OBSTETRIC EARLY WARNING SYSTEM

A DOCTORAL PROJECT

Submitted in Partial Fulfillment of the Requirements

For the degree of

DOCTOR OF NURSING PRACTICE

By

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Doctoral Project Committee Approval

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ABSTRACT

Despite access to the world’s leading healthcare, the United States has not made a significant impact on obstetrical patient safety. The Joint Commission data demonstrates that maternal adverse events such as inaccurate assessment, misinterpretation of fetal and uterine activity, and/or late communication of a patient’s clinical picture, leads to severe maternal and neonatal morbidity or death. An obstetric early warning system trigger tool, based on unique maternal physiological parameters, can be instrumental in identifying patients before negative consequences or deterioration occurs. The purpose of this project was to develop an obstetric early warning system trigger tool for the intrapartum patient in the labor and delivery setting, utilizing specific physiological parameters that may indicate a potential emergent situation. A primary literature search was conducted, and the PDSA quality improvement framework was applied, allowing for multiple applications through the project. The final product, was a subject matter expert evaluated trigger tool, now prepared for simulation testing.
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Thank you to my family for believing in me, even during times of self-doubt. Your constant support and encouragement carried me through the dark times. I love you.
DEDICATION

To my son Finn,

Thank you for being the reason that I strive to be a better person every day. You inspire me to work hard and be proud of everything I do. Thank you for sacrificing so much over the course of this degree. I know that it was difficult to have a ‘Mom in school’ and a ‘Mom who works’. This degree is for you.

Jackie, your endless support and love are the reasons that I am writing this today. I know that you too, sacrificed much for this degree to be possible, and I am eternally grateful. Thank you for always believing in me and never letting me forget why we went on this journey.
BACKGROUND

Problem Statement

As a developed nation, it is concerning that the current pregnancy-related mortality ratio for the United States is 15.9 deaths per 100,000 live births, well-above the target of 11.4 deaths per 100,000 live births set by Healthy People 2020 (Centers for Disease Control and Prevention [CDC], 2016). In addition to the alarming mortality ratio, the Centers for Disease Control and Prevention indicate that the rate of severe maternal morbidity in the United States has risen from 129/10,000 live births in 2009 to 162.76/10,000 live births in 2011 (CDC, 2016). Despite access to the world’s leading healthcare, the United States has not made a significant impact on obstetric patient safety. It is imperative to the well-being of maternal-fetal patients that a national agenda be developed to address the incidence of unexpected maternal deaths.

The literature supports multiple causes leading to unexpected maternal deaths, including associated co-morbidities, advanced maternal age, and anesthesia complications (Callaghan, Creanga, & Kuklina, 2012; Clark et al., 2008). A review of the national sentinel event data lists failure to recognize a patient’s deteriorating status leading to delay in treatment, as a primary cause of unexpected death (Callaghan et al., 2012). The Joint Commission identified that delay in treatment is the fifth leading cause of sentinel events for inpatients, only behind suicide, falls, wrong-patient, wrong-site, and retention of a foreign body (The Joint Commission, 2016). Delay of treatment is defined as a patient who does not receive the appropriate care at the right time causing patient harm or death (The Joint Commission, 2015). Specifically, The Joint Commission data demonstrates that maternal adverse events such as inaccurate assessment,
misinterpretation of fetal and uterine activity, and/or late communication of a patient’s clinical picture, have all led to either severe morbidity or maternal death (Callaghan et al., 2012).

This data supports the theory that the labor and delivery registered nurse plays an essential role in identifying and intervening promptly when a maternal patient’s status is worsening. Research suggests that patients exhibit early, and often subtle signs of physiological abnormalities that warrant swift investigation (Arora et al., 2016; Callaghan et al., 2012; Escobar et al., 2012). These potentially dangerous abnormalities can have cascading, catastrophic consequences, leading to maternal and/or fetal demise or injury. It is imperative that the labor and delivery registered nurse be prepared to conduct a thorough patient assessment and to identify those at-risk for complications, ensuring that treatment is provided in a timely manner.

In the United States, the National Partnership for Maternal Safety (NPMS), advocated for a national solution addressing the rise in maternal mortality rate (Myhre, 2014). The committee acknowledged that “40-50% of maternal deaths are potentially preventable” (Myhre et al., 2014, p. 782). This call to action prompted other prominent maternal-child organizations, to endorse the NPMS recommended minimum physiological parameters, including the need for a standardized early warning system (American College of Obstetricians and Gynecologists, 2016; Association of Women’s Health, Obstetrical and Neonatal Nursing, 2016). These organizations, along with hospitals both local and international have made attempts to develop programs solutions to decrease the occurrence of severe maternal morbidity and unexpected deaths (Cole et al., 2014; Edwards et al., 2015; Shields et al., 2016).
Multiple options have been explored to address obstetrical patient safety including bundles, protocols, trigger tools, and checklists (Arora et al., 2016; Mhyre et al., 2014; Shields et al., 2016). Unfortunately, there has been a failure to develop standardized tools that are accepted across the board as the gold standard. The current literature supports the conclusion that trigger tools have the advantage of objective assessment over bundles, protocols, and checklists (Arora et al., 2016). This advantage lies solely in the hands of the nursing profession who provides most of the primary care to the labor and delivery patient. Nursing is responsible for implementation and execution of said trigger tools, thus avoiding the pitfall of involving multiple disciplines, delivering clinicians, and subjective assessments. The potential for positive outcomes is supported by the success of trigger tools in the non-obstetric patient population for over two decades (Arora et al., 2016; Duncan, McMullen, & Mills, 2012).

An early warning system is defined as a trigger tool designed to enhance a clinician’s objective patient assessment, by scoring selected physiological parameters (Mapp, Davis, & Krowchuk, 2013). Early warning systems have multiple formats including single parameter, multiparameter, and weighted-aggregated point systems. The calculated score then determines the associated algorithm pathway, which directs the patient’s plan of care (Mapp et al., 2013).

First introduced in 1997, the concept of a vital sign trigger tool was discussed by Morgan et al. (1997) to address the phenomenon referred to as patient early warning signs. This classic study identified that a group of patients requiring admission to the ICU or succumbing to unexpected death, displayed deteriorating physiological signs up to twelve hours prior to the emergent event (Morgan et al., 1997).
Since its inception, the premise of the early warning system has been rooted in its simplicity and ease of application by the bedside clinician. Multiple early warning system studies applied to the non-pregnant adult population have published positive results (Alam et al., 2014; Albert et al., 2013). Although early warning systems have been in use in the general adult population for over 20 years, a specific tool designed to address the maternal patient in the intrapartum stage does not exist. Thus, making the development of a specific obstetric patient trigger tool necessary. At present, there are roughly ten maternity or obstetrical trigger tools developed by hospital systems in the United States as well as internationally. Considered as the initial trigger tool, the Maternity Early Warning System (MEWS) was developed and implemented in the United Kingdom in response to a national call for a standardized program, addressing the rising national maternal mortality rate (Carle et al., 2013; Cole, 2014). This tool, specific to the maternal patient population, is designed to be implemented during the perinatal stage and used throughout gestation until six weeks postpartum. However, it is not used during the intrapartum stage, at which time, the tool is abandoned until delivery of the fetus.

Subsequent early warning systems have been developed from this template, following the same implementation practice, while continuing to exclude the most vulnerable time during the maternal patient’s hospitalization. Although pregnancy is considered a state of wellness, the very nature of labor and delivery puts the maternal and fetal patient at risk for severe morbidity and mortality.

Pregnancy related physiological changes render the application of the general adult patient early warning system inappropriate. Complicating the situation is the
current overall health of the pregnant woman. Callaghan et al. (2012) stated that the comorbidities associated with pregnancy, have a severe effect on a women’s health. The increase in preexisting conditions, such as obesity, chronic medical conditions, diabetes, and cardiovascular disease have been linked directly to a rise in unexpected adverse events (Callaghan et al., 2012). The uniqueness of the intrapartum period can obscure the patient’s assessment findings, warranting a trigger tool specific to this perinatal stage to minimize missed opportunities (Arora et al., 2016). The goal of this Doctor of Nursing Practice (DNP) project was to develop an intrapartum trigger tool that will improve patient surveillance and prompt recognition of physiological abnormalities, increase timeliness of early intervention, and promote collaboration and escalation of care with the delivering clinician (Callaghan et al., 2012).

**Purpose Statement**

The purpose of this Doctor of Nursing Practice (DNP) project was to develop an obstetric early warning system trigger tool for the intrapartum patient in the labor and delivery setting. The aim of this project was to identify the physiological parameters that indicated a potential emergent situation during the intrapartum stage.

**Conceptual Framework**

Losing a maternal patient is a shock not only to the family but also to the health care team. It is especially painful if the death is determined to have been potentially preventable. Attentive clinicians will question themselves, wondering what they missed, when they missed it, and how could they have prevented this patient’s death. This Doctor of Nursing Practice project is focused on improving patient care assessment at the bedside and assisting the labor and delivery registered nurse with recognizing the subtle
changes in vital signs during the intrapartum stage. To accomplish this task, this project required a quality improvement framework to guide the improvement process to implementing change. A literature review was conducted to evaluate the application of a quality improvement framework in healthcare, and the Plan-Do-Study-Act (PDSA) model was selected. Leis and Shojania (2016) stated that the PDSA model was most appropriate to guide change in healthcare practice as it allows for the testing of a small change, provides an opportunity for refinement at each stage, and has the potential that it will reveal additional areas of improvement.

The Plan-Do-Study-Act (PDSA) model was chosen as the conceptual framework for this project. This model was adapted from the PDSA model published by the Institute for Healthcare Improvement (2015). The PDSA model focuses on providing guidance to implementing a process change and measuring the outcomes in a scientific manner (Institute for Healthcare Improvement, 2015). The model consists of four phases that may be implemented several times throughout the project in separate cycles illustrating the appropriateness of the framework for this project as it remains in a continuous process improvement sequence.

Phase one, the plan, involves identification of the problem and the selection of the proposed solution to address the situation (Institute for Healthcare Improvement, 2015). This phase involves developing a project question that provides the objective necessary to drive the planning phase. There are several ways to accomplish this phase including, a review of the literature, securing stakeholder support, and/or medical record review. Selecting a study question and its associated intervention(s) direct the project leader to the second phase.
The second phase of the PDSA framework is the do phase involving implementation of the selected intervention to test its impact (Institute for Healthcare Improvement, 2015). Following the plan, the second phase requires the actual implementation of the intervention or improvement. This phase can involve implementation of a treatment plan, facilitation of staffing changes, or integration of new equipment.

Study is the third phase of the PDSA framework which involves evaluating the data produced by the intervention or experiment (Institute for Healthcare Improvement, 2015). This phase is designed to provide the project leader with an opportunity to identify relevant data supporting success or in some cases failure of the intervention. It may also reveal facilitators and barriers to the project’s success and provide the project leader with lessons learned, returning the project to phase one.

Although referred to as the fourth phase, act is certainly not the final phase. This phase requires the project leader to evaluate next steps and consider modifications to the plan (Institute for Healthcare Improvement, 2015). During this phase, the study site would appraise the project’s results and weigh the adoption of the tested intervention or determine the need for refinement of the project’s goals and return to the beginning of the process improvement cycle. In healthcare, the application of the PDSA model is useful as it provides an opportunity to implement an intervention in a structured framework allowing for continuous cycling throughout project development (Leis & Shojania, 2016).

**Literature Examples of PDSA Application**

The literature offers several examples utilizing the PDSA framework to guide practice change in the healthcare setting. These projects illustrate the assortment of ways
the framework can be applied, the variety of results, and the sustainability of improvements. Leis & Shojania (2016) demonstrated the application of the PDSA quality improvement framework to reduce unnecessary urinary catheter use. The PDSA tool was applied in eight different cycles as the project evolved and developed.

The planning stage involved addressing the initial assumption that the emergency department frequency of catheter insertion was the main cause. During the project, leaders discovered that the problem was not only the frequency of insertion, but communication between the in-patient and emergency department nurses and duration of catheter insertions. During the do stage, the authors developed the improvement strategies designed to address identified issues including handoff between the emergency department and in-patient nurses, and a forty-eight-hour alert for the in-patient nurses to reassess the necessity of a catheter. The third phase, study, of the PDSA framework applied to this project, involved evaluating the data produced by the interventions. The authors noted an increase in proactive assessment of indwelling catheters by in-patient nurses, and communication improved between the departments. In the final stage, act, project leaders developed a nurse-driven catheter assessment criterion. Nursing was empowered to recommend catheter removal, increasing nursing accountability and improving patient outcomes.

Another case demonstrating the application of the PDSA framework can be found in the Walley & Gowland (2004) project that focused on improving patient flow through the emergency department and reducing delay of patient placement in the in-patient units. The planning phase involved the assumption that emergency department congestion was caused by delay in bed placement, thus the solution was focused on managing the in-
patient discharges in a timely manner. To address this problem, the project leaders developed a discharge lounge, that would manage in-patients who were discharged, did not require a bed, and were awaiting a ride to go home. During the do phase, a pilot project was conducted to evaluate the appropriateness of a discharge lounge. In the study phase, the lounge study data was analyzed for positive patient outcomes. Findings demonstrated that patients who waited in the lounge less than the maximum of four-hours, had improved patient satisfaction, and there was increased bed availability for emergency department patients. Additional areas for improvement consideration included attention to special needs patients, improved staff education and orientation to lounge processes, and pharmacy delays for discharge prescriptions. During the final phase of act, the project leaders repeated the intervention pilot again, proving that the discharge lounge was a viable solution to reduce wait times in the emergency department for admitted patients. The use of the PDSA provided the project leaders with an opportunity to identify additional areas of quality improvement that impacted the original assumption and allowed for program flexibility, returning to each phase as necessary.

The project conducted by Marcellus, Harrison & MacKinnon (2012), summarized the application of the PDSA quality improvement framework to an oral feeding progression guideline implementation for premature infants in the neonatal intensive care unit. This study involved three applications of the PDSA methodology as the project evolved providing opportunity for revisions and refinement. Throughout the three cycles, the planning phase involved a literature search, drafting clinical guidelines, and developed education programs to nursing and parents. The do phase involved implementing the clinical guidelines for oral feeding progression, conducting focus
groups with parents, and implementing surveys. During the *study* phase, additional questionnaires were provided to department nursing staff and physicians to assess knowledge and feelings related to the clinical guidelines. Infant medical records were reviewed and compared with pre-guideline implementation data to evaluate appropriateness of the guidelines. The *act* phase revealed that, although there wasn’t a significant difference on time to feed and gestational age, the clinical guidelines provided structure for nursing staff and encouraged active participation of parents, staff, and physicians with neonatal feeding decisions.

The PDSA framework provides structure and allows project leaders to guide participants through each cycle with direction and purpose. Without the guidance of a formal framework, quality improvement projects may be destined for failure and unintended outcomes.

**Project Application of the PDSA**

Development of an early warning system for the intrapartum patient is necessary to address the failure of bedside staff to fully appreciate the signs and symptoms of deteriorating patient status and decrease delay of care events. To design a tool that would impact patient outcomes and clinician performance, the project required a quality improvement framework to guide project progression. Despite the equally partitioned phases, this project followed a continuous pattern of sequential and circular evaluation throughout each phase of development and evaluation (Polancich et al., 2017). This project involved two complete cycles of the PDSA and is currently in the planning phase of a future third PDSA cycle.
Cycle One of the PDSA

During cycle one of the PDSA, the *planning* phase of this project required the composition of a problem statement to address the necessity of developing a tool to address scoring the assessment of maternal patients during the intrapartum stage. The *planning* phase involved conducting a literature review, analysis of causative factors in sentinel events published by The Joint Commission, and a review of maternal morbidity and mortality rates available from the CDC.

Application of the second phase, *do*, involved the selection of the physiological parameters to build the proposed trigger tool and the development of an associated action plan. The selected physiological parameters were reviewed and compared to literature resources, while consulting relevant pregnancy and intrapartum ‘normal’ vital signs findings to ensure accuracy of parameters and scoring. Additionally, the action plan for escalation of care and recommended interventions were supported by relevant literature resources and developed based on their appropriateness to the plan of care.

In the *study* phase, the project leader analyzed previously developed trigger tools for the adult non-pregnant population and compared these with proposed conceptualized physiological parameters specific to the pregnant patient during the intrapartum stage. Concurrently during this phase, the project leader reviewed the causative factors in sentinel events reported to The Joint Commission in 2016. Review of this data provided the foundation for the development of the obstetric early warning system trigger tool and further supported the need for a physiologically-specific instrument that evaluates the maternal patient during the intrapartum stage.
During the final phase, *act*, the project leader amended the proposed obstetric early warning scoring system and action plan and finalized the tools in preparation to begin cycle two of the PDSA.

**Cycle Two of the PDSA**

The PDSA framework is designed to allow for multiple applications throughout the project, providing opportunity for program revisions and improvements (Marcellus et al., 2012). This project completed two full cycles of the PDSA framework. The *planning* phase of the second application involved scheduling the group discussion sessions at the project setting, development of the discussion guide, and development the education module for the subject matter experts.

During the *do* phase, the project leader conducted group discussion sessions with volunteer subject matter experts. The group discussions were facilitated by the project leader, with a short education module presented to introduce the tools. A discussion guide was used to facilitate the sessions. The self-developed discussion guide was modeled after the Delphi process to elicit both positive and negative feedback.

The *study* phase involved the review of subject matter expert feedback, summarization of the recommended revisions and comments, and concurrent comparison with the literature sources to determine if suggested revisions were appropriate.

In the last phase, *act*, the project author finalized the tools met once again with subject matter experts to review the finalized versions. Following this meeting, the tools were prepared for a future cycle three application of the PDSA.

It is essential to any healthcare quality improvement project that the objective remain focused on impacting clinical outcomes (Batalden & Davidoff, 2007). The
application of the PDSA quality improvement framework provided structure to this project that required multiple cycle applications.
REVIEW OF LITERATURE

The literature review consisted of primary and secondary searches. The literature search utilized three databases: PubMed, CINAHL and Google Scholar. These databases were searched to identify sources with the following key words: early warning systems, early warning scores, trigger tools, failure to rescue, maternal death, patient safety, obstetrical quality, quality improvement, deteriorating patient, and vital signs. Limitations to the literature search included refereed journal publications between 1997-2017 and English language only.

Early Warning Systems

Multiple studies of the early warning systems in the non-pregnant adult population have indicated positive results (Alam et al., 2014; Albert et al., 2013; Smith et al., 2013). A systematic review containing 22 studies, evaluated the efficacy of early warning systems (Alam et al., 2014). Although examination of the findings indicated an overall positive impact on selected patient outcomes including mortality, ICU admissions, and serious adverse events, the use of multiple formats and scoring systems made it impossible to draw absolute conclusions about success. Trigger tools utilizing existing vital sign data in the electronic health record (EHR) calculate scores while using predictive modeling (Albert et al., 2013; Mitchel et al., 2010). This model successfully demonstrated an immediate identification of patients at risk for unexpected admission to the ICU from medical-surgical unit or the necessity of a code for the general adult patient population (Escobar et al., 2012).

The competence of the bedside clinician, utilizing early warning systems, was a common theme throughout most of the articles. The authors identified that the success of
the tools was dependent on bedside clinician’s objective assessments and subsequent documentation of vital signs, that ultimately directed the patient’s associated, score-driven action plan (Hammond et al., 2013; Mitchel et al., 2010). These studies identified that the frequency and accuracy of vital signs documentation pre-and post-implementation of an early warning system, was slightly improved, but also revealed that, the accuracy of the score relies solely on the skill of the clinicians. The quality of staff education and compliance with the tool utilization was essential to each program’s success.

**Maternal Morbidity and Mortality**

The pregnant and laboring woman is generally considered a well patient and is low risk unless additional risk factors are identified. The normal physiological changes in pregnancy can often hide an underlying condition. If the clinician is not acutely aware of the patient’s status, and subtle warning signs are not interpreted correctly, the maternal patient’s condition can rapidly deteriorate (Shields et al., 2016).

The CDC (2016) defines maternal morbidity as: “any physical or psychological conditions that result from or are aggravated by pregnancy and have an adverse effect on women’s health” (p. 1). It has been noted in the literature, that although maternal death is of great concern nationally, the maternal morbidity rate has steadily climbed over the last two decades affecting over sixty-five thousand women every year (CDC, 2016). The data suggests that maternal patients are more likely to suffer from severe pregnancy-related morbidity, including hemorrhage, eclampsia, sepsis and birth injuries, than they are to die during labor and delivery (Callaghan, et al., 2012; CDC, 2016). Severe maternal morbidity has long term effects on the patient, including delay of discharge,
complicated postpartum recovery, and an increase in the overall cost of care (Callaghan, et al., 2012). It is evident that there is a great need to address obstetric safety in the United States. A viable option to improve clinical surveillance at the bedside during the intrapartum stage is the implementation of a trigger tool (Mhyre et al., 2014). Acute observation and use of a calculated physiological parameter scoring system, would provide the registered nurse with a tool that assigns values to the patient’s assessment data. Evaluating the score and implementing the associated action plan would mitigate the potential risk for an adverse event.

The most common theme identified across the literature related to maternal mortality showed that, in many of these cases, maternal deaths were preventable (Clark et al., 2008; Creanga et al., 2010; Kilpatrick et al., 2016; Mhyre, et al., 2014). The authors concluded, that the leading causes of maternal death were hemorrhage, preeclampsia, failure to rescue, medication error, and infection (Clark et al., 2008; Creanga et al., 2010; Kilpatrick, et al., 2016; Mhyre, et al., 2014). Mhyre (2014) hypothesized that, if a specifically designed obstetric trigger tool was implemented, a patient assessment could identify the early signs and symptoms of a maternal patient’s worsening condition, alerting the registered nurse to activate a predetermined plan of care.

**Early Warning Systems and the Obstetric Patient**

The only nationally implemented obstetric early warning system (OEWs), the United Kingdom trigger tool, was designed by a national collaborative in 2007 (Carle et al., 2013; National Institute for Health and Care Excellence, 2007). This trigger tool was developed in response to a demand by the Royal College of Physicians (RCP) to improve the national maternal mortality rate by targeting the morbidity rate. This trigger tool was
adapted from the National Early Warning Score (NEWS) that was developed for the non-obstetric adult patient in the United Kingdom (Carle et al., 2013). The aggregate-weighted early warning scoring system identified several physiological parameters that provided objective criteria during patient assessment indicating a patient’s worsening condition. These parameters included basic vital sign collection, level of consciousness, pain, discharge and/or lochia, oxygen saturation, and proteinuria (Carle et al., 2013). This tool was only applied during the antepartum and postpartum stages because the developers believed that its applicability was limited during the intrapartum stage. The tool did not include the assessment of the fetal heart rate or uterine activity, rendering the application during the intrapartum stage ineffective and providing additional support for the development of tool specific to the laboring patient. A five-year follow-up survey was conducted to evaluate 130 hospitals currently utilizing an obstetric early warning system to determine barriers with system operations. The authors concluded that, although 117 hospitals had an early warning system in place, less than half implemented the nationally recommended tool and half had developed their own system. Despite the noted trigger tool variations, the authors reported that the respondents agreed the tool was useful in detecting abnormal, overt, and subtle vital signs (Isaacs et al., 2014).

Based on the success of the United Kingdom program, a few hospitals in the United States developed and implemented modified versions of a maternity early warning system. These tools were based on the United Kingdom obstetric NEWS template with modifications to the criteria and action plan algorithms (Shields et al., 2016).

Nationally, the United States does not have a standardized tool for the maternity patient; variation exists in inclusion criteria and the point of escalation trigger differs
from site to site. Recently, the National Partnership for Maternal Safety (NPMS) recommended that a standardized, obstetric early warning system and algorithm be created to address maternal morbidity and mortality (Mhyre et al., 2014). The specific physiological parameters selected by the NPMS included: “systolic blood pressure, diastolic blood pressure, maternal heart rate, oxygen saturation, oliguria, maternal agitation, confusion, patient with preeclampsia, a non-remitting headache, and shortness of breath” (Mhyre, 2014, p.784). The authors acknowledge that this initiative is in its infancy and does not provide clinical guidelines related to frequency of patient assessment, trigger tool implementation, or execution of the algorithm. Mhyre et al. (2014) identified that the success of an early warning system relies on the skill of the registered nurse, timeliness of response by delivering clinicians, and unit culture. The absence of fetal heart monitoring and uterine activity in the recommend assessment criteria by the NPMS committee, highlights the necessity for an intrapartum-specific trigger tool.

One hospital system piloted the use of a Maternal Early Warning Trigger (MEWT) tool and evaluated its impact on maternal morbidity (Hedriana et al., 2015; Shields et al., 2016). This pilot program utilized the hospital’s performance improvement framework to guide the implementation and evaluation of the newly designed tool. Findings demonstrated that the Maternal Early Warning Trigger tool decreased morbidity associated adverse events at the pilot sites. This tool was utilized during the intrapartum stage, which is unique in this population, although the tool did not include fetal heart rate or uterine activity assessment criteria. The study’s conclusions supported the need for a population-specific tool to improve recognition of an evolving situation warranting
additional investigation with escalation to the appropriate plan of care (Hedriana et al., 2015; Shields et al., 2016). Additional recommendations included a comprehensive staff education program and a pre-determined care pathway associated with the trigger scoring system (Hedriana et al., 2015; Shields et al., 2016). This review of literature supports the need for an obstetric early warning system designed to address the intrapartum stage ensuring provision of safe maternal-fetal dyad care.

**Fetal Monitoring and Uterine Activity**

During labor, the maternal-fetal dyad can be placed in a precarious situation if they are not monitored appropriately. These patients are at an elevated risk for severe morbidity, if subtle signs of worsening condition are not identified early (Callaghan et al., 2012; Clark et al., 2008; Kilpatrick et al., 2016). Currently, the maternal early warning systems previously published in the literature, do not include two critical elements of maternal-fetal assessment, fetal heart monitoring and uterine activity assessment. Fetal heart monitoring and uterine activity assessment are essential to the health and safety of the maternal and fetal patients (Clark et al., 2008).

Prominent experts in the field of maternal-fetal medicine are unable to arrive at a consensus on monitoring interpretation and treatment of fetal strip findings (Clark et al., 2013). Due to the variation in fetal strip interpretation, Macones et al. (2008) via the National Institute of Child Health and Human Development (NICHD), published standardized terminology for assessment and interpretation of fetal heart rate and uterine activity. Although this publication was endorsed by national and international associations specializing in the care of these patients, clinician compliance with the terminology continues to be an issue (Clark et al., 2013). Compounding this barrier to
utilizing standardized terminology, universal interpretation and management of the fetal strip findings has not been achieved. This unfortunate situation leads to another area of concern when caring for the maternal and fetal patient. Incorrect assessment, misinterpretation, and miscommunication of fetal strip assessment findings by the bedside registered nurse have led to serious adverse events (Clark et al., 2013; The Joint Commission, 2016). This supports the author’s decision to include fetal heart rate and uterine activity as criteria in the obstetric early warning system trigger tool applied specifically to the maternal patient during the intrapartum stage.
METHODS

The purpose of this project was to develop an obstetric early warning system, multi-parameter, physiological trigger tool, designed specifically for the hospitalized laboring maternity patient. The project utilized the PDSA quality improvement framework because it is an iterative process suitable for developing and evaluating the tool. Due to the multiple cycle applications, this project benefited from the structured systematic PDSA framework. Development of a patient assessment tool that has the potential to improve patient outcomes and change clinical practice requires a framework that employs fluidity (Bonnel & Smith, 2014).

Setting

The setting for this DNP project was a Southern California acute care hospital with 463 licensed beds. This hospital is a member of the tenth largest not-for profit healthcare organization in the United States. The health system is based upon a foundation of dignity, justice, service, and excellence. Maternity services provided at this hospital include caring for the low to high-risk obstetric patients, gestational diabetes support, breastfeeding classes, maternal-fetal medicine and perinatology. The fifty-bed, private room labor and delivery unit is associated with a children’s hospital, specializing in the care of newborns requiring additional support and life-saving interventions. The annual birth rate is greater than 5,000 newborns a year (St. Joseph’s Hospital, 2018).

The group sessions took place at the hospital. Hospital meeting rooms had adequate space to accommodate the groups of one to five participants and the project leader. The meeting room sizes varied from a small office to a large nursing station, with a table in the middle of the room, allowing the participants and project leader to face each
other during the group discussions. Extraneous variables that affected the planned group sessions included staffing, unit census and acuity, room scheduling conflicts, lighting, and room temperature. All possible resources were accessed to address extraneous variables during the group sessions to accommodate the subject matter experts and project leader.

**Sample**

This DNP project involved the expertise of hospital employed labor and delivery nurses. The group discussion sessions were restricted to labor and delivery registered nurses because the trigger tool is designed for application only to the intrapartum patient. These nurses served as content experts, and through group discussions, helped in the revision of the obstetric early warning system trigger tool and action plan. Participant qualifications included labor and delivery registered nurses, who have at least one-year clinical experience in labor and delivery, the completion of a fetal monitoring course and the preferred completion of advanced fetal monitoring course. These qualifications established credentials for designation as content experts. Completion of fetal monitoring courses indicated that these individuals had the required knowledge and expertise in caring for the intrapartum patient. At least one year of experience provided additional support for member selection, as community standard dictates that this allows the labor and delivery nurse to care for intrapartum patients without a preceptor. It was an expectation that the subject matter experts would provide valuable and rich suggestions to assist the project leader with tool and action plan refinement.

Exclusion criteria were any clinical ancillary department members that provided patient care but were not considered essential to the implementation of the obstetric early
warning system trigger tool. Additional exclusions from group discussion membership included, delivering clinicians, anesthesia providers, pediatricians, neonatologists, and registered nurses employed outside of labor and delivery.

**Recruitment**

Participants were recruited using an information sheet listing the project’s purpose, group discussion session goals, facilitator information, and outlined participant commitment. The information sheet was posted on the labor and delivery unit to generate project awareness. The information sheets were hung in regularly frequented, visible areas throughout the unit to ensure that the project message was communicated to the pool of subject matter experts. The project leader’s information was listed on all recruitment materials and provided via tear off sections on the flyers. Project information was also provided on the unit during a staff meeting by the unit manager. Nurses interested in participating were invited to attend a group discussion meeting, with the choice to attend one of the two (2) offered sessions.

**The Quality Improvement Project**

Subject matter experts (SME), with pre-determined qualifications, knowledge, and experience, were essential to the review process to ensure content validity. Content validity is defined as an assessment parameter, determining if the tool content accurately captures the information that is being measured (Polit & Beck, 2017). The physiological parameters that comprise the tool were evaluated by the volunteer group participants, with the goal of determining if the trigger tool would alert the nurse to a patient’s deteriorating condition.
During the group discussion session(s), the project leader provided a ten-minute education session, introducing the tool and the action plan algorithm. A group discussion guide was developed and used to conduct the sessions. The guide focused on the physiological parameters of the trigger and action plan algorithm. Participant input was solicited to determine where the tools contained the correct elements and assessment parameters; content was altered based on their input. Additionally, opinions about usability of the tool were sought to assure its applicability to the target patient population. This design allowed for contemporaneous discussion between group members and the project leader. The project leader clarified responses and posed related questions in response to statements or questions from the participants.

Participants did not receive compensation for attending the focus group sessions. Anticipated barriers to group discussion sessions included participant time commitment, unit staffing ratios, unit census on group discussion session dates, and lack of volunteer participants. As an alternative to a day shift group discussion, a night shift session was conducted to include subject matter experts from this staff population pool. Although one-on-one interviews were posited, they were not done because a sufficient number of nurses participated in the group discussions.

**Ethical Issues**

An Institutional Review Board (IRB) application process was completed with California State University, Los Angeles and the St. Joseph’s Health System. The project was deemed to be exempt by both Institutional Review Boards. St. Joseph Hospital is a Magnet accredited institution and per institutional protocol, the project additionally
required a presentation to and approval by the Nursing Research Council at St. Joseph’s Hospital.

This quality improvement project involved minimal risk to group participants. The only identified barrier was the 30-minute time commitment required to participate in the group sessions, including the ten-minute education and instructional session, and time to complete the group discussion via the project leader’s discussion guide. Demographic information was collected about the participants as well as the suggested edits, modifications, and comments about the early warning system and action plan. There was no coercion to participate and the nurses were assured that they could withdraw from the project at any time without repercussion.

**Data Collection**

After IRB approval, the author conducted a review of the proposed obstetric early warning system trigger tool and associated action plan algorithm through group discussions with subject matter experts. The group discussion method was utilized because it is cost effective, allowed the project leader and participants to interact, and offered the opportunity to record anecdotal notes contemporaneously (Polit & Beck, 2017). Group discussion sessions ideally consist of one to ten participants. The group members were considered homogenous as the criteria to participate is the same for each member (Polit & Beck, 2017). Homogeneity is important to group membership because the project author required subject matter experts, who shared the same knowledge and experience necessary to review the components of the trigger tool and action plan. The project leader developed a group discussion guide that had open-ended questions related to each physiological parameter, associated score, and the action plan algorithm. This
guide was developed based on the early warning system tool, with the intent on soliciting feedback related to its content to ensure each item was addressed for value or the need for suggested modifications.

Each session was conducted with a 30-minute timeline, utilizing the discussion guide to ensure each meeting remained focused. The project leader acted as moderator and guided the participants through the discussion, designed to critique the trigger tool and action plan. The project leader took anecdotal notes throughout the group discussions. Advantages to this method of data collection included cost effectiveness, convenience sampling, and immediate participant feedback. Barriers to effective data collection with group discussion sessions included the possibility of group think and member’s fear of disagreeing with participants who were in positions of authority on the unit (Polit & Beck, 2017).

The project leader analyzed the participant responses for similarities in suggested modifications, edits and revisions. The data was summarized and collated to streamline results for the final analysis. Revisions to the tool and action plan were considered based on the suggested edits, participant responses during group discussions, and compared to relevant support from the literature. The Delphi method allowed the project leader to implement the second phase which involved the regrouping of the subject matter experts to review the amended tool and action plan. The Delphi method was also employed to measure group member consensus. Frequency distribution at 51% was used to measure responses to the discussion guide categories (Rayens & Hahn, 2000). The Delphi method was employed during data collection to establish consensus amongst the subject matter experts (Rayens & Hahn, 2000). The Delphi method employs two cycles, the first
involved an initial review of the tools and solicitation of feedback by the SME. The project leader evaluated the feedback for relevance and revised the tools as appropriate (Rayens & Hahn, 2000). The second cycle of the Delphi process was applied during the act phase of the second cycle of the PDSA framework, involving a concluding SME group discussion to review the final tools.

Following completion of the data collection process, the project leader transitioned to the data analysis element of the project.
RESULTS

The purpose of this project was to develop an obstetric early warning system (OB EWS), multi-parameter physiological trigger tool, designed specifically for the hospitalized laboring maternal patient. The development of the obstetric early warning system trigger tool required a review by subject matter experts to provide credibility to the project purpose. A total of eight subject matter experts participated in the first group discussion, reviewing the trigger tool and the action plan. The second group discussion consisted of three subject matter experts from the night shift, who also reviewed the tools with the project leader. Once the project leader completed the amendments to the trigger tool and action plan, based on the suggested edits from the subject matter expert group discussions, an additional group of subject matter experts met to finalize the tools. This third and final meeting, with a total of five participants, reviewed the tool to ensure that the project products were in their most appropriate and complete format.

In cycle one of the PDSA framework, a gap was revealed in the literature indicating the need for a population-specific early warning system, applied in the intrapartum setting. Products of cycle one included the development of the trigger tool and associated action plan algorithm. During the second application of the PDSA cycle, group discussions with subject matter experts from the project setting were conducted to review the original tools. Following analysis of subject matter feedback, amendment of the tools based on literature support was completed and a third meeting was conducted to evaluate the final products. The trigger tool and associated action plan, both in their final format, are prepared for application of cycle three of the PDSA, as a simulation pilot at a clinical setting.
Action Plan Algorithm

Identification of themes from the first round of group discussions with subject matter experts (SME) revealed several commonalities related to recommended improvements for the OB EWS tool and action plan. The SME, sixteen of sixteen, agreed that the tools were easy to use and that it would identify patients who were in a potentially worsening condition. sixteen of sixteen of the SME are employed at a hospital that does not currently utilize an obstetric early warning system. All participants agreed that the color-coded action plan was appropriate and agreed that it would be valuable to new and veteran labor and delivery nurses, prompting escalation of care and assisting with informed decision-making.

Eight of the sixteen SME agreed with the need for an action plan, but two of the eight SME disagreed with the action plan requirements. These participants recommended that the escalation plan include detailed physician orders that address the patient’s worsening condition. The detailed recommend action plans should include laboratory test orders, physician order required interventions etc. All sixteen SME recommended that the term ‘resource nurse’ be removed and replaced with ‘charge nurse’. Sixteen of the sixteen SME agree that the action plan was easy to follow and appreciated the standardized approach to managing an obstetric patient during the intrapartum stage.

All participant SME (sixteen of sixteen) recommended that the action plan refer to the laborist for scores of >4 instead of the primary delivering clinician. This recommendation is considered valid for this site. although if implemented at other sites the action plan would be reflective of the care delivery model at that specific hospital.
Physiological Parameters

SME discussion surrounding the trigger tool’s vital signs involved, the order of the selected data points as presented on the tool, not necessarily their inclusion or exclusion. Twelve of sixteen participants recommended that blood pressure be moved to the first line on the vital sign section of the tool to identify it as the top priority. Heart rate was selected by the SME discussion group as the second physiological parameter to be listed on the OB EWS tool. Sixteen of sixteen of the SME agreed that the heart rate descending scores were appropriate and would provide early identification of a patient if the maternal status was changing. Thirteen of sixteen SME determined that respiratory rate should be listed as the third variable on the OB EWS tool.

Urine Output

Thirteen of sixteen SME agreed that urine output is a very important physiological parameter to assess when caring for the maternal-fetal dyad. Although the clinical setting only measures urine output with a physician order, thirteen of sixteen of the SME discussion group indicated that this parameter would identify patients that may be moving to a high-risk status.

Level of Consciousness

Twelve of the sixteen SME approved the inclusion of level of consciousness as a component of the tool, and one participant stated that “this would improve documentation of level of consciousness assessment while our patients have epidurals”. The remaining four SME indicated that they document level of consciousness only if required to do so by physician order.
**Quantification of Blood Loss**

Sixteen of sixteen of the SME participants recommended the removal of the quantification of blood loss (QBL) as it does not apply to the intrapartum patient. The removal of QBL was approved by all sixteen SME participants and agreed that this was only a post-partum parameter not applicable during the intrapartum stage. Although rare in the intrapartum setting, rapid maternal blood loss would be treated emergently in situations that were considered unpredictable, i.e. uterine rupture (AWHONN, 2014). In cases of potential blood loss, such as placenta previa, patients would be immediate candidates for cesarean section and would not be permitted to labor (AWHONN, 2014).

**Fetal Heart Rate and Uterine Activity Assessment**

Sixteen of sixteen of the SME agreed that inclusion of these parameters would encourage vigilance at the bedside and assist with avoidance in acceptance of normalization of deviation.

**Additional Recommendations**

The SME participants in the first group discussion provided the project leader with additional physiological parameter recommendations. Ten of sixteen SME noted that pain was not included in the OB EWS tool. The staff felt that pain is an important symptom that a maternal patient may be experiencing a progressively worsening condition.

Three of sixteen SME commented that laboratory values were missing from the tool and action plan. Laboratory tests recommended for inclusion were magnesium sulfate (applicable only to that patient treated with magnesium sulfate), platelets, white blood cells, and hemoglobin and hematocrit.
Suggested Aesthetic Revisions

In order to design the tool to be more visually appealing, the SME discussion group provided additional suggested edits related to the aesthetics of the tool and action plan. Sixteen of sixteen SME recommend that the OB EWS documentation tool be revised to include color-coding per score. For example, if the blood pressure score is a three (3), then the box should be colored red. If it scored a two (2) or a one (1) then it should be colored yellow, if it scored a zero (0) then it should be colored green. This would provide the user with an immediate visual cue that the score was either normal or abnormal, prompting further investigation if needed without additional steps to score the remaining parameters. Sixteen of sixteen SME agreed that the color coding of the tool would be helpful for all users and improved the visual aesthetics of the tool.

The Final SME Session

Following the initial sessions with the SME discussion group, an additional session was convened to review the revised tool and action plan. The tool was reflective of most of the suggested revisions that were collected during the first SME sessions. One SME repeated the recommendation that pain be included on the tool but accepted the explanation that pain would not be added due to lack of current literature support. Sixteen of sixteen SME agreement with the action plan revisions was achieved. The action plan reflected the suggested revisions that were clinical setting specific, with the inclusion of charge nurse and laborist verbiage.
DISCUSSION

The OB EWS was developed to identify patients during the intrapartum stage that breach the selected physiological parameters. The tool is designed to score the patient, direct the clinician to the associated action plan, in order to intervene appropriately at the time of discovery. The missed opportunities of delaying care when clinicians are unable to combine the alarming clinical characteristics of a worsening patient situation has led to an increase in maternal morbidity and mortality (Shields et al., 2016). Developing a standardized assessment tool that scores a patient’s physiological parameters that will, theoretically, prevent delay and decrease serious maternal adverse events, is desperately needed. This strategy, supported by the literature, is an optimal choice for the maternity community to focus a consorted effort among the leading experts in maternity care, i.e. AWHONN, ACOG, to develop and provide implementation guidelines. The main findings derived from the SME group discussions were valuable suggested edits to the tool and action plan. The suggested edits were verified with literature sources to ensure that revisions were made with support of previously published studies on maternal early warning systems. Changes that were accepted are reflected in the included final version and were verified by the references supplied with each edit.

**Action Plan Algorithm**

Although the SME suggestion to include medical orders and care management protocols in the action plan does have merit, it does not support the goal of early identification with immediate escalation of care. Smith et al. (2017) supported that specific care management stages, that correlated with a patient’s early warning system score, were equally as important as the patient’s clinical characteristics in identifying
those at risk of deteriorating conditions. The literature supports escalation of care with each change in a patient’s status but does not routinely specify physician orders that are dependent on individualized cases (Mhyre et al., 2014; Ryan et al., 2017; Zuckerwise et al., 2017).

Revisions to the action plan included clinical-setting specific terminology to eliminate confusion by the users. The initial edit involved removing ‘resource nurse’ and replacing with ‘charge nurse’. This accurately reflected the term used by the project’s setting hospital and a search of the literature supports the use of charge nurse as a common term in the acute care setting (Normand et al., 2014). Alternate terms that define the role of charge nurse may be used in other hospitals and this may require revision if the tool is implemented at additional sites.

The second terminology revision of the action plan involved replacement of ‘delivering clinician’ with ‘laborist’. As hospital obstetric practices have evolved over the last ten years, the incorporation of the laborist (obstetric hospitalist) have been included in the labor patient management team. The laborist role is relatively new and not widely used by all hospital systems. The literature lacks specific studies evaluating the direct impact of laborist programs on maternal and neonatal outcomes (Srinivas et al., 2015). The project setting employs laborists on the labor and delivery unit 24/7, and the care delivery model impacts the trigger tool’s action plan. Although unable to support an actual significant impact on maternal and neonatal outcomes, the hospital believes that the laborist’s presence does provide an increased sense of patient safety and a decrease in care delays (Feldman et al., 2015; Srinivas, et al., 2016). The recommendation to include the term ‘laborist’ is considered valid for this site, although if implemented at other
clinical settings, the action plan would be revised to reflect the care delivery model at that specific hospital. The project leader does acknowledge that these revisions may not be applicable to other clinical settings as the practice model and terminology used may differ.

All sixteen of the SME reported that the tool will provide an important visual cue for the bedside clinician which is in congruence with the literature. Smith et al. (2017) indicated that a color-coded early warning system provides a platform that would reduce confusion among the staff, increase consistency with care practices, and improve decision-making.

**Physiological Parameters**

The literature supports the need to identify vital signs that are most likely linked to predict changes in a patient’s condition and alert the nurse to a potentially worsening condition (Mhyre et al., 2014; Zuckerwise et al., 2017). The Paternina-Caicedo et al., (2016) study indicated that 45.9% of maternal ICU admissions were listed as blood pressure related disorders. Even though minor alterations to blood pressure occur during the first two trimesters of pregnancy, and are considered normal, Zuckerwise et al., (2017) indicated that blood pressure related events were associated with 50% of preventable deaths due to preeclampsia. Maternal heart rate, although a late indicator of most clinical situations, when coupled with blood pressure readings, is an appropriate indicator of the worsening severity of the patient’s status (Paternina-Caicedo et al., 2016). In several studies, missed maternal tachycardia has been linked to increasing maternal mortality rates, thus supporting its priority rating (Paternina-Caicedo et al., 2016). The abnormal maternal heart rate range, scoring the patient a high score of 3 on the obstetric
early warning system, supports the recommended heart rate parameters set by Mhyre et al. (2014). This abnormal heart rate range indicates that the patient is in immediate need of additional assessment and potential emergent intervention.

The literature supports respiratory rate be included as a physiological parameter on early warning systems. While minor changes in rate may be due to the progression of labor and maternal exertion level, major changes in respiratory rate and quality require immediate interventions (Carle et al., 2013; Singh et al., 2012). Appropriate maternal oxygenation is important to the maternal-fetal dyad, because the fetus is completely dependent on the maternal supply of adequate oxygen.

Measurement of adequate oxygenation is also required during the intrapartum stage, specifically while the maternal patient is receiving an epidural for pain relief (AWHONN, 2014). Along with the previously discussed vital sign variables, oxygen saturation is also included on the OB EWS tool. Pulse oximetry is used as an additional assessment tool to manage the laboring patient’s tolerance of labor, interventions, medications etc. associated with the labor progress. A pulse oximetry reading of <95%, requires immediate supplemental oxygen support and delivering clinician bedside assessment (Mhyre et al., 2014). Although the clinical setting does not routinely use pulse oximetry readings during management of the intrapartum stage, twelve of sixteen agreed that both respiratory rate and pulse oximetry value would be assessed in tandem if indicated by additional clinical findings. This is an important observation, as it is a clear indication that obstetric clinical practice models will vary between hospitals, states and countries.
Urine Output

Urine output is measured on all high-risk patients and surgical patients, but it is not routinely measured on the low-risk laboring patient (Mhyre et al., 2014; Smith et al., 2017). Urine output measurement is recommended on patients with indwelling epidural catheters, which is the number one source of labor pain relief. Changes in urine output may indicate a patient’s worsening condition, such as preeclampsia, shock or sepsis (Lowdermilk & Perry, 2007). These maternal conditions can put the patient in a compromised situation, with the potential to impact maternal and fetal well-being.

Level of Consciousness

According to the literature, level of consciousness (LOC) is an important physiological parameter that is evident in several maternal early warning systems previously studied (Smith et al., 2017). Incoherent responses and inappropriate answers are strong indicators that a patient’s condition is changing. Changes in maternal LOC can be related to hypoxia, medication administration, anaphylaxis of pregnancy, or epidural complications (Lowdermilk & Perry, 2007). Each situation requires an immediate need for emergency intervention by the healthcare team.

Quantification of Blood Loss

All the SME (sixteen of sixteen) requested the removal of QBL from the OB EWS. The project leader reviewed the literature, which supported this suggestion, and agreed to remove the QBL parameter. Since QBL is measured on maternal patients from stage three of labor through the post-partum hospital stay and the OB EWS target population is the intrapartum patient, the measurement of blood loss is not routine (AWHONN, 2014). Acute blood loss during the labor is a rare occurrence and would be
treated immediately with emergent interventions by the delivering clinician (AWHONN, 2014). These patients would no longer be considered laboring and the OB EWS would not apply.

**Fetal Heart Rate and Uterine Activity Assessment**

The two unique components of the OB EWS tool are the inclusion of the fetal heart rate (FHR) and uterine activity (UA) assessment. These two parameters make the tool specifically applicable to the intrapartum patient. Fetal heart rate assessment provides the clinicians with information on fetal well-being within the uterine environment. UA assessment provides the clinicians with information on maternal uterine tolerance of the labor process and contractions (AWHONN, 2015). Labor and delivery nurses conduct a FHR and UA assessment on a laboring patient every 5-30 minutes depending on the stage of labor and the risk status of the maternal-fetal dyad. Most laboring patients will be observed continuously throughout labor with electronic monitors to ensure that abnormal characteristics will be identified early. These characteristics can include decelerations, tachysystole and abnormal baseline. By assigning a score to the FHR and UA NICHD category, the labor and delivery nurse can make informed decisions regarding the appropriate interventions for patient care. Providing this assessment parameter within the OB EWS tool allows the labor nurse to use the FHR and UA assessment, along with the other priority clinical characteristics, to accurately assess the maternal-fetal dyad’s condition. Unfortunately, according to The Joint Commission (2016) root cause analysis, the factors among most often responsible for adverse perinatal events are inaccurate assessment and interpretation of the fetal strip. This is a concerning, because serious adverse events occur due to delay of care by
clinicians who do not appreciate the magnitude of the fetal strip progression from normal to abnormal over the course of labor. Tachysystole is the most common cause of abnormal fetal heart rate response in labor (Clark et al., 2007). This phenomenon can be caused by excessive endogenous or exogenous sources of oxytocin and the situation is dangerous for both the maternal and fetal patient. Tachysystole, not treated effectively, can lead to aggressive interventions, emergent deliveries, and aggressive resuscitation of the newborn (AWHONN, 2015; Clark et al., 2015).

**Additional Recommendations**

Escalating pain levels in a labor patient can be a normal finding as labor progresses and uterine contractions become more frequent. Pain can also be indicative of a maternity patient in an emergent situation leading to surgical intervention. These situations may include abruptio placenta, uterine rupture, or unresolved tachysystole (Clark et al., 2007). If rising pain levels are identified and are correlated with additional clinical characteristics, immediate bedside assessment by the delivering clinician is required. Conversely, the literature does not agree on whether pain should be included as a physiological parameter in a maternal early warning system. Overall, pain has not been included in the majority of the previously published maternal early warning systems because it failed to show a relationship with maternal morbidity (Carle et al., 2013; Mhyre et al., 2014; Singh et al., 2012). The project leader, based on the literature, did not include pain as an assessment parameter in the final OB EWS tool.

The recommendation of adding magnesium sulfate, platelets, white blood cells, hemoglobin and hematocrit was considered by the project leader. Although these are important lab values to the maternal patient, and if abnormal, are indicative of a high-risk
patient situation, they are not typically abnormal. The selected physiological parameters included on the OB EWS tool will alert the clinician to worsening patient condition before isolated lab values. A literature review of previously published maternal early warning systems found that these tools do not include lab values (Carle et al., 2013; Cole, 2014; Shields et al., 2016; Singh et al., 2011). The project leader, based on this information, declined to add lab values to the OB EWS. Rather, laboratory tests will be left under the direction of the medical team managing the care of the patient.

**Suggested Aesthetic Revisions**

The subject matter experts recommended that the trigger tool and action plan be revised to appear more visually appealing to the bedside clinician. This would provide the user with a ‘quick view’ of the patient’s score and, if necessary, the required interventions and escalation of care. One SME stated, “this will be easy to see if my patient is abnormal”. The literature supports the use of a color-coded tool and action plan, prompting the project leader to modify the tool per subject matter experts recommendations (Carle et al., 2013).

**Strengths and Limitations**

A possible weakness of this project was the use of only one clinical setting, employing a unique care delivery model that is not common at most hospitals. Without the laborist model, most obstetric units do not have 24/7 onsite coverage, and immediate, face-to-face consultation with a delivering clinician is not possible. A recommendation for further review of the tool and action plan, would include review by SME at multiple clinical sites that differ in care delivery models to ensure that a variety of practice settings are considered. This would also include sites that may already use an early warning
system for the pregnant or non-pregnant patient populations. By utilizing these sites, the SME would have previous knowledge and understanding of the intent of the early warning system, thus providing an educated foundation for review of the tool.

The physiological parameters on the tool were vetted by the SME in a total of three separate group discussions, finalizing the proposed documents. Each parameter can be found in the literature, supported by a consensus of the experts published in the community. It would strengthen the tool if there was agreement amongst the national associations, responsible for obstetric clinical practice, to publish standardized normal values for vital signs and clinically relevant data points for the pregnant patient population. Until this is completed, variation will continue to exist in the community and clinicians will be unable to agree what thresholds are considered relevant. The inability to establish agreed upon norms, will lead to an increase in self-developed early warning system tools, making it difficult to demonstrate a positive impact on maternal and neonatal morbidity and mortality.

The SME group discussions were successful and offered valuable insight into the potential application of the tool and action plan to actual patient care and assessment. The SME provided enriching discussions surrounding theoretical patient scenarios of high-risk situations where the tool would benefit the patient and the clinician. A consideration for implementation would be to educate the staff on tool utilization with relevant clinically-based scenarios (e.g. using a simulation lab), requiring the clinician to score the patient during a simulated labor. This would allow for accurate application of the tool and escalation of care using the action plan appropriately.
A weakness identified by one SME during the group discussions was that because the tool is a weighted-aggregate design, it ‘was complicated and the scoring system may be confusing for some nurses’, this may also be considered one of its strengths. This is a valuable observation with many examples of multiple and single-aggregate early warning systems in the literature. Based on this information, the project leader determined that labor and delivery nurses would benefit from a scoring tool that incorporated multiple variables, to avoid missing important data that could potentially add up to a high-risk situation. The tool is structured on a simple scoring system, allowing even the most novice labor and delivery nurse to assign a score to a laboring patient. By eliminating unnecessary variables from the original tool, the SME final document is a succinct tool, with only the most valuable elements remaining for scoring.

The OB EWS was strengthened with the addition of color-coding the trigger tool and the action plan. The color-coding system is associated with the level of escalation required to care for the maternal-fetal dyad at the specific time of scoring. The scoring system is based on the stop light analogy, with red (>5) as abnormal, yellow (3-4) requiring additional assessment, and green (<2) as normal scoring (Carle et al., 2013; Ryan et al., 2017; Thorpe-Gardner, Love, Wrightson, Walsh. & Keeling, 2006). Providing a visual alert, as well as a weighted-score, assists the clinician with recognition of a patient at risk and comprehension of required interventions at each scoring level. A potential weakness of the action plan algorithm is the absence of specified observation and assessment parameters. Although this was not identified during the SME discussion groups, the project leader purposefully did not include specific assessment, documentation or interventions due to the variations in clinical practice. It would be
prudent for the hospitals utilizing the tool, to educate their staff on unit policy and procedures, because these would encompass the clinical guidelines associated with patient care at each level. These policy and procedures should refer the clinician to the appropriate interventions, physician orders, and assessment requirements.

One SME commented on the use of the electronic health record (EHR) to prepopulate the scoring tool versus using a paper documentation version. Currently the clinical setting uses a separate electronic fetal surveillance and documentation system from the hospital EHR. The availability of the tool as a paper document only may be considered a weakness due to the shift of most hospitals across the country to electronic documentation systems. Because clinical setting does not allow integration between the two systems, the paper tool is the only route that can be taken at this time if the tool were piloted. This weakness may put an undue burden on the staff as they will have to document the physiological parameters in the labor and delivery EHR and on the paper tool.

An additional strength of the tool is its development and underpinnings in the literature. The physiological parameters selected and vetted via multiple resources, ensure that the thresholds included were congruent with those the experts considered a set of norms. By establishing normal ranges from previously published and retrospectively applied early warning systems, the tool is well-situated to be implemented as a pilot project. This strength is amplified by the extensive reference list and the introduction presentation by the project leader to the SME groups prior to the initiation of the group discussions.
The featured standout of this tool is the unique inclusion of the fetal heart rate and uterine activity assessment as a component of the early warning system. Assigning a score to the maternal uterine response and fetal tolerance to the labor process provides an additional alert to the clinician. These two parameters are unique to the laboring patient and can be crucial to identification of potentially emergent intrapartum complications. Including FHR and UA differentiates the OB EWS from the previously published maternal early warning systems (Carle et al., 2013; Shields et al., 2016). This is essential, as childbirth is not without risk and requires vigilant assessment of both the maternal and fetal patient.

**Recommendations for Future Research**

Since the initial development of maternal early warning systems, there has not been a tool specific to the laboring patient. The need to identify patients at risk for complications during labor and delivery is of utmost importance as the maternal morbidity and mortality rate continues to rise. There is a need for national standardization of intrapartum physiological parameters, agreed upon by all maternal care organizations, that will identify patients at risk for worsening condition during childbirth. The implementation of the OB EWS in a clinical pilot would strengthen the applicability of the tool and action plan.

Additional areas of research include standardizing the vital sign normal thresholds, testing scoring system format and associated action plans, and the development of a clinical decision support tool that would electronically identify patients at risk and notify the nurse.
SUMMARY

The purpose of this project was to develop an obstetric early warning system, encompassing physiological parameters designed specifically for the hospitalized laboring maternity patient. The necessity of a tool that addresses clinical vigilance and assessment during the intrapartum stage is supported by current literature. The obstetric early warning system provides an individualized approach to patient care, allowing decision-making to be based upon an objective calculation of scores. This instrument removes the subjective interpretation of the physiological parameters and establishes a clear and concise approach to communication with delivering clinicians as well as escalation of bedside assessment. With the clinical application of the obstetrics early warning system, the maternal-fetal dyad may experience reduced delay in care and a reduction in morbidity and mortality rates.
REFERENCES


APPENDIX A

DATA COLLECTION PROCEDURES

The following process was used to guide the data collection procedures:

1. The group sessions were conducted at the hospital.

2. The subject matter experts attended one of three sessions offered.

3. The sessions were thirty (30) minutes in length.

4. The project leader provided a copy of the tool and action plan to the participants during the group discussion sessions.

5. The project leader facilitated a ten-minute education segment to introduce the tool and action plan.

6. The project leader facilitated the group discussion sessions utilizing the self-developed discussion guide designed with open-ended questions per physiological parameter and each trigger score associated action plan.

7. The project leader hand wrote anecdotal comments and suggestions that are not included as content on the discussion guide.
APPENDIX B

CYCLE ONE APPLICATION OF THE PDSA FRAMEWORK

- Developed obstetric early warning system trigger tool and action plan algorithm
- Evaluation of previously published maternal early warning systems
- Comparison of physiological parameters to ensure accuracy of tools
- Conducted primary literature search on early warning systems and secondary search on obstetric early warning systems
- Amended obstetric early warning system tool and action plan algorithm based on support by the literature
- Developed obstetric early warning system trigger tool and action plan algorithm
APPENDIX C

CYCLE TWO APPLICATION OF THE PDSA FRAMEWORK

- Conducted group discussion sessions with subject matter experts
- SME reviewed and provided feedback to project leader
- Evaluated feedback, edits and suggested revisions from subject matter experts
- Developed education presentation for SME
- Developed discussion guide for SME sessions
- Scheduled SME sessions
- Adapted the early warning system tool and action plan algorithm per SME revisions and suggested edits supported by the literature
APPENDIX D

FUTURE CYCLE THREE APPLICATION OF THE PDSA FRAMEWORK

- Conduct focus group discussion
- Develop simulation case scenario
- Schedule simulation in clinical skills lab
- Conduct simulation

- Schedule focus group discussion
- Develop simulation case scenario
- Schedule simulation in clinical skills lab
- Conduct simulation

- Adapt the early warning system tool and action plan algorithm per focus group and simulation lab results revisions and suggested edits supported by the literature

- Evaluated feedback, edits and suggested revisions focus group
- Evaluate results from simulation

- Conduct focus group
- Conduct simulation

Act
Plan
Study
Do
## APPENDIX E
### RESULTS CHART

<table>
<thead>
<tr>
<th>SME Suggested Revisions</th>
<th>SME Response Rate</th>
<th>SME Response Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action plan algorithm was simple to follow</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>Action plan algorithm is required to guide frequency of assessment and escalation of care</td>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td>Blood Pressure should be listed as first physiological parameter</td>
<td>12</td>
<td>75</td>
</tr>
<tr>
<td>Color coding of action plan algorithm is considered appropriate and valuable, especially to new RN</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>SME disagreed with action plan algorithm, suggesting specific physician orders per scoring category</td>
<td>3</td>
<td>37.5</td>
</tr>
<tr>
<td>Heart Rate should be listed as second physiological parameter</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>Inclusion of FHR &amp; UC are appropriate physiological parameters</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>Documentation of LOC with medical order only</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Inclusion of LOC is an appropriate physiological parameter</td>
<td>12</td>
<td>75</td>
</tr>
<tr>
<td>Removal of ‘Resource Nurse’ replace with ‘Charge Nurse’</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>Remove QBL parameter</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>Replace ‘delivering clinician’ with ‘laborist’</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>SME requested addition of lab tests to action plan algorithm</td>
<td>5</td>
<td>31.25</td>
</tr>
<tr>
<td>SME requested addition of pain assessment/scoring</td>
<td>9</td>
<td>56.25</td>
</tr>
<tr>
<td>OB EWS and action plan algorithm should be color-coded according to scoring severity of action and parameter</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>Respiratory rate should be listed as third physiological parameter</td>
<td>13</td>
<td>81.25</td>
</tr>
<tr>
<td>OB EWS and action plan algorithm are easy to use</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>Inclusion of urine output is an appropriate physiological parameter</td>
<td>13</td>
<td>81.25</td>
</tr>
</tbody>
</table>
## APPENDIX F

### OBSTETRIC EARLY WARNING SYSTEM

**Obstetric Early Warning Score**
For each dimension, circle the highest score for which *any part* of the criteria is met.

<table>
<thead>
<tr>
<th></th>
<th>3</th>
<th>2</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt;10 or &gt;30</td>
<td>&gt;24 but &lt;30</td>
<td>21-24</td>
<td>12-20</td>
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<tr>
<td>B</td>
<td>&lt;50 or &gt;120</td>
<td>41-59 OR 111-119</td>
<td>101-110</td>
<td>60-100</td>
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<tr>
<td>C</td>
<td>&lt;90 or &gt;160</td>
<td>80-100</td>
<td>141-160</td>
<td>101-140</td>
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<tr>
<td>D</td>
<td>&lt;40 or &gt;100</td>
<td>41-50</td>
<td>91-100</td>
<td>51-90</td>
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<td>E</td>
<td>&lt;95.1 F OR &gt;101.3 F</td>
<td>95.1-96.8 F OR 100.5-101.3 F</td>
<td>96.9-100.4 F</td>
<td>Alert</td>
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<tr>
<td>F</td>
<td>90-93</td>
<td>&lt;95</td>
<td>95</td>
<td>96-100</td>
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<tr>
<td>G</td>
<td>Maternal agitation, confusion, or unresponsiveness</td>
<td>Unremitting headache with preeclamptic diagnosis</td>
<td>Inappropriate responses</td>
<td>Alert</td>
</tr>
<tr>
<td>H</td>
<td>&lt;35 ml/hr</td>
<td>36-40 ml/hr</td>
<td>41-50 ml/hr</td>
<td>51-60 ml/hr or 210-240 ml/4 hrs</td>
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<tr>
<td>I</td>
<td>Category III</td>
<td>Category II</td>
<td>Category II</td>
<td>Category I</td>
</tr>
<tr>
<td>J</td>
<td><em>Preterm/Antepartum with &gt;5 contractions in a 1 hour period without stimulated labor or Tachysystole</em></td>
<td>Preterm/Antepartum w/ fewer than 5 contractions/hr without stimulated labor OR Hx uterine scar with &gt;5 contractions/hr OR TOLAC</td>
<td>Mild contractions/uterine irritability OR any augmented labor (e.g., Pitocin, Cytotec, Cervidil)</td>
<td>Term gestation, normal uterine activity without stimulated labor AND no hx previous C-section</td>
</tr>
</tbody>
</table>

*Term defined as ≥ 37 wks gestation; Preterm defined as <37 wks gestation; Normal Uterine activity defined as ≤ 5 contractions in 10 minutes, averaged over a 30 minute window; Tachysystole defined as > 5 contractions in 10 minutes, averaged over a 30-minute window (AWHONN, 2009)*
**Hospital logo here**

Obstetric EWS

To be completed with every set of vital signs (at least every 4 hours) and with any change in status

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**If OB EWS Total ≥ 8:** Notify Laborist IMMEDIATELY; Prepare for potential imminent delivery or maternal–fetal rescue.

**If OB EWS Total 4–5:** Immediately review patient status with Charge Nurse and notify Laborist; increase monitoring frequency to q5-15 minutes until score is 3 or less; if score remains above 3 after one hour of increased monitoring, update Laborist (sooner if requested).

**If OB EWS Total 2–3:** Review patient status with Charge Nurse. If intervention is required, primary RN will complete, notify Laborist of concern, continue to monitor.

**If OB EWS Total 0–1:** Continue to monitor and document findings according to AWHONN and hospital policy and procedure for maternal and fetal monitoring standards.
## APPENDIX G

### TABLE OF EVIDENCE

**Obstetric Early Warning System**

<table>
<thead>
<tr>
<th>Purpose (Author(s), year)</th>
<th>Design &amp; Key Variables</th>
<th>Sample &amp; Setting</th>
<th>Measurements, Operational Definitions of Variables</th>
<th>Results or Findings</th>
<th>Authors’ Conclusions; Study Limitations &amp; Your Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of a predictive tool utilizing the EMR data on hospitalized patients to predict unanticipated transfer to the ICU. Escobar, G. J., LaGuardia, J. C., Turk, B. J., Ragins, A., Kipnis, P., &amp; Draper, D. (2012).</td>
<td>Retrospective case-control study IV – MEWS DV - unplanned ICU admission; or patient death on the floor</td>
<td>Total N = 92,797 Medical Surgical patients  Case=N=13153 ICU admissions  Control=N=89,269 No ICU admissions  All hospitalized adults &gt; 18 years of age Excluding childbirth admissions  14 hospitals in the KPMCP in Northern CA</td>
<td>Retrospective application of the EMR predictor tool and retrospective assignment of a MEWs score.</td>
<td>Overall, the calculated MEWs score would identify 15% of cases that transferred to the ICU and the EMR predictor tool identified the same amount of cases. The MEWs score triggered 34.4% of false transfer cases; and the EMR predictor tool only triggered 14.5% of false cases.</td>
<td>Limitations include: EMR data is dependent upon bedside clinician with a manual scoring and downtime of EMR was not addressed. Inappropriate admissions to lower levels of care were not addressed. The article identifies variables that are similar in scope to project with focus on physiological parameters.</td>
</tr>
<tr>
<td>Purpose (Author(s), year)</td>
<td>Design &amp; Key Variables</td>
<td>Sample &amp; Setting</td>
<td>Measurements, Operational Definitions of Variables</td>
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<tr>
<td>To study if a MEWT can predict deterioration of patient status to reduce maternal morbidity and mortality.</td>
<td>Retrospective case-control study</td>
<td>Total n =100 maternal patients</td>
<td>Retrospective application of the MEWT to medical records of obstetrics patients admitted to the ICU following vaginal delivery.</td>
<td>4.81 ICU admissions/100 deliveries</td>
<td>Currently OB EWS trigger benchmarks do not. ACOG recommends a tailored tool to objectively assign MEWS score. Small sample size, conducted in a single hospital system. Appropriate for project inclusion because of specific population studied. Supports need for further research and development of specific trigger tool that is sensitive to patient</td>
</tr>
<tr>
<td>Hedriana, H. L., Wiesner, S., Downs, B. G., Pelletreau, B., &amp; Shields, L. E. (2016).</td>
<td>IV – MEWTs</td>
<td>Case n = 50 with ICU admission</td>
<td>ICU OB patients had two or more MEWTs abnormal parameters compared to normal deliveries.</td>
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<td></td>
<td>DV – Admission to the ICU</td>
<td>Control n = 50 no ICU admission</td>
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<td>7 pilot hospitals selected within the Dignity Health System with hospitals in California, Arizona, and Nevada</td>
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<td>identified via EMR.</td>
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<tr>
<td>Purpose (Author(s), year)</td>
<td>Design &amp; Key Variables</td>
<td>Sample &amp; Setting</td>
<td>Measurements, Operational Definitions of Variables</td>
<td>Results or Findings</td>
<td>Authors’ Conclusions; Study Limitations &amp; Your Notes</td>
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</tr>
<tr>
<td>To evaluate nursing practice against an established EWS system and what if any influences had effect on those practices. Odell, M. (2014)</td>
<td>Retrospective predesigned data collection pro forma</td>
<td>N = 120 patient medical records</td>
<td>Medical records were reviewed for accuracy of EWS scoring and nursing assessment of the patient up to 12 hours prior to cardiac arrest event</td>
<td>50% of the cases who met the need for early intervention per the EWS failed to receive the minimum standard for nursing assessment and care 25% met the standard for EWS scoring and associated referral for escalation of care</td>
<td>Concerning results that over half the patients that didn’t have the minimum required nursing assessment. Staffing levels, care models, weekends, nights shift and skill level of RN are considered causative factors of poor nursing care. EWS scoring systems is appropriate and does assist with identification of deteriorating patients if used appropriately.</td>
</tr>
<tr>
<td>Purpose (Author(s), year)</td>
<td>Design &amp; Key Variables</td>
<td>Sample &amp; Setting</td>
<td>Measurements, Operational Definitions of Variables</td>
<td>Results or Findings</td>
<td>Authors’ Conclusions; Study Limitations &amp; Your Notes</td>
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<tr>
<td>Identify risk factors associated and newborn unexpected outcomes associated with maternal deaths. Nair, M., Knight, M., &amp; Kurinczuk, J. J. (2016).</td>
<td>Unmatched case-control analysis IV – 13 IV Gravida/Para status, multiple gestation, gestational diabetes, anemia, insufficient prenatal care, history of pregnancy problems, medical comorbidities, BMI, maternal age, smoking status, substance abuse, employment status, and ethnicity. DV- newborn adverse outcomes (AO) (stillbirth, admission to NICU, neonatal</td>
<td>Case N = 383 women who died from • indirect (pre-existing medical conditions) • direct causes (obstetrical) during pregnancy • within 42 days of pregnancy termination Control N = 1516 women with uncomplicated pregnancy and childbirth 5 years of national data from the United Kingdom on maternal deaths</td>
<td>Studied the causal link between maternal deaths and thirteen potential risk factors for maternal mortality and morbidity. Seven factors identified associated with increased risk of maternal death: medical comorbidities, maternal age, inadequate prenatal care, previous pregnancy problems, anemia, substance abuse, and unemployment. Higher risk of stillbirth, admission to the NICU and neonatal death if maternal loss. More than two risk factors increased incidence of</td>
<td>Study results are generalizable to the population as a whole because it sampled the case and control group directly from the same source. Comorbidities associated with pregnancy bias to adverse maternal and neonatal outcomes. Appropriate inclusion in literature search for project as it relates to neonatal and maternal adverse outcomes. Direct aim of the intended clinical problem statement is to reduce maternal and neonatal events.</td>
<td></td>
</tr>
<tr>
<td>Purpose (Author(s), year)</td>
<td>Design &amp; Key Variables</td>
<td>Sample &amp; Setting</td>
<td>Measurements, Operational Definitions of Variables</td>
<td>Results or Findings</td>
<td>Authors’ Conclusions; Study Limitations &amp; Your Notes</td>
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<td>death with maternal death</td>
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<td>maternal death and neonatal AO.</td>
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<tr>
<td>Purpose (Author(s), year)</td>
<td>Design &amp; Key Variables</td>
<td>Sample &amp; Setting</td>
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<tr>
<td>Retrospective application of six pre-selected MOEWS trigger tools to maternal patient records.</td>
<td>Retrospective cohort study IV – MOEWS DV – prediction of severe sepsis in patients with chorioamnionitis</td>
<td>Total N = 364 Single tertiary maternity unit in Chicago, IL.</td>
<td>Retrospective application of six MOEWS trigger tools to patients diagnosed with chorioamnionitis to a researcher selected VS set.</td>
<td>Comparison of six MOEWS trigger tools to one patient vital sign data set provided varied results. Sensitivity of the MOEWS trigger tools varied: MOEWS E – 40% MOEWS A &amp; C – Sixteen of sixteen</td>
<td>MOEWS tools do not predict sepsis. Limitations included: comparison of only one vital sign data set (the worst). Appropriate inclusion for project as it discusses the need for a reliable EWS trigger tool for the OB population. The review of six MOEWS trigger tools supports the project trigger tool inclusion of physiological parameters to predict patient deterioration.</td>
</tr>
<tr>
<td>Purpose (Author(s), year)</td>
<td>Design &amp; Key Variables</td>
<td>Sample &amp; Setting</td>
<td>Measurements, Operational Definitions of Variables</td>
<td>Results or Findings</td>
<td>Authors’ Conclusions; Study Limitations &amp; Your Notes</td>
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</table>
| Implementation of the MEWT tool to and then to assess reduction of maternal morbidity.                                                                                                                                                                                                   | Prospective before and after intervention quality improvement project                                                                                                                                                                                                             | Pre-MEWT $N = 24, 221$  
Post-MEWT $N = 12, 611$  
Maternity patients admitted to 6 hospitals within a large hospital system in the United States.                                                                                                                                                                                                                 | IV – MEWT  
Collected information related to the four areas, details on pg. 4  
Two levels of activation and two abnormal values sustained for $>20$ minutes were required to trigger tool  
DV – maternal morbidity as defined by CDC (severe and composite maternal morbidity)                                                                                                                                                                                                 | Decrease in severe and composite maternal morbidity at MEWT pilot sites compared to 23 non-pilot sites.                                                                                                                                                                                                                           | The MEWT tool is useful to assist with early intervention and reduction of maternal morbidity.  
The MEWT is different from other MOEWS and MERC tools because it focuses on four major causes, provided evaluation and treatment pathways.  
Highly applicable to project because of patient population and decrease in maternal morbidity.                                                                                                                                                                                      |
Addressed four areas: Hemorrhage, preeclampsia, sepsis and cardiovascular function  
DV – maternal morbidity                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                           |
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<th>Purpose (Author(s), year)</th>
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<th>Measurements, Operational Definitions of Variables</th>
<th>Results or Findings</th>
<th>Authors’ Conclusions; Study Limitations &amp; Your Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop and evaluate a scoring system for newborns.</td>
<td>Retrospective study   IV – NTS  DV – NICU admissions and interventions based on trigger score</td>
<td>&gt;35-week newborns admitted to the NICU N = 193  &gt;35 week well newborns not requiring NICU admission N = 292</td>
<td>Retrospective application of NTS to newborn patients in the labor and postpartum unit.</td>
<td>Identifies newborns who are at risk for decompensating with recognition of subtle clinical signs of deterioration. Trigger score for initiation of action was &gt;2. Sensitivity and specificity of the NTS was higher than the PEWS scores for the newborn population.</td>
<td>NTS identified which newborns were becoming unwell on the floor. Perception of tool being cumbersome to nursing the same as the project tool. Tool was better than PEWS for identification of suspected patient deterioration and applicable to patient population.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Purpose (Author(s), year)</th>
<th>Design &amp; Key Variables</th>
<th>Sample &amp; Setting</th>
<th>Measurements, Operational Definitions of Variables</th>
<th>Results or Findings</th>
<th>Authors’ Conclusions; Study Limitations &amp; Your Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>To conduct a systematic review to evaluate the impact of EWS. Alam, N., Hobbelink, E. L., van Tienhoven, A. J., van de Ven., Jansma, E. P., &amp; Nanayakkara, (2014)</td>
<td>Systematic review IV – EWS DV – patient clinical outcomes (in hospital mortality, ICU mortality, serious adverse events, cardiopulmonary events, length of stay, documentation of physiological parameters)</td>
<td>N=7 Controlled studies that met eligibility criteria (EWS implemented)</td>
<td>Three independent reviewers evaluated studies that met inclusion criteria.</td>
<td>Specifically, reviewed decrease in in-hospital mortality rate, ICU admissions, cardiac events, serious adverse events</td>
<td>The authors agreed that the simplicity of the tool and bedside application both lends to ease of implementation and improved compliance. The authors recommended that a tool be developed specific to each population. This applies perfectly to my project as it supports the need for a population specific tool for the maternal patient.</td>
</tr>
<tr>
<td>Purpose (Author(s), year)</td>
<td>Design &amp; Key Variables</td>
<td>Sample &amp; Setting</td>
<td>Measurements, Operational Definitions of Variables</td>
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<td>Comparison of hospital-specific ObsEWS to identify the vital signs used, predicting normal patient parameters, escalation of care, and documentation format.</td>
<td>Comparison evaluation IV – ObsEWS DV- hospital ObsEWS</td>
<td>N=120 Maternity units in UK and Channel Islands</td>
<td>120 documentation forms were collected from a possible 194 hospitals. The documentation forms were compared to each other to determine the vital sign ranges, abnormal parameters, escalation instructions and documentation formats.</td>
<td>As expected, much variation is present. 89.2% with color coded forms 69.2% used color-coded escalation systems 34.2% multi-aggregate scoring system 75 different vital sign combinations were identified that would indicate ‘normal’</td>
<td>Requires a standardization of normal physiological parameters. Call for a standardized tool with action plan and observation frequencies.</td>
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<tr>
<td>Implementation of a MEWS trigger tool via an education program for clinicians, and response of MET to detect clinical adverse events prior to deterioration of patient condition.</td>
<td>Prospective, before and after intervention trial IV – gender, age, admission ward, admission diagnosis, documented DNR status DV – Primary outcome the incidence of unplanned admissions to ICU, Secondary outcomes – unexpected deaths, frequency of VS documentation, documentation of communication, documented medical assessment</td>
<td>Medical Surgical Patients Control group n = 1157 Intervention group n = 985 Two teaching facilities in the Australian National University health system (Canberra &amp; Calvary)</td>
<td>Implementation of a newly designed vital signs chart, trigger tool and education program.</td>
<td>Decrease in unplanned admissions to the ICU (1.8% to 0.5%).</td>
<td>The trigger tool may have proved useful for inexperienced nurses with identification of failing patient status. Limitations include small sample size, only two hospitals, and readmissions were excluded. Appropriateness for study inclusion in project literature review because trigger tool positively predicted need for immediate intervention.</td>
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<td>Assess the existing early warning system process prior to implementing the National Early Warning Scoring (NEWS) tool in order to develop an education plan for implementing NEWS.</td>
<td>Mixed-method service evaluation</td>
<td>Tertiary referral University Hospital in central London</td>
<td>Medical records were reviewed for accuracy of EWS scoring and nursing assessment of the patient and those were compared with the survey responses related to comprehension of the trigger tool.</td>
<td>Identified the need for a system-wide approach to decreasing the morbidity and mortality rate resulting from unrecognized signs of deteriorating patient status.</td>
<td>Recommendation for increased education and training to improve compliance. Relevant to project as assess the educational process for implementing all additional components of the tool (action plan algorithm and escalation of communication).</td>
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| Smith, D. J., & Aitken, L. M., (2015) | IV – current EWS | Four departments using the tool:  
- 2 medical  
- 2 surgical | | | |
<p>| | DV – nurse comprehension of EWS | N=105 student nurses, health care assistants and registered nurses only 31 were returned completed N = 74 patient medical records | | | |
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<td>Quality improvement project utilizing the Tanner Model to implement an early warning system from initial education to final tool revisions. (Hanley, D., Abele, D., Alley, A. J., Smith, K., Gaden, N. W., &amp; Bittner-Phoenix, N. (2016))</td>
<td>Quality improvement project</td>
<td>Pilot – one busy medical-surgical unit at Boston Medical Center, MA</td>
<td>Tanner Model used to assess readiness and implementation of EWS. (Noticing, interpreting and responding)</td>
<td>The tool required several revisions to widen the parameters to allow for clinical judgement. 60 (7.4%) scored a rating of 4 or greater 15(25%) were transferred to higher level of care Codes decreased in units outside of the ICU (0.69/1000 discharges) Anecdotal – assisted with trend identification, increased staff confidence, improved communication to primary physician and RRT.</td>
<td>Note – maternity unit added fetal heart rate, uterine activity and bleeding. Limitations included small pilot and not patient specific. Support for project related to selected physiological parameters and pilot implementation.</td>
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<td>Design and validate an aggregate weighted EWS for the obstetric patient. Carle, C., Alexander, P., Columb, M., &amp; Johal, J. (2013)</td>
<td>Retrospective application of the Intensive Care National Audit and Research Center Obstetric Early Warning System to maternal patients admitted to the ICU IV- OB EWS DV - statistically significant maternal physiological parameters identified as components for early warning system</td>
<td>National data base from England, Wales and Northern Ireland Obstetric patients admitted to ICU Random assignment to cohorts Total N = 5,288 Set 1 N = 2240 direct OB admission N = 439 indirect OB admission Set 2 (for comparison) N = 2200 direct N = 449 indirect</td>
<td>Retrospective application of the OB EWS to maternal patient admitted to the ICU for direct OB and indirect OB diagnosis and statistical analysis of aggregate weighted scoring system.</td>
<td>Overall, the physiological parameters selected were statistically significant including high HR, low systolic BP, SaO2, minimum temperature, respiratory rate, highest non-ventilated.</td>
<td>Highlights the importance and need for a standardized early warning system for the maternal patient. Limitation as this study was only applied to patients after their admission to the ICU. Would be beneficial to see a study on the obstetric patient in labor and delivery or in the postpartum unit.</td>
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<td>Evaluation of the impact of implementing the NEWS on both patients and staff. Fareenden, S., Gamble, D. &amp; Welch, J. (2017)</td>
<td>Retrospective comparison study IV – NEWS DV – referrals to the rapid response team</td>
<td>One hospital in the University College London Hospitals Foundation Pre N = 230 Post N = 276 All hospitalized patients &gt; 16 years of age excluding pregnant patients</td>
<td>Retrospective comparison study to analyze referrals to rapid response team following application of NEWS specific to sepsis patients.</td>
<td>Findings were not statistically significant when evaluated based on demographics and patient outcomes.</td>
<td>Concluded that the application of the NEWS did not increase staff workload, high NEWS score positively correlated with referrals to rapid response team. Limitations, study was specific to sepsis patients, and did not provide statistically significant data for evaluation by the reader.</td>
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<td>The application of the MEWS to surgical in-patients at one hospital. Thorpe-Gardner, J., Love, N., Wrightson, J., Walsh, S., &amp; Keeling, N. (2006)</td>
<td>Prospective observational study IV – MEWS DV – admission to a higher level of care (ICU)</td>
<td>West Suffolk Hospital Total N = 334 Emergency and elective surgical patients admitted to the colorectal unit Adult patients &gt;16 years of age</td>
<td>Prospective observational study of the MEWS to colorectal surgical patients who were admitted to higher level of care (ICU).</td>
<td>Overall, the MEWS was an accurate predictor of patients scoring 4 or more. The patients more likely to trigger 4 or more were older, malignant diagnosis, or bowel obstruction. MEWS was statistically significant (P&lt;0.001). 75% of patients requiring admission to ICU, had a score of 4 or more.</td>
<td>Conclusions, the tool was able to identify patients at risk requiring admission to a higher level of care. MEWS is an important warning system and recommends implementation on all patients.</td>
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<td>Evaluate the MEOWS as a predictor for maternal morbidity.</td>
<td>Prospective study</td>
<td>One hospital in London, England Maternity unit</td>
<td>Prospective application of the MEOWS</td>
<td>Overall the MEOWS triggers were statistically significant for predicting maternal morbidity.</td>
<td>Conclusions included the most frequent trigger was high blood pressure, tachycardia, and low blood pressure.</td>
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<td>All patients between 20 EGA and 6 weeks postpartum, admitted to the maternity unit</td>
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<td>Application of the OBEWS to predict maternal deaths.</td>
<td>Retrospective study</td>
<td>Total N = 702</td>
<td>Retrospective application of the OBEWS to maternal patients admitted to the ICU within 24 hours.</td>
<td>Overall, the OBEWS was a statistically significant predictor for non-survivors.</td>
<td>Concluded that predictive value was higher when related to maternal patients with direct admit for OB related event.</td>
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<td>To assess the impact of an Irish maternal early warning system (IMEWS) on vital sign documentation with maternal patients diagnosed bacteremia.</td>
<td>Mixed retrospective and prospective case study&lt;br&gt; IV - MEWS&lt;br&gt; DV – maternal patients with bacteremia</td>
<td>N = 61 retrospective&lt;br&gt; N = 17 prospective&lt;br&gt; Coombe Women’s and Infants University Hospital (Dublin, Ireland) ABV 8500</td>
<td>Retrospective application of the IMEWS to maternal patients diagnosed with bacteremia from 1/2009 – 3/2013, and prospective application of the IMEWS to maternal cases of bacteremia from 4/2013 – 4/2014.</td>
<td>MEWS implementation improved documentation of vital signs for patients with bacteremia. Although not statistically significant, the time in minutes from recognition of infection to antibiotic administration was decreased.</td>
<td>Following introduction of the MEWS, there was an improvement in vital sign documentation, especially respiratory rate.</td>
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<td>To externally validate the current CEMACH MEOWS in a Canadian hospital.</td>
<td>Retrospective, observational, case-controlled validation study IV- CEMACH MEOWS DV – maternal ICU admission</td>
<td>N=46 maternal patients requiring ICU admission N=138 control group Two tertiary obstetric units • British Columbia Women’s Hospital • St. Paul’s Hospital</td>
<td>Retrospective application of the CEMACH MEOWS to the physiological parameters of pregnant or recently delivered maternal patients in the 24 hours prior to admission to the ICU.</td>
<td>MEOWS had high sensitivity (0.96) MEOWS had low specificity (0.54) for ICU admissions</td>
<td>Limitations – if MEOWS data was missing it was presumed normal and would not trigger a red or amber category (abnormal findings). MEOWS requires modification to improve specificity and external validation is required to improve the tool and prediction of potential ICU admissions. Relevant to project as it uses maternal patients, and current CEMACH MEOWS.</td>
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<td>To assess identification and response to select Category II FHR patterns and uterine tachysystole. Clark, S. L., Meyers, J. A., Frye, D. K., Garite, T., Lee, A. J. &amp; Perlin, J. B. (2015)</td>
<td>Prospective, nonrandomized study IV - Category II management algorithm DV - maternal patients with induction of labor</td>
<td>N=14, 398 with Oxytocin induction of labor Hospital Corporation of America 110 hospitals with obstetric and newborn services</td>
<td>Singleton term fetus &gt;37 weeks, with induction of labor with oxytocin. Each chart was independently reviewed by an RN trained as an AWHONN fetal monitoring instructor. Measured against clinical practices considered appropriate management of Category II FHR and tachysystole patterns.</td>
<td>Clear, concise definitions of abnormal tracings with defined interventions does improve neonatal outcomes. Reduction in oxytocin dosage during abnormal FHR and uterine activity resulted in an increase in c-section rates and improved neonatal outcomes.</td>
<td>Excellent study mapping the importance of uniformity of care, the use of check lists and careful management of oxytocin. Use of strip assessment and standardized terminology is required to replicate these outcomes. Relevant to project as it supports the inclusion of FHR and UA in the OB early warning system.</td>
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<tr>
<td>To evaluate the impact of a</td>
<td>Retrospective chart review</td>
<td>N-100 patients receiving oxytocin</td>
<td>One month prior to implementation</td>
<td>Significant decrease in c-</td>
<td>Oxytocin checklist-based</td>
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<td>checklist-based oxytocin protocol.</td>
<td>IV- checklist-based oxytocin protocol DV- maternal and newborn outcomes</td>
<td>before implementation of the checklist N-100 patients receiving oxytocin after the implementation of the checklist Hospital Corporation of America 125 hospitals with obstetric and newborn services</td>
<td>of the oxytocin checklist and one month following implementation. Maternal and newborn outcomes were analyzed.</td>
<td>section rate (23.6% -21.0%). Statistically significant difference in 1-minute Apgar scores between the pre-and post-groups (improved scores in the post group).</td>
<td>protocol is an important safety step to ensure improved maternal and neonatal outcomes. Conservative management of oxytocin did not prolong labor. Relevant to project as it supports the inclusion of FHR and UA on the OB EWS trigger tool</td>
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Note. AO = Adverse outcomes; BMI = Body mass index; BP = Blood pressure; CEMACH = Confidential Enquiries into Maternal and Child Health; DNR = Do no resuscitate; DV = Dependent variables; EMR = Electronic medical record; EWS = early warning system; IMEWS = Irish Maternal Early Warning System; IV = independent variables; MET = Medical emergency team; MEWT = Maternal early warning triggers; MEWS = modified early warning system; MOEWS = Modified obstetric early warning system; NICU = Neonatal intensive care unit; OB = obstetrics; OB EWS = Obstetrics early warning system; P = Pulse