrated whether concurrent use of telemonitoring and preeclampsia e-alerts supported the organization's goal of early detection of maternal hypertension. The analysis showed that preeclampsia e-alerts and telemonitoring enables earlier detection and improved surveillance of maternal hypertension. It is important to evaluate whether QI intervention(s) are achieving the intended result of improving patient care and outcomes while allowing for iterative changes along the way.

The demand for safe, timely, effective, efficient, equitable, and patient-centered care calls for nurses at every level of an organization to partner in the design of care

delivery models that meet customer needs (Nelson-Brantley & Ford, 2017). The DNP project illuminated how health care technology can enhance patient care and promote safety. The ability to leverage technology to increase access to, and convenience of home BP monitoring holds significance for the professional practice of nursing as it allows nurses to provide evidence-based care that is timely, equitable, and personalized.

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