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Using the SEIPS Framework to Understand Systems-Level Factors Affecting Obstetric Nurse Decision Making: A Convergent Parallel Mixed Methods Study

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Affecting Obstetric Nurse Decision Making:
A Convergent Parallel Mixed Methods Study

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A dissertation submitted to the faculty of the Medical University of South Carolina in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Nursing.

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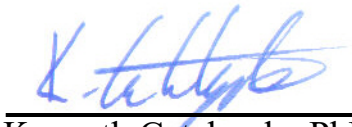

Kenneth Catchpole, PhD

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Acknowledgements

I've always known this was going to be the hardest part of my PhD. There are so many people I need to thank and words will never express my feelings adequately. I'll start with my dissertation committee: Drs. Teresa Kelechi, Kenneth Catchpole, and Lynne Nemeth. I began communicating with Drs. Nemeth and Catchpole a year before I applied to MUSC. I started with only a vague understanding of implementation science and human factors; they have generously shared their expertise and their interest and enthusiasm for my work has motivated me throughout my time at MUSC. Dr. Nemeth has been the ideal mentor. She has egged me on to apply for scholarships and fellowships that never occurred to me. After every rejection, she was quick to say "just keep going" and always reminded me that rejection is just a part of academia. Dr. Nemeth is the only teacher I have ever had who was willing to let me learn at my own rapid pace. She never tried to slow me down.

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Trish Harper-Lentricchia taught me to be a labor and delivery nurse. When I was hired at Monadnock Community Hospital without any labor experience, Trish was dubious. But she precepted me anyway and taught me everything she knew about physiologic labor and birth. She is one of my greatest teachers.

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Abstract

The United States has the worst maternal morbidity and mortality in the developed world, with a maternal death rate of 17.3/100,000 live births. Efforts to improve this have not been fruitful. This dissertation suggests that future research with a patient safety focus and human factors framework may improve our understanding of this multifactorial problem and identify new potential solutions for improving this devastating crisis. The first manuscript is a scoping review discussing the use of trigger tools to identify women in labor in need of care escalation. The second manuscript is a realist review describing current approaches to the problem of obstetric failure to rescue. The third manuscript details a convergent parallel mixed methods study looking at the systems-level factors affecting nurses who are caring for women in labor and makes recommendations for systems changes with the potential to improve outcomes.

Key words: *maternal morbidity and mortality, patient safety, human factors*

Introduction

Overview

This mixed methods dissertation addresses maternal morbidity and mortality through the lens of the sociotechnical and human factors perspectives of the obstetric system. Studying how people interact with systems offers an opportunity to identify what goes wrong and how it goes wrong to cause maternal harms. Sociotechnical systems theory asserts that system design and improvement must consider human interaction with technology to achieve optimal results.(1) A sociotechnical system includes social, psychological, and technical elements.(2) Social elements are ways that people interact with one another, including teamwork and communication. Psychological elements are the intrapersonal aspects of the individual, such as education, emotional state, and acquired skills. Technical elements incorporate technology (such as computers and other equipment) as well as also physical plant attributes such as floor materials, workspace design, and the heating and cooling of the workplace.

Nurses are relied upon to provide continuous assessment for women in labor. Thus, studying nurse-work system interactions may help the development of system improvements. By pursuing a better overall understanding of the work system, this project provides insights to create new systems and repair or redesign current systems to prevent maternal morbidity and mortality.

Background/Problem/Gap

Severe maternal morbidity affects approximately 50,000 American women annually, and the rate of maternal mortality in the United States is 17.3/100,000 live births, far exceeding similarly-resourced nations (see Figure 1). (3,4) These rates are

worse for women who identify as Black, Indigenous, and People of Color (BIPOC) (see Figure 2). Over 78% of American maternal deaths are preventable (5) and these care failures are the consequence of the defects in the system of care. (6)

There is scant work describing the obstetric work system. The extant research has described system effects on medical-surgical nurses (7,8), neonatal outcomes (9), and cardiac nurses (10), but there is inadequate research describing the obstetric work system or effects on obstetric nurses. Other researchers describe obstetric nurses' experiences of being "swamped" by too many simultaneous tasks (11) and the potential consequences of understaffing (12), but complete system assessment has not yet occurred. The language of human error is often used, implying that outcomes can be improved by the actions of individuals, which does not reflect a fundamental principle within safety science of looking to the systems-of-work for causes of failure. (13) Sociotechnical challenges are less examined despite expert recommendations that this approach is preferred. (14–16) Prior work has also examined systems issues following maternal deaths (17–21), but these retrospective studies are restricted to events resulting in maternal harms and thus may have both hindsight and outcome biases. There is minimal research in obstetrics addressing how nurses are affected by the sociotechnical system in which they work. (12–14)

Design and Methods

The dissertation research used a mixed methods observational study design synthesizing observations of the labor and delivery unit, and analyzing and integrating quantitative survey and qualitative interview data to analyze the work system and make

recommendations for future research and changes to the work system to decrease maternal harms.

Aim 1: Assess systems-level factors affecting obstetric nurses during critical decision-making.

Observations of the labor and delivery unit occurred over six nursing shifts (distributed over days, nights, and weekends) and included information about workflow, as well as sketches of the unit to describe processes for admitting, caring for, and discharging patients.

A modified critical incident technique was used to interview nurses, midwives, and physicians, opening discussion on situations that did and did not go well during patient deterioration. This technique comprised probing questions designed to inquire about similarities and differences between the situations the clinicians described. Interviews were coded and data were thematically analyzed to understand the factors affecting nurses during patient deterioration.

Aim 2: Identify performance obstacles that increase obstetric nursing workload.

Nurses were surveyed about performance obstacles experienced in their most recent shift. The Performance Obstacles for ICU Nurses survey was adapted for this environment and gathered information about specific impediments including nursing tasks (precepting new nurses, accompanying patients off unit, communicating with patient families), environmental challenges (physical environment and workspace design), organizational issues (inadequate handoffs and information from physicians and midwives), and other situations that may impede nursing work (disorganized supply areas, shortage of computers, pharmacy delays, equipment issues, and poorly stocked

patient rooms.)(22) The data were then analyzed to determine how frequently nurses experienced the twelve performance obstacles measured by the survey.

Aim 3: Synthesize the relationships between nurse decision-making and performance obstacles by merging the data from Aims 1 & 2 in a joint display.

Data from observations, surveys, and interviews were merged in a joint display to create a complete picture of the systems level factors affecting nurses during patient deterioration.

Key Concepts and Terms

Maternal morbidity is difficult to study; it occurs frequently but there is no consensus as to definition. Severe maternal morbidity is defined by the American College of Obstetrics and Gynecology and the Society for Maternal-Fetal Medicine as outcomes which were not intended or could not have been predicted.(23) Thus, if an obstetric patient with a cardiac condition experiences a planned ICU admission after giving birth, her illness would not be counted as severe maternal morbidity because her ICU admission was pre-planned. This definition of several maternal morbidity does not capture all birthing people experiencing serious pregnancy-related illness in the United States. However, this definition does promote a focus on preventable maternal morbidity and failure to rescue scenarios, which is a key to decreasing maternal mortality.

Maternal mortality occurs at a high *rate* in the United States, but it is a small number of deaths (approximately 700 maternal deaths annually), making it difficult to identify causal patterns.(24) One solution to this problem is the study of **near miss** events. Near miss events occur when a patient experiences clinical deterioration but is successfully cared for and their condition improves.(25) Near miss events likely have

similarities to situations resulting in patient death.(25) Studying near miss events may help researchers understand system weaknesses during the care of women in labor.

Sometimes flaws in the system do lead to patient death. **Failure to rescue** describes the inability of the healthcare team to save a patient from a medical complication. (26) A recent literature review suggests that this phenomenon is due to errors in one (or more) of three stages: recognition of deteriorating patient condition, communication of patient condition to the team, and appropriate escalation of patient care. (27) Rather than focusing only on the individual, a systems model might help to understand the barriers to recognition, communication, and escalation.

Theoretical Framework

The use of a model to analyze the sociotechnical system is appropriate to understand how elements of the work environment contribute to outcomes. The Systems Engineering Initiative for Patient Safety (SEIPS) model guides the analysis of the hospital labor and delivery work system to illuminate how the system provides patient care.(28) The work system includes the people, what they do (task), what they do it with (tools), where they do it (work environment) and why they do it (organization). (2) The obstetric work system comprises many overlapping subsystems including social systems (the people, the professional and personal roles) and technological systems (computer hardware, software, and other equipment including IV pumps, electronic fetal heart monitors, and the hospital physical plant).

A more comprehensive understanding of how these subsystems contribute to maternal harms can provide insight on potential system changes likely to promote better outcomes. For example, when a nurse makes a medication error, this may be due to

medication labeling issues, task overload, scanning device failures, or a patient wearing an incorrect identification band, among possible causes. It helps to understand the subsystems that contribute to the medication error, prior to recommending strategies for prevention. The complexity of the obstetric work system means that maintaining safety requires a significant investment in developing a thorough understanding of the work system and its flaws.

The SEIPS model frames this dissertation research to evaluate how nurses interact with the work system when providing care to birthing people. The dissertation research primarily examined the effects of the obstetric work system on the ways in which nurses care for birthing people.

Manuscripts of the Dissertation

Three manuscripts are included in this dissertation which together provide a comprehensive view of the issue of maternal morbidity and mortality and the relation of the obstetric work system to the problems within.

The first manuscript is a scoping review examining the development and use of trigger tools for women in labor.(29) Trigger tools prompt clinicians to notice and take action when patient condition is deteriorating, using vital sign changes as signals to escalate care. These tools have been promoted to prevent late recognition of patient deterioration, but there is no consensus on which tools perform optimally.(30) Findings from the scoping review suggest tool development largely ignored the context in which the tools were used; researchers did not consider the interactions between the tools and the clinicians using the tools.(29) The most salient conclusion of this review was that further research addressing tool development and implementation is necessary and that

contextual factors such as patient acuity and institutional resources should be considered when institutions select tools for obstetric units.(29) This conclusion led to the second manuscript seeking understanding of other approaches to decrease maternal morbidity and mortality.

The second manuscript is a realist review describing the interventions designed to prevent or address obstetric failure to rescue (FTR) events. (31) Most interventions to prevent FTR focused on teamwork, clinician education, and protocols surrounding maternal care and transfer when care escalation was necessary. (31) We concluded that further research could help identify and understand the systems-level factors affecting obstetric nurses. (31) This conclusion inspired the dissertation study described in the third manuscript.

The third manuscript reports an original mixed methods research study examining systems-level factors affecting obstetric nurses during patient deterioration. The study was informed by a pragmatic epistemology, acknowledging that there are many sources of truth that make up the reality of the work system. (32) The overall findings indicate that nurses suffered from a range of systems level problems amenable to improvement, including high task burden, shortages of equipment, and difficult ergonomics, such as problems with physical space, orientation of computers, and an excessively loud work environment. These results can be used to design changes to the work environment and improve outcomes for patients, employees, and institutions.

Innovation

The application of the SEIPS framework to the labor and delivery unit is unique and provides new information about the obstetric work system. The use of multiple data

sources in a mixed methods design provided a thorough picture of the strengths and weaknesses of the current work system. This contributes to the patient safety literature by providing an improved understanding of the obstetric work system; this information can be used to synthesize solutions to work system flaws, towards the goal of decreasing maternal morbidity and mortality.

Figure 1. Selection of maternal mortality ratios, by country (1)

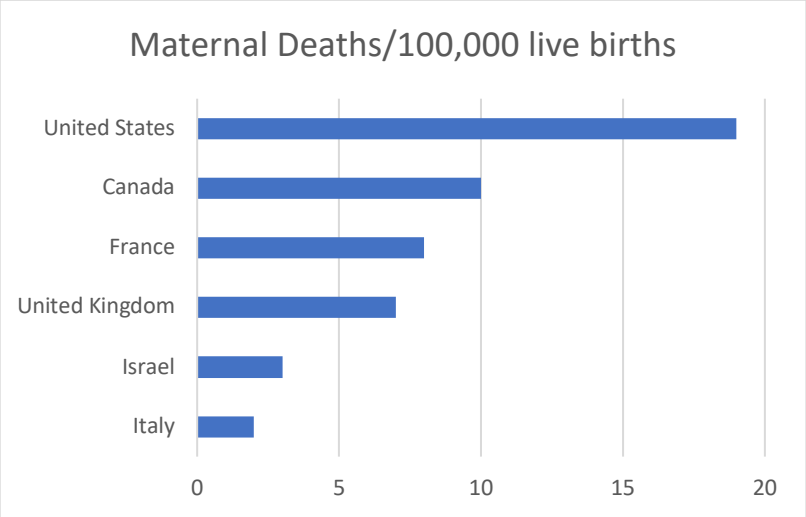
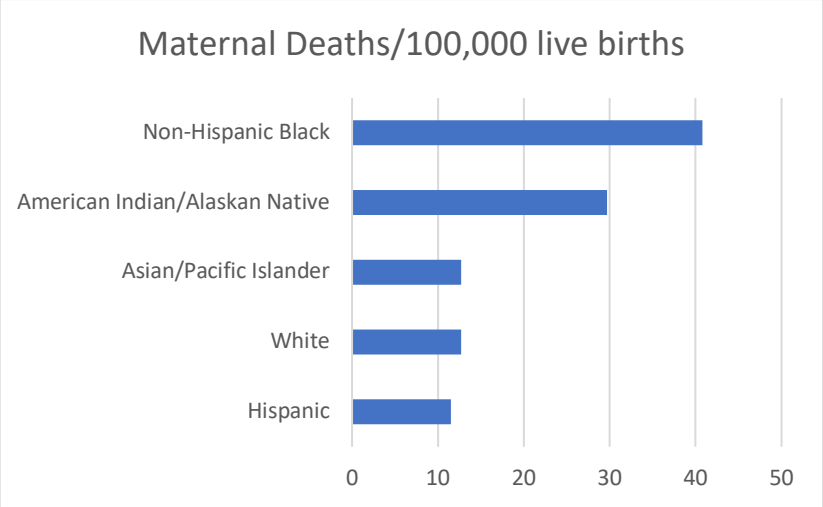


Figure 2. Maternal mortality ratios by racial subgroup in the United States (2007-2016) (33)



References

1. Trist E, Bamforth K. Some social and psychological consequences of the longwall method of coal-getting: an examination of the psychological situation and defences of a work group in relation to the social structure and technological content of the work system. Human Relations. 1951;4(1):3–38.

2. Vicente K. Cognitive work analysis: Toward safe, productive, and healthy computer-based work. Mahwah, NJ: Lawrence Erlbaum Associates; 1999.

3. World Health Organization. Trends in maternal mortality 2000-2017: Estimate by WHO, UNICEF, ENFPA, World Bank Group, and the United Nations Population Division. Geneva: World Health Organization; 2019.

4. Severe maternal morbidity in the United States [Internet]. Centers for Disease Control and Prevention. 2021 [cited 2021 Jun 16]. Available from: https://www.cdc.gov/reproductivehealth/maternalinfanthealth/severematernalmorbidity.html

5. Friedman A, Ananth C, Huang Y, D'Alton M, Wright J. Hospital delivery volume, severe obstetrical morbidity, and failure to rescue. Am J Obstet Gynecol. 2016;215(6):795.e1-795.e14.

6. Howell E, Zeitlin J. Improving hospital quality to reduce disparities in severe maternal morbidity and mortality. Semin Perinatol. 2017;41(5):266–72.

7. Orique SB, Despins L, Wakefield BJ, Erdelez S, Vogelsmeier A. Perception of clinical deterioration cues among medical-surgical nurses. J Adv Nurs [Internet]. 2019/04/24 ed. 2019 Apr 22; Available from: https://www.ncbi.nlm.nih.gov/pubmed/31012138

8. Massey D, Chaboyer W, Anderson V. What factors influence ward nurses' recognition of and response to patient deterioration? An integrative review of the literature. Nurs Open. 2017 Jan;4(1):6–23.

9. Herrick HM, Lorch S, Hsu JY, Catchpole K, Foglia EE. Impact of flow disruptions in the delivery room. Resuscitation. 2020/03/21 ed. 2020 Mar 16;150:29–35.

10. Danesh MK, Garosi E, Mazloumi A, Najafi S. Identifying factors influencing cardiac care nurses' work ability within the framework of the SEIPS model. Work. 2020;66(3):569–77.

11. Roth C, Brewer M, Bay RC, Gosselin K. Nurses' experiences of "being swamped" in the clinical setting and sssociation with adherence to AWHONN nurse staffing guidelines. MCN Am J Matern Child Nurs. 2020;45(5):271–9.

12. Simpson K, Lyndon A, Ruhl C. Consequences of inadequate staffing include missed care, potential failure to rescue, and job stress and dissatisfaction. J Obstet Gynecol Neonatal Nurs. 2016;45(4):481–90.

13. Patel SM, Loveridge R. Obstetric Neuraxial Drug Administration Errors: A Quantitative and Qualitative Analytical Review. Anesth Analg. 2015 Dec;121(6):1570–7.

14. Carayon P. Human factors of complex sociotechnical systems. Applied Ergonomics. 2006/06/08 ed. 2006 Jul;37(4):525–35.

15. Johnson C, Handberg E, Dobalian A, Gurol N, Pearson V. Improving perinatal and neonatal patient safety: the AHRQ patient safety indicators. J Perinat Neonatal Nurs. 2005 Jan;19(1):15–23.

16. Carayon P, Wood K. Patient safety: The role of human factors and systems engineering. Studies in Health Technology and Informatics. 2010;153:23–46.

17. Morton C, VanOtterloo L, Seacrist M, Main E. Translating maternal mortality review into quality improvement opportunities in response to pregnancy-related deaths in California. J Obstet Gynecol Neonatal Nurs. 2019 May;48(3):252–62.

18. VanOtterloo L, Seacrist M, Morton C, Main E. Quality improvement opportunities identified through case review of pregnancy-related deaths from venous thromboembolism. J Obstet Gynecol Neonatal Nurs. 2019;48(3):300–10.

19. VanOtterloo L, Morton C, Seacrist M, Main E. Quality improvement opportunities identified through case review of pregnancy-related deaths from cardiovascular disease. J Obstet Gynecol Neonatal Nurs. 2019;48(3):263–74.

20. Seacrist M, Morton C, VanOtterloo L, Main E. Quality improvement opportunities identified through case review of pregnancy-related deaths from sepsis. J Obstet Gynecol Neonatal Nurs. 2019/04/12 ed. 2019 May;48(3):311–20.

21. Seacrist M, VanOtterloo L, Morton C, Main E. Quality improvement opportunities identified through case review of pregnancy-related deaths from obstetric hemorrhage. J Obstet Gynecol Neonatal Nurs. 2019;48(3):288–99.

22. Gurses, A, Carayon, P, Wall, M. Impact of performance obstacles on intensive care nurses' workload, perceived quality and safety of care, and quality of working life. Health Serv Res. 2009;44:422–43.

23. American College of Obstetricians and Gynecologists and the Society for Maternal–Fetal Medicine, Kilpatrick SK, Ecker JL. Severe maternal morbidity: screening and review. Am J Obstet Gynecol. 2016 Sep;215(3):B17-22.

24. First Data Released on Maternal Mortality in Over a Decade [Internet]. 2020 [cited 2021 Jun 18]. Available from: https://www.cdc.gov/nchs/pressroom/nchs_press_releases/2020/202001_MMR.htm

25. Adverse Events, Near Misses, and Errors. [cited 2021 Jan 21]; Available from: https://psnet.ahrq.gov/primer/adverse-events-near-misses-and-errors

26. Silber JH, Williams SV, Krakauer H, Schwartz JS. Hospital patient characteristics associated with death after surgery: A study of adverse occurrence and failure to rescue. Medical Care. 1992;30(7).

27. Burke JRMb, Downey CMbc, Almoudaris AMBs (Hons). Failure to rescue deteriorating patients: A systematic review of root causes and improvement strategies. Journal of Patient Safety. 2020;

28. Carayon P, Schoofs Hundt A, Karsh B, Gurses A, Alvarado C, Smith M, et al. Work system design for patient safety: the SEIPS model. Qual Saf Health CareM. 2006/12/05 ed. 2006 Dec;15 Suppl 1:i50-8.

29. Bernstein S. Scoping Review on the Use of Early Warning Trigger Tools for Women in Labor. J Obstet Gynecol Neonatal Nurs. 2021 May 1;50(3):256–65.

30. Arnolds DE, Smith A, Banayan JM, Holt R, Scavone BM. National Partnership for Maternal Safety recommended maternal early warning criteria are associated with maternal morbidity. Anesthesia & Analgesia [Internet]. 2018/11/01 ed. 2018 Oct 30; Available from: https://www.ncbi.nlm.nih.gov/pubmed/30379672

31. Bernstein SL, Kelechi TJ, Catchpole K, Nemeth LS. Prevention of failure to rescue in obstetric patients: A realist review. Worldviews Evid Based Nurs [Internet]. 2021 [cited 2021 Sep 5]; Available from: https://sigmapubs.onlinelibrary.wiley.com/doi/abs/10.1111/wvn.12531

32. Goodson P. Theory in Health Promotion Research and Practice. Jones and Bartlett Publishers; 2010.

33. Grobman WA, Bailit JL, Rice MM, Wapner RJ, Reddy UM, Varner MW, et al. Racial and ethnic disparities in maternal morbidity and obstetric care. Obstet Gynecol. 2015/05/23 ed. 2015 Jun;125(6):1460–7.

Chapter 2: Manuscript 1

Scoping Review on the Use of Early Warning Trigger Tools for Women in Labor

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This paper has been accepted for publication to the *Journal of Gynecologic, Obstetric, and Neonatal Nursing* (reprinted with permission). Bernstein, S. (2021), May 1; 50(3))256-65. Scoping Review on the Use of Early Warning Trigger Tools for Women in Labor. DOI: 10.1016/j.jogn.2021.01.003

Abstract

Objective- To identify existing obstetric trigger tools, evaluate their sensitivity and specificity to correctly identify women in need of care escalation, and describe clinicians' experiences of using these tools while caring for women in labor.

Data Sources- Iterative searches of three databases: CINAHL, PubMed, and SCOPUS, in October 2019 and June 2020 using the keywords *maternal surveillance system, obstetric**, *early warning scores, early warning systems,* and *trigger tools*.

Study Selection- Primary quantitative and qualitative studies on the utility or implementation of trigger tools for women in labor that were written in English. Through the initial search, I identified 208 articles and included 11 full-text articles in this review.

Data Extraction- I extracted data related to aims, population, methodology, outcomes, and key findings for each study and entered them into a matrix based on the Joanna Briggs Institute Review Guidelines.

Data Synthesis- Quantitative researchers found that the sensitivity and specificity to correctly identify women in need of care escalation of tools varied and recommended that institutions should consider burdens of false-positives versus risks of false-negatives when choosing a tool for their contexts. Qualitative researchers described clinicians' experiences with the use of trigger tools and systems-level barriers to implementation, including lack of training, poor management of implementation, increased workload due to redundant charting, and belief that tools were not appropriate for women with low-risk pregnancies. High rates of false positives led clinicians to use trigger tools only for women with high-risk pregnancies rather than as a screening tool for all women.

Conclusion- Trigger tools may help with early identification of worsening clinical condition, but further research is needed to refine and improve tools, as well as

understand best practices for tool implementation. Systems-level factors should be considered in tool selection.

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REVIEW

Scoping Review on the Use of Early Warning Trigger Tools for Women in Labor

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Keywords
pregnancy
trigger tools
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ABSTRACT

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Conclusion: Trigger tools may help with early identification of worsening clinical condition, but further research is needed to refine and improve tools, as well as understand best practices for tool implementation. Systems-level factors should be considered in tool selection.

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The current rate of maternal mortality in the United States is 17 deaths per 100,000 live births, which is approximately double the rate in the 1980s (Centers for Disease Control and Prevention, 2019). Since the 1980s, the rate of severe maternal morbidity (SMM) also increased by 200% (Centers for Disease Control and Prevention, 2020). It is estimated that 41% to 90% of cases of pregnancy-related death in the United States are preventable, and most negative outcomes are attributed to late recognition of changes in condition and resulting delays in needed diagnosis and treatment (Main et al., 2015). Early identification of women's clinical deterioration is believed to be a key to the prevention of maternal morbidity and mortality, because delays in treatment may result in failure to rescue, which is defined as poor management of a medical condition that leads to death. In a study of more than 50 million births in the United States from 1998 to 2010, there were 2,795 cases of failure to rescue that represented 78.7% of the 3,550 pregnancy related deaths (Friedman et al., 2016).

AWHONN

The four most common types of SMM are hemorrhage, infection, thromboembolic events, and hypertensive disorders of pregnancy (chronic hypertension, gestational hypertension, preeclampsia/eclampsia, and chronic hypertension with superimposed preeclampsia; Anderson & Schmella, 2017). Although there are known risk factors for these conditions, it is not possible to predict which women will develop SMM, and the dynamic processes of labor mean that decisions are made even as a woman's status is changing. Women who survive SMM may experience ongoing negative effects, including mistrust of the health care system. Women of color experience disproportionately greater rates of SMM and thus may also experience increased mistrust (Grobman et al., 2015; McLemore et al., 2018).

The identification of clinical deterioration is important because it must precede the escalation of care, which may include, but is not limited to, increased monitoring, the use of medications, and/or calls to the provider for patient assessment. In their systematic review of 21 studies on early warning systems in medical–surgical populations, Smith et al. (2014) concluded that early identification of clinical deterioration was associated with improved outcomes. Researchers are increasingly interested in studying the use of validated instruments to help bedside clinicians identify clinical deterioration early and effectively. These instruments, which are used to capture vital signs and symptoms, are referred to as *trigger tools*. The use of validated trigger tools for patients in intensive care units (ICUs) and medical–surgical units has been beneficial, but these tools are not useful for women in labor. In a systematic review of 25 studies, Ryan et al. (2016) found that use of the Acute Physiology and Chronic Health Evaluation II (APACHE II) tool resulted in gross overestimation of the risk of maternal death in high-, middle-, and low-resource environments. The APACHE II tool is commonly used in ICU settings and includes 12 physiologic variables, age, and baseline health to predict survival as well as readmission risk (Lee et al., 2015). Thus, researchers recommended the development and use of an obstetric-specific trigger tool for women during labor (Ryan et al., 2016).

Several women's health organizations have also recommended the use of trigger tools in perinatal settings. The National Partnership for Maternal Safety acknowledged that these tools can improve patient safety (Mhyre et al., 2014), and a similar statement was made by the California Maternal Quality Care Collaborative (2019). These organizations drew their recommendations from expert consensus and encouraged hospital administrators to implement the use of trigger tools. The National Partnership for Maternal Safety suggests the use of the Maternal Early Warning Criteria but also acknowledged that further research is needed to determine if this tool decreases maternal morbidity and mortality (Mhyre et al., 2014). The California Maternal Quality Care Collaborative does not recommend any specific trigger tool. The knowledge gap of valid and reliable trigger tools for obstetric emergencies presented an opportunity to map the literature using a scoping review with five distinct steps. The aim of this review was to identify existing obstetric trigger tools, evaluate their sensitivity and specificity to correctly identify women in need of care escalation, and describe clinicians' experiences of using these tools while caring for women in labor.

Early identification of women's physiologic deterioration during the perinatal period is important to decrease rates of maternal morbidity and mortality.

Methods

Scoping reviews are used to survey the literature to develop a broad understanding of the extant research on a specific topic (Peters et al., 2020). I chose a scoping review because it provides an overview of the evidence and can help identify gaps in the literature to guide needed research (Peters et al., 2020). Arksey and O'Malley's (2005) five-stage methodologic framework guided this scoping review. This framework includes defining the question, searching the literature, selecting studies, visually organizing the information, and summarizing the information. The process results in an overview of the available data that can assist in identifying research gaps in the literature (Arksey & O'Malley, 2005).

Step 1: Define the question

Although many different obstetric-specific trigger tools were developed in previous patient safety research to help clinicians recognize when a woman's status is deteriorating during labor, it remains unclear if these tools improve outcomes. The experiences of nurses, midwives, and

physicians who use the tools are not well reported. Thus, the aim of this review was to answer the following questions: What are the existing trigger tools? How well do they work to identify women in need of care escalation? What are the barriers to their use?

Step 2: Locate relevant studies

I performed the initial literature searches in September 2019 with the assistance of a research and education informaticist to identify appropriate search terms, databases, and inclusion/exclusion criteria. These searches were refined and repeated in June 2020 using three electronic databases (PubMed, CINAHL, and SCOPUS) to identify studies that described the validation or use of obstetric-specific trigger tools in an intrapartum inpatient setting. Multiple combinations of the following terms were used: *maternal surveillance system*, *obstetric**, *early warning scores*, *early warning systems*, and *trigger tools*. An iterative process informed the searches and the use of progressive search terms.

Step 3: Choose studies

I used the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flowchart to guide the screening and selection of articles (see Figure 1) and the PRISMA extension for Scoping Reviews checklist. I included articles that were reports of quantitative or qualitative studies, were published in English in peer-reviewed journals from 2010 to 2020, and included trigger tools used for women in labor. Included articles were original research in which authors assessed the validation of a tool used for women in labor; developed a new tool; or collected data about the context of use, barriers to adoption, and/or consistent use of tools. I excluded studies that included women with only vaginal or only caesarean births, only antenatal or postpartum use of tools, or only one rather than all causes of maternal morbidity and those that were conducted in developing countries or entirely in intensive care settings. I also excluded review articles, commentaries, and organizational guidelines or recommendations. Although Arksey and O'Malley (2005) recommend reading the full text of articles instead of depending on abstracts for exclusion/inclusion, other researchers accepted the review of abstracts at this stage (Levac et al., 2010). With a single author reading all studies, the review of abstracts for this stage was considered an appropriate balance between rigor and feasibility. After removing duplicates and evaluating abstracts, I screened the full text of 34 articles and included 11 articles in this review.

Step 4: Visually organize the information

I created a matrix to organize the literature and assist with analysis (see Supplemental Table S1). The matrix was used to summarize studies focused on the use and implementation of the tools and the experiences of the nurses, midwives, and physicians who used the tools.

Results

Study characteristics

Of the 11 studies, nine were quantitative and two were qualitative (one ethnography and one grounded theory; see Supplemental Table S1). Seven of the nine quantitative studies addressed how the tools worked to identify women with morbidity, and two described the clinician experience of using the tool. Four studies were conducted in the United States, five in the United Kingdom, and one in New Zealand; one spanned Denmark, Norway, and Sweden in Scandinavia.

Scoring tools

Five specific scoring tools were identified in the 11 studies: the Modified Early Obstetric Warning System (MEOWS; Blumenthal et al., 2019; Mackintosh et al., 2014; Singh et al., 2012), the Maternal Early Warning Trigger (MEWT; Blumenthal et al., 2019; Shields et al., 2016), the Maternal Early Warning Criteria (MEWC; Arnolds et al., 2018), the Maternal Early Warning System (MEWS; Blumenthal et al., 2019), and the Maternal Early Recognition Criteria (MERC; Blumenthal et al., 2019). Bick et al. (2014) described a nonspecific early warning system developed by the institution, and Hedriana et al. (2016) used "maternal early warning triggers" that were not part of a named tool (p.337).

The trigger tools all required six to eight patient parameters to support or provoke a response from clinical staff and/or promote critical thinking and situational awareness. The tools showed a wide range of sensitivity and specificity to identify maternal morbidity or predict mortality (see Supplemental Table S2). Sensitivity was calculated by the study authors based on the correct identification of women with morbidity and specificity on the correct identification of women without morbidity.

The MEOWS tool includes eight variables including maternal vital signs, oxygen saturation, pain score,

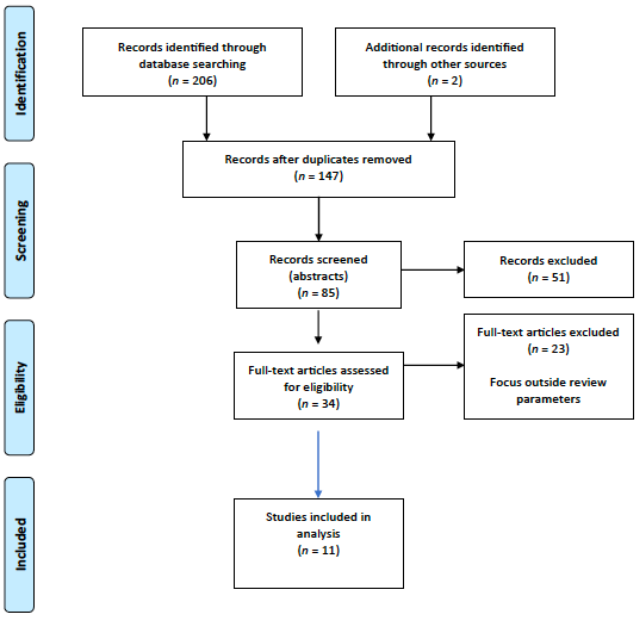

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) flow diagram

and neurologic response (Singh et al., 2012). Variable measurements are charted onto a MEOWS flow sheet with color-coded areas indicating red or yellow trigger zones. Researchers did not describe whose responsibility it was to chart these variables but did tell midwives and physicians that compliance with the tool was important. Women were considered to have triggered in the presence of one red or two yellow zone measurements; a trigger was followed by a mandatory call to a clinician. Singh et al. (2012) validated the MEOWS tool with a prospective sample of 676 consecutive women in labor. Of these women, the status of 200 women (30%) triggered calls to clinicians, and 86 (13%) were diagnosed with a morbidity, including hemorrhage, preeclampsia, suspected infection, pulmonary embolus, thromboses, stroke, asthma exacerbation, seizure, diabetic ketoacidosis, myocardial infarction, or anesthetic complications (Singh et al., 2012). The MEOWS tool showed 89% sensitivity and 79% specificity (Singh et al., 2012).

The MEWT is a detailed algorithm that begins with assessment of maternal vital signs and peripheral oxygen saturation (SpO_2; Shields et al., 2016). Abnormal measurements lead down a decision tree indicating the next actions to take and a suggestion of the possible underlying pathology. The researchers used a 24-month baseline control period followed by a 13-month study period. Nurses used the MEWT tool at pilot sites with 12,611 births; maternal morbidity at those sites was compared to nonpilot (control) sites with 50,641 births (Shields et al., 2016). The tool was used in 93.4% of women in labor at the pilot sites and showed 96.9% sensitivity and 99.9% specificity for ICU admission (Shields et al., 2016).

The MEWC was developed by a subcommittee of the National Partnership for Maternal Safety (Mhyre et al., 2014), which included representatives from eight diverse women's health organizations (nurses, midwives, and physicians.) These representatives used discussion and a consensus process to develop the MEWC as a screening tool. This tool has a single-parameter scoring system; thus, if a vital sign outside the defined range is observed, it is a trigger, which warrants increased observations, assessments, or interventions (Mhyre et al., 2014). The tool was then externally validated by using 400 births at an urban tertiary care center (Arnolds et al., 2018). Of those 400 women, 281 (70%) had triggers at

least once, and 198 (50%) had multiple triggers. Ninety-nine (25%) were diagnosed with morbidities including hemorrhage, infection, and preeclampsia with severe features (Arnolds et al., 2018). The MEWC has 97% sensitivity and 39% specificity in predicting morbidity for women with a single trigger. For women with multiple or recurrent triggers, the sensitivity was 84% and the specificity was 62% for predicting morbidity (Arnolds et al., 2018).

The MEWS was developed retrospectively for general hospital inpatient use (Ludikhuize et al., 2012) and validated by Blumenthal et al. (2019) for use in laboring women without adaptation. The MEWS uses an aggregate-weighted scoring system; out-of-range vital signs are assigned points based on their distance from standardized normal values. The tool instructs nurses to call a physician for scores of 3 points or greater (Ludikhuize et al., 2012). In this retrospective study, researchers reviewed vital signs from medical records and applied the criteria of four different trigger tools to see how different tools triggered for the same sets of vital signs recorded by nursing staff during labor (operating room vital signs were excluded from this study). Researchers then reviewed charts to determine if triggers had clinical relevance; clinical relevance was determined by using a consensus practice among a group of practicing obstetricians.

By comparing 79 women with morbidity to 123 women without morbidity as controls, Blumenthal et al. (2019) found the MEWS to be more specific (93.5%) than the MEOWS (51.2%) or the MERC (60.2%; $p < .001$) for predicting morbidity. The MEOWS and MERC were more sensitive (67.1% and 67.1%, respectively) for predicting morbidity than the MEWS or MEWT (19.5% and 50.5%, respectively; $p < .001$; Blumenthal et al., 2019).

The MERC includes the items on the MEWC tool developed by the National Partnership for Maternal Safety with the addition of temperature of greater than 38.5 °C as a trigger. It also retained the single-parameter scoring system of the MEWC tool (Blumenthal et al., 2019). The MERC had 67.1% sensitivity and 60.2% specificity to predict morbidity (Blumenthal et al., 2019). Supplemental Table S3 shows the signs and symptoms used in each tool.

Step 5: Summarizing

Stage five of Arksey and O'Malley's (2005) scoping review methodology involved the reporting of the results of the review by summarizing common areas of agreement or disagreement across all articles and identifying gaps in the literature. Because these authors also recommended the use of an analytic framework to assist in the organization of the information, I used the structure of the Social Ecological Model (SEM) to guide the analysis and presentation of the results of this scoping review (McLeroy et al., 1988). Supplemental Table S4 shows which levels of the model are addressed by each article.

Social Ecological Model

The five levels of the SEM are intrapersonal, interpersonal, institutional, community, and public policy factors (McLeroy et al., 1988). I adapted these levels for the clinical setting (see Figure 2) and used this framework to report the results. I used definitions of McLeroy et al. for each level. Examples of intrapersonal factors that may affect trigger tool use are clinical staff's beliefs and attitudes, as well as their knowledge, skills, and experience (McLeroy et al., 1988). The interpersonal factors encompass the relationships among staff members and the effect of trigger tools on teamwork; communication within work groups is an important aspect of the SEM (McLeroy et al., 1988). Institutional factors include staffing matrices, institutional culture, and hospital policies; McLeroy (1988) considers formal and informal rules at this level. Community factors describe the relationships among organizations (McLeroy et al., 1988). Finally, public policy factors include the effect of legislation, as well as governmental and quasigovernmental organizations (McLeroy et al., 1988).

Intrapersonal level. The intrapersonal level includes factors that may affect trigger tool use, such as clinical staff's beliefs and attitudes about childbirth, as well as their knowledge, skills, and experience.

Bedside nurses are challenged by the large amount of information that they must process and hold in their minds about each woman, including medical and obstetric history and issues with the current pregnancy, while measuring vital signs, providing ongoing assessments, and meeting the support needs of the woman and her family. Screening tools help draw nurses' attention to the most relevant signs and symptoms a woman is experiencing.

The MEOWS tool was recommended as a screening tool to promote early identification of women at risk of clinical deterioration, but

midwives questioned the tool's utility for low-risk women (Martin, 2015). Midwives' perceptions of labor and birth as a natural event made tools feel burdensome and inappropriate for use with low-risk women (Carlstein et al., 2018; Mackintosh et al., 2014). Midwives also communicated an unwillingness to interrupt laboring women's work for the measurement of vital signs (Carlstein et al., 2018). Other common concerns were that the use of a tool diminished the value and/or independence of midwives' professional judgment (Mackintosh et al., 2014). Physicians and midwives objected to the use of trigger tools for low-risk women because they believed the tools increased workload and were unnecessary where one-to-one care was being provided (Mackintosh et al., 2014). These concerns led staff to use tools only for women they already perceived as being at greater risk rather than as a screening tool (Mackintosh et al., 2014).

The use of any tool requires that specific vital signs be measured and recorded, but respiratory rate values were often left blank in women's charts (Austin et al., 2014; Carle et al., 2013). These missing respiratory rate values were a common limitation of the studies; there was no discussion in any study of the reasons why respiratory rate values might be blank in the medical record or how respiratory rate was measured. This was categorized as an intrapersonal factor because an individual chose to not measure or record the vital sign.

Interpersonal level. The interpersonal level of the SEM reflected engagement of the clinician with other members of the health care team, including the patient. Most researchers did not indicate which member of the health care team should use the tool, but the design of the tools (requiring the measuring and recording of vital signs) implied that it was likely the nurse caring for the woman. Despite this, few researchers described the experiences of nurses.

Researchers designed the MEWT algorithm to decrease delays in patient assessment by providing clear instructions regarding when physicians should be notified (Blumenthal et al., 2019; Shields et al., 2016). However, midwives described feeling a loss of autonomy when the trigger tool mandated that they call an attending physician (Carlstein et al., 2018; Martin, 2015). Other midwives believed there was pressure not to call the obstetrician for help even when needed (Mackintosh et al., 2014). This interpersonal issue reflected institutional cultures and illustrates overlap in the ways that interpersonal difficulties interacted with other levels of the SEM.

A key finding is the need for validated tools with better sensitivity and specificity to identify women in need of escalation in care.

Institutional and community levels. To determine which of the available tools would best suit their hospital or hospital system, Blumenthal et al. (2019) compared four different trigger tools: the MEWS, MEOWS, MERC, and MEWT. They found that none of the tools produced the desired 90% sensitivity and 95% specificity but concluded that in their practice environment (a busy tertiary care center with more than 6,000 births annually), a tool with lower sensitivity met their needs, because tools with greater sensitivity are prone to false positives, which can be a burden in a busy institution (Blumenthal et al., 2019). A heavier alert rate might be acceptable in a less busy environment, where the desire to avoid false negatives would outweigh the burden of a greater rate of false positives (Arnolds et al., 2018; Blumenthal et al., 2019; Carle et al., 2013; Hedriana et al., 2016; Shields et al., 2016).

Institutional culture and traditional hierarchies limited the utility of the tools because of hierarchical relationships between physicians and midwives or nurses (Bick et al., 2014; Martin, 2015). The traditional relationships, where physicians give orders and nurses carry them out, made it difficult for some nurses and midwives to tell physicians that they had to come to the bedside (Mackintosh et al., 2014). Midwives believed they received inadequate training from their institution on the use of trigger tools and were not consulted about this change in practice (Bick et al., 2014; Martin, 2015). Although these are interpersonal difficulties, it was institutional culture made these challenges complex to overcome.

In an effort to adapt the tool to the institution, clinicians changed the timing or structure of the original tool (Carlstein et al., 2018; Mackintosh et al., 2014; Martin, 2015; Swanton et al., 2009). Researchers did not discuss how these adaptations might affect tool validity. A lack of training on how and when to use the tools was also a barrier to tool implementation (Bick et al., 2014; Martin, 2015; Swanton et al., 2009).

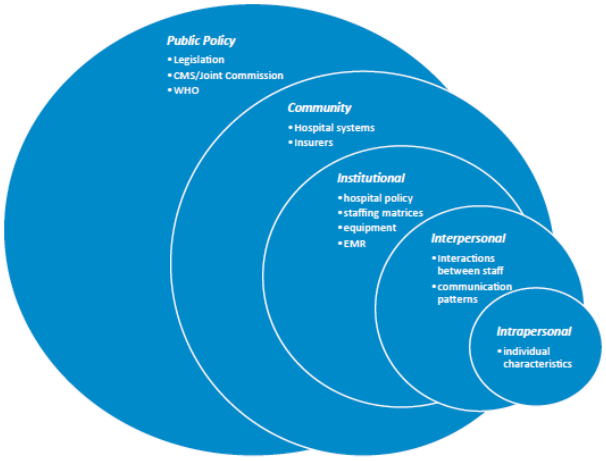

Figure 2. The Social Ecological Model adapted for the clinical environment. CMS = Centers for Medicare & Medicaid Services; EMR = electronic medical record; WHO = World Health Organization.

Public policy. Following recommendations by the United Kingdom's National Institute for Health and Clinical Excellence, Carle et al. (2013) created a scoring tool aligned with the National Early Warning Score used on general hospital wards. In 2013, the United Kingdom's National Health Service planned to implement a National Obstetric Early Warning Score for all National Health Services hospitals in an effort to decrease maternal morbidity and mortality but was unable to come to consensus on a single tool; the hospitals of the National Health Service continue to use varied trigger tools (Carle et al., 2013; Knight, 2016).

In the United States, the MEWC tool was studied to determine whether use of the tool could decrease maternal morbidity in 400 births at a tertiary care center (Arnolds et al., 2018). Although the tool worked adequately as a screening tool for maternal morbidity with 97% sensitivity, it had only 39% specificity; thus, false positives were likely (Arnolds et al., 2018). Further research was deemed necessary before the nationwide use of any tool.

Discussion

The aim of this review was to identify the currently available obstetric trigger tools, describe their sensitivity and specificity, and describe clinicians' experiences of using these tools, including barriers to use. A key finding of my review is that there is a need for tools with greater sensitivity and specificity to identify women in need of care escalation during labor. Although many tools were validated in specific contexts, they had a wide range of sensitivity and specificity, which is likely due to the lack of consensus on normal vital sign ranges during labor (Bick et al., 2014; Carlstein et al., 2018; Smith et al., 2017). An analysis of 120 different hospital vital sign charts found 75 unique combinations of vital sign ranges labeled as "normal" (Smith et al., 2017).

Authors promoted change at the intrapersonal level by the use of an algorithm that encouraged decision making by an individual clinical staff member, who was expected to escalate care based on signs and symptoms displayed by a woman (Carle et al., 2013; Shields et al., 2016; Singh et al., 2012). This escalation of care often depended on communication with women during assessment, as well as with other clinicians, thus integrating the interpersonal factors. The clinical staff's communication with the woman was critical during clinical deterioration because the subjective signs and symptoms of altered mental status, pain, and dyspnea are crucial in understanding the overall condition of the woman in labor. The subjective report from a woman or her family that something seemed wrong could be a useful addition to trigger tools (Bick et al., 2014).

For the trigger tools to work as designed, vital signs must be accurately measured and recorded, neither of which is guaranteed with the current systems of gathering these data. Respiratory rate was frequently omitted (Arnolds et al., 2018). In addition, although trigger tools were validated for a specific use (such as screening for all women in labor), many hospital administrators changed their use to better suit the needs of the hospital. Some hospitals used tools only for women deemed to be at greater risk to decrease the rate of false positives and address clinician concerns about alarm fatigue (Bick et al., 2014; Carlstein et al., 2018). This is a different context than the validated use and, thus, may alter the in situ sensitivity and specificity of a tool.

Another reason administrators made changes to tools was a desire to create a less burdensome tool for clinical staff. When trigger tools required redundant charting or had greater trigger rates, staff members were less likely to use them (Arnolds et al., 2018; Shields et al., 2016). A lack of appropriate change management also hindered tool implementation (Bick et al., 2014; Martin, 2015). Of the clinical staff affected, registered nurses are typically the staff members expected to use the tools, yet there was a surprising lack of research focused on nurses' experiences with tool use.

Recommendations made by authors of the reviewed studies suggested that no one specific tool can be used at all hospitals, likely because of inadequate evidence that any one tool could meet the needs of all clinical environments or patient populations. However, Shields et al. (2016) noted that their successful testing of the MEWT algorithm included hospitals with 860 to 3,000 births per year and concluded that the MEWT would be appropriate for use in the majority of hospitals in the United States. Although the use of trigger tools may be helpful to clinical staff, many tools had inadequate sensitivity and specificity, leading to a greater number of false positives, which may contribute to alarm fatigue and tax hospital resources (Blumenthal et al., 2019; Carlstein et al., 2018; Mackintosh et al., 2014; Shields et al., 2016; Singh et al., 2012). In a rural, less resourced hospital, a greater alert rate might result in an unnecessary transfer to a tertiary care hospital, but this is preferable to a woman experiencing increased morbidity or even mortality (Shields et al., 2016).

Recommendations to prevent maternal morbidity and mortality from state and national organizations and partnerships must include implementation guidelines for different levels of maternal care.

Research implications

There are several important research implications from this review. First, nurses, midwives, and physicians need validated trigger tools appropriate for a wide range of maternity settings. This may begin with descriptive research to define normal vital sign ranges for women in labor. To protect patient safety, the validation of tools must precede implementation efforts. Second, in future tool development, researchers should consider how the inclusion of a woman's or her family's concerns might add to a patient-centered perspective on care escalation.

Future research focused on the use of tools by registered nurses would be beneficial in understanding issues surrounding tool implementation in the clinical environment. In future trigger tool development, researchers must consider the interaction between the accuracy of tools and the logistics and workload of data collection by nurses using trigger tools. Research on the current use of tools and the creation of new tools should be undertaken by nurses, who are ideally positioned to conduct such research (Trego, 2020).

The position of nurses within a hospital and the cultural tension between providers and nurses was only minimally addressed in the included articles. Research is needed to study system-level factors, such as how institutional culture and team communication may inhibit or accelerate adoption of trigger tools.

The reduction of maternal morbidity and mortality is a critical area of research, and future efforts are needed to address how policy can be directed to improve maternal outcomes. Recommendations to reduce maternal morbidity and mortality from state and national partnerships should include implementation guidelines for different levels of maternal care because tertiary care hospitals have different needs and capabilities than less resourced and rural hospitals.

Researchers developing implementation guidelines for trigger tools should use a systems approach to problem solving and address multiple levels of the SEM. Zuckerwise and Lipkind

(2017) recommended that the implementation of early warning systems include a plan for addressing intra- and interpersonal factors. Specifically, they suggested that nurses' comfort with care escalation and chain of command activation be explicitly addressed in the implementation planning for the use of these tools. Hospital culture influences care escalation protocols and, thus, must be considered during implementation planning.

Limitations

Because this was a scoping review, I focused on understanding the use of the obstetric trigger tools currently available and did not assess the myriad other tools used in nonobstetric units. Second, one of the exclusions was research performed in developing nations. These studies were intentionally excluded to limit the variation in practice environments, but this exclusion may limit the generalizability of the findings. Finally, this review is limited by single authorship, although this factor was mitigated by the use of several readers to promote impartiality.

Conclusions

Findings from this review suggest that there is a lack of well-validated trigger tools to identify women in labor who are experiencing clinical deterioration requiring an escalation in care. Researchers of the existing tools do not adequately address barriers to their use at the intrapersonal and interpersonal levels, nor do they take into account how hospital culture may affect the use of trigger tools. Further research is needed to validate tools across a wide variety of institutions, to understand best practices for their implementation, and to improve understanding of nurses' use of trigger tools and the systems-level factors affecting nurses' use. Administrators implementing any trigger tool or patient recognition system should consider factors at all levels of the SEM to maximize efficiency, effectiveness, and utility.

SUPPLEMENTARY MATERIAL

Note: To access the supplementary material that accompanies this article, visit the online version of the *Journal of Obstetric, Gynecologic, & Neonatal Nursing* at http://jognn.org and at https://doi.org/10.1016/j.jogn.2021.01.003.

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CONFLICT OF INTEREST

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Check for updates

REFERENCES

Anderson, C., & Schmella, M. (2017). Preeclampsia: Current approaches to nursing management. *American Journal of Nursing, 117*(11), 30–38. https://doi.org/10.1097/01.NAJ.0000526722.26893.b5

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology, 8*(1), 19–32. https://doi.org/10.1080/1364557032000119616

Arnolds, D. E., Smith, A., Banayan, J. M., Holt, R., & Scavone, B. M. (2018). National Partnership for Maternal Safety recommended maternal early warning criteria are associated with maternal morbidity. *Anesthesia and Analgesia, 129*(6), 1621–1626. https://doi.org/10.1213/ANE.0000000000003889

Austin, D. M., Sadler, L., McLintock, C., McArthur, C., Masson, V., Farquhar, C., & Rhodes, S. (2014). Early detection of severe maternal morbidity: A retrospective assessment of the role of an Early Warning Score System. *Australian and New Zealand Journal of Obstetrics and Gynaecology, 54*(2), 152–155. https://doi.org/10.1111/ajo.12160

Bick, D. E., Sandall, J., Furuta, M., Wee, M. Y., Isaacs, R., Smith, G. B., & Beake, S. (2014). A national cross sectional survey of heads of midwifery services of uptake, benefits and barriers to use of obstetric early warning systems (EWS) by midwives. *Midwifery, 30*(11), 1140–1146. https://doi.org/10.1016/j.midw.2014.03.016

Blumenthal, E. A., Hooshvar, N., McQuade, M., & McNulty, J. (2019). A validation study of maternal early warning systems: A retrospective cohort study. *American Journal of Perinatology, 36*(11), 1106–1114. https://doi.org/10.1055/s-0039-1681097

California Maternal Quality Care Collaborative. (2019). *Preeclampsia Early Recognition Tool (PERT).* https://www.cmqcc.org/resource/preeclampsia-early-recognition

Carle, C., Alexander, P., Columb, M., & Johal, J. (2013). Design and internal validation of an obstetric early warning score: Secondary analysis of the Intensive Care National Audit and Research Centre Case Mix Programme database. *Anaesthesia, 68*(4), 354–367. https://doi.org/10.1111/anae.12180

Carlstein, C., Helland, E., & Wildgaard, K. (2018). Obstetric early warning score in Scandinavia. A survey of midwives' use of systematic monitoring in parturients. *Midwifery, 56*, 17–22. https://doi.org/10.1016/j.midw.2017.09.015

Centers for Disease Control and Prevention. (2019). *Pregnancy Mortality Surveillance System.* https://www.cdc.gov/reproductivehealth/maternalinfanthealth/pregnancy-mortality-surveillance-system.htm?

Centers for Disease Control and Prevention. (2020). *Severe maternal morbidity in the United States.* https://www.cdc.gov/

reproductivehealth/matemalinfanthealth/severematernalmorbidity.html

Friedman, A., Ananth, C., Huang, Y., D'Alton, M., & Wright, J. (2016). Hospital delivery volume, severe obstetrical morbidity, and failure to rescue. *American Journal of Obstetrics and Gynecology, 215*(6), 795.e1-795.e14. https://doi.org/10.1016/j.ajog.2016.07.039

Grobman, W. A., Bailit, J. L., Rice, M. M., Wapner, R. J., Reddy, U. M., Varner, M. W., … VanDorsten, J. P. (2015). Racial and ethnic disparities in maternal morbidity and obstetric care. *Obstetrics & Gynecology, 125*(6), 1460–1467. https://doi.org/10.1097/AOG.0000000000000735

Hedriana, H. L., Wiesner, S., Downs, B. G., Pelletreau, B., & Shields, L. E. (2016). Baseline assessment of a hospital-specific early warning trigger system for reducing maternal morbidity. *International Journal of Gynaecology and Obstetrics, 132*(3), 337–341. https://doi.org/10.1016/j.ijgo.2015.07.036

Knight M., Naur M., Tuffnell D., Kenyon S., Shakespeare J., Brocklehurst P., Kurinczuk J. (Eds.) on behalf of EMBBRACE-UK. (2016). *Saving lives, improving mothers' care*. Oxford: National Perinatal Epidemiology Unit.

Lee, H., Lim, C. W., Hong, H. P., Ju, J. W., Jeon, Y. T., Hwang, J. W., & Park, H. P. (2015). Efficacy of the APACHE II score at ICU discharge in predicting post-ICU mortality and ICU readmission in critically ill surgical patients. *Anaesthesia Intensive Care, 43*(2), 175–186. https://doi.org/10.1177/0310057X1504300206

Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: Advancing the methodology. *Implementation Science, 5*, Article 69. https://doi.org/10.1186/1748-5908-5-69

Ludikhuize, J., Smorenburg, S. M., de Rooij, S. E., & de Jonge, E. (2012). Identification of deteriorating patients on general wards; measurement of vital parameters and potential effectiveness of the Modified Early Warning Score. *Journal of Critical Care, 27*(4), 424.e7–424.e13. https://doi.org/10.1016/j.jcrc.2012.01.003

Mackintosh, N., Watson, K., Rance, S., & Sandall, J. (2014). Value of a modified early obstetric warning system (MEOWS) in managing maternal complications in the peripartum period: An ethnographic study. *BMJ Quality & Safety, 23*(1), 26–34. https://doi.org/10.1136/bmjqs-2012-001781

Main, E., McCain, C., Morton, C., Holtby, S., & Lawton, E. (2015). Pregnancy-related mortality in California: Causes, characteristics, and improvement opportunities. *Obstetrics & Gynecology, 125*(4), 938-947.

Martin, R. L. (2015). Midwives experiences of using a modified early obstetric warning score (MEOWS): A grounded theory study. *Evidence Based Midwifery, 13*(2), 59–65.

McLemore, M. R., Altman, M. R., Cooper, N., Williams, S., Rand, L., & Franck, L. (2018). Health care experiences of pregnant, birthing and postnatal women of color at risk for preterm birth. *Social Science & Medicine, 201*, 127–135. https://doi.org/10.1016/j.socscimed.2018.02.013

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly, 15*(4), 351–377. https://doi.org/10.1177/109019818801500401

Mhyre, J. M., D'Oria, R., Hameed, A. B., Lappen, J. R., Holley, S. L., Hunter, S. K., … D'Alton, M. E. (2014). The maternal early warning criteria: A proposal from the National Partnership for Maternal Safety. *Obstetrics & Gynecology, 124*(4), 782–786. https://doi.org/10.1097/AOG.0000000000000480

Peters, M. D. J., Godfrey, C., McInerney, P., Munn, Z., Tricco, A. C., & Khalil, H. (2020). Scoping reviews. In E. Aromataris and Z. Munn (Eds.). *JBI manual for evidence synthesis*. https://wiki.jbi.global/display/MANUAL/Chapter+11%3A+Scoping+reviews

Ryan, H. M., Sharma, S., Magee, L. A., Ansermino, J. M., MacDonell, K., Payne, B. A., Walley, K. R., & von Dadelszen, P. (2016). The usefulness of the APACHE II Score in obstetric critical care: A structured review. *Journal of Obstetrics and Gynaecology Canada, 38*(10), 909–918. https://doi.org/10.1016/j.jogc.2016.06.013

Shields, L. E., Wiesner, S., Klein, C., Pelletreau, B., & Hedriana, H. L. (2016). Use of Maternal Early Warning Trigger tool reduces maternal morbidity. *American Journal of Obstetrics and Gynecology, 214*(4), 527.e1–527.e6. https://doi.org/10.1016/j.ajog.2016.01.154

Singh, S., McGlennan, A., England, A., & Simons, R. (2012). A validation study of the CEMACH recommended modified early obstetric warning system (MEOWS). *Anaesthesia, 67*(1), 12–18. https://doi.org/10.1111/j.1365-2044.2011.06896.x

Smith, G. B., Isaacs, R., Andrews, L., Wee, M. Y. K., van Teijlingen, E., Bick, D. E., & Hundley, V., on behalf of the Modified Obstetric Early Warning Systems Research Group. (2017). Vital signs and other observations used to detect deterioration in pregnant women: An analysis of vital sign charts in consultant-led UK maternity units. *International Journal of Obstetric Anesthesia, 30*, 44–51. https://doi.org/10.1016/j.ijoa.2017.03.002

Smith, M. E. B., Chiovaro, J. C., O'Neil, M., Kansagara, D., Quiñones, A. R., Freeman, M., Motu'apuaka, M. L., & Slatore, C. G. (2014). Early Warning System Scores for Clinical Deterioration in Hospitalized. Patients: A Systematic Review. *11*(9), 12. https://doi.org/10.1016/j.ijoa.2017.03.002

Swanton, R. D., Al-Rawi, S., & Wee, M. Y. (2009). A national survey of obstetric early warning systems in the United Kingdom. *International Journal of Obstetric Anesthesia, 18*(3), 253–257. https://doi.org/10.1016/j.ijoa.2009.01.008

Trego, L. L. (2020). Why nurses are essential to research on birth outcomes in the United States. *Journal of Obstetric, Gynecologic, & Neonatal Nursing, 49*(4), 336–347. https://doi.org/10.1016/j.jogn.2020.05.004

Zuckerwise, L. C., & Lipkind, H. S. (2017). Maternal early warning systems—Towards reducing preventable maternal mortality and severe maternal morbidity through improved clinical surveillance and responsiveness. *Seminars in Perinatology, 41*(3), 161–165. https://doi.org/10.1053/j.semperi.2017.03.005

Table S1.
Studies Addressing the Use of Trigger Tools for Women in Labor

Author,Year	Country	Aims	Population/Sample size	Methodology	Outcomes	Key Findings
Arnolds et al., 2018	United States	Determine if vital signs triggered the MEWC and to identify women with morbidity	High risk women, *N* = 400	Retrospective	281 women (70%) triggered the tool, 99 (25%) had morbidity	The MEWC tool is an appropriate screening tool to identify maternal morbidity.
Austin et al., 2014	New Zealand	Determine if the EWS could improve identification of women with maternal morbidity	Women admitted to intensive care or high-dependency unit. *N*= 64	Retrospective	Tool might have reduced severity of morbidity in 5 women (7.6%).	EWS could speed recognition of women in need of care escalation. Women's vital sign charts were frequently missing values, especially respiratory rates.
Bick et al., 2014	United Kingdom	To understand current use of EWS, including barriers to uptake	Heads of midwifery services, *N* = 107	Survey	EWS used by 99% of midwives antenatally, 76% use for women in labor, 100% use for women in postpartum period. Barriers include burden of charting and staffing issues.	Differences in EWS tools being used limits ability to determine usefulness or make systems-level decisions about universal use.

Author,Year	Country	Aims	Population/Sample size	Methodology	Outcomes	Key Findings
Blumenthal et al., 2019	United States	To compare four early warning systems in women with and without morbidity	*N* = 132, women with morbidity (*n* = 79) and controls (*n* = 123)	Retrospective	None of the 4 systems tested demonstrate high sensitivity or specificity. MEWT may have acceptable clinical relevance for most contexts.	Choice of warning system must consider context and risks of high "false alarm" rates such as alarm fatigue
Carle et al., 2013	United Kingdom	Development of aggregate weighted early warning scoring system to predict survivorship in women receiving critical care during the intrapartum period	*N* = 4440 *n* = 2240 for model development *n* = 2200 for validation of model	Secondary analysis	Developed tool can accurately predict survivorship.	Further research necessary to develop a tool to use throughout all maternity wards. Experienced significant missing data, particularly respiratory rate.

Author,Year	Country	Aims	Population/Sample size	Methodology	Outcomes	Key Findings
Carlstein et al., 2018	Denmark, Norway, and Sweden	Understand midwives use of early warning systems and barriers to use	*N* = 125 midwives	Survey	*N* = 13 midwives (10%) used early warning systems. Barriers included interrupting laboring woman, *n* = 48 (38%), lack of evidence for systems, *n* = 42 (34%), tools not being appropriate for women in labor, *n* = 42 (34%), and tools taking too much time to use, *n* = 42 (34%).	Midwives rarely use early warning systems. Recommend further practice assessment before implementation to avoid increasing workload for midwives.
Hedriana et al., 2016	United States	Determine if single or multiple MEWT triggers can predict maternal morbidity	*N* = 100, *n* = 50 women admitted to intensive care for maternal morbidity, *n*= 50 women without morbidity	Retrospective case-control	Single or multiple triggers are related to increased morbidity. Two or more triggers warrant increased assessment or escalation of care.	Use of MEWTs to determine need for escalation may decrease severity of maternal morbidity. MEWTs may increase situational awareness and improve women's outcomes.

Author,Year	Country	Aims	Population/Sample size	Methodology	Outcomes	Key Findings
Mackintosh et al., 2014	United Kingdom	Understand implementation of MEOWS and contextual factors influencing use of system	*N* = 45, Midwives, physicians, and managers	Ethnography	Use of MEOWS increased inter-professional communication. Midwives and physicians questioned tool's value, tool increased workload. Midwives used tool selectively, not as universal screening tool.	Significant variation in implementation of MEOWS. Culture and belief about birth and safety influenced decision-making by providers.
Martin, 2015	United Kingdom	Understand midwives experience using MEOWS, identify barriers to use.	*N* = 6 midwives	Grounded theory	Barriers: changes to practice to include MEOWS were not well communicated, midwives lacked training in tool use, and tool required redundant charting	Implementation of tool requires active change management involving stakeholders. Training on tool use could improve uptake.

Author,Year	Country	Aims	Population/Sample size	Methodology	Outcomes	Key Findings
Shields et al., 2016	United States	Determine if it's possible to reduce maternal morbidity using an algorithm based on MEWT	*N* = 183,191 births *n* = 36,832 births at pilot study sites *n* = 146,359 at nonpilot study sites	Prospective	Tool implementation was associated with significant reduction in severe maternal morbidity (-18.4%, *p* = .01).	Could not connect reduced morbidity with reduced intensive care admissions.
Singh et al., 2012	United Kingdom	Determine if MEOWS can be used to predict maternal morbidity, measure sensitivity, specificity, and predictive value.	*N* = 676 Consecutive admissions *N* = 200 women triggered the tool, of whom *n* = 86 women had morbidity	Prospective	Sensitivity = 89 % (95% CI 81-95%) Specificity = 79% (95% CI 76-82%) Positive predictive value = 39% (95% CI = 32-46%) Negative predictive value = 98% (95% CI = 96-99%)	Low blood pressure values designated as abnormal on this tool may need refinement to decrease false positives. Reasonable sensitivity and specificity to strongly recommend broader use for all women in labor to identify maternal morbidity.

Note. MEOWS = Modified Early Obstetric Warning System, MEWS = Maternal Early Warning System, MEWT= Maternal Early Warning Trigger, MERC = Maternal Early Recognition Criteria, EWS = Early Warning System

Table S2

Comparison of sensitivity and specificity of trigger tools

Tool	# variables	Sensitivity	Specificity	Author	Criterion
Modified	7-8	89%	79%	Singh, et al, 2012	To predict morbidity
Early Obstetric Warning System		36.7%	64.2%	Blumenthal, et al, 2019	To predict morbidity
Maternal	7-8	13.9%	90.2%	Blumenthal, et al, 2019	To predict morbidity
Early Warning Trigger [a]		96.9%	99.9%	Shields, et al, 2016	To predict ICU admission only
Maternal Early Recognition Criteria	7	34.2%	69.9%	Blumenthal, et al, 2019	To predict morbidity
Maternal Early	6	97%	39%	Arnolds, et al	Single trigger used to predict morbidity
Warning Criteria		84%	62%	Arnolds, et al	Recurrent/multiple triggers to predict morbidity

Maternal Early Warning System	7	7.6%	97.6%	Blumenthal, et al, 2019	To predict morbidity

Note. ICU = Intensive Care Unit

[a] Maternal Early Warning Trigger uses 7 variables for cardiopulmonary, hypertensive, and hemorrhage pathways, and adds fetal heart rate as an 8th variable for the infection pathway

Table S3

Signs and Symptoms Included in the Trigger Tools

	SBP (mm Hg)	DBP (mm Hg)	HR beats/ min	RR breaths/min	Mental Status	SpO_2 on room air	Temp	Oliguria
MEOWS[a]	<90 or < 160	>100	<50	<10 or >30	Not alert	< 95%	<35°C or >38°C	N/A
MEWT[b]	<80 or >155	<45 or >105	<50 or >110	<12 or >24	"altered"	< 94%	>100.4°F	N/A
MEWC[c]	<90 or >160	>100	<50 or >120	<10 or >30	Agitation, confusion, unresponsiveness	< 95%	N/A	<35 mL/hr for >= 2 hours
MEWS[d]	<101 or >200	N/A	<51 or >100	<9 or >14	Not alert	< 90% with O_2 therapy	<36.6° C or > 37.5° C	<75 mL in prior 4 hours
MERC	<90 or >160	>100	<50 or >120	<10 or >30	Agitation, confusion, unresponsiveness	<95%	>38.5°C	<35 mL/hr for >= 2 hours

Note. MEOWS = Modified Early Obstetric Warning System, MEWT = Maternal Early Warning Trigger, MEWC = Maternal Early Warning Criteria, MEWS = modified early warning systems, MERC = maternal early recognition criteria, SBP = systolic blood pressure, DBP = diastolic blood pressure, HR = heart rate, RR = respiratory rate, SpO_2 = oxygen saturation, Temp = temperature.

[a] MEOWS also includes a pain score of >1 on a 0-3 pain scale

[b] MEWT also considers FHR > 160 if concerned about sepsis

[c] MEWC also includes a woman with preeclampsia complaining of non-remitting headache or shortness of breath
[d] MEWS includes clinicians being worried about woman's condition.

Table S4

Social Ecological Model Levels Addressed

Author, Year	Intrapersonal	Interpersonal	Institutional	Community	Public Policy
Arnolds et al., 2018	X	X			X
Austin et al., 2014	X	X			
Bick et al., 2014	X	X			
Blumenthal et al., 2019	X	X			
Carle et al., 2013	X	X	X	X	X
Carlstein et al., 2018	X				
Hedriana et al., 2016	X	X			
Mackintosh et al., 2014	X	X			
Martin, 2015	X		X		
Shields et al., 2016	X	X	X	X	
Singh et al., 2012	X	X			

Chapter 3: Manuscript 2
Title: Prevention of Failure to Rescue in Obstetric Patients: A Realist Review

Short Title: Failure to Rescue in Obstetric Patients

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Abstract

Background: At least 40% of maternal deaths are attributable to failure to rescue events. Nurses are positioned to prevent failure to rescue events, but there is minimal understanding of systems-level factors affecting obstetric nurses when patients require rescue.

Methods: A realist review was conducted to identify the nurse-specific contexts, mechanisms, and outcomes underlying obstetric failure to rescue and the interventions designed to prevent these events. This review included literature from 1999-2020 to understand the systems level factors affecting obstetric nurses during failure to rescue events using a human factors framework designed by the Systems Engineering Initiative for Patient Safety.

Results: Existing interventions addressed the prevention of maternal death through education of clinicians, improved protocols for care and maternal transfer, and an emphasis on communication and teamwork.

Linking Evidence to Action: Few researchers addressed task overload or connected employee and organizational outcomes with patient outcomes, and the physical environment was minimally considered. Future research is needed to understand how systems level factors affect nurses during failure to rescue events.

Keywords: *maternal morbidity and mortality, failure to rescue, human factors, obstetric nursing*

Evidence Review

Prevention of Failure to Rescue in Obstetric Patients: A Realist Review

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Key words
maternal morbidity and mortality, failure to rescue, human factors, obstetric nursing

ABSTRACT

Background: At least 40% of maternal deaths are attributable to failure to rescue (FTR) events. Nurses are positioned to prevent FTR events, but there is minimal understanding of systems-level factors affecting obstetric nurses when patients require rescue.

Aims: To identify the nurse-specific contexts, mechanisms, and outcomes underlying obstetric FTR and the interventions designed to prevent these events.

Methods: A realist review was conducted to meet the aims. This review included literature from 1999 to 2020 to understand the systems-level factors affecting obstetric nurses during FTR events using a human factors framework designed by the Systems Engineering Initiative for Patient Safety.

Results: Existing interventions addressed the prevention of maternal death through education of clinicians, improved protocols for care and maternal transfer, and an emphasis on communication and teamwork.

Linking Evidence to Action: Few researchers addressed task overload or connected employee and organizational outcomes with patient outcomes, and the physical environment was minimally considered. Future research is needed to understand how systems-level factors affect nurses during FTR events.

INTRODUCTION

Maternal morbidity and mortality in the United States have more than doubled in the past 30 years, from 7.2 per 100,000 live births in 1987 to 16.9 per 100,000 live births in 2017 (Centers for Disease Control & Prevention [CDC], 2019b). The racial disparities are significant, as Black women's maternal mortality rate was 42.4 per 100,000 livebirths from 2011 to 2016, while White women's was 11.3 per 100,000 live births (CDC, 2019b). Forty to 60% of maternal deaths are considered preventable (CDC, 2019b; Main, McCain, Morton, Holtby, & Lawton, 2015). Preventable deaths are specified as failure to rescue (FTR) events and defined by the Agency for Healthcare Research and Quality (AHRQ) as the failure or late recognition of a patient's potentially fatal complication (Hall et al., 2020).

Initial studies of FTR found hospital characteristics, such as the presence of surgical and anesthesia house staff and level of technology, were better predictors of a patient's risk of FTR than patient characteristics such as age and comorbidities (Silber, Williams, Krakauer, & Schwartz, 1992). Seeing FTR as a health systems problem might be useful for understanding FTR, as system configurations that predispose failures are significant contributors to maternal deaths (Howell & Zeitlin, 2017). The FTR rate is a relevant quality measure because it is affected by nursing processes including care omission, communication with the healthcare team, and decision-making (Hall et al., 2020; Mushta, Rush, & Andersen, 2018).

Obstetric nurses have the essential responsibility of activating the healthcare team when patients deteriorate due to severe maternal morbidity (SMM; Simpson, 2005). SMM includes 21 diagnoses (e.g., shock, eclampsia, sepsis, and thrombotic embolism; CDC, 2019a), all of which can lead to fatal complications and are linked with system failures.

Systems provide conditions under which FTR is more or less likely to occur. In the Systems Engineering Initiative for Patient Safety (SEIPS) Model, work system factors include the organization, environment, people, tasks, and technologies and tools (Carayon et al., 2006). An improved understanding of how work system factors affect nurses can help us make needed system changes to decrease obstetric FTR. Therefore, we conducted a realist review using a five-step process to understand factors associated with FTR (Pawson, Greenhalgh, Harvey, & Walshe, 2005).

Theoretical Framework

The SEIPS model describes the elements of the healthcare environment and the processes and interactions between

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those elements, as well as potential outcomes (Carayon et al., 2006). A hospital is understood as a complex adaptive sociotechnical system made up of smaller interacting subsystems which are affected by social, technological, and environmental inputs (Henriksen, Dayton, Keyes, Carayon, & Hughes, 2008). The SEIPS model describes the system using structure, process, and outcomes categories, as shown in Figure 1 (Carayon et al., 2006). The inclusion of process is vital because patient rescue is a three-step process: (1) recognizing the need to escalate care, (2) communicating information to the healthcare team, and (3) intervening to save the patient (Burke, Downey, & Almoudaris, 2020).

METHODS

The aim of a realist review is to understand what works, for whom, and in what contexts (Pawson et al., 2005). The five steps of a realist review are (1) define the guiding question, (2) search the literature, (3) appraise literature, (4) synthesize evidence and develop interventional theories, and (5) implement interventions. The Pawson et al. (2005) methodology and the Realist and Meta-narrative Evidence Syntheses: Evolving Standards publication standards (Wong, Greenhalgh, Westhorp, Buckingham, & Pawson, 2013) were used with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (Figure 2; Moher, Liberati, Tetzlaff, & Altman, 2009). This review includes steps 1 through 4.

Step 1: Define the Guiding Question

The guiding question for this review was "What contextual influences might affect nurses' failure to rescue when patients suffer severe maternal morbidity?".

Step 2: Search the Literature

A research librarian assisted with database selection and search terms. Searches began with the terms "failure to rescue," "obstetric*," "maternity," and "nurs*" in four databases: (1) PubMed, (2) Scopus, (3) CINAHL, and (4) ProQuest Healthcare Administration Database. Initial searches using the term "failure to rescue" resulted in scant literature. Background reading of obstetric research identified the synonym "preventable death" as a more frequently appearing term, thus leading to two additional search terms: "preventable death" and "maternal mortality." Inclusion criteria were publications in English, addressing obstetric FTR, and articles published from 1999 to 2020. Included publications either explicitly mentioned the effects on nurses or contained sufficient detail to provide understanding of how nurses would be affected in the described context. Publication dates align with the Institute of Medicine's landmark "To Err is Human" document in 1999, which marked the beginning of the patient safety movement (Kohn, Corrigan, & Donaldson, 2000). We excluded neonatal research, outdated organizational recommendations, and research conducted outside the United States, due to the contextual nature of FTR.

Documents were included in the data extraction process per inclusion and exclusion criteria. Quality and rigor were evaluated using the Pawson et al. criteria (2005), i.e., publications met the requirement of quality by demonstrating relevance and addressing theories under consideration. Rigor was met if researchers' conclusions contributed to understanding a developing intervention theory (Pawson et al., 2005).

Database searching located over 1,600 publications, followed by ancestry searches of the reference lists. Covidence software facilitated removal of duplicates, document screening, and categorizing as shown in Figure 2 (Covidence Systematic Review Software, 2020). Articles were deductively coded by one author using the SEIPS framework with NVIVO software (version 1.3; NVIVO Qualitative Data Analysis Software, 1999). The SEIPS codes included Work Systems (Person, Organization, Technologies and Tools,

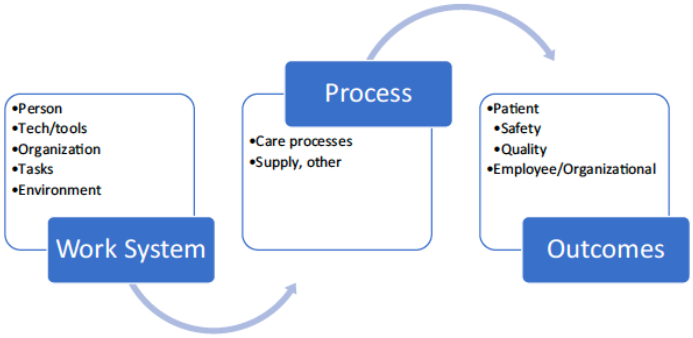

Figure 1. System components of the SEIPS model, Adapted from Carayon et al. (2006).

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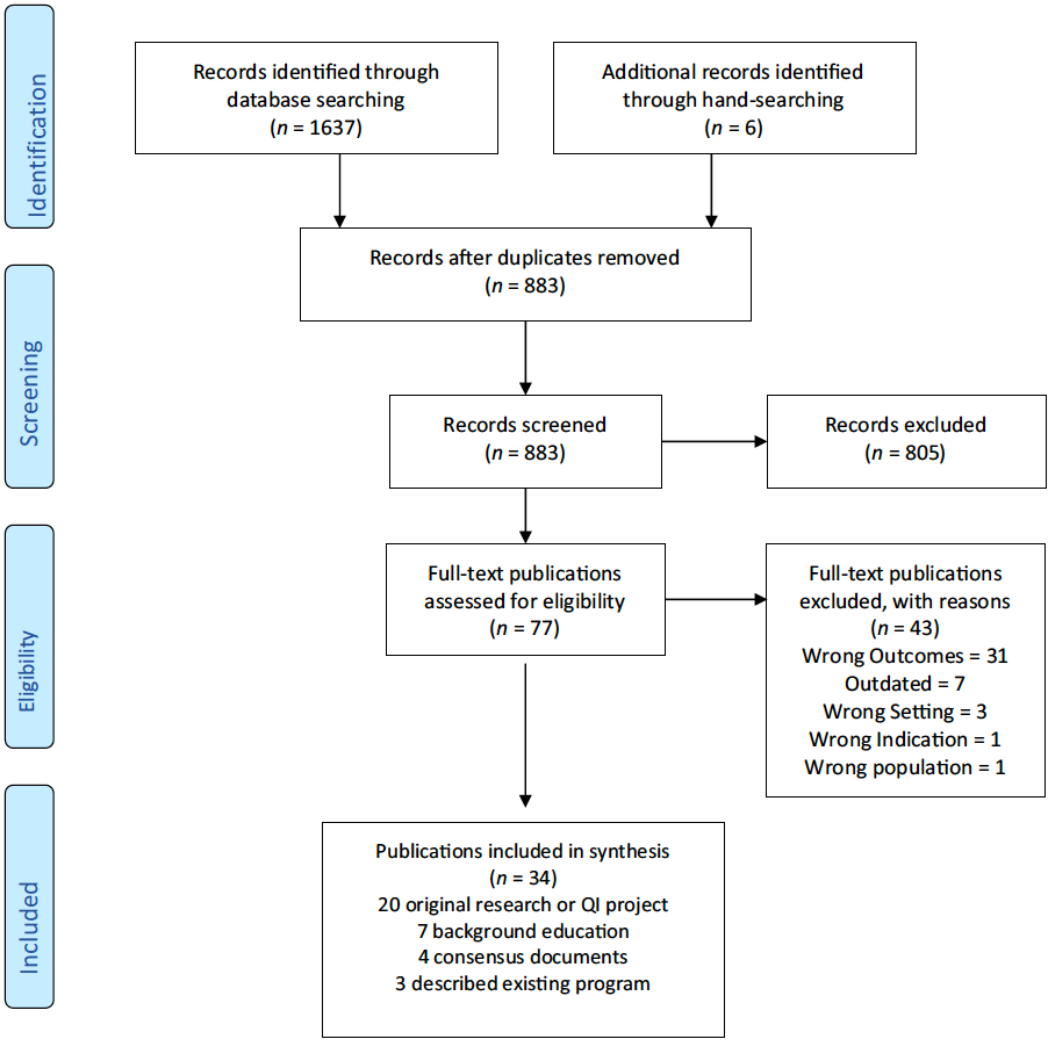

Figure 2. Document selection flow diagram.

Tasks, Environment), Processes, and Outcomes (Employee/Organizational Outcomes, and Patient Outcomes; Carayon et al., 2006).

Step 3: Appraisal and Extraction

All publications were read multiple times by the first author, and documents were grouped by SEIPS framework component using an iterative process. Publications were first categorized by "system," "process," or "outcomes" and then were further divided into the smaller components of the model.

RESULTS

The synthesis results are organized by SEIPS component (Table S1). The publications in this synthesis include 20 original studies or quality improvement (QI) projects, seven background education on FTR, four consensus bundles, and three existing QI programs. QI programs are activities designed to assess, monitor, and enhance patient care. Consensus bundles are groups of interventions and processes developed by teams of maternity-care professionals, including physicians, midwives, and nurses.

Work System Components

Person

Clinicians' lack of knowledge contributes to FTR, meaning that educational interventions could prevent FTR (Baird & Graves, 2015; Bingham, 2012; Bittle, O'Rourke, & Srinivas, 2018; Geller, Cox, & Kilpatrick, 2006; Lundsberg et al., 2018). The consensus bundles recommended improving the education of clinicians (Bernstein et al., 2017; D'Alton et al., 2016; Howell et al., 2018; Main, Goffman, et al., 2015). Clinicians perceived improved safety after education, but the studies lacked evaluation of provider behavior change and the perception of safety improvements were not compared to outcomes (Chagolla, Bingham, Wilson, & Scheich, 2018; Dadiz et al., 2013).

Women often delayed seeking care, and this delay was attributed to inadequate education, particularly at hospital discharge (Suplee, Kleppel, & Bingham, 2016). Improved patient education contributed to better coordination of care (Kleppel, Suplee, Stuebe, & Bingham, 2016; Morton, Seacrist, VanOtterloo, & Main, 2019; Seacrist, Morton, VanOtterloo, & Main, 2019; Seacrist, VanOtterloo, Morton, & Main, 2019; VanOtterloo, Morton, Seacrist, & Main, 2019).

Finally, Witcher and Sisson (2015) suggested that nurses critically evaluate how their actions may influence how the team delivers care to improve outcomes.

Organization

Issues included teamwork, communication, collaboration, nurse-to-patient ratios, and management styles. Nurse staffing and teamwork needed to be enhanced (Bernstein et al., 2017; Brown & Arafeh, 2015; Main, Goffman, et al., 2015; Simpson, Lyndon, & Ruhl, 2016). The perception of teamwork and communication were improved by simulation-based training (Baird & Graves, 2015; Bittle et al., 2018; Chagolla et al., 2018; Dadiz et al., 2013). Formal teamwork curricula were essential to improving outcomes (Brennan & Keohane, 2016; Lazarra et al., 2014; Morton, Seacrist, et al., 2019; Puck, Oakeson, Morales-Clark, & Druzin, 2012; Raab, Will, Richards, & O'Mara, 2013). Lyndon (2019) noted that while these programs are necessary, they are inadequate to create meaningful change in hospital culture.

An overall hospital culture of patient safety was beneficial for the implementation of QI efforts to reduce FTR, whereas a lack of hospital resources impeded improvement efforts (Bingham, Scheich, & Bateman, 2018; DeTina et al., 2019; Seacrist, Bingham, Scheich, & Byfield, 2018; Seacrist, Morton, et al., 2019). The Delphi method was recommended to identify local barriers to improvement efforts and to choose bundle components for implementation (DeTina et al., 2019).

Technologies and tools

Technology was minimally discussed, although the use of multiple electronic medical records (EMR) within a hospital was a detriment to consistent patient care (Seacrist, VanOtterloo, et al., 2019; VanOtterloo, Morton, et al., 2019) and negatively impacted staff efficiency (Raab et al., 2013). EMR documentation was a common type of "missed care" secondary to inadequate staffing (Simpson et al., 2016).

"Hemorrhage carts," analogous to code carts, were essential tools (Main et al., 2017; Seacrist et al., 2018; Seacrist, VanOtterloo, et al., 2019). Carts were stocked with supplies needed for maternal hemorrhage events, which decreased the time nurses spent searching for materials during an emergency.

The electronic fetal monitor was mentioned as a potential trigger for nursing actions although it is used for fetal, not maternal, safety (Simpson, 2005). Electronic surveillance was also mentioned as an object of distraction as it either drew nurses' attention away from the patient or was used as a nurse-extender when there was insufficient staff for the patient burden (Simpson, 2016).

Tasks

Nurses with heavy patient assignments experienced high task loads, thus nurses mentally triaged tasks based on perceived risk of task omission (Simpson et al., 2016). High task loads were a mechanism leading to disparate racial and ethnic maternal outcomes. With heavier workloads, clinicians relied more on automatic reactions, which increased the likelihood of activating implicit bias (Howell et al., 2018), i.e., the unconscious tendency to utilize ethnic, racial, and cultural stereotypes in decision-making (Staats, Capatosto, Wright, & Contractor, 2015).

Environment

Only one group discussed the physical environment, recommending that centrally locating obstetric patients within the hospital would provide the best opportunities for inter-disciplinary care (Leovic, Robbins, Foley, & Starikov, 2016).

Process Components

Protocols included algorithms for hypertensive medication use (Witcher & Sisson, 2015), tools assessing a woman's risk of venous thromboembolism (D'Alton et al., 2016), and methods for blood loss measurement (Ladouceur & Goldbort, 2019). Consensus documents emphasized the importance of process improvement for patient care, blood banking, and care coordination for critically ill women (Bernstein et al., 2017; Howell et al., 2018; Main, Goffman, et al., 2015).

Standing processes were recommended to appropriately escalate care (Ladouceur & Goldbort, 2019), including regionalization when community hospitals transferred patients requiring tertiary care (D'Alton et al., 2016; Main, Goffman, et al., 2015; Morton, Seacrist, et al., 2019; Seacrist, Morton, et al., 2019; Seacrist, VanOtterloo, et al.,

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2019; Seacrist et al., 2019; VanOtterloo & Connelly, 2018; VanOtterloo, Morton, et al., 2019).

Nearly 10% of surveyed hospitals did not regularly engage in morbidity and mortality reviews, and approximately 15% did reviews but did not utilize the data for work improvement (Lundsberg et al., 2018). A lack of consistent diagnostic criteria and charting terminology inhibited improvement efforts (Bernstein et al., 2017; Howell et al., 2018; Ivory, 2014; Main, Goffman, et al., 2015).

Outcome Components

Employee and organizational

Inadequate nurse staffing and impaired patient safety were connected to increased nurse burnout and a related potential for increased staff turnover (Simpson et al., 2016). No study discussed organizational outcomes.

Patient

Outcome measurement techniques differed by morbidity and were sometimes omitted. No connection was found between the hospital's self-identified level of care and maternal outcomes. However, both high and low hospital volumes were associated with increased risk of FTR and SMM (Friedman, Ananth, Huang, D'Alton, & Wright, 2016; Vanderlaan, Rochat, Williams, Dunlop, & Shapiro, 2019).

DISCUSSION

This realist review identified what contextual influences affect nurses' FTR when patients suffer SMM. The 34 publications revealed potential effects on nurses in all SEIPS components. Step four of the realist review process involves development of theories based on critical analysis of the literature and examination of assumptions underlying the suggested interventions. Five underlying theories were identified and organized visually in Figure 3 to suggest a model for FTR prevention.

Interventional Theories

Theory one

When people have knowledge, they act on that knowledge (Baird & Graves, 2015; Bingham, 2012; Bittle et al., 2018; Geller et al., 2006; Lundsberg et al., 2018; Simpson, 2005). However, an overwhelming patient assignment may make it difficult for nurses to act. For example, task overload is one mechanism for missed patient care leading to FTR (Simpson et al., 2016). The consensus bundles reviewed focused on the missed signs of patient deterioration but did not address why clinicians missed the signs (Bernstein et al., 2017; D'Alton et al., 2016; Main, Goffman, et al., 2015). A human factor lens suggests that "human errors" are an outcome of systems rather than the cause of FTR. Thus, future research should evaluate contextual factors affecting nurses during decision-making, including the effects of increased cognitive load, risks of false alarms versus risks of FTR, and perceptive issues of monitor displays.

Similarly, factors affecting patients who delay seeking care should be examined. This delay was described as resulting from a knowledge deficit, but little evidence supports that assertion (Morton, VanOtterloo, Seacrist, & Main, 2019; Seacrist, Morton, et al., 2019; Seacrist, VanOtterloo, et al., 2019; VanOtterloo, Seacrist, Morton, & Main, 2019). Alternatively, women may delay care due to a lack of transportation and childcare. Assuming that care delay is due to a knowledge deficit ignores the realities of women's lives and prevents the creation of solutions to such systemic problems.

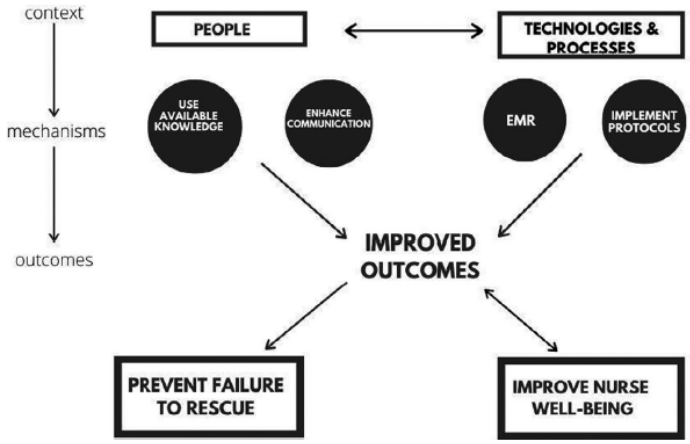

Figure 3. Interventional theories and relationships to improved outcomes.

Theory two
The healthcare team is the vital influence affecting nurses' FTR. TeamSTEPPS, an evidence-based set of teamwork tools, and crew resource management curricula are recommended to help teams flatten hierarchies and improve communication. The solution to the maternal mortality crisis may lay outside obstetrics (Bernstein et al., 2017; Main, Goffman, et al., 2015). The included publications lacked a thorough investigation of other escalation inhibitors, including interpersonal penalties for false alarms and concerns that calling for help implies clinician incompetence. While well-discussed in the patient safety literature (Carayon et al., 2006; Hall et al., 2020), these issues have not been adequately investigated in the context of obstetrics.

Theory three
Redundant or conflicting EMRs inhibit access to information (Raab et al., 2013; Seacrist, Morton, et al., 2019; Seacrist, VanOtterloo, et al., 2019; VanOtterloo & Connelly, 2018; VanOtterloo, Seacrist, et al., 2019). Legislation during the 2008 financial crisis incentivized hospitals to rapidly institute EMR use. However, insufficient evidence exists to support that this technology improved safety (Wears & Sutcliffe, 2020). Future studies should address the relationship between nurses' interaction with the EMR and patient safety. This interaction is connected to Theory One, i.e., the medical record has the potential to be a source of actionable knowledge.

Theory four
Process improvement efforts to protocolize care can result in better patient outcomes (Bernstein et al., 2017; Howell et al., 2018; Main, Goffman, et al., 2015; Morton, VanOtterloo, et al., 2019; Seacrist, Morton, et al., 2019; Seacrist, VanOtterloo, et al., 2019; VanOtterloo, Seacrist, et al., 2019). This theory depends on the belief that protocols decreasing care variation do not simultaneously cause other problems. However, protocols may increase nursing task load by requiring increased assessments. Protocols may interfere with patient-centered care, requiring all patients receive the same pre-determined interventions. Future research that critically evaluates the unintended consequences of protocols would be beneficial.

Theory five
Nurse well-being and patient safety are linked. Nurse-patient ratio is connected to patient safety (Needleman et al., 2011), but scant research evaluates the effects of nurse-patient ratio on the nurse even though higher staff turnover is connected to impaired patient safety (Simpson et al., 2016). Prospective research regarding if and how nursing units with lower staff turnover produce better outcomes for patients, employees, and institutions would help clarify mechanisms for improved safety.

LINKING EVIDENCE TO ACTION

- Clinician and patient education are important, however what is not known is why people might not use or act on the knowledge they have. Contextual influences are key to understanding how and why people do or do not use and act on their knowledge.
- Team training such as TeamSTEPPS, available free from the AHRQ, is an evidence-based team development program that can improve understanding within healthcare teams.
- Standardized safety huddles and debriefs can augment or support team development and action on clinical priorities.
- A nursing workload evaluation is important for decreasing the burden on nurses. However, the evaluation needs to consider factors beyond staffing ratios, like redundant practices and non-clinical work reductions.

Implications
This realist review demonstrates that current research is available for underlying obstetric FTR mechanisms and outcomes, but the research lacks a sufficient exploration of context. A prior FTR concept analysis suggested that early warning systems, rapid response teams, and nurse education could prevent FTR (Mushta et al., 2018). Minimal research addresses obstetric FTR specifically, and the AHRQ strongly suggests that context is the primary factor to consider when developing patient safety practices (Hall et al., 2020). Thus, further research is necessary for understanding the context in which obstetric nurses work. A better understanding of work context could result in more efficacious interventions for improving systems and maternal clinical outcomes.

A broader view must be taken on FTR. Care of women in labor occurs within a complex adaptive sociotechnical system; however, the bulk of research focused intently on small system components, such as staff education or the creation of protocols. This leads to siloed solutions which solve one problem but may create others.

Limitations
Several limitations exist related to this review. First, only the first author evaluated the papers in this review. This review approach raises the possibility of confirmation bias. However, bias was mitigated through an interdisciplinary committee that provided critical guidance and feedback to the first author. Second, scant research is available on the context in which obstetric nurses work; there are few researchers doing this work. Thus, this

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review relies on works by repeated authors. Third, few articles explicitly described effects on nurses. Instead, prior experience in obstetric nursing was used to extrapolate potential effects on nurses. Finally, this review does not include the fifth and final step of the realist review process, i.e., implementation (Pawson et al., 2005). Due to significant research gaps, implementation of a program to address FTR is premature.

CONCLUSIONS

Current evidence regarding systems factors related to nurses' FTR women who experience SMM focuses on mechanisms and outcomes. Little is known about the underlying contexts affecting nurse decision-making. The fifth step of this realist review, implementation of appropriate interventions, was unrealized due to gaps in the literature. Further, a deeper understanding of the contextual factors is needed prior to implementation in order to understand the systems in which nurses work to decrease maternal morbidity and mortality **WVN**

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REFERENCES

Baird, S., & Graves, C. (2015). REACT: An interprofessional education and safety program to recognize and manage the compromised obstetric patient. *Journal of Perinatal and Neonatal Nursing*, 29(2), 138–148. https://doi.org/10.1097/JPN.0000000000000098

Bernstein, P. S., Martin, J. N., Barton, J. R., Shields, L. E., Druzin, M. L., Scavone, B. M., … Menard, M. K. (2017). Consensus bundle on severe hypertension during pregnancy and the postpartum period. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 46(5), 776–787. https://doi.org/10.1016/j.jogn.2017.05.003

Bingham, D. (2012). Applying the generic errors modeling system to obstetric hemorrhage quality improvement efforts. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 41(4), 540–550, quiz 549. https://doi.org/10.1111/j.1552-6909.2012.01373.x

Bingham, D., Scheich, B., & Bateman, B. (2018). Structure, process, and outcome data of AWHONN's postpartum hemorrhage quality improvement project. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 47(5), 707–718. https://doi.org/10.1016/j.jogn.2018.05.002

Bittle, M., O'Rourke, K., & Srinivas, S. (2018). Interdisciplinary skills review program to improve team responses during postpartum hemorrhage. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 47(2), 254–263. https://doi.org/10.1016/j.jogn.2017.09.002

Brennan, R., & Keohane, C. (2016). How communication among members of the health care team affects maternal morbidity and mortality. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 45(6), 878–884. https://doi.org/10.1016/j.jogn.2016.03.142

Brown, K., & Arafeh, J. (2015). Obstetric sepsis: Focus on the 3-hour bundle. *Journal of Perinatal & Neonatal Nursing*, 29(3), 213–221. https://doi.org/10.1097/JPN.0000000000000115

Burke, J. R., Downey, C., & Almoudaris, A. M. (2020). Failure to rescue deteriorating patients: A systematic review of root causes and improvement strategies. *Journal of Patient Safety*. https://doi.org/10.1097/PTS.0000000000000720. [Epub ahead of print].

Carayon, P., Schoofs Hundt, A., Karsh, B., Gurses, A., Alvarado, C., Smith, M., & Flatley Brennan, P. (2006). Work system design for patient safety: The SEIPS model. *Quality & Safety in Health Care*, 15(Suppl. 1), i50–i58. https://doi.org/10.1136/qshc.2005.015842

Centers for Disease Control and Prevention. (2019). *How does CDC identify severe maternal morbidity?* Retrieved from https://www.cdc.gov/reproductivehealth/maternalinfanthealth/smm/severe-morbidity-ICD.htm

Centers for Disease Control and Prevention. (2019). *Prevent pregnancy-related deaths*. Retrieved from https://www.cdc.gov/vitalsigns/maternal-deaths/index.html

Chagolla, B., Bingham, D., Wilson, B., & Scheich, B. (2018). Perceptions of safety improvement among clinicians before and after participation in a multistate postpartum hemorrhage project. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 47(5), 698–706. https://doi.org/10.1016/j.jogn.2018.04.140

Covidence Systematic Review Software. (2020). *Veritas Health Innovation*. Retrieved from www.covidence.org

D'Alton, M. E., Friedman, A. M., Smiley, R. M., Montgomery, D. M., Paidas, M. J., D'Oria, R., … Clark, S. L. (2016). National Partnership for Maternal Safety: Consensus bundle on venous thromboembolism. *Anesthesia & Analgesia*, 123(4), 942–949. https://doi.org/10.1213/ANE.0000000000001569

Dadiz, R., Weinschreider, J., Schriefer, J., Arnold, C., Greves, C. D., Crosby, E. C., … Guillet, R. (2013). Interdisciplinary simulation-based training to improve delivery room

communication. *Simulation in Healthcare*, 8(5), 279–291. https://doi.org/10.1097/SIH.0b013e31829543a3

DeTina, A., Chau, A., Carusi, D., Robinson, J., Tsen, L., & Farber, M. (2019). Identifying barriers to implementation of the National Partnership for Maternal Safety obstetric hemorrhage bundle at a tertiary center: Utilization of the Delphi method. *Anesthesia and Analgesia*, 124(9), 1045–1050. https://doi.org/10.1213/ANE.0000000000003451

Friedman, A., Ananth, C., Huang, Y., D'Alton, M., & Wright, J. (2016). Hospital delivery volume, severe obstetrical morbidity, and failure to rescue. *American Journal of Obstetrics and Gynecology*, 215(6), 795.e1–795.e14. https://doi.org/10.1016/j.ajog.2016.07.039

Geller, S., Cox, S., & Kilpatrick, S. (2006). A descriptive model of preventability in maternal morbidity and mortality. *Journal of Perinatology*, 26(2), 79–84. https://doi.org/10.1038/sj.jp.7211432

Hall, K., Shoemaker-Hunt, S., Hoffman, L., Richards, S., Gall, E., Schoyer, E., … Lim, A. (2020). *Making healthcare safer III: A critical analysis of existing and emerging patient safety practices*. Rockville, MD: Agency for Healthcare Research and Quality.

Henriksen, K., Dayton, E., Keyes, M., Carayon, P., & Hughes, R. (2008). Understanding adverse events: A human factors framework. In R. Hughes (Ed.), *Patient safety and quality: An evidence-based handbook for nurses*. Rockville, MD: Agency for Healthcare Research and Quality.

Howell, E. A., Brown, H., Brumley, J., Bryant, A. S., Caughey, A. B., Cornell, A. M., … Grobman, W. A. (2018). Reduction of peripartum racial and ethnic disparities: A conceptual framework and maternal safety consensus bundle. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 47(3), 275–289. https://doi.org/10.1016/j.jogn.2018.03.004

Howell, E. A., & Zeitlin, J. (2017). Improving hospital quality to reduce disparities in severe maternal morbidity and mortality. *Seminars in Perinatology*, 41(5), 266–272. https://doi.org/10.1053/j.semperi.2017.04.002

Ivory, C. (2014). Standardizing the words nurses use to document elements of perinatal failure to rescue. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 43(1), 13–24. https://doi.org/10.1111/1552-6909.12273

Kleppel, L., Suplee, P., Stuebe, A., & Bingham, D. (2016). National initiatives to improve systems for postpartum care. *Maternal Child Health Journal*, S60–S70. https://doi.org/10.1007/s10995-106-2171-1

Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (Series Eds.). (2000). *To err is human: Building a safer health system*. Washington, DC: The National Academies Press. https://doi.org/10.17226/9728

Ladouceur, M., & Goldbort, J. (2019). A proactive approach to quantification of blood loss in the perinatal setting. *Nursing for Womens Health*, 23(6), 471–477. https://doi.org/10.1016/j.nwh.2019.09.007

Lazarra, E., Benishek, L. E., Sonesh, S. C., Patzer, B., Robinson, P., Wallace, R., & Salas, E. (2014). The 6 "ws" of rapid response systems: Best practices for improving development, implementation, and evaluation. *Critical Care Nursing Quarterly*, 37(2), 207–218. https://doi.org/10.1097/CNQ.0000000000000020

Leovic, M., Robbins, H., Foley, M., & Starikov, R. (2016). The "virtual" obstetrical intensive care unit: Providing critical care for contemporary obstetrics in nontraditional locations. *American Journal of Obstetrics and Gynecology*, 215(6), 736.e1–736.e4. https://doi.org/10.1016/j.ajog.2016.08.016

Lundsberg, L. S., Lee, H. C., Dueñas, G. V., Gregory, K. D., Grossetta Nardini, H. K., Pettker, C. M., … Xu, X. (2018). Quality assurance practices in obstetric care: A survey of hospitals in California. *Obstetrics and Gynecology*, 131(2), 214–223. https://doi.org/10.1097/AOG.0000000000002437

Lyndon, A. (2019). Failure to rescue, communication, and safety culture. *Clinical Obstetrics & Gynecology*, 62(3), 507–517. https://doi.org/10.1097/GRF.0000000000000461

Main, E., Cape, V., Abreo, A., Vasher, J., Woods, A., Carpenter, A., & Gould, J. (2017). Reduction of severe maternal morbidity from hemorrhage using a state perinatal quality collaborative. *American Journal of Obstetrics and Gynecology*, 216(3), 298.e1–298.e11. https://doi.org/10.1016/j.ajog.2017.01.017

Main, E. K., Goffman, D., Scavone, B. M., Low, L. K., Bingham, D., Fontaine, P. L., … Levy, B. S. (2015). National Partnership for Maternal Safety: Consensus bundle on obstetric hemorrhage. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 44(4), 462–470. https://doi.org/10.1111/1552-6909.12723

Main, E., McCain, C., Morton, C., Holtby, S., & Lawton, E. (2015). Pregnancy-related mortality in California: Causes, characteristics, and improvement opportunities. *Obstetrics & Gynecology*, 125(4), 938–947. https://doi.org/10.1097/AOG.0000000000000746

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *PLoS Med*, 6(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Morton, C., Seacrist, M., VanOtterloo, L., & Main, E. (2019). Quality improvement opportunities identified through case review of pregnancy-related deaths from preeclampsia/eclampsia. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 48(3), 275–287. https://doi.org/10.1016/j.jogn.2019.02.008

Morton, C., VanOtterloo, L., Seacrist, M., & Main, E. (2019). Translating maternal mortality review into quality improvement opportunities in response to pregnancy-related deaths in California. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 48(3), 252–262. https://doi.org/10.1016/j.jogn.2019.03.003

Mushta, J., Rush, K., & Andersen, E. (2018). Failure to rescue as a nurse-sensitive indicator. *Nursing Forum*, 53(1), 84–92. https://doi.org/10.1111/nuf.12215

Needleman, J., Buerhaus, P., Pankratz, V. S., Leibson, C. L., Stevens, S. R., & Harris, M. (2011). Nurse staffing and inpatient hospital mortality. *New England Journal of Medicine*, 364(11), 1037–1045. https://doi.org/10.1056/NEJMsa1001025

NVIVO Qualitative Data Analysis Software (Version Release 1.3). (1999). *QSR International*. Retrieved from qsrinternational.com/nvivo/nvivo-products/

Pawson, R., Greenhalgh, T., Harvey, G., & Walshe, K. (2005). Realist review—A new method of systematic review designed for complex policy interventions. *Journal of Health Services Research & Policy*, 10, 21–34.

Puck, A., Oakeson, A., Morales-Clark, A., & Druzin, M. (2012). Obstetric life support. *Journal of Perinatal & Neonatal Nursing*, 26(2), 126–135. https://doi.org/10.1097/jpn.0b013e318252ce3e

Raab, C., Will, S., Richards, S., & O'Mara, E. (2013). The effect of collaboration on obstetric patient safety in three academic facilities. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 42(5), 606–616. https://doi.org/10.1111/1552-6909.12234

Seacrist, M., Bingham, D., Scheich, B., & Byfield, R. (2018). Barriers and facilitators to implementation of a multistate collaborative to reduce maternal mortality from postpartum hemorrhage. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 47(5), 688–697. https://doi.org/10.1016/j.jogn.2017.11.009

Seacrist, M., Morton, C., VanOtterloo, L., & Main, E. (2019). Quality improvement opportunities identified through case review of pregnancy-related deaths from sepsis. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 48(3), 311–320. https://doi.org/10.1016/j.jogn.2019.02.007

Seacrist, M., VanOtterloo, L., Morton, C., & Main, E. (2019). Quality improvement opportunities identified through case review of pregnancy-related deaths from obstetric hemorrhage. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 48(3), 288–299. https://doi.org/10.1016/j.jogn.2019.03.002

Silber, J. H., Williams, S. V., Krakauer, H., & Schwartz, J. S. (1992). Hospital patient characteristics associated with death after surgery: A study of adverse occurrence and failure to rescue. *Medical Care*, 30(7), 615–629.

Simpson, K. (2005). Failure to rescue: Implications for evaluating quality of care during labor and birth. *Journal of Perinatal and Neonatal Nursing*, 19(1), 24–36. https://doi.org/10.1097/00005237-200501000-00008

Simpson, K. (2016). Nurse staffing and failure to rescue. *MCN: the American Journal of Maternal/Child Nursing*, 41(2), 132. https://doi.org/10.1097/NMC.0000000000000224

Simpson, K., Lyndon, A., & Ruhl, C. (2016). Consequences of inadequate staffing include missed care, potential failure to rescue, and job stress and dissatisfaction. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 45(4), 481–490. https://doi.org/10.1016/j.jogn.2016.02.011

Staats, C., Capatosto, K., Wright, R., & Contractor, D. (2015). *State of the science: Understanding implicit bias*. Kirwan Institute. Retrieved from http://kirwaninstitute.osu.edu/research/understanding-implicit-bias/

Suplee, P., Kleppel, L., & Bingham, D. (2016). Discharge education on maternal morbidity and mortality provided by nurses to women in the postpartum period. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 45(6), 894–904. https://doi.org/10.1016/j.jogn.2016.07.006

Vanderlaan, J., Rochat, R., Williams, B., Dunlop, A., & Shapiro, S. (2019). Associations between hospital maternal service level and delivery outcomes. *Women's Health Issues*, 29(3), 252–258. https://doi.org/10.1016/j.whi.2019.02.004

VanOtterloo, L., & Connelly, C. (2018). Risk-appropriate care to improve practice and birth outcomes. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 47(5), 661–672. https://doi.org/10.1016/j.jogn.2018.05.004

VanOtterloo, L., Morton, C., Seacrist, M., & Main, E. (2019). Quality improvement opportunities identified through case review of pregnancy-related deaths from cardiovascular disease. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 48(3), 263–274. https://doi.org/10.1016/j.jogn.2019.03.001

VanOtterloo, L., Seacrist, M., Morton, C., & Main, E. (2019). Quality improvement opportunities identified through case review of pregnancy-related deaths from venous thromboembolism. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 48(3), 300–310. https://doi.org/10.1016/j.jogn.2019.02.006

Wears, R., & Sutcliffe, K. (2020). *Still not safe: Patient safety and the middle-managing of American medicine*. New York, NY: Oxford University Press.

Witcher, P., & Sisson, M. (2015). Maternal morbidity and mortality: Identifying opportunities to improve clinical outcomes. *The Journal of Perinatal & Neonatal Nursing*, 29(3), 202–212. https://doi.org/10.1097/JPN.0000000000000112

Wong, G., Greenhalgh, T., Westhorp, G., Buckingham, J., & Pawson, R. (2013). RAMSES publication standards: Realist syntheses. *BMC Medicine*, 11(21). https://doi.org/10.1186/1741-7015-11-21

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's web site:

Table S1 Summary of Articles Describing Failure to Rescue.

Table 1.

Summary of Articles Describing Failure to Rescue

Author, Date	Context	Mechanism	Outcome	Components of SEIPS model included							
				Work System or Structure					Process	Outcomes	
				Person	Organization	Tech & tools	Tasks	Environment		Employee and organizational outcomes	Patient Outcomes
Baird et al., 2015	QI project managing compromised obstetric patient	Recognize, Education, Activate, Communicate Treat (REACT) program	Educational and safety program increased knowledge and decreased maternal transfers to ICU	X	X		X				X
Bernstein et al., 2017	Consensus bundle for severe hypertension	Bundle of evidence-based guidelines, "4Rs" Framework[1]	Improve hospital readiness for women with severe hypertension	X	X	X	X		X		X
Bingham, 2012	Obstetric hemorrhage	Application of human error research to healthcare environment	Using Generic Errors Modeling System (GEMS) may improve understanding of errors	X	X	X	X		X		X
Bingham, Scheich,	QI project addressing postpartum	Assess structure,	No hospital was fully able to implement. 18-	X	X	X			X		X

Author, Date	Context	Mechanism	Outcome	Components of SEIPS model included							
				Work System or Structure					Process	Outcomes	
				Person	Organization	Tech & tools	Tasks	Environment		Employee and organizational outcomes	Patient Outcomes
Bateman, 2018	hemorrhage processes	process, and outcome data	month implementation phase may be inadequate								
Bittle et al., 2018	QI project to improve response during hemorrhage	Skills review program	Participants felt more confident, positive response	X	X	X	X		X		
Brennan & Keohane, 2016	Team communication	Promote strategies improving communication	Trainings such as TeamSTEPPS, PURE Communication, SBAR, and I-PASS handoffs are recommended. Safety huddles may also be helpful.	X	X	X			X		
Brown & Arafeh, 2015	Obstetric sepsis	3-hour sepsis bundle	Hospitals should develop implementation protocol for sepsis bundle	X	X	X					X
Chagolla et al., 2019	Postpartum hemorrhage project	Before and after measurement using Safety Attitudes Questionnaire	Did not reach statistical significance in most domains. Perceptions were already high. Improved feeling of nursing care	X	X	X			X		

Author, Date	Context	Mechanism	Outcome	Components of SEIPS model included							
				Work System or Structure					Process	Outcomes	
				Person	Organization	Tech & tools	Tasks	Environment		Employee and organizational outcomes	Patient Outcomes
			quality. Actual safety not measured								
D'Alton et al., 2016	Consensus bundle for venous thromboembolism	Bundle of evidence-based guidelines, "4 Rs" framework	Reduce frequency of venous thromboembolism	X	X	X			X		X
Dadiz et al., 2013	Delivery room communication	Simulation	Communication and perception of communication improved	X	X	X					
DeTina et al., 2019	Identify barriers to hemorrhage bundle implementation & high impact components	Delphi consensus building	Barriers poorly defined. Highest impact components are protocols, drills, quant blood loss measurement, and huddles/debriefing	X	X	X			X		
Friedman et al., 2016	Cohort study of 50.4 million births measuring hospital volume and failure to rescue risk	Measuring hospital volume and failure to rescue risk	Both high and low volume is associated with increased risk of FTR, but individual hospital characteristics may have greater effect on outcome	X					X		X
Geller et al., 2006	Women with preventable	Develop understandin	Preventable deaths are due to	X	X	X			X		X

Author, Date	Context	Mechanism	Outcome	Components of SEIPS model included							
				Work System or Structure					Process	Outcomes	
				Person	Organization	Tech & tools	Tasks	Environment		Employee and organizational outcomes	Patient Outcomes
	morbidity and mortality (n=79)	g of preventability of maternal morbidity and mortality	delays in diagnosis, treatment, and inadequate documentation								
Howell et al., 2018	Consensus bundle for reduction of racial disparities	Bundle of interventions for healthcare systems to use, addressing racial and ethnic disparities	Improve quality of maternal health care and reduce disparities	X	X				X		X
Ivory, 2014	Bedside nurses documenting failure to rescue	Standardize language used in perinatal FTR, Delphi study	Consensus on documentation terminology can improve process measurement	X	X	X			X		
Kleppel et al., 2016	Maternal morbidity and mortality increasing, “near misses” increasing	National initiatives to improve safety	Improving d/c teaching, coordination of care, and better tracking improves maternal safety	X	X	X			X		X
Ladouceur & Goldbort, 2019	Community hospital QI project to improve quantification of maternal perinatal blood loss	Provide education to nurses and physicians to begin quantitative	Education for nurses and physicians on methods of blood estimation vs accuracy were	X	X	X			X		

Author, Date	Context	Mechanism	Outcome	Components of SEIPS model included							
				Work System or Structure					Process	Outcomes	
				Person	Organization	Tech & tools	Tasks	Environment		Employee and organizational outcomes	Patient Outcomes
		measurement of blood loss	helpful for compliance								
Lazarra et al., 2014	Use of Rapid Response systems to manage obstetric emergencies	Describe best practices for use of Rapid Response Teams in obstetrics	Rapid Response Teams are beneficial with significant admin and unit-level support. Most important is building processes that work for institution.	X	X				X		
Leovic et al., 2016	Obstetric intensive care unit (ICU)	Promotes a new model: virtual obstetric ICU	Placing patients centrally in the hospital with creation of mobile ICU team to care for critically ill women has potential to improve outcomes for staff and patients		X			X	X	X	X
Lundsberg et al., 2018	185 California hospitals	Measure QA processes in use in 185 California hospitals	10% of hospitals did not regularly review morbidity and mortality cases						X		
Lyndon, 2019	Preventable maternal morbidity and mortality	Connection between communication, safety	Improvements will require significant culture change, beyond use of	X	X					X	X

Author, Date	Context	Mechanism	Outcome	Components of SEIPS model included							
				Work System or Structure					Process	Outcomes	
				Person	Organization	Tech & tools	Tasks	Environment		Employee and organizational outcomes	Patient Outcomes
		culture, and failure to rescue	structured communication tools								
Main et al., 2015	Consensus bundle on obstetric hemorrhage	Bundles of interventions to prevent and respond to hemorrhage	Reduce frequency of hemorrhage with > 1500cc blood loss, improve maternal outcomes	X	X	X			X		X
Main et al., 2015	67,000 births at 16 California hospitals	Validation of CDC severe maternal morbidity criteria	CDC criteria had high sensitivity= 0.77 and PPV = 0.44, thus can serve as administrative measure of SMM for population				X		X	X	
Main et al., 2017	147 California hospitals with >330,000 births	Collaborative QI project to decrease maternal hemorrhage using "4 Rs" framework	Implementation of safety bundles can be scaled up to decrease hemorrhage rates	X	X	X			X		X
Morton et al., 2019	Pregnancy related deaths in California, all causes, *N*=203	Retrospective chart review to identify themes, opportunities for preventing	Facility readiness, patient education, coordination of care, and education of bedside clinicians	X	X				X		

Author, Date	Context	Mechanism	Outcome	Components of SEIPS model included							
				Work System or Structure					Process	Outcomes	
				Person	Organization	Tech & tools	Tasks	Environment		Employee and organizational outcomes	Patient Outcomes
		deaths using "4 Rs" Framework	are opportunities for improvement								
Morton et al., 2019	Pregnancy related deaths in California from preeclampsia/eclampsia, *N*=54	Retrospective chart review to identify themes, opportunities for preventing deaths using "4 Rs" Framework	Standardizing protocols and improving response, issues with recognition of patient deterioration, inadequate treatment	X	X				X	X	
Puck et al,. 2012	Maternal cardiac arrest	Obstetric life support training program	Individuals improved knowledge and better response of teams than with traditional Advanced Cardiac Life Support training	X	X				X	X	
Raab et al., 2013	Three academic medical facilities	Collaborative patient safety initiatives	Improved health outcomes for women and neonates. Programs require both frontline and institutional support	X	X	X			X	X	

Author, Date	Context	Mechanism	Outcome	Components of SEIPS model included							
				Work System or Structure					Process	Outcomes	
				Person	Organization	Tech & tools	Tasks	Environment		Employee and organizational outcomes	Patient Outcomes
Seacrist et al., 2018	Six hospitals (nurses and physicians, *N*=21)	Qualitative study describing QI project experience to reduce maternal mortality due to hemorrhage	Barriers: negative individual attitudes, lack of resources, lack of admin support. Facilitators: Admin support, presence of nurse and physician "champions," culture of safety	X	X	X					X
Seacrist et al., 2019	Pregnancy-related deaths in California, obstetric hemorrhage, *N*=33	Retrospective chart review to identify themes, opportunities for preventing deaths using "4 Rs" Framework	Need for improved protocols, better access to equipment, better measurement of blood loss to facilitate provider recognition, reduction of delays in care, better transfer procedures	X	X				X	X	
Seacrist et al., 2019	Pregnancy-related deaths in California, sepsis *N*=27	Retrospective chart review to identify themes, opportunities for preventing deaths using	Women delayed seeking care, providers missed clinical signs of worsening condition, therefore late antibiotic administration.	X	X				X	X	

Author, Date	Context	Mechanism	Outcome	Components of SEIPS model included							
				Work System or Structure					Process	Outcomes	
				Person	Organization	Tech & tools	Tasks	Environment		Employee and organizational outcomes	Patient Outcomes
		"4 Rs" Framework	Poor communication during hospitalization and after patient discharge.								
Simpson, 2005	Intrapartum care	Failure to rescue and measurement of quality	Proposes the use of "failure to rescue" in maternity care, recommends development of outcome measurement techniques		X	X			X		X
Simpson, Lyndon, & Rule, 2016	Bedside obstetric nurses' experience (*N*=884)	Inadequate staffing	Missed care, due to task overload opens possibility of FTR, and increases nurse stress and job dissatisfaction	X	X				X	X	X
Suplee, Kleppel, & Bingham, 2016	Patient education	Nurse-provided materials and discharge information for postpartum patients	Different information given to different patients based on individual nurse judgement, within and across hospitals	X	X				X		

Author, Date	Context	Mechanism	Outcome	Components of SEIPS model included							
				Work System or Structure					Process	Outcomes	
				Person	Organization	Tech & tools	Tasks	Environment		Employee and organizational outcomes	Patient Outcomes
Vanderlaan et al., 2019	High maternal risk births in Georgia from 2008-2012, *N* = 6,427	Hospital self-described maternal level of care	No association was found between hospital level of care and delivery outcome. More research to define maternal levels of care is warranted.		X				X		X
VanOtterlo et al., 2019	87 pregnancy-related deaths due to cardiovascular disease	Retrospective chart review with thematic analysis using 4Rs framework	Need for better regionalization and transfer protocols, education of nurses/providers on signs/symptoms. Significant delays in treatment/transfer	X	X	X			X		
VanOtterlo et al., 2019	29 pregnancy-related deaths due to venous thromboembolism	Retrospective chart review with thematic analysis using 4Rs framework	Need for improved patient education, care protocols, appropriate tools not always available. Many nurses/doctors missed signs and symptoms; timing of treatment was an issue.	X	X	X			X		
VanOtterlo &	High risk pregnancy	Regionalization can provide risk-	Improvement via implementation of better systems of	X	X	X			X	X	X

Author, Date	Context	Mechanism	Outcome	Components of SEIPS model included							
				Work System or Structure					Process	Outcomes	
				Person	Organization	Tech & tools	Tasks	Environment		Employee and organizational outcomes	Patient Outcomes
Connelly, 2018		appropriate care	care and protocols for transfer								
Witcher & Sisson, 2015	Bedside obstetric nurses	Opportunities to improve outcomes identified through Covey's Circle of Influence Theory	Nurses should focus efforts where they can be most useful: via actions within the scope of nursing practice. Opportunities increase with improved knowledge and technical skills	X	X	X	X		X		X

Note. "4Rs" framework- Readiness, Recognition and prevention, Response, and Reporting and systems learning, PPV = positive predictive value, SMM = severe maternal morbidity

Chapter 4: Manuscript 3

Systems Level Factors Affecting Registered Nurses During Care of Women in Labor

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Abstract

Objective: To identify the systems level factors affecting registered nurses during care of women in labor experiencing clinical deterioration.

Data Sources: Observational, survey and qualitative interview data were collected on the labor and delivery floor of a tertiary care center in Boston, Massachusetts from July 2021 through August 2021.

Study Design: A convergent parallel mixed methods observational study.

Data Collection/Extraction Methods: Observations, survey data from the Performance Obstacles for ICU Nurses instrument (adapted), and semi-structured interviews with nurses, midwives, and physicians were used. Survey eligibility included registered nurses with 3 months of experience on the unit. Registered nurses, physicians, and midwives with 3 months of experience on the unit were eligible for the interviews. Interviews were coded using Bradley's integrated deductive and inductive methods and the Systems Engineering for Improving Patient Safety (SEIPS) categories.

Principal Findings: The SEIPS model was useful in framing identified performance obstacles of nurses in the care of women in labor; many of these are amenable to design improvements, including task overload, shortages of tools/technology, and ergonomic changes to work environment. Emergent themes also imply a relationship between task overload and feelings of burnout.

Conclusion: Specific performance obstacles are common in obstetrical units and may be factors related to maternal morbidity and mortality. Healthcare administrators and clinicians responsible for designing care/making care improvements to hospital units should consider teamwork and communication strategies that may mitigate the harms of other performance obstacles.

Keywords:

Pregnancy,

maternal mortality,

obstetric nursing,

parturition,

quality indicators, health care,

nurse’s role

Callout Box:

What is known about this topic:

• Maternal morbidity and mortality are deeply complex and multi-factorial with myriad factors affecting the rising rates in the United States.

• Nurses spend more time with patients than other clinicians and are well-positioned to prevent or respond to a patient's worsening clinical condition.

• Task overload is one factor that affects nurses during care of labor and delivery patients and nursing short staffing contributes to this problem.

What this study adds:

• Difficulties using electronic health records (EHRs) and being short of critical equipment are additional performance obstacles for nurses as they care for individuals in the birthing process.

• Unit design and improvement of ergonomics may decrease the work burden of nurses.

• While good teamwork mitigates task overload to a degree, when nurses feel swamped, they experience feelings of inadequacy and have concerns for patient and personal safety.

Introduction

Maternal morbidity and mortality in the United States have doubled over the past 40 years.(4)The most recent available statistics indicate there are 17.3 maternal deaths per 100,000 live births, with 40-70% of these deaths considered preventable.(3,5) While there is no consensus definition of severe maternal morbidity (SMM), it is understood as a precursor to maternal mortality and includes a variety of diagnoses, such as preeclampsia/eclampsia, cardiovascular conditions, hemorrhage, sepsis, and thrombotic

events. (5)(23) Women who are Black, Indigenous, and People of Color (BIPOC) have higher rates of severe maternal morbidity and mortality.(6) The rate of maternal death for Black women is 41.7/100,000, for Indigenous women is 28.3/100,000, for Asian women is 13.8/100,000, and for White women is 13.4/100,000.(1) As 40-70% of these deaths are considered preventable, these high rates of maternal morbidity and mortality are a patient safety concern.

The goal of patient safety is the avoidance of preventable patient harms. The Agency for Healthcare Research and Quality recommends a patient safety approach in obstetrics, further suggesting that hospitals partner with nurses in this work.(2,3) One goal of the patient safety approach in obstetrics is to improve early identification of patient deterioration with the goal of reducing preventable morbidity and death. (4) When women are in labor, patient deterioration may be identified by changes in vital signs, level of consciousness, and/or sudden increases in pain.

Nurses have a significant effect on patient safety.(35–37) Clinical deterioration affects patient safety in medical surgical and intensive care environments.(7,8,10) Nurses affect a patients' likelihood of experiencing c-section.(38,39) High task load due to inadequate staffing has also been studied as a contributor to impaired patient safety and potential increase in failure to rescue events.(11) Failure to rescue events are prevented by early recognition of patient deterioration.(15) (34) Obstetric nurses are well-positioned to improve obstetric patient safety and new perspectives might inform a better understanding of contextual factors affecting bedside nurses.

One perspective, the Systems Engineering Initiative for Patient Safety (SEIPS) model has been utilized to assess the work system and processes of cardiac, critical care, and

primary care nurses.(10,40–42) This model aligns well with obstetric nursing and was the guiding framework for this research to answer the question: This research used the SEIPS model to address the question: **what are the systems level factors affecting nurses during labor patients' clinical deterioration?**

Methods

Design and sample

We used a convergent parallel mixed methods design to guide three types of data collection approaches: observational, quantitative survey, and qualitative interviews. A mixed methods approach was selected for this research because understanding both the context of nurses' work experience and content of their daily shifts was essential to answering the research question. The Agency for Healthcare Quality and Research (AHRQ) recommends the use of mixed methods approaches to study the work system. (34,43,44) The SEIPS model guided the design of the research strategy, including the development of the interview guide and the selection of the quantitative instrument.(45)

The study setting was the labor and delivery floor of an urban tertiary care center in Boston, Massachusetts with approximately 3500 births/ per year. Data were collected during July and August of 2021. Quantitative and qualitative data were collected simultaneously, analyzed separately, and converged for understanding. (46) Inclusion criteria were registered nurses, physicians, and certified nurse midwives working on a specific labor and delivery unit in an urban tertiary care hospital for a minimum of three months. Recruitment occurred via email, flyers in workspaces, and direct approaches by the principal investigator (PI). The only exclusion criterion was lack of willingness to

participate. Data were obtained from interviews and surveys. Observations were used to provide context for the PI who interviewed all participants.

The Good Reporting of a Mixed Methods Study (GRAMMS) criteria was used to maintain rigor and transparency in reporting (47); recruitment methods are described here, along with Institutional Review Board permissions, types of data to be collected, interview questions (Appendix B), and recording methods are included. We have also included the structured form that was used during observations (Appendix A) and the instrument used for quantitative data collection (Appendix C). This low risk research was deemed exempt by the institutional review boards of the Medical University of South Carolina and Mass General Brigham.

Qualitative

Observations included all daily nursing tasks, as well as inter-disciplinary safety rounds, pre-procedure huddles, triage huddles, and hemorrhage huddles and occurred during eight nursing shifts (totaling approximately 90 hours) across weekdays, nights, and weekends. These data were used for background context and informed interview questions. (Appendix B) The principal investigator (PI, SB) used an observation template upon which to record data (Appendix A) and observed from the nurses' station, triage area, hallways, physician work areas, and patient care areas.

Semi-structured interviews of the nurses, physicians, and certified midwives included questions about important events related to maternal deterioration to elicit stories about those events. The PI used a modified critical incident technique to guide the development of semi-structured interview questions and for documentation of responses.(48) The sampling goal to reach thematic saturation was 20 nurses and 10 physicians and

midwives. Physicians were recruited from three specialties: obstetrics, neonatology, and anesthesiology. Interviews were video-recorded using Microsoft Teams and uploaded and auto-transcribed using QSR International's NVIVO (Release 1)(49)(50). Interviews continued until data saturation occurred and no new themes were identified for several interviews in a row. Each interview transcription was checked by the PI against the documented responses and corrected for accuracy; reflexive memoing was used to identify emerging ideas and member-checking for rigor.(51)(46) Memoing is a method used by qualitative researchers to describe developing ideas about the data and concepts as they occur during coding.(5) Member checking promotes rigor by requesting feedback from participants about developing themes and confirming accuracy of researchers' interpretations. (5) Corrected transcripts were coded with Bradley's integrated inductive and deductive approach using NVIVO qualitative data analysis software. (52)(50) This integrated approach combines inductive reasoning with deductive reasoning using a pre-existing code structure. In this case, we used the SEIPS model categories as our pre-existing code structure.

A code book was developed during the coding process; codes were then combined and grouped into themes. The coding structure was reviewed midway through the analysis with a senior qualitative mentor. Thematic areas for further inquiry were identified and purposive sampling adapted to investigate emerging hypotheses for theoretical saturation. A coding summary of all codes and thematic narratives were reviewed with the co-authors to ensure a rigorous process of evaluation. Following discussions with mentors, the primary themes were finalized.

Themes that emerged from the deductive approach were defined by SEIPS model categories: tasks, tools and technology, person, organization, environment, and processes. Themes that emerged from inductive analyses were identified by the researchers from this study's mixed observational and interview data. Thus, the final coding scheme includes both a priori codes as well as new codes that emerged from interviews.

Quantitative

Quantitative data included forty-six surveys filled out by nurses. These data were measured with the Performance Obstacles for ICU Nurses instrument adapted for the labor and delivery environment (used with permission, endorsed by the author) and available through an online survey link Research Electronic Data Capture (REDCap) database.(22,53,54) (Appendix C) The instrument was selected to measure the work environment because obstetric nurses' work environment is similar to ICU nurses' as they work in a highly technological environment and are responsible for a high workload due to rapidly changing patient status and the need to continuously provide support to patient and family at a time of intense emotions. Cronbach's alpha values for individual items range from 0.78-0.91.(55)

The instrument was completed by nurses toward the end of their shifts; items included the presence or absence of 12 obstacles that may hinder nurses' work: nursing tasks (precepting new nurses, accompanying patients off unit, communicating with patient families), environmental challenges (physical environment and workspace design), organizational issues (inadequate handoffs and information from physicians and midwives), and issues with tools and technology (shortage of computers, stocking of central supply areas and patient rooms, equipment issues, pharmacy delays. A series of

questions asked nurses to rate on a scale the usefulness and timeliness of help from three role groups: nursing assistants, unit clerks, and other nurses. (Table 2) The instrument's twelve performance obstacle categories are aligned with the SEIPS model categories.

The available population for the survey data was 73 nurses. The goal sample size was set at 70% (51 nurses) of the registered nurses working on the labor floor. The final sample included 46 nurses (63%). Race and gender demographics are not reported here to maintain confidentiality for research participants. Data in the REDCap database were reviewed and cleaned by the PI. After consultation with a biostatistician, descriptive statistics were computed using SPSS v 27 software and Microsoft Excel v16.52 software.(56)(57) We then determined the frequency that nurses experienced the twelve performance obstacles measured by the instrument, and were categorized according to the SEIPS categories. Finally, we calculated mean, standard deviation, and interquartile range for continuous variables.

Data integration methods

Following the completion of data collection, a joint display was developed for merging and comparing the data sources for a convergent analysis and interpretation.(58, 6,7) [Table 3] We used the joint display to observe for similar concepts across the data and compared the qualitative and quantitative data, looking for relationships between and across concepts.(6,7) We transformed the qualitative data using frequency counts of qualitative themes and compared them to the quantitative data.

Results

Qualitative results

Observation

Observations of the work systems provided context for the interviews. Understanding the usual practices on the hospital unit helped inform interview questions about the experiences of nurses, nurse-midwives, and physicians working on the unit. For instance, the PI observed significant noise on the unit and noticed that many alarms appeared to be ignored. These observations led to interview questions focusing on alarms and how people answer them. Other observations informing interview questions included emergency management during maternal hemorrhages, calls for help during neonatal resuscitation, and organization around nurses' lunch and coffee breaks.

Interview

Thematic saturation was achieved after eleven interviews and the final sample included 16 participants: nine nurses, five physicians, and two certified nurse midwives. The deductive thematic findings are reported via the SEIPS model concepts of tasks, tools and technology, person, organization, environment, and processes were evident as well as emergent subthemes. Subthemes were identified via inductive analysis and included *swamped*, *is this safe?*, and *feeling inadequate*. The themes and subthemes are discussed in the paragraphs below and shown in Table 3, which shows how the qualitative and quantitative data merged for the mixed methods analyses.

Tasks. Nurses frequently felt overwhelmed by required tasks and researchers identified the inductive subtheme "swamped," previously defined as the subjective experience of being so overwhelmed by tasks that nurses are unable to focus on the most important information.(11) The feeling of being swamped was attributed to heavy patient loads and inadequate staffing, but sometimes occurred secondary to an individual patient's high acuity or need for care coordination. When swamped, nurses relied on other team

members to take on tasks, such as changing IV fluid bags, or giving other medications. When an individual nurse was swamped, they felt overwhelmed and were often unable to find help because all other nurses were experiencing the same phenomenon.

Nurses on this unit do not generally perform cervical exams to assess dilation and stage of labor. Several nurses and providers suggested that performing cervical exams could improve workflow, decrease patient wait times, and enhance nurses' sense of professionalism, growth, and autonomy. Physicians and midwives agreed that patients often wait for a provider even though it is within nursing scope of practice to do cervical exams.

Person. Individual strengths and weaknesses were rarely mentioned in interviews. Some participants mentioned their own personality traits as helpful to their success in overcoming difficult clinical situations. Nurses, physicians, and midwives talked about team membership and close relationships among and across professions, describing the entire healthcare team as a positive mitigating factor against individual weakness. The exception to this was the inductively identified subtheme "feeling inadequate" which occurred when nurses were overwhelmed by tasks, leading to negative patient outcomes nurses thought may have been preventable. This subtheme was restricted to registered nurses and certified nurse midwives; no physician described this experience.

Organization. We found consensus (across nurses, physicians, and midwives) that the teamwork on this unit was excellent. All participants mentioned that the unit was "a well-oiled machine" or that teamwork was rarely or never a problem. All participants noted few interprofessional conflicts and described that twice daily interdisciplinary safety

rounds have led to a respectful atmosphere where all team members are equally able to voice patient safety concerns.

Tools & Technology. Nurses reported frequently broken or missing fetal monitoring equipment, as well as a shortage of cables for EKG monitoring. This resulted in nurses spending extended time searching for equipment, adding to task burdens. In some cases, participants reported that patients were insufficiently monitored due to equipment shortages.

The use of centralized fetal heart rate (FHR) monitoring made monitoring easier for nurses with multiple patients, but other issues complicated its efficiency. The PI observed that when greater than nine patients were monitored simultaneously, at least one alarm sounded at all times. Clinicians described difficulty discerning important from unimportant alarms. One physician said they ignore alarms and trust nurses to identify important alarms and inform physicians of critical events. Causes of alarms were occasionally unclear. Some nurses didn't know if central monitoring alarmed for maternal high or low blood pressure or if auditory alarms were only for fetal issues.

Environment. The physical environment was mentioned frequently as an obstacle. The unit was built for approximately 2400 births annually but there are currently over 3500 babies being delivered annually. This has led to a significant space shortage, with doubling of some patient rooms, although correct wiring of doubled rooms for centralized monitoring is an ongoing concern. The five-bed triage area has been overwhelmed by patient volume, thus the unit added a bench outside triage for patients to sit and wait. The triage area is physically separated from the main labor and delivery floor by a

hallway. Eight participants mentioned that this layout makes it hard for people working in the triage area to have a "feel" for what is going on on the labor and delivery floor.

While there were generally enough computers, nurses documenting cannot see the central monitoring FHR without turning around. Several nurses suggested monitors be strategically placed to improve their ability to monitor patients while documenting.

Processes. The ways in which information was transmitted across professions, within the institution, and between institutions for patient transfers was frequently mentioned as a barrier to patient care. The resource/charge nurse spent considerable time doing administrative tasks (such as making phone calls to identify patient medical record numbers), physically moving beds, or tracking down medications from pharmacy or equipment from other departments. These non-nursing tasks inhibited the resource nurses' ability to support less experienced nurses caring for clinically complicated patients.

Quantitative results

Forty-six nurses, representing 63% of the nurses currently working on the unit completed the online questionnaire. The most common performance obstacles experienced by nurses were in the SEIPS category "technology and tools" (endorsed by 91.4% nurses) and the least common were in the category "organization" (10.6% of nurses). [Table 2] The "help from others" ratings strongly trended towards timely, adequate, and useful, with an overall mean of 10.79 for these questions.

Summary of quantitative and qualitative results

While the quantitative data findings suggests that nurses are most affected by tools and technology, interviews indicate that task issues due to staffing shortages are the most

frequent performance obstacle experienced by nurses. Staffing patterns and schedules come under the SEIPS category "organization," but the experience of nurses working under short staffing is a high task burden. Concerns about the effect of the physical environment on work and work flow were present in the analysis of results from both qualitative and quantitative data.

Discussion

In this observational mixed methods study of systems level factors on registered nurses who care for women receiving care on a labor and delivery unit, we sought to determine which factors most frequently affect nurses and how that is experienced by nurses. We found the most common performance obstacle was high task burden (due to staff shortages) and the second was issues related to tools and technology, followed by problems with the physical environment. Our qualitative and quantitative results converge, with similar findings across data types.

Qualitative data collected during our observations and interviews suggest that staffing challenges were a frequent difficulty and that nurses' feeling "swamped" was associated with being over burdened by heavy patient assignments. This was usually due to having too many patients, greater than those recommended by the Association of Women's Health, Obstetric, and Neonatal Nurses' (AWHONN) staffing guidelines. Prior researchers found nurses working in units adhering to AWHONN staffing guidelines report fewer shifts of feeling swamped.(11,59)

Tools and technology created a range of difficulties described in both surveys and interviews. In some cases, the burden of nurse documenting was believed to inhibit time with patients; the high-tech childbirth environment necessitated significant nurse time

locating appropriate monitors and cables. Nurses participating in our research overwhelmingly referred to their workplace as noisy rather than quiet. This noise was a persistent problem for nurses, midwives, and physicians. Simultaneous alarms increased overall environmental noise and may have impaired clinicians' ability to respond because noise in the physical environment is distracting and may take up cognitive space. (60) Findings from research in intensive care unit environments suggest frequent alarms may trigger sensory overburden for nurses and cause nurse delay alarm responses or even ignore alarms. (60,61) Noise contributes to clinicians' cognitive workload and interrupts other vital tasks.(62) Nurses were enthusiastic about participation in this research and frequently invited the PI into patient rooms or demonstrated particular technological or ergonomic issues for inclusion in the research.

Nurses, physicians, and midwives in our study mentioned issues in the physical environment and technology issues frequently, including lack of physical space, poorly placed central monitoring, and excessive environmental noise. Prior research has focused on communication as a barrier to improving patient safety; the extant research has not sufficiently examined other factors despite significant evidence that the physical work environment and shortages or difficulty with tools and technology impair patient safety. (22)(5,63) Thus, administrators should include bedside nurses in quality improvement project design and invest in resources that improve unit ergonomics.

Clinicians in our study reported that excellent teamwork and a culture of patient safety mitigated other difficulties, including inadequate staffing, and lack of equipment and other resources. This finding is supported by the balance theory of job design, which describes that some aspects of a job tax human and other resources and act as stressors,

but these stressors may be counteracted by other, positive job qualities.(64) High workload and poor nursing staffing are both correlated with nursing burnout(65) and clinician exhaustion may impair patient safety.(66) The theme “feeling inadequate” was unique to nurses and reflects dissatisfaction with one’s work performance, a factor previously identified as a risk for burnout.(67) Further interventional research studying techniques to balance the work system could help determine moderating variables that diminish job stressors and decrease the risk of burnout.

Nurses on labor and delivery units are qualified to perform cervical exams, but it was less common on this unit. Promoting nurses’ acquisition of new skills may improve patient safety by shortening the time to assessment. (68) This approach could also mitigate burnout by increasing nurses’ sense of autonomy; low autonomy in work is associated with burnout.(69) Further research is needed to understand barriers and facilitators to this type of “top of license” nursing practice.(70)

Limitations

The most significant limitation of this study is that it took place in a specific hospital unit at a particular time. The summer of 2021 was exceptionally busy for the unit and clinicians faced challenges from the ongoing Covid-19 crisis as well as from a nursing shortage, changing policies, and physical construction on their unit. Recruitment for the study was difficult resulting in not meeting our targeted quantitative arm enrollment of 51 nurses which may have been due to nurse fatigue. Thus, our sample may be skewed toward nurses, physicians, and certified nurse-midwives who had the time and energy to take a survey and be interviewed. Our findings are not generalizable to less-resourced

hospitals, but this work does provide a model for applying the SEIPS framework to the labor and delivery work system.

Another limitation is that the critical incident interview method relies on memory. However, most clinicians shared recent patient situations from the prior month, and in some cases, from shifts immediately prior to the interview. The coding of interviews by broad themes also diminishes the importance of the details of each story.

Finally, this was a small study. With a total pool of 73 available nurses, our initial goal of 51 nurses (70%) was not achieved, likely for the recruitment reasons discussed above. Our goal of thematic saturation in the qualitative arm was achieved, with a total of 16 nurses, physicians, and certified nurse-midwives participating in interviews.

Implications of results for practice and future research:

Observation was a critical aspect of this research, promoting an understanding of how work on this unit was done, rather than relying on how people said the work was done. The use of formal process mapping with nurses, physicians, and midwives combined with observation of processes would be useful to understanding these differences and evaluating potential effects of changes to processes.

Recently a set of tools based upon SEIPS has been developed for work system improvement; "SEIPS 101" offers a practical application of the SEIPS framework for use by clinicians and administrators. (73) These tools may help less-resourced hospitals benefit from the SEIPS model without requiring high-level expertise.

Bedside nurses should be included in system design and re-design work, including quality improvement projects. Assessing hospital units for problems in the physical environment affecting patient care can support nurses in their work. Interventions

improving communication can balance performance obstacles; these interventions include team training, huddles, and ongoing process improvement activities.(74) Future research studying the use of the SEIPS 101 toolbox and its effects on patient outcomes can guide ongoing process improvement work and selection of appropriate tools for different hospital environments.(73) Ongoing assessment of how nurses are affected by their work system can also assist in the selection of systems level interventions to improve patient safety and decrease maternal morbidity and mortality.

References

1. Trist E, Bamforth K. Some social and psychological consequences of the longwall method of coal-getting: an examination of the psychological situation and defences of a work group in relation to the social structure and technological content of the work system. Human Relations. 1951;4(1):3–38.

2. Vicente K. Cognitive work analysis: Toward safe, productive, and healthy computer-based work. Mahwah, NJ: Lawrence Erlbaum Associates; 1999.

3. World Health Organization. Trends in maternal mortality 2000-2017: Estimate by WHO, UNICEF, ENFPA, World Bank Group, and the United Nations Population Division. Geneva: World Health Organization; 2019.

4. Severe maternal morbidity in the United States [Internet]. Centers for Disease Control and Prevention. 2021 [cited 2021 Jun 16]. Available from: https://www.cdc.gov/reproductivehealth/maternalinfanthealth/severematernalmorbidity.html

5. Friedman A, Ananth C, Huang Y, D'Alton M, Wright J. Hospital delivery volume, severe obstetrical morbidity, and failure to rescue. Am J Obstet Gynecol. 2016;215(6):795.e1-795.e14.

6. Howell E, Zeitlin J. Improving hospital quality to reduce disparities in severe maternal morbidity and mortality. Semin Perinatol. 2017;41(5):266–72.

7. Orique SB, Despins L, Wakefield BJ, Erdelez S, Vogelsmeier A. Perception of clinical deterioration cues among medical-surgical nurses. J Adv Nurs [Internet]. 2019/04/24 ed. 2019 Apr 22; Available from: https://www.ncbi.nlm.nih.gov/pubmed/31012138

8. Massey D, Chaboyer W, Anderson V. What factors influence ward nurses' recognition of and response to patient deterioration? An integrative review of the literature. Nurs Open. 2017 Jan;4(1):6–23.

9. Herrick HM, Lorch S, Hsu JY, Catchpole K, Foglia EE. Impact of flow disruptions in the delivery room. Resuscitation. 2020/03/21 ed. 2020 Mar 16;150:29–35.

10. Danesh MK, Garosi E, Mazloumi A, Najafi S. Identifying factors influencing cardiac care nurses' work ability within the framework of the SEIPS model. Work. 2020;66(3):569–77.

11. Roth C, Brewer M, Bay RC, Gosselin K. Nurses' experiences of "being swamped" in the clinical setting and sssociation with adherence to AWHONN nurse staffing guidelines. MCN Am J Matern Child Nurs. 2020;45(5):271–9.

12. Simpson K, Lyndon A, Ruhl C. Consequences of inadequate staffing include missed care, potential failure to rescue, and job stress and dissatisfaction. J Obstet Gynecol Neonatal Nurs. 2016;45(4):481–90.

13. Patel SM, Loveridge R. Obstetric Neuraxial Drug Administration Errors: A Quantitative and Qualitative Analytical Review. Anesth Analg. 2015 Dec;121(6):1570–7.

14. Carayon P. Human factors of complex sociotechnical systems. Applied Ergonomics. 2006/06/08 ed. 2006 Jul;37(4):525–35.

15. Johnson C, Handberg E, Dobalian A, Gurol N, Pearson V. Improving perinatal and neonatal patient safety: the AHRQ patient safety indicators. J Perinat Neonatal Nurs. 2005 Jan;19(1):15–23.

16. Carayon P, Wood K. Patient safety: The role of human factors and systems engineering. Studies in Health Technology and Informatics. 2010;153:23–46.

17. Morton C, VanOtterloo L, Seacrist M, Main E. Translating maternal mortality review into quality improvement opportunities in response to pregnancy-related deaths in California. J Obstet Gynecol Neonatal Nurs. 2019 May;48(3):252–62.

18. VanOtterloo L, Seacrist M, Morton C, Main E. Quality improvement opportunities identified through case review of pregnancy-related deaths from venous thromboembolism. J Obstet Gynecol Neonatal Nurs. 2019;48(3):300–10.

19. VanOtterloo L, Morton C, Seacrist M, Main E. Quality improvement opportunities identified through case review of pregnancy-related deaths from cardiovascular disease. J Obstet Gynecol Neonatal Nurs. 2019;48(3):263–74.

20. Seacrist M, Morton C, VanOtterloo L, Main E. Quality improvement opportunities identified through case review of pregnancy-related deaths from sepsis. J Obstet Gynecol Neonatal Nurs. 2019/04/12 ed. 2019 May;48(3):311–20.

21. Seacrist M, VanOtterloo L, Morton C, Main E. Quality improvement opportunities identified through case review of pregnancy-related deaths from obstetric hemorrhage. J Obstet Gynecol Neonatal Nurs. 2019;48(3):288–99.

22. Gurses, A, Carayon, P, Wall, M. Impact of performance obstacles on intensive care nurses' workload, perceived quality and safety of care, and quality of working life. Health Serv Res. 2009;44:422–43.

23. American College of Obstetricians and Gynecologists and the Society for Maternal–Fetal Medicine, Kilpatrick SK, Ecker JL. Severe maternal morbidity: screening and review. Am J Obstet Gynecol. 2016 Sep;215(3):B17-22.

24. First Data Released on Maternal Mortality in Over a Decade [Internet]. 2020 [cited 2021 Jun 18]. Available from: https://www.cdc.gov/nchs/pressroom/nchs_press_releases/2020/202001_MMR.htm

25. Adverse Events, Near Misses, and Errors. [cited 2021 Jan 21]; Available from: https://psnet.ahrq.gov/primer/adverse-events-near-misses-and-errors

26. Silber JH, Williams SV, Krakauer H, Schwartz JS. Hospital patient characteristics associated with death after surgery: A study of adverse occurrence and failure to rescue. Medical Care. 1992;30(7).

27. Burke JRMb, Downey CMbc, Almoudaris AMBs (Hons). Failure to rescue deteriorating patients: A systematic review of root causes and improvement strategies. Journal of Patient Safety. 2020;

28. Carayon P, Schoofs Hundt A, Karsh B, Gurses A, Alvarado C, Smith M, et al. Work system design for patient safety: the SEIPS model. Qual Saf Health CareM. 2006/12/05 ed. 2006 Dec;15 Suppl 1:i50-8.

29. Bernstein S. Scoping Review on the Use of Early Warning Trigger Tools for Women in Labor. J Obstet Gynecol Neonatal Nurs. 2021 May 1;50(3):256–65.

30. Arnolds DE, Smith A, Banayan JM, Holt R, Scavone BM. National Partnership for Maternal Safety recommended maternal early warning criteria are associated with maternal morbidity. Anesthesia & Analgesia [Internet]. 2018/11/01 ed. 2018 Oct 30; Available from: https://www.ncbi.nlm.nih.gov/pubmed/30379672

31. Bernstein SL, Kelechi TJ, Catchpole K, Nemeth LS. Prevention of failure to rescue in obstetric patients: A realist review. Worldviews Evid Based Nurs [Internet]. 2021 [cited 2021 Sep 5]; Available from: https://sigmapubs.onlinelibrary.wiley.com/doi/abs/10.1111/wvn.12531

32. Goodson P. Theory in Health Promotion Research and Practice. Jones and Bartlett Publishers; 2010.

33. Grobman WA, Bailit JL, Rice MM, Wapner RJ, Reddy UM, Varner MW, et al. Racial and ethnic disparities in maternal morbidity and obstetric care. Obstet Gynecol. 2015/05/23 ed. 2015 Jun;125(6):1460–7.

34. Hall K, Shoemaker-Hunt S, Hoffman L, Richards S, Gall E, Schoyer, et al. Making healthcare safer III: A critical analysis of existing and emerging patient safety practices [Internet]. Agency for Healthcare Research and Quality, Rockville, MD (US); 2020. Available from: https://www.ahrq.gov/research/findings/making-healthcare-safer/mhs3/index.html

35. O'Neill L, Miler L, Rohan A. Threats to patient safety in the inpatient maternity setting. MCN Am J Matern Child Nurs. 2020 Apr;45(2):74–81.

36. Carayon P, Gurses AP. Nursing Workload and Patient Safety—A Human Factors Engineering Perspective. In: Hughes RG, editor. Patient Safety and Quality: An Evidence-Based Handbook for Nurses. Rockville (MD): Agency for Healthcare Research and Quality (US); 2008. (Advances in Patient Safety).

37. Krueger L, Funk C, Green J, Kuznar K. Nurse-related variables associated with patient outcomes: A review of the literature 2006–2012. Teaching and Learning in Nursing. 2013 Oct;8(4):120–7.

38. Edmonds JK, Weiseth A, Neal BJ, Woodbury SR, Miller K, Souter V, et al. Variability in cesarean delivery rates among individual labor and delivery nurses compared to physicians at three attribution time points. Health Services Research. 2021;56(2):204–13.

39. Simpson KR, Lyndon A. Labor nurses' views of their influence on cesarean birth. MCN Am J Matern Child Nurs. 2017 Apr;42(2):81–7.

40. Lumley C, Ellis A, Ritchings S, Venes T, Ede J. Using the Systems Engineering Initiative for Patient Safety (SEIPS) model to describe critical care nursing during the SARS-CoV-2 pandemic. Nurs Crit Care. 2020;25(4):203–5.

41. Wooldridge AR, Carayon P, Hundt AS, Hoonakker PLT. SEIPS-based process modeling in primary care. Appl Ergon. 2017 Apr;60:240–54.

42. Krupp A, Steege L, King B. A systematic review evaluating the role of nurses and processes for delivering early mobility interventions in the intensive care unit. Intensive Crit Care Nurs. 2018 Aug;47:30–8.

43. Carayon P, Kianfar S, Li Y, Xie A, Alyousef B, Wooldridge A. A systematic review of mixed methods research on human factors and ergonomics in health care. Appl Ergon. 2015 Nov;51:291–321.

44. Werner NE, Ponnala S, Doutcheva N, Holden RJ. Human factors/ergonomics work system analysis of patient work: state of the science and future directions. International Journal for Quality in Health Care. 2021 Jan 12;33(Supplement_1):60–71.

45. Fetters MD, Curry LA, Creswell JW. Achieving integration in mixed methods designs—Principles and practices. Health Serv Res. 2013 Dec;48(6 Pt 2):2134–56.

46. Creswell JW, Plano Clark V. Designing and conducting mixed methods research. 3rd ed. Los Angeles: SAGE Publications; 2018.

47. O'Cathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health services research. J Health Serv Res Policy. 2008 Apr;13(2):92–8.

48. Gremler D. The Critical Incident Technique. Journal of Service Research. 2004 Aug 1;7:65–89.

49. Microsoft Teams. Redmond, WA: Microsoft Corporation; 2021.

50. NVIVO Qualitative data analysis software [Internet]. QSR International; 1999. Available from: qsrinternational.com/nvivo/nvivo-products/

51. Creswell JW, Poth CN. Qualitative Inquiry & Research Design: Choosing Among Five Approaches. Los Angeles: Sage Publications; 2018.

52. Bradley EH, Curry LA, Devers KJ. Qualitative Data Analysis for Health Services Research: Developing Taxonomy, Themes, and Theory. Health Serv Res. 2007 Aug;42(4):1758–72.

53. Gurses AP, Carayon P. Exploring performance obstacles of intensive care nurses. Appl Ergon. 2009 May;40(3):509–18.

54. REDCap [Internet]. [cited 2021 Feb 21]. Available from: https://projectredcap.org/software/

55. Ahmed WAEM, Soliman ES, Shazley MM. Staff nurses' performance obstacles and quality of work life at Benha University Hospital. Nurs Health Sci. 2018;7(2):65–71.

56. SPSS Statistics for Macintosh. Armonk, NY: IBM Corp.; 2020.

57. Microsoft Excel [Internet]. Redmond, WA: Microsoft Corporation; 2021. Available from: https://office.microsoft.com/excel

58. Guetterman TC, Fetters MD, Creswell JW. Integrating quantitative and qualitative results in health science mixed methods research through joint displays. Ann Fam Med. 2015 Nov;13(6):554–61.

59. Simpson K, Lyndon A, Spetz J, Gay C, Landstrom G. Adherence to the AWHONN staffing guidelines as perceived by labor nurses. Nurs Womens Health. 2019/05/06 ed. 2019 Jun;23(3):217–23.

60. Wung S-F, Malone DC, Szalacha L. Sensory overload and technology in critical care. Crit Care Nurs Clin North Am. 2018 Jun;30(2):179–90.

61. Lewandowska K, Weisbrot M, Cieloszyk A, Mędrzycka-Dąbrowska W, Krupa S, Ozga D. Impact of alarm fatigue on the work of nurses in an intensive care

environment—A systematic review. Int J Environ Res Public Health. 2020 Nov;17(22):8409.

62. Carayon P, Alvarado CJ, Systems Engineering Initiative for Patient Safety. Workload and patient safety among critical care nurses. Crit Care Nurs Clin North Am. 2007 Jun;19(2):121–9.

63. Baird S, Graves C. REACT: An interprofessional education and safety program to recognize and manage the compromised obstetric patient. J Perinat Neonatal Nurs. 2015;29(2):138–48.

64. Smith MJ, Sainfort PC. A balance theory of job design for stress reduction. International Journal of Industrial Ergonomics. 1989 Jul 1;4(1):67–79.

65. Dall'Ora C, Ball J, Reinius M, Griffiths P. Burnout in nursing: a theoretical review. Hum Resour Health. 2020 Jun 5;18(1):41.

66. Welp A, Meier LL, Manser T. Emotional exhaustion and workload predict clinician-rated and objective patient safety. Front Psychol. 2014;5:1573.

67. Maslach C, Jackson SE. The measurement of experienced burnout. Journal of Organizational Behavior. 1981;2(2):99–113.

68. Twigg D, McCullough K. Nurse retention: a review of strategies to create and enhance positive practice environments in clinical settings. Int J Nurs Stud. 2014 Jan;51(1):85–92.

69. Maslach C, Leiter MP. Understanding the burnout experience: recent research and its implications for psychiatry. World Psychiatry. 2016 Jun;15(2):103–11.

70. Buck J, Loversidge J, Chipps E, Gallagher-Ford L, Genter L, Yen P-Y. Top-of-license nursing practice: describing common nursing activities and nurses' experiences that hinder top-of-license practice, part 1. J Nurs Adm. 2018 May;48(5):266–71.

71. Catchpole K, Alfred M. Industrial conceptualization of health care versus the Naturalistic Decision-Making paradigm: Work as imagined versus work as done. J Cogn Eng Decis Mak. 2018;12(3):222–6.

72. Hollnagel E, Wears, RL, Braithwaite J. From Safety-I to Safety-II: A White Paper. 2015 [cited 2021 Sep 24]; Available from: https://psnet.ahrq.gov/issue/safety-i-safety-ii-white-paper

73. Holden RJ, Carayon P. SEIPS 101 and seven simple SEIPS tools. BMJ Qual Saf. 2021 May 26;bmjqs-2020-012538.

74. Aggarwal R, Plough A, Henrich N, Galvin G, Rucker A, Barnes C, et al. The design of "TeamBirth": A care process to improve communication and teamwork during labor. Birth [Internet]. [cited 2021 Jul 13];available online ahead of publication. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/birt.12566

75. Robbins T, Shennan A, Sandall J. Modified early obstetric warning scores: A promising tool but more evidence and standardization is required. Acta Obstetricia et Gynecologica Scandinavica. 2019;98(1):7–10.

76. Zuckerwise LC, Lipkind HS. Maternal early warning systems-Towards reducing preventable maternal mortality and severe maternal morbidity through improved clinical surveillance and responsiveness. Semin Perinatol. 2017/04/19 ed. 2017 Apr;41(3):161–5.

77. Pawson R, Greenhalgh T, Harvey G, Walshe K. Realist review- A new method of systematic review designed for complex policy interventions. Journal of Health Services Research & Policy. 2005;10:21–34.

78. Brennan R, Keohane C. How communication among members of the health care team affects maternal morbidity and mortality. JOGNN - Journal of Obstetric, Gynecologic, and Neonatal Nursing. 2016;45(6):878–84.

79. Werner NE, Rutkowski R, Graske A, Finta MK, Sellers CR, Seshadri S, et al. Exploring SEIPS 2.0 as a model for analyzing care transitions across work systems. Appl Ergon. 2020 Oct;88:103141.

Table 1. Demographics of sample

Characteristics of sample	**Frequency (N=53)**	**Percent**
Role		
Registered Nurse	46	87%
Physician	5	9%
Certified Nurse Midwife	2	4%
Gender Identity		
Female	51	96%
Male	1	2%
Non-binary	0	0
Prefer not to say	1	2%
Registered Nurses	**Frequency (n=46)**	**Percent**
Educational Level		
Associate's degree	4	9%
Bachelors degree	36	78%
Masters degree	2	4%
Declined to answer	5	11%
Shift worked today		
7AM- 7PM	27	59%
7PM- 7AM	12	26%
Other shift	2	4%
Declined to answer	16	35%
	Mean (SD)	**Median, Interquartile range**
Years at this hospital	11.33 (8.15)	9, 4-20 years
Years as registered nurse	15.79 (10.95)	12.5, 6- 24.25 years
Hours worked in prior 7 days	34.40 (14.78)	36, 24- 38 hours
Hours worked in prior 24 hours	12.38 (3.96)	12, 12-12 hours

Note: Ethnicity and race demographics were collected but are omitted here to protect confidentiality of participants

Table 2. *Performance obstacles experienced by nurses*

Performance Obstacles, grouped by SEIPS category	# nurses endorsing n=46	% nurses endorsing?
Technology & tools	43	93.5%
Organization	5	10.9%
Tasks	37	80.4%
Help from other people *(scale from 0-100)*	Mean (SD)	Median, IQR range
Unit clerks		
Timely-late	6.34 (10.64)	0, 0-11.5
Adequate- inadequate	6.05 (8.43)	0.5, 0-11.5
Useful-useless	4.0 (7.27)	0, 0- 4
Nursing assistants		
Timely-late	14.15 (25.15)	4, 0-14
Adequate- inadequate	12.73 (24.03)	3, 0-13
Useful-useless	11.24 (19.85)	3, 0-15
Other nurses		
Timely-late	14.54 (22.76)	1, 0-22
Adequate-inadequate	15.15 (24.22)	2, 0- 18.5
Useful-useless	12.95 (22.69)	1, 0-16
Physical Environment *(scale from 0-100)*		
During my shift today, my workplace was…		
Noisy-quiet	23.59 (20.01)	22, 10-31
Crowded-roomy	30.51 (24.27)	25, 7.5- 50
Hectic-calm	23.23 (23.04)	20, 0- 34
Organized-disorganized	46.18 (27.02)	20, 25.25- 65.75
When I came in for my shift today, I found the patient room assigned to me….		
Organized-disorganized	20.85 (24.08)	14, 2.50- 27.00

Note: percentages may not add up to 100 due to rounding.

Table 3. *Joint display and merging of qualitative and quantitative findings*

Theme	**Qualitative-Interview Findings, participants mentioning this theme, n=16**	**Exemplar Quotation**	**Quantitative-Survey Findings n= 47**
Tasks	13 (81%)	"I'm charting every 15 minutes on two patients. You're looking at their vital signs, you're… Maybe helping out somebody and turning your patient or doing something with your patient… Now you're behind on charting on two patients, I just feel like it's…you're just constantly targeting."	36 (78%)
Swamped	5 (31%)	"I'm gonna turn [this patient] and then I'm gonna be able to tend to my [other] patient. I didn't foresee this ….cycling of …events that was gonna like keep me away."	N/A
Tools and Technology	14 (87%)	"I feel like everybody always has like all eyes on like the [fetal monitoring] strip."	42 (91%)
Organization	16 (100%), mentioned as positive	"[there is] continuous support …for somebody to speak up and to feel	5 (10%) rated as obstacle

		comfortable doing that without fear of repercussion or embarrassment or, you know, what have you. I think that's one of our strongest qualities that we have as a team."	
Is this safe	7 (44%)	"I did not feel safe and I think that that was why…I had a very low threshold for getting in touch with our charge nurse [and] contacting the residents"	N/A
Person	12 (75%)	"I'm sort of like an old battleaxe, I usually get business taken care of one way or another."	Mean ratings of helpfulness of others were high (timely adequate, useful) at 10.8 on a scale of 0-100 (0 best/100 worse)
Feeling inadequate	6 (38%)	"nobody gets decent care on that night and everybody leaves feeling terrible"	N/A
Environment	12 (75%)	"I'm taking patients into the back room to listen to a fetal heart because I have nowhere else to put them."	Ratings of environment tended less positive, for noisy, crowded, hectic, with a mean of 25.8 (0 worse/100 best)
Processes	15 (94%)	"We have come together to say, how can we deliver the best practice and there are groups of	N/A

		obstetricians and midwives who make up those, nurses best practice things. So I was on that committee for years to say 'this is a good way.' How can we prevent a bad outcome? And we want the best outcome for patients."	

Note: percentages may not add up to 100 due to rounding.

Appendix A. Structured observation form

Research Observation form

Shift (day/night):

Month:

Technology and tools (Fetal monitor, IV pumps, EMR, communication devices)

Tasks (assigned, autonomy, unassigned)

Environment (noise, lighting, temperature, work station design)

Organization (coordination, huddles)

Processes

Appendix B. Interview Guide

Introduction:

Thanks for meeting with me today. As you know, I am a registered nurse doing research on Blake 14. I'm trying to understand the factors that affect nurse decision-making when labor patients experience clinical deterioration.

You are being asked to participate in this research because you have at least 3 months of experience on Blake 14. Your participation is voluntary and confidential. The risks of participation include discomfort with questions and a loss of confidentiality. You can withdraw from the research at any time for any reason and every effort will be made to maintain confidentiality. Participation or discontinuance will not constitute an element of you job performance or evaluation, and it will not be a part of your personnel record at MGH.

I am recording this interview and it will be transcribed and stored on a secure server. Only study team personnel will have access to it. You will receive a $20 Amazon gift card to thank you for your participation.

I'm interested in hearing about your experiences on Blake 14 when things have gone well and when they haven't gone well. This interview should take about 45-60 minutes. You can choose to stop the interview any time you want for any reason. Do you have any questions before we get started?

1. Can you tell me about a time when you took care of a labor patient experiencing deterioration and things went well? (further questions below if something doesn't get mentioned)
    a. Was the unit busy or quiet?
    b. How was the staffing level?
    c. Who else was there?
        i. How do you think they experienced this?
    d. Was the patient's family there?
    e. What were your major concerns about the patient?
    f. Did you have what you needed- equipment?
    g. Did it feel like you were safe (physically or emotionally)?
    h. Did you use a huddle at any point?
    i. Generally, did you feel like unit procedures and policies were followed during this event?
    j. Was there a debrief afterwards??
2. Can you tell me about a time when you took care of a labor patient experiencing deterioration and things didn't go well? (further questions below if something doesn't get mentioned)
    a. Was the unit busy or quiet?
    b. How was the staffing level?
    c. Who else was there?
        i. How do you think they experienced this?
    d. Was the patient's family there?

e. What were your major concerns about the patient?
f. Did you have what you needed- equipment?
g. Did it feel like you were safe (physically or emotionally)?
h. Did you use a huddle at any point?
i. Generally, did you feel like unit procedures and policies were followed during this event?
j. Was there a debrief afterwards??

WRAP UP—Are there other things that you want to tell me that I didn't ask about?
Thank them for participation in interview, confirm email address, remind them to look for email with gift card.

Appendix C. Survey Instrument

Performance Obstacles for Nurses

You are being asked to participate in this research because you have at least 3 months of experience on Blake 14. Your participation is voluntary and includes only those who choose to take part. Participation or discontinuance will not constitute an element of your job performance or evaluation, and it will not be a part of your personnel record at MGH.

This research will help us to understand the work system on Blake 14 so that there can be future improvements.

The risks of participation include discomfort with questions and a loss of confidentiality. You can withdraw from the research at any time for any reason and every effort will be made to maintain confidentiality.

I'm looking forward to getting to know you and your unit. If you have any questions about this project, you can reach me on my cell phone (603)831-1386, or via email: slerman@bics.bwh.harvard.edu.

Thanks,

Samantha Bernstein, MSN, RN

I have worked on Blake 14 for at least 3 months.	◯ Yes ◯ No
I certify that I am at least 18 years old and that I give my consent freely to participant in this study.	◯ I consent ◯ I do not consent

As a participant in this study, please provide a response to each questions below.	
What ethnicity do you primarily identify with?	◯ Hispanic or Latinx ◯ NOT Hispanic or Latinx ◯ Unknown ◯ Prefer not to answer
What race do you primarily identify with?	◯ American Indian/Alaska Native ◯ Asian ◯ Native Hawaiian or Other Pacific Islander ◯ Black or African American ◯ White ◯ More Than One Race ◯ Unknown ◯ Prefer not to answer ◯ Please specify _____ (type your response)
If other race, please tell us	_____
What gender do you primarily identify with?	◯ Female ◯ Male ◯ Non-binary ◯ Other _____ (please type your response) ◯ Prefer not to answer
If other, please tell us	_____
What is your professional role?	◯ Registered Nurse ◯ Physician ◯ Certified Nurse Midwife
Would you like to participate in the survey, an interview, or both?	◯ Survey ◯ Interview ◯ Both
Please provide your contact details below, where you can be reached by a study team member to set up an interview.	
First Name	_____
Last Name	_____
Email Address	_____

I appreciate your taking the time to complete this survey. It will take you about 15 minutes to complete. This information will help us understand what it's like to work on Blake 14.

Your participation is voluntary and your responses will be kept confidential. All reports about this survey will include only data from groups of nurses, so no one will know how you answered any question. This study poses no physical, social, or legal risks. You may stop the survey at any time and for any reason.

Participation or discontinuance will not constitue an element of your job performance or evaluation, and it will not be a part of your personnel record at MGH.

If you have any additional questions or comments, feel free to call or email the Primary Investigator, Samantha Bernstein, RN at (603)831-1386 or slerman@bics.bwh.harvard.edu

Please answer the following questions considering only your shift today.

I had difficulty finding a computer to work on in the unit.	◯ Yes ◯ No
My patients' rooms were close to each other.	◯ Yes ◯ No ◯ No applicable
I had to use equipment that was in poor condition.	◯ Yes ◯ No
I spent a lot of time looking for equipment because it wasn't located where it was supposed to be.	◯ Yes ◯ No
I had to wait to use a piece of equipment because someone else was using it.	◯ Yes ◯ No
I spent a lot of time looking for supplies in the central stock area.	◯ Yes ◯ No
There was a delay in getting medications for my patient from the pharmacy.	◯ Yes ◯ No
The isolation rooms that I worked in were well-stocked.	◯ Yes ◯ No ◯ Not applicable
The non-isolation rooms I worked in were well-stocked.	◯ Yes ◯ No ◯ Not applicable
I got adequate information from physicians/midwives about my patient(s).	◯ Yes ◯ No ◯ Not applicable
The change of shift report(s) took longer than they should There was a delay before I saw new orders for my patient(s).	◯ Yes ◯ No ◯ Yes ◯ No

I was responsible for orienting a nurse.	◯ Yes ◯ No
The central stock area was well-stocked.	◯ Yes ◯ No
The patient-related information given to me by the previous shifts' nurses during shift change was sufficient.	◯ Yes ◯ No
The patient-related information given to me by the previous shifts nurse(s) during shift change was unnecessarily detailed.	◯ Yes ◯ No
I had distractions from patients' family members	◯ Yes ◯ No
I spent a lot of time dealing with family needs.	◯ Yes ◯ No
I received a lot of phone calls from family members.	◯ Yes ◯ No
I spent a considerable amount of time teaching my patient or their family members.	◯ Yes ◯ No

The next three questions are about nursing assistants. If there were no nursing assistants on the unit today, please skip these questions.

The help I received from nursing assistants was...	timely	late
	(Place a mark on the scale above)	
The help I received from nursing assistants was...	adequate	inadequate
	(Place a mark on the scale above)	
The help I received from nursing assistants was...	useful	useless
	(Place a mark on the scale above)	

The next three questions are about help from other nurses today. If you didn't need any help from other nurses today, please skip these questions.

The help I received from other nurses today was...	timely	late
	(Place a mark on the scale above)	
The help I received from other nurses today was...	adequate	inadequate
	(Place a mark on the scale above)	
The help I received from other nurses today was...	useful	useless
	(Place a mark on the scale above)	

The next three questions are about unit clerks. If there were no unit clerks during your shift today, please skip these questions.

The help I received from unit clerks today was...	timely	late
	(Place a mark on the scale above)	
The help I received from unit clerks today was...	adequate	inadequate
	(Place a mark on the scale above)	
The help I received from unit clerks today was...	useful	useless
	(Place a mark on the scale above)	
During my shift today, my workplace was...	Noisy	Quiet
	(Place a mark on the scale above)	
During my shift today, my workplace was...	Crowded	Roomy
	(Place a mark on the scale above)	
During my shift today, my workplace was...	Hectic	Calm
	(Place a mark on the scale above)	
During my shift today, my workplace was...	Organized	Disorganized
	(Place a mark on the scale above)	
When I came in for my shift today, I found the patient room assigned to me...	Organized	Disorganized
	(Place a mark on the scale above)	

How many nursing assistants were in the unit during today's shift?	○ 0 ○ 1 ○ 2 ○ 3 ○ 4+
How many patients were assigned to you today at the beginning of the shift?	○ 1 ○ 2 ○ 3 ○ 4+
How many patients did you admit?	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7+
How many of your patients were transferred out of the unit?	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7+
How many of your patients were isolation/precautions patients?	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7+

--- ABOUT YOU ---	
What is the highest level of education that you have completed?	○ ADN ○ BSN ○ MSN ○ DNP ○ PhD
Which of the following describes your current job position?	○ Staff Nurse ○ Float Nurse ○ Traveler/Agency Nurse
How long have you been working at Mass General? (Please round to the nearest whole year)	○ < 1yrs ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 ○ 11 ○ 12 ○ 13 ○ 14 ○ 15 ○ 16 ○ 17 ○ 18 ○ 19 ○ 20 ○ 21 ○ 22 ○ 23 ○ 24 ○ 25 ○ 26 ○ 27 ○ 28 ○ 29 ○ 30 ○ 31 ○ 32 ○ 33 ○ 34 ○ 35 ○ 36 ○ 37 ○ 38 ○ 39 ○ 40
How long have you been a Registered Nurse? (Please round to the nearest whole year)	○ < 1yrs ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 ○ 11 ○ 12 ○ 13 ○ 14 ○ 15 ○ 16 ○ 17 ○ 18 ○ 19 ○ 20 ○ 21 ○ 22 ○ 23 ○ 24 ○ 25 ○ 26 ○ 27 ○ 28 ○ 29 ○ 30 ○ 31 ○ 32 ○ 33 ○ 34 ○ 35 ○ 36 ○ 37 ○ 38 ○ 39 ○ 40

How many hours did you work during the last seven days including today's shift?

< 1	◯ 1	◯ 2	◯ 3
4	◯ 5	◯ 6	◯ 7
8	◯ 9	◯ 10	◯ 11
12	◯ 13	◯ 14	◯ 15
16	◯ 17	◯ 18	◯ 19
20	◯ 21	◯ 22	◯ 23
◯ 24	◯ 25	◯ 26	◯ 27
◯ 28	◯ 29	◯ 30	◯ 31
◯ 32	◯ 33	◯ 34	◯ 35
◯ 36	◯ 37	◯ 38	◯ 39
◯ 40	◯ 41	◯ 42	◯ 43
◯ 44	◯ 45	◯ 46	◯ 47
◯ 48	◯ 49	◯ 50	◯ 51
◯ 52	◯ 53	◯ 54	◯ 55
◯ 56	◯ 57	◯ 58	◯ 59
◯ 60	◯ 61	◯ 62	◯ 63
◯ 64	◯ 65	◯ 66	◯ 67
◯ 68	◯ 69	◯ 70	◯ 71
◯ 72	◯ 73	◯ 74	◯ 75
◯ 76	◯ 77	◯ 78	◯ 79
◯ 80	◯ 81	◯ 82	◯ 83
◯ 84	◯ 85	◯ 86	87
◯ 88	◯ 89	◯ 90	91
◯	◯	◯	
◯	◯	◯	

92	93	94	95
96	97	98	99
100	101	102	
103	104	105	
106	107	108	
109	110	111	
112	113	114	
115	116	117	
118	119	120	
121	122	123	
124	125	126	
127	128	129	
130	131	132	
133	134	135	
136	137	138	
139	140	141	
142	143	144	
145	146	147	
148	149	150	
151	152	153	
154	155	156	
157	158	159	
160	161	162	
163	164	165	
166	167	168	

How many hours did you work during the last 24 hours?

< 1hr ◯ 1 ◯ 2 ◯ 3
4 ◯ 5 ◯ 6 ◯ 7
8 ◯ 9 ◯ 10 ◯ 11
12 ◯ 13 ◯ 14 ◯ 15
16 ◯ 17 ◯ 18 ◯ 19
20 ◯ 21 ◯ 22 ◯ 23
24

What shift did you work today?

◯ 7A-7P
◯ 7P-7A
◯ 7A-3P
◯ 3P-11P
◯ 11 P-7A
◯ other, please specify _____

Please describe the shift you worked today

_____

--- CONTACT INFORMATION ---

Thank you for completing this survey.

Please provide your name and email address below, where you will be sent a $5.00 gift card to Coffee Central to thank you for your participation.

First name

_____

Last name

_____

Email

_____

Performance Obstacles for Nurses

You are being asked to participate in this research because you have at least 3 months of experience on Blake 14. Your participation is voluntary and includes only those who choose to take part. Participation or discontinuance will not constitute an element of your job performance or evaluation, and it will not be a part of your personnel record at MGH.

This research will help us to understand the work system on Blake 14 so that there can be future improvements.

The risks of participation include discomfort with questions and a loss of confidentiality. You can withdraw from the research at any time for any reason and every effort will be made to maintain confidentiality.

I'm looking forward to getting to know you and your unit. If you have any questions about this project, you can reach me on my cell phone (603)831-1386, or via email: slerman@bics.bwh.harvard.edu.

Thanks,

Samantha Bernstein, MSN, RN

I have worked on Blake 14 for at least 3 months.	○ Yes ○ No
I certify that I am at least 18 years old and that I give my consent freely to participant in this study.	○ I consent ○ I do not consent

As a participant in this study, please provide a response to each questions below.

What ethnicity do you primarily identify with?	◯ Hispanic or Latinx ◯ NOT Hispanic or Latinx ◯ Unknown ◯ Prefer not to answer
What race do you primarily identify with?	◯ American Indian/Alaska Native ◯ Asian ◯ Native Hawaiian or Other Pacific Islander ◯ Black or African American ◯ White ◯ More Than One Race ◯ Unknown ◯ Prefer not to answer ◯ Please specify _____ (type your response)
If other race, please tell us	_____
What gender do you primarily identify with?	◯ Female ◯ Male ◯ Non-binary ◯ Other _____ (please type your response) ◯ Prefer not to answer
If other, please tell us	_____
What is your professional role?	◯ Registered Nurse ◯ Physician ◯ Certified Nurse Midwife
Would you like to participate in the survey, an interview, or both?	◯ Survey ◯ Interview ◯ Both

Please provide your contact details below, where you can be reached by a study team member to set up an interview.

First Name	_____
Last Name	_____
Email Address	_____

Chapter 5- Summary

Brief overview of three manuscripts

This research began with the question: how can we improve maternal morbidity and mortality on labor and delivery hospital units in the United States? This dissertation includes three manuscripts to explore that question through different approaches; 1) a scoping review on obstetric trigger tools that identify women at risk of deterioration for use by nurses, physicians, and midwives during labor and delivery 2) a realist review describing current approaches to the prevention of obstetric failure to rescue, and 3) observational research describing the systems factors affecting nurses while caring for women in labor experiencing clinical deterioration.

The first manuscript described the design and use of five trigger tools used to identify women in need of care escalation during labor and delivery. (29) These tools were all designed to draw a clinician's attention to a patient's worsening clinical condition. Early identification of patient deterioration is believed to be a key to preventing maternal death. (75) The tools are based upon shared assumptions that human beings need help noticing when patients deteriorate and that tools can help us with this task. As an estimate 40-60 percent of maternal deaths are considered preventable and tools are believed to improve clinician awareness. (76) However, this review concluded that no single tool meets the needs of all American obstetric units. Hospital units vary by size, staffing, and clinical resources and thus, each hospital must consider its own culture and resources when determining which trigger tool (if any) would be most beneficial to its clinicians. (29)

The second manuscript reviewed the current approaches to the prevention of obstetric failure to rescue events in hospital units in the United States. (31) Hospitals and hospital

systems have taken a range of tactics to ensure laboring women are kept safe from preventable harms. The realist review asked "what works, for whom, and in what contexts?" and used the Systems Engineering Initiative for Patient Safety (SEIPS) framework to describe a range of quality improvement and experimental interventions meant to improve maternal outcomes. (28,77) The use of the SEIPS framework revealed that nearly all interventions assumed that the person/clinician is the cause of negative patient outcomes. The vast majority of interventions suggested educational programs to improve nurse and physician knowledge. The effect of tools and technology on healthcare workers was under-appreciated and the physical environment was rarely mentioned. While teamwork and communication were appropriately emphasized, there was no discussion of the effects of task overload or the potential connections between employee, institutional, and patient outcomes. None of the research began with an assessment of the work system.

This finding directly led to the original research described in the final manuscript. This mixed-methods observational study assessed the effects of the work system on nurses taking care of labor patients experiencing clinical deterioration on one nursing labor and delivery unit in an urban tertiary care center. By combining qualitative and quantitative data and using the SEIPS framework, this manuscript described the range of performance obstacles experienced by nurses from a systems perspective. While the findings are limited by the single-site design, it is notable that nurses on this labor and delivery unit felt that strong teamwork mitigated other problems in their work system. Specifically, nurses suffered from task overload due to staffing shortages and high acuity of patients and struggled with environmental challenges due to outgrowing their physical

space. Nurses were challenged by equipment shortages but empowered by a strong patient safety culture which included twice-daily inter-disciplinary huddles and a "speak up" culture in which they felt comfortable bringing up patient safety concerns. This finding is supported by the balance theory of work design which suggested that some aspects of a job act as stressors (such as staffing shortages or problematic ergonomics) and may be counteracted by positive job qualities, such as autonomy and teamwork. (64)

Limitations

The major limitation of the dissertation research is that the findings may be specific to this nursing unit and difficult to generalize. The unit on which the study was conducted has a unique and notable patient safety culture, thus improving teamwork would be unlikely to improve patient outcomes. This finding is a departure from the patient safety literature describing poor teamwork and communication as the most frequent contributors to poor maternal outcomes and preventable death. (78) Other recent interventions to prevent maternal harms also take a team improvement approach.(74)

Relevance of the theory

The SEIPS framework has been used in many other contexts, including cardiac care, critical care during Covid-19 surges, primary care, and to describe patient care transitions. (10,40,41,44,79) This is the first time the model has been applied to understanding systems level factors affecting nurses caring for labor patients and the first time describing the obstetric work system. SEIPS is an excellent fit for this use, because it includes the myriad ways that nurses interact with subsystems within and across hospital departments.

Future Trajectory

The dissertation research occurred at a busy, urban, tertiary care center with high acuity and a wide range of available clinical resources. The next step for this research program is to perform a similar study at a rural, critical access hospital with fewer resources. Using the SEIPS framework and a similar mixed-methods study design at a small hospital affiliated with the same hospital system as the dissertation study will allow comparing and contrasting of results. By studying several hospitals using a similar design and the same framework, we may be able to draw more generalizable conclusions applicable to a wider range of labor and delivery settings. An improved understanding of these systems can lead to interventions to improve maternal health outcomes. Recently a set of tools based upon SEIPS has been developed. (73) "SEIPS 101" offers a practical application of the SEIPS framework; studying one or more of these tools as an intervention offers an opportunity to make system improvements based upon a proven framework.

I will also be scanning the funding opportunity announcements for calls for proposals in this area and will consider development of interventions based on the human factors framework as well as organizational systems and leadership models to improve patient safety and support of healthy nursing work environments. The Agency for Healthcare Quality and Research has issued a program announcement creating transdisciplinary patient safety learning laboratories using systems engineering models. This announcement is well-aligned with the proposed program of research and may be a source of future funding.

Contribution of Research

This research has taken a unique approach to the problem of maternal morbidity and mortality. We found that the current approaches addressing obstetric failure to rescue focus heavily on individual clinicians and teamwork, while insufficient resources have been applied to environmental issues and problems associated with tools and technology. This observational research has laid groundwork for future SEIPS-based interventions to improve outcomes for employees, patients, and institutions.

This research has broadly applied the nursing process to nursing itself. Assessment always comes before plan. While this assessment has limitations, it can be used as a model for labor and delivery units to think critically about their own strengths and weaknesses and devise appropriate plans for improving their local work systems.

References

1. Enhancing Reviews and Surveillance to Eliminate Maternal Mortality (ERASE MM) | CDC [Internet]. 2020 [cited 2021 Jan 18]. Available from: https://www.cdc.gov/reproductivehealth/maternal-mortality/erase-mm/index.html

2. Making Healthcare Safer III [Internet]. AHRQ. [cited 2021 Sep 12]. Available from: http://www.ahrq.gov/research/findings/making-healthcare-safer/mhs3/index.html

3. Johnson C, Handberg E, Dobalian A, Gurol N, Pearson V. Improving perinatal and neonatal patient safety: the AHRQ patient safety indicators. J Perinat Neonatal Nurs. 2005 Jan;19(1):15–23.

4. Pettker CM, Grobman WA. Obstetric Safety and Quality. Obstet Gynecol. 2015 Jul;126(1):196–206.

5. Polit DF, Beck CT. Nursing Research: Generating and Assessing Evidence for Nursing Practice. Wolters Kluwer; 2017.

6. Creswell JW, Plano Clark V. Designing and conducting mixed methods research. 3rd ed. Los Angeles: SAGE Publications; 2018.

7. Fetters MD, Curry LA, Creswell JW. Achieving integration in mixed methods designs—Principles and practices. Health Serv Res. 2013 Dec;48(6 Pt 2):2134–56.

Appendix A. IRB approvals

Institutional Review Board for Human Research (IRB)
Office of Research Integrity (ORI)
Medical University of South Carolina

1 South Park Circle, Bldg. 1, Suite 401
Charleston, SC. 29407
Tel 843 792 4148
Fax 843-792-7457
Federal Wide Assurance # 1888

APPROVAL:
This is to certify that the research proposal **Pro00110071** entitled:
Using the SEIPS Framework to Understand Systems-Level Factors Affecting Obstetric Nurse Decision Making: A Convergent Parallel Mixed Methods Study

submitted by: **Samantha Bernstein**
Department: **Medical University of South Carolina**

for consideration has been reviewed by **IRB-I - Medical University of South Carolina** and approved. In accordance with 45 CFR 46.104(d), the referenced study is exempt from Human Research Subject Regulations. No further action or Institutional Review Board (IRB) oversight is required, as long as the project remains the same. However, you must inform this office of any changes in procedures involving human subjects. Changes to the current research protocol could result in a reclassification of the study and further review by the IRB.

Approval Date: **5/7/2021**
Approval Expiration: **5/6/2026**

Type: **Exempt**

Administrator, **IRB-I - Medical University of South Carolina**
Kristin Zaks∗

***∗Electronic Signature**: This document has been electronically signed by the IRB Chairman through the HSSC eIRB Submission System authorizing IRB approval for this study as described in this letter.*

Mass General Brigham IRB
Mass General Brigham
399 Revolution Drive, Suite 710
Somerville, MA 02145
Tel: 857-282-1900
Fax: 857-282-5693

Notification of IRB Review

Protocol #: 2021P001679

Date:	July 13, 2021
To:	West, Elizabeth MGH Mass General Brigham > MGH > OB/GYN Service
From:	Mass General Brigham IRB 399 Revolution Drive, Suite 710 Somerville, MA 02145
Title of Protocol:	Using the SEIPS Framework to Understand Systems-Level Factors Affecting Obstetric Nurse Decision Making: A Convergent Parallel Mixed Methods Study
Version/Number:	
Version Date:	
IRB Review Type:	Expedited
IRB Approval Date:	07/09/2021
Approval/Activation Date:	07/13/2021
Next Review:	Exempt Check In
IRB Expiration Date:	**07/09/2024**
IRB Review Action:	Exempt

The IRB has determined that this project meets the criteria for exemption 45 CFR 46.104(d)(#).

EXEMPTION (2) Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least ONE of the following criteria is met:

(ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or

(iii) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by §46.111(a)(7).

The following documents were reviewed and approved by the IRB:

Official Version Generated from the Mass General Brigham Human Research System
07/13/2021 09:24

Mass General Brigham IRB
Mass General Brigham
399 Revolution Drive, Suite 710
Somerville, MA 02145
Tel: 857-282-1900
Fax: 857-282-5693

Protocol Summary (version dated July 6, 2021)
Recruitment Email
Consent Fact/Information Sheet
Flyer
Questionnaires (3)

ANCILLARY COMMITTEES

1. **MCA (MGB) : Review not needed**
2. **Nursing (MGH) : Approved**

As Principal Investigator, you are responsible for the following:

1. Ensuring that this project is conducted in compliance with this determination.
2. Ensuring that all study staff have completed the required human research education requirements through the Collaborative Institutional Training Initiative (CITI).
3. Submission of significant proposed changes to this project to ensure that the project continues to meet the criteria for exemption.
4. Submission of Exempt Check-In every 3 years as required by institutional policy.

Questions related to this project may be directed to **Sheila Speller | Tel: 857-282-1913 | Email: SSPELLER@PARTNERS.ORG**

cc:

Elizabeth West, Principal Investigator, OB/GYN Service

Samantha Bernstein, MSN, RN, Co-Investigator, Mass General Brigham

Appendix B. Recruitment Materials

Dear MGH nurse, midwife, or physician,

I am writing to introduce myself and the research project that I'll be doing on Blake 14. I am an obstetric nurse and PhD candidate in nursing and I'm studying the systems level factors that affect nurse decision-making when we care for women in labor. I am a student at Medical University of South Carolina and I have received a small grant from the College of Nursing to support this research. Beth West, RN, CNS will be helping me with this project and has indicated that you may be eligible to participate.

You are being asked to participate in this research because you have at least 3 months of experience on Blake 14. Your participation is voluntary and includes only those who choose to take part. Participation or discontinuance will not constitute an element of you job performance or evaluation, and it will not be a part of your personnel record at MGH. We hope to include 56 nurses in this research and about 10 physicians and midwives (combined).

I will be observing on Blake 14 and interviewing nurses, midwives, and physicians. Interviews will be done on Microsoft Teams, take about 30-60 minutes, and participants will receive a $20 Amazon gift card to thank them. I will be asking questions about times when things have gone well and when they have not gone well when caring for women in labor. The information you share is confidential. These interviews will be recorded, auto-transcribed, and stored securely on a secure institutional network.

I also have a survey for nurses to complete at the end of their shift. It will take about 15 minutes and nurses will receive a $5 Starbucks gift card to thank them for their help.

The risks of participation include discomfort with questions and a loss of confidentiality. You can withdraw from the research at any time for any reason and every effort will be made to maintain confidentiality. Your de-identified information may be shared with other researchers without your additional informed consent.

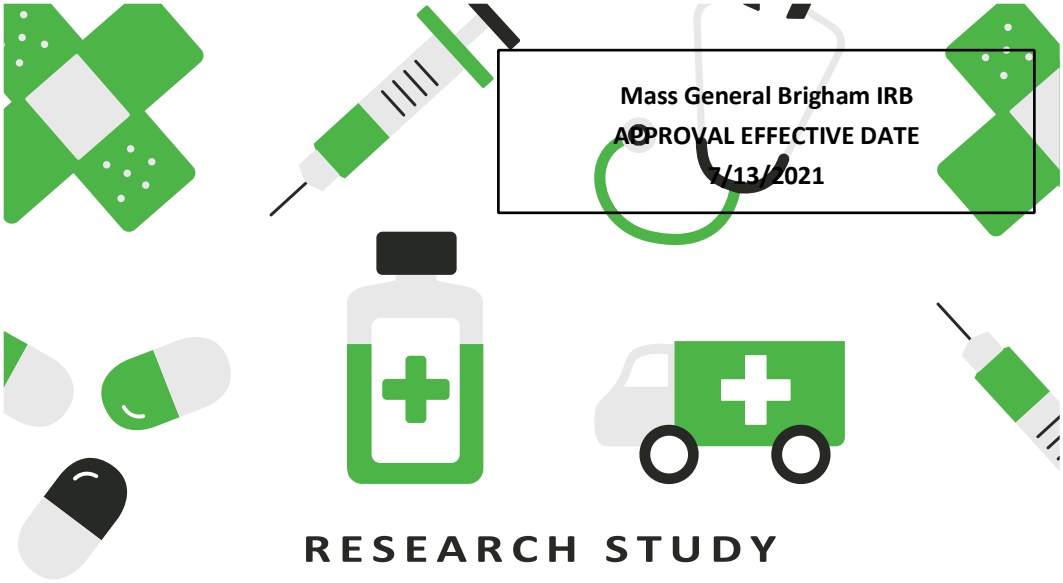
I'm looking forward to getting to know you and your unit. If you have any questions about this project, you can reach me on my cell phone (603)831-1386, or via email: sbernstein@mghihp.edu.

IRB Contact information: If you'd like to speak to someone not involved in this research about your rights as a research subject, or any concerns or complaints you may have about the research, contact the Mass General Brigham IRB at (857) 282-1900.

Thanks,

Samantha Bernstein, MSN, RN

To enroll in this research, you can use scan the QR code below, or use this link: https://redcap.musc.edu/surveys/?s=JMJT7DM7XW



Mass General Brigham IRB
APPROVAL EFFECTIVE DATE
7/13/2021

RESEARCH STUDY

HAVE YOU WORKED ON BLAKE 14 FOR 3 MONTHS?

We're studying the work system.
Have 15 minutes?
Fill out a survey.
Want to talk?
Let's do an interview.

We need RNs for surveys/interviews,
CNMs and physicians for interviews.

For more information, contact
Samantha Bernstein, RN
(603)831-1386
slerman@bics.bwh.harvard.edu

A research study at the Medical University of South Carolina.

Appendix C. Instruments –

Performance Obstacles for Nurses

You are being asked to participate in this research because you have at least 3 months of experience on Blake 14. Your participation is voluntary and includes only those who choose to take part. Participation or discontinuance will not constitute an element of your job performance or evaluation, and it will not be a part of your personnel record at MGH.

This research will help us to understand the work system on Blake 14 so that there can be future improvements.

The risks of participation include discomfort with questions and a loss of confidentiality. You can withdraw from the research at any time for any reason and every effort will be made to maintain confidentiality.

I'm looking forward to getting to know you and your unit. If you have any questions about this project, you can reach me on my cell phone (603)831-1386, or via email: slerman@bics.bwh.harvard.edu.

Thanks,

Samantha Bernstein, MSN, RN

I have worked on Blake 14 for at least 3 months.	◯ Yes ◯ No
I certify that I am at least 18 years old and that I give my consent freely to participant in this study.	◯ I consent ◯ I do not consent

As a participant in this study, please provide a response to each questions below.	
What ethnicity do you primarily identify with?	◯ Hispanic or Latinx ◯ NOT Hispanic or Latinx ◯ Unknown ◯ Prefer not to answer
What race do you primarily identify with?	◯ American Indian/Alaska Native ◯ Asian ◯ Native Hawaiian or Other Pacific Islander ◯ Black or African American ◯ White ◯ More Than One Race ◯ Unknown ◯ Prefer not to answer ◯ Please specify _____ (type your response)
If other race, please tell us	_____
What gender do you primarily identify with?	◯ Female ◯ Male ◯ Non-binary ◯ Other _____ (please type your response) ◯ Prefer not to answer
If other, please tell us	_____
What is your professional role?	◯ Registered Nurse ◯ Physician ◯ Certified Nurse Midwife
Would you like to participate in the survey, an interview, or both?	◯ Survey ◯ Interview ◯ Both
Please provide your contact details below, where you can be reached by a study team member to set up an interview.	
First Name	_____
Last Name	_____
Email Address	_____

I appreciate your taking the time to complete this survey. It will take you about 15 minutes to complete. This information will help us understand what it's like to work on Blake 14.

Your participation is voluntary and your responses will be kept confidential. All reports about this survey will include only data from groups of nurses, so no one will know how you answered any question. This study poses no physical, social, or legal risks. You may stop the survey at any time and for any reason.

Participation or discontinuance will not constitue an element of your job performance or evaluation, and it will not be a part of your personnel record at MGH.

If you have any additional questions or comments, feel free to call or email the Primary Investigator, Samantha Bernstein, RN at (603)831-1386 or slerman@bics.bwh.harvard.edu

Please answer the following questions considering only your shift today.

I had difficulty finding a computer to work on in the unit.	◯ Yes ◯ No
My patients' rooms were close to each other.	◯ Yes ◯ No ◯ No applicable
I had to use equipment that was in poor condition.	◯ Yes ◯ No
I spent a lot of time looking for equipment because it wasn't located where it was supposed to be.	◯ Yes ◯ No
I had to wait to use a piece of equipment because someone else was using it.	◯ Yes ◯ No
I spent a lot of time looking for supplies in the central stock area.	◯ Yes ◯ No
There was a delay in getting medications for my patient from the pharmacy.	◯ Yes ◯ No
The isolation rooms that I worked in were well-stocked.	◯ Yes ◯ No ◯ Not applicable
The non-isolation rooms I worked in were well-stocked.	◯ Yes ◯ No ◯ Not applicable
I got adequate information from physicians/midwives about my patient(s).	◯ Yes ◯ No ◯ Not applicable
The change of shift report(s) took longer than they should There was a delay before I saw new orders for my patient(s).	◯ Yes ◯ No ◯ Yes ◯ No

I was responsible for orienting a nurse.	◯ Yes ◯ No
The central stock area was well-stocked.	◯ Yes ◯ No
The patient-related information given to me by the previous shifts' nurses during shift change was sufficient.	◯ Yes ◯ No
The patient-related information given to me by the previous shifts nurse(s) during shift change was unnecessarily detailed.	◯ Yes ◯ No
I had distractions from patients' family members	◯ Yes ◯ No
I spent a lot of time dealing with family needs.	◯ Yes ◯ No
I received a lot of phone calls from family members.	◯ Yes ◯ No
I spent a considerable amount of time teaching my patient or their family members.	◯ Yes ◯ No

The next three questions are about nursing assistants. If there were no nursing assistants on the unit today, please skip these questions.

The help I received from nursing assistants was...	timely	late
	(Place a mark on the scale above)	
The help I received from nursing assistants was...	adequate	inadequate
	(Place a mark on the scale above)	
The help I received from nursing assistants was...	useful	useless
	(Place a mark on the scale above)	

The next three questions are about help from other nurses today. If you didn't need any help from other nurses today, please skip these questions.

The help I received from other nurses today was...	timely	late
	(Place a mark on the scale above)	
The help I received from other nurses today was...	adequate	inadequate
	(Place a mark on the scale above)	
The help I received from other nurses today was...	useful	useless
	(Place a mark on the scale above)	

The next three questions are about unit clerks. If there were no unit clerks during your shift today, please skip these questions.

The help I received from unit clerks today was...	timely	late
	(Place a mark on the scale above)	
The help I received from unit clerks today was...	adequate	inadequate
	(Place a mark on the scale above)	
The help I received from unit clerks today was...	useful	useless
	(Place a mark on the scale above)	
During my shift today, my workplace was...	Noisy	Quiet
	(Place a mark on the scale above)	
During my shift today, my workplace was...	Crowded	Roomy
	(Place a mark on the scale above)	
During my shift today, my workplace was...	Hectic	Calm
	(Place a mark on the scale above)	
During my shift today, my workplace was...	Organized	Disorganized
	(Place a mark on the scale above)	
When I came in for my shift today, I found the patient room assigned to me...	Organized	Disorganized
	(Place a mark on the scale above)	

How many nursing assistants were in the unit during today's shift?	○ 0 ○ 1 ○ 2 ○ 3 ○ 4+
How many patients were assigned to you today at the beginning of the shift?	○ 1 ○ 2 ○ 3 ○ 4+
How many patients did you admit?	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7+
How many of your patients were transferred out of the unit?	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7+
How many of your patients were isolation/precautions patients?	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7+

--- ABOUT YOU ---	
What is the highest level of education that you have completed?	○ ADN ○ BSN ○ MSN ○ DNP ○ PhD
Which of the following describes your current job position?	○ Staff Nurse ○ Float Nurse ○ Traveler/Agency Nurse
How long have you been working at Mass General? (Please round to the nearest whole year)	○ < 1yrs ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 ○ 11 ○ 12 ○ 13 ○ 14 ○ 15 ○ 16 ○ 17 ○ 18 ○ 19 ○ 20 ○ 21 ○ 22 ○ 23 ○ 24 ○ 25 ○ 26 ○ 27 ○ 28 ○ 29 ○ 30 ○ 31 ○ 32 ○ 33 ○ 34 ○ 35 ○ 36 ○ 37 ○ 38 ○ 39 ○ 40
How long have you been a Registered Nurse? (Please round to the nearest whole year)	○ < 1yrs ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 ○ 11 ○ 12 ○ 13 ○ 14 ○ 15 ○ 16 ○ 17 ○ 18 ○ 19 ○ 20 ○ 21 ○ 22 ○ 23 ○ 24 ○ 25 ○ 26 ○ 27 ○ 28 ○ 29 ○ 30 ○ 31 ○ 32 ○ 33 ○ 34 ○ 35 ○ 36 ○ 37 ○ 38 ○ 39 ○ 40

How many hours did you work during the last seven days including today's shift?

< 1	◯ 1	◯ 2	◯ 3
4	◯ 5	◯ 6	◯ 7
8	◯ 9	◯ 10	◯ 11
12	◯ 13	◯ 14	◯ 15
16	◯ 17	◯ 18	◯ 19
20	◯ 21	◯ 22	◯ 23
◯ 24	◯ 25	◯ 26	◯ 27
◯ 28	◯ 29	◯ 30	◯ 31
◯ 32	◯ 33	◯ 34	◯ 35
◯ 36	◯ 37	◯ 38	◯ 39
◯ 40	◯ 41	◯ 42	◯ 43
◯ 44	◯ 45	◯ 46	◯ 47
◯ 48	◯ 49	◯ 50	◯ 51
◯ 52	◯ 53	◯ 54	◯ 55
◯ 56	◯ 57	◯ 58	◯ 59
◯ 60	◯ 61	◯ 62	◯ 63
◯ 64	◯ 65	◯ 66	◯ 67
◯ 68	◯ 69	◯ 70	◯ 71
◯ 72	◯ 73	◯ 74	◯ 75
◯ 76	◯ 77	◯ 78	◯ 79
◯ 80	◯ 81	◯ 82	◯ 83
◯ 84	◯ 85	◯ 86	87
◯ 88	◯ 89	◯ 90	91
◯	◯	◯	
◯	◯	◯	

92	93	94	95
96	97	98	99
100	101	102	
103	104	105	
106	107	108	
109	110	111	
112	113	114	
115	116	117	
118	119	120	
121	122	123	
124	125	126	
127	128	129	
130	131	132	
133	134	135	
136	137	138	
139	140	141	
142	143	144	
145	146	147	
148	149	150	
151	152	153	
154	155	156	
157	158	159	
160	161	162	
163	164	165	
166	167	168	

How many hours did you work during the last 24 hours?

< 1hr ◯ 1 ◯ 2 ◯ 3
4 ◯ 5 ◯ 6 ◯ 7
8 ◯ 9 ◯ 10 ◯ 11
12 ◯ 13 ◯ 14 ◯ 15
16 ◯ 17 ◯ 18 ◯ 19
20 ◯ 21 ◯ 22 ◯ 23
24

What shift did you work today?

◯ 7A-7P
◯ 7P-7A
◯ 7A-3P
◯ 3P-11P
◯ 11 P-7A
◯ other, please specify _____

Please describe the shift you worked today

_____

--- CONTACT INFORMATION ---

Thank you for completing this survey.

Please provide your name and email address below, where you will be sent a $5.00 gift card to Coffee Central to thank you for your participation.

First name

_____

Last name

_____

Email

_____

Appendix D. Permission for previously published manuscripts

Permission to use scoping review (JOGGN)

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