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Impact of a Modified Early Warning Score Tool on Nurses' Ability to Recognize and Respond to Clinical Deterioration

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Abstract

Timely recognition of signs of impending clinical deterioration in acute care hospitalized patients can prevent an unexpected illness from becoming a fatal event. Failure to recognize the precursors of impending doom can have many factors, but the most influential of these is the role of the bedside nurse in detecting the subtle signs of decline. The Modified Early Warning Score (MEWS) has been used successfully to detect clinical deterioration in hospitalized patients, while simulation has been used successfully to provide an environment to test reaction to acute patient decline without harm to actual patients. A translational research project implemented the MEWS tool through an educational intervention that included simulated patient experiences. The aims of this project were to 1) increase awareness of bedside nurses to acute patient deterioration in the rural hospital setting and 2) increase action of bedside nurses to acute patient deterioration in the rural hospital setting. Results indicate that use of the MEWS increases nurses' use of other deterioration screening tools as well as their knowledge and confidence in responding to a deterioration event. The usefulness of simulation as a method to provide education in post-licensure nurses is also discussed. Finally, the MEWS tool was shown to accurately predict patient deterioration of hospitalized clients if completed consistently. Future research should focus on how to increase usage of deterioration tools to detect acute clinical decline earlier in the deterioration process.

Keywords: clinical deterioration, modified early warning system (MEWS), nursing, simulation

Impact of a Modified Early Warning Score Tool on Nurses' Ability to Recognize and Respond to Clinical Deterioration

Providing adequate care for hospitalized patients requires staff trained in monitoring and promptly responding to acute deterioration (NICE, 2007). For an acute care nurse, this charge requires nursing judgment along with objective and subjective signs of decline. Implementation of rapid response teams (RRT) and medical emergency teams (MET), as proposed by the Institute for Healthcare Improvement (IHI) *100,000 Lives Campaign,* were meant to help decrease the preventable death rate in United States Hospitals from the initial figure of 98,000 people yearly (IHI, 2004). This strategy is partially responsible for the 8% decline in inpatient hospital deaths in the United States reported by the Centers for Disease Control (CDC) over the 10-year period from 2000-2010 (Hall, Levant, & DeFrances, 2013). Still, this same period saw over 700,000 hospitalized patient deaths and a septicemia death rate that increased by 17% (Hall et al., 2013). Clearly, these teams are not enough. One potential reason is that clinical deterioration must first be recognized by hospital staff before these teams can be activated; and this recognition and activation are not consistently occurring (NICE, 2007). A large study in the United Kingdom found that more than half of patients who experienced a severe adverse event (SAE) during their hospitalization showed measurable physiological signs of their decline prior to their event (Kause et al., 2004). In addition, although that remote study indicated that up to 42% of patients had documented delays in recognition of acute deterioration (NCEPOD, 2005), a more recent study in the United States has suggested that nearly 65% of patients who qualified for transfer to the intensive care setting had a delay in the escalation of their care of greater than four hours from the time the transfer criteria was met (Sankey, McAvay, Siner, Barsky, & Chaudhry, 2016). In the earlier study, this delay in recognition was markedly more common in

patients who were past their date of admission as 66% of those patients had delays of up to 12 hours compared to only 6% of those in their first hospital day having documented delays of this length of time. This delay in all cases was further indicated to cause a greater than 50% increase in the incidence of in-hospital mortality in the later study (Sankey et al., 2016). It is clear that another strategy must be used to further decrease the potential for hospitalized patients to have undetected clinical deterioration in the United States.

Problem Statement

Respiratory failure is the number one cause of death for inpatients in the United States followed very closely by septicemia and pneumonitis (Hall et al., 2013). Nearly 17 out of every 100 patients hospitalized for respiratory failure will die during their hospital stay, while 16.3 of those admitted with sepsis and 13.6 of those admitted with pneumonitis are expected to have the same fate (Hall et al., 2013), indicating that recognition of clinical deterioration is imperative. This study was designed to assist the nurses at a rural hospital located in the Southeastern United States to detect and respond to the deterioration of these patients before it was too late.

Aggregated data from the study facility revealed that approximately 8% of patients admitted in Fiscal Year 2017-2018 had the primary diagnosis of sepsis while pneumonia comprised 3% of the primary and 5.5% of the secondary diagnoses in the adult inpatient population (NHB, 2018). Chest pain, acute kidney failure, acute respiratory failure, and chronic obstructive pulmonary disease (COPD) together comprised an additional 14.9% of the primary diagnosis makeup of the facility. However, the top diagnosis of those who experienced cardiopulmonary arrest during hospitalization remained sepsis (NHB, n.d.).

Poverty and poor overall health could also be factors in the rates of deterioration in the surrounding community. When examining the demographic composition of the study facility's

county, the median household income was less than $35,000 (United States Census Bureau, 2017). Furthermore, surveys completed by the Robert Wood Johnson Foundation reported that the county ranked 109th of the 159 counties in the state, and nearly a quarter of the residents rated their overall health as *poor* or *fair* (RWJF, 2018). The study facility also provides care to the estimated 90,000 residents of the seven surrounding counties that do not have tertiary care facilities within their own borders (Navicent Health, n.d.).

Purpose

This study was designed to evaluate impact of the Modified Early Warning Score (MEWS) tool on the ability of bedside nurses to both recognize and react to clinical deterioration in the inpatient population prior to the severe adverse events that are more likely to occur if those symptoms are not acted on in a timely manner. A recent study by the Institute for Healthcare Improvement indicated that early warning scoring systems (EWSS) such as the MEWS are a necessary addition to the process of early intervention to treat clinical deterioration (IHI, n.d.). Earlier intervention can increase the effectiveness of the rapid response teams that are already in place in many international areas (IHI, n.d.). However, EWSS are not yet commonly used in the United States though they are well researched elsewhere in the world (IHI, n.d.). The lack of research into this population helped to guide the choice of intervention. Most previous research into use of the MEWS to detect clinical deterioration has been conducted in urban facilities outside of the United States. The intent of this project was to improve both detection and documentation of actions taken by nursing staff to avoid clinical deterioration in the inpatient population through a simulation-based educational intervention. Evaluation of the effectiveness of the simulation-based educational intervention took place over a three-month period. This

evaluation was completed through both simulation and retrospective chart review. The study addressed the following specific aims and clinical questions:

Specific Aims:

1. To determine the impact of a simulation-based educational intervention on nurses' knowledge of the signs of pending clinical deterioration.
2. To determine the effect of the MEWS tool on nurses' self-confidence in recognizing and responding to clinical deterioration.
3. To determine the effect of the MEWS tool on nurse recognition of and response to clinical deterioration in simulation.
4. To determine the effect of the MEWS tool on nurse recognition of and response to clinical deterioration in practice.
5. To determine the impact of a simulation-based educational intervention on nurses' use of deterioration screening tools.

Clinical Questions:

1. How does a simulation-based educational intervention impact nurses' knowledge about signs of pending clinical deterioration?
2. What effect will a simulation-based educational intervention have on nurses' self-confidence in recognition of and response to clinical deterioration?
3. What effect will the use of the MEWS tool have on nurse recognition of and response to clinical deterioration in simulation?
4. What effect will the use of the MEWS tool have on nurse recognition of and response to clinical deterioration in practice?

5. How does a simulation-based intervention influence nurses' use of deterioration screening tools in practice (MEWS for all causes and existing sepsis screening tool for sepsis)?

Needs Assessment

This study was intended to address the issue of early detection and prevention of clinical deterioration in the inpatient population. Simulation has been used often to facilitate this process in nursing students, but recent studies have shown usefulness with this technique for the post licensure nurse population (Bliss & Aitken, 2018; Crowe, Ewart, & Derman, 2018; Elder, 2017, & Schubert, 2012). Similarly, Early Warning Scoring Systems (EWSS) and other Clinical Decision Support Systems (CDSS) have been proven to be useful to support the decision-making process, particularly in nurses who lack a strong clinical background in caring for critically ill patients (Albert & Huesman, 2011; Bunkenborg, Poulsen, Samuelson, Ladelund, & Akeson, 2016; Burns et al., 2018; Dalton, Harrison, Malin, & Leavey, 2018; De Meester et al., 2013; Gagne, 2018; Ludikhuize, de Jonge, & Goossens, 2011; Ludikhuize, Smorenburg, de Rooij, & de Jonge, 2012; Maupin, Roth, & Krapes, 2009; Stafseth, Grønbeck, Lien, Randen, & Lerdal, 2016; Subbe, Kruger, Futherford, & Gemmel, 2001; & Zografakis et al., 2018). However, none of the aforementioned studies were completed on nurses working in a rural hospital in the southeastern United States, which therefore created a need for this study.

The location choice for the proposed study was based largely on the relationship between the study site and the academic institution associated with the primary researcher. The academic institution has a translational research center located within the host facility that is equipped with high fidelity simulation mannequins and a video recording system to allow for a comprehensive debriefing experience. Although the study site had a rate of severe adverse events within

national standards, hospital stakeholders identified severe adverse events as an area needing improvement among their nursing staff. Both internal and external factors were identified that could have affected this process. Potential causes for the issue included the lack of a standardized orientation process to acclimate newly hired nurses to their home units, the previous education given to the current staff once telemetry was added to their unit, and the instability and skill mix of the current staff on the primary inpatient unit of the facility.

The orientation process of new nurses to the facility was mentioned by the focused interview participants during the needs assessment process as a contributor to the potential for nurses on the main study unit to fail to recognize decline in the patient population in a timely manner. It was mentioned that the orientation process for the facility was not standardized and had changed with the purchase of the hospital by a parent company in late 2017. During this process the education department at the facility was disbanded, leaving staff without a local educator. Since the time of the initial needs assessment, the parent company has also undergone a merger with a larger company and has since hired facility-based educators. However, the orientation process is still under revision. Some newly hired employees are given the option to complete a critical care academy training offered by the parent company if working in an area that requires such training, but existing employees have not yet been offered the same opportunity and some new employees in emergency care areas have also not yet attended.

Facilities management stated that the primary inpatient medical unit of the facility previously did not have the capability to admit patients on telemetry or continuous oxygen level monitoring. Patients requiring this service after admission to the unit during that period were transferred to an Intermediate Care Unit that was equipped with bedside monitors and staff trained to monitor their status more closely. Many of these trained staff were lost through the

process of unit consolidation over the past decade, thereby leaving a core base of nurses on the primary medical-surgical/telemetry unit who were not familiar with specialized monitoring. Those who remained received an abbreviated course on cardiac monitoring, but no additional training was provided for caring for patients with advanced interventions such as Bilevel Positive Airway Pressure (BiPAP) or High Flow nasal oxygen who are known to be more likely to deteriorate.

The nursing staff of the study facility was comprised of a large proportion of both Licensed Practical Nurses (LPNs) and contract agency nurses of all nursing levels during the time of the needs assessment. The continued use of agency nurses who may not be familiar with all of the resources and policies available at the facility was a cause for concern but was unavoidable due to lack of permanent staff. Although interviews were ongoing to attract more permanent staff, hospital operations could not be maintained without using both of these staffing options. Finally, the sheer number of available staff members was mentioned by some mid-level managers at the facility as potential causes for past unrecognized decline in patient condition. When staff numbers (both nursing and ancillary) were not adequate to meet the patients' acuity needs, they surmised that severe adverse events were more likely to occur. Since the time of the initial needs assessment, the staffing has attempted to be addressed by the unit nurse managers and the organization through increased interviews and hiring of staff, but this is an ongoing process.

Due to inconsistencies in the educational process described above and the desire to ensure sustainability beyond the time span of the translational research product, a tool that could be imbedded into the nursing process within the electronic worklist was determined to be more beneficial than a one-time educational intervention. Strength, Weaknesses, Opportunities, and

Threats (S.W.O.T.) and Technologic, Economic, Legal, Organizational, and Structural (T.E.L.O.S.) analyses supported the proposed translational project as a viable option to mitigate the above concerns.

Background

Many reasons for undetected clinical deterioration in hospitalized patients have been discovered in the literature. These reasons include unrecognized decline in vital signs, need for a system to provide an organized process for clinical decision making, and speed of detection and reaction to decline (NICE, 2007). Usually, a combination of one or more of these issues is the reason for the unrecognized or untreated deterioration in this population (NICE, 2007).

Unrecognized Decline in Vital Signs

Decline in vital signs and mental status are the most common physiological markers of clinical deterioration in the acute care setting (NICE, 2007; NCEPOD, 2005). However, the use of vital signs as a sole method to detect clinical deterioration has been controversial in the literature. Although abnormalities in baseline vital signs have been identified to be a primary factor in recognition of clinical decline in the studies reviewed, this phenomenon is also one that is not consistently documented. Despite monitoring vital signs more frequently being shown to increase detection of decline, this task is not consistently completed by the bedside nurse. Increasing vitals frequency to every two hours was shown in one study to cut the risk of failure to recognize and respond to acute inpatient deterioration in half (Shever, 2011). However, some studies have indicated that when nurses are occupied with many tasks, obtaining vital signs seems to be pushed to a lower priority level (Petersen, Rasmussen, & Rydahl-Hansen, 2017 & van Galen et al., 2016). Delegating this task has the potential to lead to missed opportunity if values are not correctly recorded. One study reported that analysis of the elevated respiratory

rates found in more than half of patients experiencing a deterioration event had incorrect assessment of this parameter recorded by clinical assistants (Duncan, McMullan, & Mills, 2012). Failure to monitor vital signs has also been identified as a primary cause for unplanned ICU transfer in one study (van Galen et al., 2016). In another study, nurses reported that they neglected vital signs when they were busy with other tasks (Petersen et al., 2017).

There is also a documented lack of understanding of the importance of individual vital signs as an indicator of pending crisis. In one study, nurses were found to not call for help when the only abnormal vital sign was the respiratory rate (Adelstein, Piza, Nayyar, Mudaliar, & Rubin, 2011). However, respiratory decline was the most common cause of contacting the Rapid Response Team (RRT) or transferring the patient to the Intensive Care Unit in several other studies (Duncan et al., 2012; Jonsson, Jonsdottir, Möller, & Baldursdottir, 2011; Katadzic & Jelsness-Jørgensen, 2017; Plate et al., 2018). Hypotension was found to be the main causative factor detected in some studies (Iddrisu, Hutchinson, Sungkar, & Considine, 2018; Sankey et al., 2016), while heart rate increase accounted for over 20% of the reasons for transfer to ICU in the Sankey and colleagues (2016) study. Overall, the use of vital signs as the sole indicator of clinical deterioration is controversial at best. This dispute leads to the need for additional means to detect decline in the inpatient population.

Need for System to Provide Organized Process for Clinical Decision Making

Some nurses have expressed a desire to have a set framework to aid in their decision-making process (Dalton et al., 2018). However, the use of Clinical Decision Support Systems (CDSS) have likewise been controversial in literature (Adelstein et al., 2011; Dalton et al., 2018, Massey, Chaboyer, & Aitken, 2014; vanGalen et al., 2016). Although proven in many studies to be helpful to give hospital staff a tool to help detect decline, it is important to not allow the

CDSS to overtake the nursing judgment process. One identified concern with using a scoring tool exclusively to define clinical deterioration is that nurses are often reluctant to contact the rapid response or medical emergency team if the CDSS scores are lower than set triggers or if the patient has chronically abnormal vital signs because they may fear being ridiculed or ignored by the medical staff or emergency teams (Adelstein et al., 2011; Cherry & Jones, 2015; Dalton et al., 2018; Duncan et al., 2012; Greaves J., Greaves D., Gallagher, Steven, & Pearson, 2016; Iddrisu et al., 2018; Massey et al., 2014; & Stewart, Carman, Spegman, & Sabol, 2014). The opposite may also be true. In a recent qualitative study, nurses expressed concerns about their willingness to escalate care if the CDSS did not indicate that the patient was acutely worsening (Dalton et al., 2018). Less drastic actions such as contacting a more experienced nurse were mentioned as alternatives used when scores did not indicate a need for provider consult (Massey et al., 2014). Finally, some nurses included in the review studies felt that they recognized the signs of decline well enough without the need for a CDSS (Iddrisu et al., 2018).

Speed of Detection and Reaction to Decline

Many times, even when deterioration is identified, this recognition is far later than when symptoms first occurred. Studies have found retrospective evidence of signs of decline from 30 minutes to 16 hours prior to severe adverse events (Adelstein et al., 2011; Albert & Huesman, 2011; Maupin et al., 2009; Sankey et al., 2016; Zografakis et al., 2018). Early recognition of the signs of deterioration can decrease the incidence of severe adverse events such as cardiopulmonary arrest as well as improve overall survivability (IHI, n.d.). The number of patients who were found to have a documented delay in recognition and treatment in the studies reviewed ranged from 26-64.6%. (Adelstein et al., 2011; Sankey et al., 2016). Lack of patient interaction can also affect the speed of detection of crisis. One study reviewed discovered that

patients and families reported not feeling comfortable escalating their own care although they did report feeling that an escalation initiated by nursing staff was acceptable (Guinane, Hutchinson, & Bucknall, 2018). There was also an assumption that recognizing deterioration is the responsibility of the healthcare team instead of the patients themselves (Guinane et al., 2018).

Early detection is not the only issue, however. Even when the documentation of abnormal vitals was accurately completed in one study, there was a lack of documentation as to what response was enacted to correct the issue (Niegsch, Fabritius, & Anhøj, 2013). In addition, when documentation showed that an escalation of care was needed, less than 40% were then followed through (Niegsch et al., 2013). Part of this phenomena could be due to the perceived interprofessional difficulties explained above but also could be due to the inability to alter a CDSS to reflect an abnormal baseline (Stewart et al., 2014) or to consider alternative criteria such as skin color or presence of diaphoresis (Petersen et al., 2017).

Developing a system that can address unrecognized decline in vital signs and mental status, improve speed of detection and reaction to deterioration, and provide an organized decision-making process that can be objectively measured may be an ideal solution to implement in a facility with less resources to manage a crisis. The use of a system that incorporates measurable physiological parameters to activate a response is a major recommendation of the recently written guideline used by the National Healthcare System (NICE, 2007) and use of simulation to both teach and evaluate nurses' ability to react and respond to those alerts has similarly been a frequent topic in nursing education (Bliss & Aitken, 2018; Crowe et al., 2018; Elder, 2017; & Schubert, 2012). For this reason, the CDSS of the Modified Early Warning Score as taught through a simulated patient experience was chosen as the preferred intervention in the current study.

Review of Literature

Review of synthesized literature concerning early detection and prevention of clinical deterioration pointed to several strategies to alleviate this issue in the acute care setting. The *Acutely ill patients in hospital: Recognition of and response to acute illness in adults in hospital* clinical practice guideline indicated that use of physiological track and trigger systems to support clinical decision making along with education and training of staff to ensure ability to recognize and respond to acute deterioration are key aspects of this process (NICE, 2007). Similarly, the National League of Nursing (n.d.) reported that simulation is rapidly developing into a preferred teaching strategy in both nursing education and staff development. When investigating clinical decision support systems, education of nursing staff, and simulation, it was noted that most of the articles use a combination of two or all of these.

The National Institute for Health and Clinical Excellence guideline (2007) was used to provide a basis for development of a facility specific protocol for identification and management of acutely ill patients experiencing a deterioration event. This guideline has been reviewed every three years since inception to ensure continued clinical relevance with the most current review occurring in 2019 (NICE, 2019). The use of risk scoring tools or track and trigger systems, response strategies for patients identified as experiencing a deterioration event and the transfer process of patients from critical areas are all covered within the guideline, but the literature review focused on the use of the Modified Early Warning Score and strategies for implementation of this tool. This tool was chosen as it meets all of the specifications listed in recommendation 1.2.2.2 of the guideline by using heart rate, respiratory rate, systolic blood pressure, level of consciousness, oxygen saturation and temperature to both monitor and alert caregivers to changes in patient condition (NICE, 2007).

Search Strategy

A literature search was conducted from August 2018 to October 2018 regarding the use of Early Warning Scoring Systems (EWSS), simulation, and education to detect and respond to clinical deterioration using the CINAHL Complete, MEDLINE, ProQuest Central, and Science Direct databases. These databases were chosen due to a general focus on nursing and nursing research. A graduate librarian was consulted to assist with defining search terms and strategies. Terms used during the search for relevant literature included: “clinical deterioration” OR “clinical deteriorat*” OR “failure to rescue” AND “nursing” OR “nur*”. The combination of “nurs*” AND “modified early warning system” OR “MEWS” was also used for search. Initial records identified through database searching numbered 250. An additional five articles were identified through predictive links when initial articles were retrieved from their respective journals. Two articles older than 10 years were chosen as they proved to be seminal works validating the use of the MEWS as a tool in general and specifically to be used to detect clinical deterioration in the acute care inpatient population. One of these articles was only able to be located as an abstract but contained the information necessary to be included in review. This strategy yielded an initial total of 257 articles. A total of 23 duplicates were found leaving a total of 234 articles to be initially screened.

In addition to using keywords, defined inclusion criteria included: primary research studies published between January 2008 and October 2018 using the Modified Early Warning Score (MEWS) tool as an intervention. Only studies with subjects greater than the age of 18 were included though the subjects could be either licensed acute care nurses or patients who had experienced clinical deterioration during hospitalization. Initial exclusion criteria included

studies using pediatric clients, those being primarily focused on a student nursing population, and those limited to surgical patients only as surgical patient decline was not shown to be an issue in the chosen study facility. A total of 145 articles were excluded after initial review leaving 89 full text articles to undergo a closer screening. From these articles, an additional 69 articles were excluded due to various reasons such as not being primary research as originally suggested or having a primary purpose to validate or test other interventions or tools other than the MEWS. This left a total of 21 articles to undergo a rapid clinical appraisal. After this process, all 21 articles were found to be useful to answer the study question and were therefore included. The Preferred Reporting Items for Systemic Reviews and Meta-Analyses (PRISMA) flow diagram was used to summarize the study selection process (see Figure 1).

Modified Early Warning Score

The Modified Early Warning Score (MEWS) tool was originally validated for the use in the post-surgical patient population in a study completed nearly 20 years ago as an effective predictor of the potential for patient deterioration (Stenhouse, Coates, Tivey, Allsop, & Parker, 2000). In one retrospective study, this prediction rate was found to be as high as 81% (Ludikhuize et al., 2012). It is also stated to help with prioritization and promote a culture of proactive instead of reactive treatment of patient condition (Burns et al., 2018). When evaluating the seminal studies about the MEWS, the premier study found the MEWS tool to be as effective as the APACHE II tool that is more commonly used in the United States hospital population (Stenhouse et al., 2000). The MEWS was later validated on the general inpatient population through a prospective study that found that scores greater than five were correlated with increased rates of clinical deterioration or death (Subbe et al., 2001).

Early Warning Scores (EWS) assist with interdisciplinary collaboration and in particular help nurses to frame the conversation with providers about concerns noted with their patients (Burns et al., 2018; Dalton et al., 2018; Greaves et al., 2016; Stafseth et al., 2016). Primarily, use of the MEWS has been shown to decrease rates of cardiopulmonary arrest and other severe adverse events (Albert & Huesman, 2011; De Meester et al., 2013; Duncan et al., 2012; Maupin et al., 2009). Part of this phenomena is due to the tendency for the MEWS to increase the frequency of how often nurses reassessed their patients to include their vital signs (Bunkenborg et al., 2016; De Meester et al., 2013; Ludikhuize et al., 2011).

When deciding to implement the Modified Early Warning Score in an organization, it is necessary to understand that use of the MEWS can increase the use of the rapid response team and potentially transfers to the Intensive Care Unit (ICU) or Critical Care Unit (CCU). This increased utilization ranged from 20-50% in the majority of studies reviewed (Albert & Huesman, 2011; Duncan et al., 2012; Gagne, 2018; & Rose, Hanna, Nur, & Johnson, 2015) but was as high as a 246% increase in one study (Maupin et al., 2009). Of those who are transferred, the MEWS has been shown to facilitate a transfer earlier in the deterioration process (Gagne, 2018; Stenhouse et al., 2000). Only one study did not find a clinically significant increase in activation of the Rapid Response Teams (Stewart et al., 2014). However, this increase is not necessarily unwarranted. The Gagne (2018) study found that the increase only occurred in those with elevated early warning scores while the Maupin and colleagues (2009) study saw a 70% decrease in cardiopulmonary arrests after implementation. Use of MEWS criteria and early intervention caused less than 10% of the calls for assistance to end in transfer of the patient to ICU in one study (Katadzic & Jelsness-Jørgensen, 2017). When looking retrospectively, the

Maupin et al. (2009) study found that 25% of their previous severe adverse events could have been prevented if the MEWS had been in place.

In examining potential pitfalls with use of the MEWS, the accuracy of documentation and scoring was found to be a potential concern (Cherry & Jones, 2015; De Meester et al., 2013; Jonsson et al., 2011; Ludikhuize et al., 2011; Stewart et al., 2014; van Galen et al., 2016). Negative attitudes of the Rapid Response or Medical Emergency Teams have also been reasons found in literature review to be barriers to nurse escalation of care, especially if the tool has a lower trigger score (Petersen et al., 2017). Finally, issues arise if the MEWS is used as the sole indicator of pending crisis while neglecting nurses' own clinical judgment (Dalton et al., 2018; Stewart et al., 2014).

Simulation

Simulation has recently gained increased recognition as a strategy to help teach and evaluate nurses and nursing students on their ability to respond and react to patients in crisis (NLN, n.d.). Simulation has been shown to improve the assessment skills of nurses, to provide a safe environment of learning, and to serve as a psychomotor reference (Bliss & Aitken, 2018; IHI, n.d.; NLN, n.d.). Having strong assessment skills is critical to the success of tools such as the MEWS (IHI, n.d.). The safety of the environment for both the nurses and the ability to learn while avoiding patient harm has also been noted as an advantage to using simulation-based teaching methodologies (Bliss & Aitken, 2018). Providing a reference for decision making and critical conversations has also been mentioned (Bliss & Aitken, 2018). Specific to the purposes of this study, simulation-based training has been shown to increase both knowledge and confidence in nurses when dealing with patients in crisis (Crowe et al., 2018; Elder, 2017; & Schubert, 2012). It has also been shown to decrease the incidence of unanticipated cardiac arrest

and increase intervention rates prior to severe adverse event (Crowe et al., 2018). High fidelity simulation has also been proposed to be equal to standardized patients in terms of measured performance (Ignacio, et al., 2015).

Still, the growth in critical thinking gained through simulation experiences has been purported to not always be sustainable. One study found that that participants returned to their baseline critical thinking levels by as few as two weeks post intervention, though their knowledge levels were still significantly above baseline (Schubert, 2012). For this reason, simulation was not chosen to be the main intervention in this translational research study to sustain the growth in this population over time.

Synthesis of Evidence

Early recognition of clinical deterioration has been shown to be useful to prevent the occurrence of severe adverse events (SAE) and overall survival rates in acute care patients (Zografakis et al., 2018). Rapid detection can lead to a decline in Intensive Care Unit (ICU) patient population due to early intervention and stabilization (Gagne, 2018) or an increase in appropriate transfer to ICU or Critical Care Unit (CCU) prior to SAE (Rose et al., 2015; Stenhouse et al., 2000). Research has shown that the MEWS has been proven to detect pending clinical decline for up to 16 hours prior to SAE (Albert & Huesman, 2011; Zografakis et al., 2018). Use of an EWS has been shown to have a variable effect on Rapid Response Team (RRT) or Medical Emergency Team (MET) activation. Two previous studies found no significance increases (Gagne, 2018; Stewart et al., 2014) while another found that the RRT incidence increased up to 50% (Albert & Huesman, 2011). All studies reviewed have shown a decrease in cardiopulmonary arrest rates.

The use of the MEWS as a tool to detect clinical decline has been seen as both a positive and negative topic through research. Although the EWS has been shown to increase awareness and help with prioritization in some studies (Bunkenborg et al., 2016; Burns et al., 2018; Stewart et al., 2014), one of the most frequently mentioned topics was the potential for staff to rely solely on the MEWS to detect deterioration instead of using it to supplement their own clinical judgment (Dalton et al., 2018; Stewart et al., 2014). Nursing judgement is even sometimes used to supersede the MEWS which has been described as both a positive (Bunkenborg et al., 2016; Petersen et al., 2017) and negative (Flabouris et al., 2015) finding. In addition, personal experiences can affect the way a nurse interprets the information given. As mentioned by Thompson and colleagues (2009), the same quantitative information can be interpreted in several different ways depending on who is translating the information. If MEWS scores were not above the set parameters for the institution, escalation of care often did not occur in a timely manner (Dalton et al., 2018; Greaves et al., 2016). While the ability to quantitatively show an increased risk of deterioration was shown to assist with nurses being able to communicate the reason for their concern about a patient situation with a provider in some situations (Burns et al., 2018; Dalton et al., 2018; Stafseth et al., 2016), the lack of an elevated MEWS to prove this concern was also found to cause issues in communication between the nursing and medical staff. When the MEWS score was not able to be used as a validation of a nurse's concerns, they often felt as if they could not effectively express those concerns to the medical staff attending to the patient (Dalton et al., 2018; Greaves et al., 2016; Petersen et al., 2017). Finally, the accuracy of the MEWS documentation can make a drastic difference in the ability to use it as a tool. Inaccuracy and/or incompleteness of data collection and the inability to amend the tool for patients that have an altered baseline has been mentioned to be a limitation of the tool in some studies (Jonsson et

al., 2011; Kyriacos, Jelsma, & Jordan, 2014; Ludikhuize et al., 2011; Ludikhuize et al., 2012; Niegsch et al., 2013; Petersen et al., 2017; Stewart et al., 2014).

Limitation of Current Evidence

There are a few shortcomings found in the available evidence. Only one article was located that described the use of the MEWS in a rural facility, and it was merely a description of a quality improvement project and was thus unable to be used as evidence for literature review. Furthermore, very few articles were discovered showing the use of simulation in the post-licensure nursing population though many were located showing usefulness in the prelicensure nursing student population. There is also a paucity of research related to EWSS and particularly the MEWS in the United States population. Due to the need to expand the practice globally, the Institute of Health began a campaign in 2012 to extend the usefulness of these systems into the United States (Duncan et al., 2012). The largest limitation is the fact that although there are many different track and trigger systems, none has been proven to be useful in all situations and age groups. It is striking that, despite continued searches for new evidence, the latest update of the NICE guidelines in January 2019 was still unable to definitively determine that one tool was better than another for all cases (NICE, 2019).

Strength of Current Evidence

There was an abundance of information suggesting the usefulness of early warning scoring systems such as the MEWS in detection of clinical deterioration of acutely ill adults. Simulation, likewise, was readily purported in literature review to be a viable method of evaluating clinical competence without the risk of actual patient harm. The evidence presented indicated that the MEWS could be implemented for this population, but with considerations. Consistent and accurate charting by the nursing staff was necessary to ensure accuracy of the

MEWS. Clear definitions of both the MEWS parameters that were acceptable as well as the actions to be taken at each level were also required. Finally, there had to be agreement by both the nursing and medical staff to listen to and consider the judgments of each that may conflict with the results of the MEWS tool.

Conceptual Theory

The Essentials of Doctoral Education for Advanced Nursing Practice was published in 2006 by the American Association of Colleges of Nursing (AACN) in an effort to identify the criteria that must be present in all Doctor of Nursing Practice (DNP) programs (AACN, 2006). Essential III of this document speaks specifically about the responsibility of the DNP to apply knowledge gleaned by research to the practice environment. This project was designed to use the Clinical Judgement Model developed in 2006 by Dr. Christine Tanner to integrate the thought processes of post-licensure nurses into the simulation realm typically used in the prelicensure population.

The Clinical Judgment Model

Despite initial use as a guide for debriefing of simulated clinical experiences in the pre-licensure population, the Clinical Judgement Model is also useful for nurses already in clinical practice (Tanner, 2006). This model considers that nurses will use not only the tools and information that they are given for a specific situation but also their personal past experiences when making a treatment decision. It also recognizes that the intuitive decision process of experienced nurses and the analytical process used by the novice or advanced beginner nurse must both be accounted for when evaluating the process as a whole. It further suggests that a combination of reasoning patterns such as intuition and narrative thinking are used along with objective information to make decisions by nurses of all experience levels. These considerations

would indicate that the model also appreciates the concerns expressed earlier that use of a clinical decision support system should supplement nursing judgement instead of replacing it. The model reminds that a portion of the clinical judgment decisions made by nurses relies on how well they know their patient. Knowing a patient refers to both knowing their baseline vital signs as well as nurse engagement with the patient to be able to notice any changes in condition. This concept is especially useful in the rural hospital setting in which many patients have been admitted to the same unit in the past, thereby increasing nurse familiarity.

This model also realizes that the culture of the nursing unit and the context by which the nurse receives abnormal information about their patient can have a profound impact on the way that care is delivered by the bedside staff. Although the current administrative and educational staff is very supportive of the project other internal or external interpersonal difficulties, power struggles and previous experiences have the ability to impact the future decisions of the nursing staff.

Finally, this model realizes that a breakdown in clinical judgment often triggers a reflection on the circumstances surrounding the breakdown which then leads to growth in thought processes and improvement in the clinical reasoning process. Both *narrative* and *experiential* learning have been proposed by nursing theorist, Patricia Benner, for many years as effective models of nursing education (Tanner, 2006). Simulation-based training is a good fit with this model, as the mistakes made during simulation can provide a reference point for future situations involving actual patients, especially for a unit in which there is a large proportion of Licensed Practical Nurses (LPNs) and nurses who have not undergone critical care training.

The Clinical Judgment Model is comprised of four aspects (noticing, interpreting, responding and reflection) that form a circular pattern as the reflection from one event helps to shape the way that future events will be handled (Tanner, 2006):

Noticing. The initial phase of the model occurs when the nurse notes a deviation from the expected trajectory of healing that is normally anticipated for the patient. This trajectory is not just based on standardized guidelines but also the context surrounding the situation as well as the personal relationship that has been built between the nurse and the patient. The combination of standards and personal inflection ensures that although any elevation in MEWS criteria must be called to the provider, the nurse is able to frame the conversation to ensure that the seriousness of the situation is also conveyed. This tactic will lead to patient specific care.

Interpreting. In this section, the reasoning patterns that assist a nurse to decide on a treatment action become important. Additional assessments and review of patterns of data were considered to ensure that the action taken is the best for the patient. This action is directly related to the effect of past experiences on the nurse's current judgment. The use of simulation in this case is to provide a point of reference that the nurse can use to help guide them in future situations.

Responding. This aspect is when the nurse takes action to work towards the desired outcome. It is important to note that this response may take many forms. Initially, the nurse might complete a more focused assessment to allow for a better determination of what response is required for the situation. Another alternative is to increase the monitoring of the patient to allow for subtle changes to be detected more quickly. The nurse could also choose to contact the provider or consult the rapid response team to aid in the assessment or treatment process

depending on the severity of the findings. Once the immediate event either shifts to another focus or is completed, nurses can move on to the final aspect of the model.

Reflection. This final component refers to both reflecting during and after the crisis situation. The reflection during the situation assists the nurse to make adjustments to the plan based on how the patient is actively responding to interventions. Reflection after the crisis after the situation has resolved helps to develop the clinical reasoning that was used as a basis to interpret and react to future events. Dr. Tanner (2006) proposed that recognition of the methods used to determine decisions during crisis could help nurses identify weaknesses in their decision process that they can correct for future practice. Together, the aspects of this approach were determined to be the most useful to guide this translational research project.

Methodology

This study was designed as a four-phase learning experience using simulation as the basis for both teaching and evaluation of learning outcomes. Phase one began on August 20th, 2019 after receiving Institutional Review Board approval from all involved facilities. This first phase consisted of chart reviews of patients discharged between June 30th and July 31st, 2019. The necessary sample size of past charts to review was determined by an online statistics calculator. Phase two occurred from August 20th to September 29th, 2019 and included group educational classes to review the most common clinical deterioration indicators for the organization, strategies to recognize and respond to those indicators, use of the sepsis screening and modified early warning score tools, and interprofessional communication during a deterioration event. Phase three began August 21st and continued until through September 30th, 2019 and consisted of individual simulation experiences meant to test nurses' ability to recognize and respond to acute clinical deterioration. Phase four lasted from December 16th, 2019 to January 9th, 2020 and was comprised of retrospective chart reviews of patients admitted after MEWS implementation on October 1st, 2019 and continued until the needed sample size was reached with those admitted on November 23rd, 2019.

Setting

This study took place in a 140-bed acute care hospital located in the rural southeastern United States. The study facility has a research partnership agreement with the university at which the primary researcher is a student. Data was collected at the hospital in the simulation center and within the quality department.

Design of Study

This study used a pre- and post-intervention correlational design with a convenience sampling method. Study objectives were taught to participants both through the cognitive domain in the form of a standard group educational session led by the primary investigator and through the affective and psychomotor domains through simulated patient experiences created by the National League of Nursing and ran by the primary investigator. The classroom educational sessions took place in the hospital education center and library depending on the number of attendees and room availability. All simulation sessions were completed in the Simulation and Translational Research Center located on the third floor of the study facility. Evaluation of the learning occurred through pre- and post-intervention chart reviews and use of previously developed and validated tools specific to simulation evaluation and clinical decision making. To promote long-lasting evaluation of the educational process, the chart review tool was left with the quality department of the study facility to ensure ability to determine if the intervention has a lasting effect.

Sampling method

A voluntary convenience sampling was obtained of all bedside inpatient nurses at the study facility who attended one of the 37 classroom training sessions offered over the six-week period of training. Those nurses who only work with Obstetric and/or pediatric clients were excluded due to inapplicability of the standard MEWS tool in these specialty populations. However, those nurses in the obstetric department who worked mainly with post-partum mothers and general medical patients who are admitted as overflow to the unit were included. Those who worked primarily in management or in the outpatient settings were also excluded from the study; however, those who work in the Emergency Department were included as the facility had

inpatient clients who remained in this department for extended times due to decreased bed availability. Therefore, the included nurses had primary units of Medical/Surgical/Telemetry, Intensive Care Unit, Emergency Department, Postpartum, and the Resource Pool.

All bedside inpatient nurses meeting inclusion criteria were required by nursing administration to attend both the classroom group educational intervention and the individual simulation as part of their annual facility specific training. Nurses were notified of this training by emails, posters located on the nursing units, and by personal visits from the primary investigator to the nursing units during the study period. Those attending the training received their usual hourly rate of pay for time spent in the classroom and simulation sessions. This time period was approximately two hours per participant. The additional time to complete the study tools was voluntary and was approximately 30 minutes per participant. These tools included the demographic survey, pre- and post-intervention knowledge quiz, pre-and post-intervention Clinical Decision-Making Self-Confidence Scale (CDMSCS), and Clinical Reasoning Evaluation Simulation Tool. No additional compensation besides the participants' usual hourly wages as paid by the organization for attendance at educational sessions.

The target sample size to complete a two-tailed paired samples *t*-test for data collected during phases II and III of the study was 128 nurses as determined by an online statistics calculator for an anticipated Cohen's *d* of 0.5, power level of 0.8 and a 95% confidence interval (Soper, 2004). Per human resources' estimates as of April 2019, the potential sample size at the study site was 119 if agency nurses were not included in the training and 147 if they were (A. King & V. Humphrey, personal communication, April 23, 2019). Agency nurses were not included per the wishes of nursing administration at the study facility who were hoping to have

decreased agency usage by the time of implementation. Of the eligible 119 staff nurses, 85 attended the training and 29 agreed to participate in the study.

The sampling method chosen for phases I and IV included chart reviews of patients admitted to the study facility with the diagnoses of acute kidney failure, bowel obstruction, chest pain, chronic obstructive pulmonary disease, congestive heart failure, pneumonia, and sepsis who displayed abnormalities in their vital signs or level of consciousness that would have triggered a change in the plan of care, such as increased monitoring or provider notification. Consent for obtaining this information was waived as the information is already a part of the medical record and was covered by the existing consent for treatment at the facility. The target sample size for both of these reviews was 84 to achieve significance for a multiple regression as per an online statistics calculator (Soper, 2004). A total of 459 medical records were reviewed to find 170 charts that had vital signs that would trigger a change in the plan of care per the MEWS. Charts were divided evenly into 85 pre-intervention and 85 post-intervention groups.

Data Collection Methods

All data for this project was compiled by the primary researcher. Data from the medical record was retrospectively obtained from the electronic medical record (EMR) and entered into SPSS for collection. The list of records matching the aforementioned diagnoses was obtained through a flash drive provided by the hospital quality department and was marked off as data was entered into SPSS. This drive was kept by the quality department when not in use by primary investigator and remained with the department after data collection was completed. Data collected from the medical record during pre-intervention chart reviews included 1) primary and secondary admission diagnoses, 2) frequency of vital sign documentation (the number of vital signs obtained by nursing or nursing assistant staff in the 24-hour period after documentation of

a MEWS trigger), 3) incidence of sepsis screening tool use (number of times sepsis screening tool was completed), 4) accuracy of sepsis screening tool documentation (number of times tool was correctly and incorrectly completed based on primary investigator review of the chart documentation of parameters listed in the screen at the time of screen completion), 5) incidence and type of severe adverse event (defined as cardiac arrest, rapid response team activation, transfer to the Intensive Care Unit prior to rapid response, and/or transfer to a higher level facility), and 6) documentation of events taken to prevent severe adverse event (both action and time frame for completion). Post-intervention chart reviews included the same items, along with additionally collecting data surrounding the MEWS to include 1) incidence of MEWS tool use (number of times tool was completed during hospital admission) and 2) accuracy of MEWS tool documentation (number of correctly marked areas on form based on values at time of completion). Information collected during these reviews were used to determine the effect of the MEWS tool on nurse knowledge, recognition, and response to clinical deterioration. Additionally, this information allowed for evaluation of the effect of the educational intervention on nurses' use of deterioration screening tools.

Admission diagnosis information was obtained from the spreadsheet provided by the quality department. Vital sign documentation data was obtained from the *vital signs* tab in the electronic medical record (EMR). Sepsis screening tool documentation was obtained from the *sepsis re-screening* and *adult shift assessment* interventions in the electronic medical record. Accuracy of that information was evaluated through review of the *vital signs*, *laboratory results,* and the provider notes located in the *other notes* sections of the medical record. Documentation of actions taken was obtained from the *nursing notes* section in the EMR, the *hourly rounds* section of the EMR, the provider notes located in the *other notes* section of the EMR, the *eMAR*

(electronic medication administration record), and the paper forms completed during rapid responses and cardiac arrests at the study facility. This data mining was completed in the quality management department using a desktop computer provided by the organization.

Data from the nursing staff to complete phases II and III of the study was collected during the classroom and simulation educational sessions. This data included a demographic survey, a pre- and post-interventional knowledge quiz, and pre- and post-intervention self-confidence scales that were completed by the study participant as well as a simulation evaluation tool that was completed by the primary investigator.

Phase I: Pre-interventional retrospective chart reviews. All charts of adult patients 18 years old or greater admitted to the study facility with the diagnoses of sepsis, pneumonia, chest pain, acute kidney failure, bowel obstruction, chronic obstructive pulmonary disease and/or congestive heart failure were evaluated for the items listed on the chart review form (see Appendix J). These diagnoses were chosen based on the aggregated data received by the facility indicating top admission and deterioration diagnoses (NHB, 2018). Although bowel obstruction was not listed as a primary diagnosis for this facility, just over 20% of the cardiopulmonary arrests during this period involved a diagnosis of bowel obstruction (NHB, 2018). Charts of patients found to have a severe adverse event (SAE) defined as cardiopulmonary arrest, rapid response team activation, transfer to the intensive care unit, or increase in level of care also had a retrospective MEWS score calculated for four-hour intervals up to 24 hours prior to the event (see Appendix L). This action was to determine if the MEWS tool could have identified the decline prior to the SAE. These chart reviews were completed by the primary investigator at the study facility using a desktop computer belonging to the facility and a researcher developed chart review form (see Appendix J).

Phase II: Group educational classes. The mandatory educational intervention began with 34 group educational classes provided by the primary investigator at varied times convenient to participants over a 6-week period. Although the classes were announced as mandatory, only 85 of the listed 119 staff nurses attended training. Of those, 29 agreed to be study participants. The curriculum focused on identification and reaction to abnormalities identified through use of the MEWS, the nursing assessment considerations of the study facility's most common diagnoses, and the communication process between the nurse and other hospital personnel such as providers who care for a patient experiencing decline. Teaching items about the MEWS were derived from review of the studies identified in literature review with particular attention to the original article examining usefulness of the tool in the inpatient population (Subbe et al., 2001) and an article describing the use of a color-coding system to assist with identification of patients in crisis (Duncan et al., 2012).

As recommended by the NICE (2007) guidelines, actions for the study facility's MEWS protocol was divided into three levels of low, medium, and high with actions corresponding to each level. These levels were coded by the colors of the stoplight (red, yellow, and green), similar to the four-color scheme seen in the Duncan and colleagues (2012) study. A score of four was used to indicate the need for immediate intervention such as a rapid response or Code Blue call as per recommendations of the Subbe and colleagues (2001) study indicating that scores of five or greater are indicative of increased risk of death. Scores in this range or higher fell into the red indicator section on the MEWS intervention. Patients in this range should have had increased frequency of assessment to at least hourly increments or be transferred to a higher level of care. Scores of two to three were listed as yellow and required contacting the patient's primary inpatient provider as well as increased frequency of monitoring with parameter

assessment at least every two hours or as per provider recommendation. If the score was found to decrease, frequency of monitoring could be decreased after a continuous period of four hours without increase in MEWS score. The four-hour time frame was chosen as it is the usual time frame of vital sign assessment on the medical-surgical nursing unit at the study facility. Scores of zero to one were listed as green and required vital sign monitoring at least every four hours to avoid the incidence of unrecognized increase. Nurses were required to complete the MEWS at least every four hours or with any abnormality in a vital sign parameter outside of the patient's baseline.

Teaching also included communication used in the Situation Background Assessment Recommendation (SBAR) tool originally developed by Kaiser Permanente through a toolkit developed by the Institute of Healthcare Improvement (IHI, 2017). Information on respiratory distress was compiled from the debriefing overview and case considerations that were provided with the chosen simulation from the National League of Nursing (NLN) (Hall et al., 2013). Nursing considerations for all of the aforementioned diagnoses and case studies used in the classroom educational sessions were obtained from online course content available with purchase of *Brunner & Suddarth's Textbook of Medical-Surgical Nursing, Fourteenth Edition* (Hinkle & Cheever, 2018). This resource was chosen based on the partnership between Wolters Kluwer Health, the National League of Nursing, and Laerdal (NLN, n.d.). The classroom educational session was facilitated through the use of a PowerPoint presentation comprised from these resources. The educational experience included the use of case studies allowing participants to complete a paper form of both the MEWS and the existing sepsis screening tool. Each scenario was followed by group discussions that allowed participants to collaborate with their peers to determine the best actions to treat the scenario given.

Study participants additionally completed a researcher developed demographic survey, the Clinical Decision-Making Self-Confidence Scale (CDMSCS) and a quiz developed by the primary investigator covering the content to be taught during the session to evaluate their baseline knowledge and perception of their knowledge. All items were given to participants in paper format at the beginning of the educational intervention. Nurses attending the classroom session who did not agree to be a part of the study did not complete any paperwork other than signing in for the training session.

Phase III: Individual educational simulation. The second part of the educational intervention was a simulated patient experience in which the nurse was exposed to a patient with signs of pending clinical deterioration. The chosen scenario was developed by the National League of Nursing (NLN) and purchased from Laerdal to be used with their high fidelity SimMan3G mannequins and Laerdal Learning Application (LLEAP) software. Laerdal has long been a leader in the world of simulation with the creation of high-fidelity mannequins such as the SimMan3G that was used for this simulation. The partnership between Laerdal, the NLN, and the educational company formerly known as Lippincott-Wolters Kluwer Health has become a well-documented force in the simulation community and is frequently commended for development of evidence-based simulations and faculty development courses related to simulation (NLN, n.d.). This particular scenario was chosen for a few reasons. The primary diagnosis of pneumonia was a good fit with the respiratory failure and pneumonitis diagnoses that have been previously mentioned as leading causes of death in hospitalized patients (Hall et al., 2013) and a leading primary and secondary admitting diagnosis for the study facility (NHB, 2018). The initial vital signs of the patient in this scenario provided a trigger for both the MEWS and the existing sepsis screening tool used by the facility. As previously mentioned, sepsis is a

leading cause of death in both study facility (NHB, 2018) and the inpatient population of the United States (Hall et al., 2013). Finally, the objectives of the scenario aligned closely with the objectives of the proposed project. The simulation-based educational intervention followed the curriculum provided by the scenario as given with the exception of removing all additional participant roles besides the primary caregiver.

The literature provided by Laerdal indicated that the estimated time to complete the scenario and debriefing would be 60-75 minutes as completed by a group of four pre-licensure students in a Fundamentals Course (Cato, Maas, Milgrom, & Tiffany, n.d.). As participants were post-licensure nurses, each simulation was completed individually over a period of 45 to 60 minutes. The primary researcher served as the sole simulationist, evaluator, and de-briefer of the simulation to ensure consistency in all phases of the simulation process for participants.

Each session began with a 5-minute pre-briefing period in which the participant was oriented to patient room and the simulator, followed by a 5-minute period to review the patient chart and answer question one of the Clinical Reasoning Evaluation Simulation Tool (CREST) which asked for their primary interpretation of the scenario based on the provided case information. This introductory period was followed by the scenario, which lasted from 10 to 20 minutes depending on the participant and was followed by a 20 to 40-minute time for reflection and debriefing. Debriefing was completed using the Promoting Excellence and Reflective Learning in Simulation (PEARLS) tool (Eppich & Cheng, 2015). Usage of this tool allowed for a blended debriefing process that provided some scripting for structure but followed each participant's individual experience while focusing on their personal reactions, description, analysis, and summary of the simulation experience. The reflection/debriefing time was divided into two sections for study participants. The first section was a review of the recorded session to

provide uninterrupted time for self-reflection for the participant and uninterrupted evaluation time for the primary investigator to complete the objective measures of the CREST. This evaluation was augmented through the use of a checklist (see Appendix H) developed by the primary investigator and based upon the expected participant interventions provided as a part of the simulation. The purpose for this checklist was to provide an unambiguous manner by which to evaluate participant performance since terms such as “thorough” and “optimal” are used to describe the observation elements of the CREST. This section was followed by a guided debriefing discussion (see Appendix I) to allow for the verbal questioning portions of the CREST to be completed as well as all other objectives of simulation to be addressed. The simulation checklist was again used to evaluate participant performance during this section as terms such as “thorough” and “clear ability” are used to describe the questioning elements of the CREST. Those nurses who did not agree to participate in the simulation were not videotaped and therefore only completed the guided debriefing session. The topic outline for discussion was derived from both the required verbal discussion points from the CREST and the recommended discussion points from the NLN to cover such topics as patient care coordination, evidence-based practice, quality improvement, safety, therapeutic communication, and informatics. The only personnel who were able to view the video during each debriefing session were the principal investigator, the participant, and the Georgia College faculty on the study team (Dr. Leslie Moore, Dr. Laura Darby, & Dr. Sterling Roberts). After the guided debriefing discussion, each participant’s video was deleted in his/her presence as indicated on the consent form to protect their anonymity. No copies of the video were retained after the session. The paper CREST form and checklist with the participants’ information de-identified were kept with the other paper

documentation of the study in a locked drawer in the primary investigator's office and will be destroyed after three years.

Only study participants were videotaped during simulation to allow the completion of the CREST tool. Those simulation attendees who did not agreed to be part of the study did not have their simulation session videotaped. The CDMSCS and a primary investigator developed knowledge quiz were also completed after the simulation by study participants only to allow for assessment of participants' knowledge growth and perception of the learning process. Nurses attending the simulation who did not agree to be a part of the study only participated in the simulation and the guided debriefing discussion without any paperwork being completed.

Phase IV: Post intervention chart reviews. Following completion of the training sessions, the MEWS tool was implemented into the electronic medical record. Staff nurses were given badge cards with a color-coded reminder of actions to be taken for elevations in MEWS criteria (see Appendix C). All charts of patients admitted with the aforementioned diagnoses after implementation were evaluated for abnormalities that would trigger an intervention based on the MEWS. Once selected, charts were examined for documentation surrounding the event as well as any potential for consistent use of the MEWS and sepsis screening tools to have predicted the event. Overall compliance was reported to the study organization, but individual compliance was not reported so that the vulnerability of study participants could be protected.

Instruments

Data collection was obtained from a variety of sources. Data collected included the demographics questionnaire, primary investigator developed quizzes, the Clinical Decision-Making Self-Confidence Scale (CDMSCS), the Clinical Reasoning Evaluation Simulation Tool (CREST), simulation checklist, pre- and post-interventional chart reviews, and severe adverse

events forms. All tools were used in conjunction to evaluate the ability of nurses at the study facility to recognize and respond to acute deterioration.

Demographic questionnaire. A demographic questionnaire was created by the primary investigator (see appendix E). Information gathered included age, gender, highest level of nursing education, length of nursing experience, type of primary nursing unit, and if they have any previous experience with initiating or responding to a Rapid Response or Code Blue call. This questionnaire was completed voluntarily through a paper form at the time of educational classroom intervention.

Pre- and Post-Educational Quiz. A voluntary 20-item quiz was developed by the primary investigator and administered to study participants before the classroom educational session and after the simulation session (see appendix M). Items on the quiz evaluated study participants' ability to correctly complete the MEWS tool and the study facility's existing sepsis screening tool as well as determine the correct actions to take based on those scores. Questions for the quiz were derived from the same resources as the educational session and represented facts delivered in the educational session.

Clinical Decision-Making Self-Confidence Scale (CDMSCS). This 12-question, Likert style scale was used to determine the participating nurses' confidence in handling deterioration events from their own perspective (see Appendix F). Each question was graded on a scale of one to five with the lower score indicating that the participant was *not at all confident* in their ability on that question and the highest score indicating that the participant was *very confident* in their ability (Hicks, Coke, & Li, 2009). The lowest possible score on the total scale is 12 and the highest is 60. Sample items include *How confident are you that you can recognize signs and*

symptoms of a cardiac event? and *How confident are you that you can appropriately intervene for an individual with chest pain?* (Hicks et al., 2009).

The CDMSCS was initially developed in 2006 by Dr. Frank Hicks based on results from his previous study on critical thinking and clinical decision making of critical care nurses (Hicks et al., 2009). This instrument was pilot tested through a study sponsored by the National Council of State Boards of Nursing evaluating the use of high-fidelity simulation in an undergraduate nursing curriculum. The tool is divided into four sub-sections, each of which examines a different portion of the process taken by a nurse when responding to a patient in crisis-recognition, assessment, intervention, and evaluation of interventions. Scores for each sub-section can range from 3 to 15. The total scale is also divided into three categories which examine cardiac, respiratory, or neurological changes as defined as chest pain, shortness of breath, or a mental status change. Scores on each of these subscales range from 4 to 20 (Hicks et al., 2009).

Initial evaluation of the tool during the pilot study did not complete a full psychometric testing, but an analysis was later completed in 2014 comparing pre-licensure Bachelor of Science in nursing students to post-licensure registered nurses (Hart, Spiva, & Mareno, 2014). Cronbach's alpha for the registered nurse population was calculated at 0.95, while the overall calculation including nursing students was calculated as 0.98 during reliability assessment. Significant differences between pre- and post-licensure groups and inter-item correlations ranging from 0.69-0.85 were used to describe the validity of the instrument. Overall, the CDMSCS was found to be an effective tool to assess levels of self-confidence in nurses when caring for patients experiencing acute patient deterioration. The respiratory and cardiac events subscales had a combined Cronbach's alpha of 0.94 for registered nurses while the neurological

events subscale had a Cronbach's alpha of 0.91 for this population. Individual scores for cardiac and respiratory subscales were not calculated during this review (Hart et al., 2014).

Permission for use of this tool was freely given by the National Council of State Boards of Nursing (NCBSN) on the pilot study using the tool (Hicks et al., 2009). This tool was completed at two time periods for this project. The first instance was immediately prior to the first educational session while the second was immediately after the simulation experience at the end of the post-simulation debriefing.

Clinical Reasoning Evaluation Simulation Tool (CREST). The tool used to measure participant's ability to detect clinical deterioration during simulation was the Clinical Reasoning Evaluation Simulation Tool (CREST) (See Appendix G). This tool is an 11-item Likert style scoring system that can be used to quantitatively measure nurse or nursing student performance both during and in the period immediately following the simulation experience (Liaw et al., 2018). The first 10 items on the scale are scored on a five-point Likert scale while the final question is a 10-point Likert scale. The lowest score than can be received is an 11 while the highest is 60. The first 10 items are divided equally into observations made during the simulation experience and verbal questioning. Of the verbal questions, one is to be completed prior to the simulation experience while the others are all completed after the simulation experience. Although there are eight subscales in the tool dealing with each portion of the deterioration process from considering the patient situation to reflecting on the process for new learning, the tool is meant to be used as a whole (Liaw et al., 2018).

The CREST was developed by an eight-person team led by Dr. Sok Ying Liaw (Liaw et al., 2018). This tool was a more user-friendly amendment of the 42-item Rescuing A Patient In Deteriorating Simulation (RAPIDS) tool that has been used in many previous studies since

validation testing in 2011 (Liaw, Scherpbier, Klainin-Yobas, & Rethans, 2011). Developed in part by the same primary researcher, Dr. Liaw, the CREST was validated in a recent mixed methods study on a nursing student population with a Cronbach's alpha of 0.92 for internal consistency, an intraclass correlation coefficient (ICC) of 0.88 for total score, an overall scale level content validity index (S-CVI) of 0.93, and a construct validity determined by significant differences in the test groups based on level in the nursing program (Liaw et al., 2018). Permission for use of this tool was both given by the primary developer and is also listed as freely available at http://medicine.nus.edu.sg//nursing/rapids/sbet.html through the university that was the site for the flagship study. This tool was completed by the primary investigator in the debriefing period after simulation.

Simulation checklist. A checklist was developed by the primary investigator to allow for consistent evaluation of participants' performance during simulation. This checklist was attached to the CREST and completed during each simulation debriefing by the primary investigator. The observation items were completed during the video viewing session while the questioning items were completed during the guided debriefing discussion. Each item on the checklist correlated with an item on the CREST. Focal points that could be used to evaluate each item objectively were listed with check boxes beside each. Each item had clearly marked guidelines to achieve each of the five potential scores for that CREST item. For example, CREST item three, entitled *Recognizes and interprets patient abnormalities*, is stated to be evaluated by observation of the participant verbally mentioning the abnormalities during the simulation (Liaw et al., 2018). Seven abnormalities were identified that should be realized by the study participant during the initial assessment such as increase in heart rate from 104 to 119 and decrease in oxygen saturation from 95% to 87% since vitals given during report (Cato et al.,

n.d.). Mentioning all of the listed physical abnormalities and their significance to the situation was required to achieve a score of five while mentioning only three or four abnormalities and significance would receive a score of three. For the final overall scale in CREST item 11, the aggregated scores from the previous sections were used to ensure that study participants are measured objectively with no potential bias from past experiences with primary investigator. Scores on this checklist were transferred to the CREST tool for entry into SPSS.

Chart review form. The chart review form was composed by the primary investigator. Chart reviews were completed on all charts of patients with the six aforementioned diagnoses until the amount determined to indicate significance per power analysis was reached. The pre- and post-intervention chart evaluation tools were identical except the addition of items addressing MEWS documentation in the post- intervention review form. Items collected were admission diagnoses, vital sign frequency, incidence of sepsis screening tool and MEWS tool use, accuracy of sepsis screening tool and MEWS tool documentation, incidence of severe adverse event, and documentation of events taken to prevent severe adverse event including timeframes for such actions. If a patient experienced a severe adverse event, the retrospective MEWS scores were calculated for a period of up to 24 hours before the event to determine when trigger should have occurred. This calculation was shown on an additional form (see Appendix L).

Severe adverse event form. This form was used only for those charts identified to have a severe adverse event. Data points were the time of the incident and a retrospective MEWS score for 24 hours prior to the incident in 4-hour intervals. Nursing actions and the timeframe for these actions were also collected (see Appendix L).

Human Subjects Protection

Nurse participation in the study was on a voluntary basis though attendance at the educational sessions was presented as mandatory. Nurses who participated in the study were assigned a unique participant identification code at the time of their attendance at a classroom educational session. Each participant's code was known only to the participant and the investigator. All data collected from participants remained coded and unidentifiable to uphold anonymity. Only aggregated data was given to the study organization with all identifiers that could identify the study participants removed. Participation in this study did require consent to be videotaped during the simulation experience (see appendix D). This consent was included in the overall consent for the study and specifically delineated by initials on this form as well. Video recordings of the simulation experience were destroyed in the presence of the participant after the debriefing period. Printed paperwork was kept in a locked drawer in a locked room at the simulation center during the study and has since been moved to the primary investigator's office in a locked drawer where it will remain for a three-year period after the study and then destroyed. Other electronic media was kept on a flash drive that is password protected and encrypted. This drive was also kept in a locked drawer in a locked room at the simulation center or in the primary investigator's office when not in use and has since been moved the locked drawer in the primary investigator's office. Only the primary investigator knows the password. This drive will also be destroyed at the end of the three-year period. All information was input directly from collection media into Statistical Package for the Social Sciences (SPSS) version 25. No additional compensation other than usual work wages was given for participation in the study. Subjects were informed that they could withdraw from participation in the study at any point without penalty.

No patient identifying information was gathered during chart reviews. Charts of patients identified to have one of the desired diagnoses of acute kidney failure, bowel obstruction, chest pain, chronic obstructive pulmonary disease, congestive heart failure, pneumonia, or sepsis as either a primary or secondary diagnosis were coded directly into SPSS to determine correlation with outcomes. The list of records matching these requirements was obtained through the quality department and did not leave that area. This information was aggregated into totals prior to release of information.

Individual benefits to study participants include improved ability to recognize and respond to clinical deterioration and the opportunity to evaluate their performance without actual patient harm. Benefits to local humankind include increased nurse ability to recognize and respond to a deterioration event of a hospitalized patient. The benefits to others in the field are to show the possibility to expand simulation beyond the pre-licensure population that it currently most used in. This study gives an example of the utility of simulation to evaluate attainment of cognitive and psychomotor objectives by bedside nurses in a safe environment that does not allow for actual patient harm.

Informed consent was obtained from all participants. Assent is not applicable as all participants are 18 years of age or older. Consent forms were provided at the beginning of the classroom educational sessions by the primary investigator (see Appendix D). Participation in all educational sessions was available to all participants regardless of agreement to participate in the study. Study items requiring consent were the demographic survey, post-simulation knowledge quiz, the CDMSCS tool and the CREST tool. Participants could withdraw consent without penalty at any point in the process. Participants were not expected to experience physical, psychological, social, or legal risks beyond those ordinarily encountered during their

usual performance in the work environment. The debriefing period after simulation was used to allow participants to express their feelings about the simulation experience and work through any emotions it evoked. No deception was necessary for this project. IRB approval was obtained from both the study facility and the university. No legality issues were associated with study participation. All data will be destroyed three years following study completion.

Results

The results of the two aims of this study are discussed in this chapter. Reported findings include demographics of the nurse participants, the effect of the Modified Early Warning Score on nurse recognition and response to clinical deterioration, and the change in nurse participants' self-confidence following the educational intervention. A standardized simulation performance evaluation tool along with pre-and post-knowledge quizzes and self-confidence surveys were used to determine the effect of the intervention on both nurse awareness of and action to acute decline in a hospitalized patient. Data was entered into SPSS Version 25. Data analysis began with evaluating for missing data and standard data cleansing. No missing nor out of range values were found. Data was assessed for the need for manipulation, and it was determined that no manipulation was necessary. All distribution of data was assessed for normality with the application of the appropriate parametric and non-parametric testing.

Sample Description

Nurse sample. Eighty-five participants of the estimated 119 staff nurses in the study organization attended the education sessions, and of those, 29 (34%) agreed to participate in the study. The study sample displayed diversity in most demographic variables measured. The sample of predominately female Registered Nurses were heterogeneous in terms of age, length of experience, educational background, and primary nursing unit. Eighty-six percent of the sample reported never having been a member of a rapid response, medical emergency, or critical action team in the past. See Table 1 for complete demographics of the participant sample.

Table 1
Descriptive characteristics of Nurse Participants (N=29)

Variable	*n*	*(%)*
Age		
20-29	7	(24.1)
30-39	9	(31.0)
40-49	5	(17.2)
50-59	5	(17.2)
60-69	3	(10.3)
Gender		
male	2	(6.9)
female	27	(93.1)
Highest Educational Level		
LPN	6	(20.7)
ADN	8	(27.6)
BSN	12	(41.4)
MSN	3	(10.3)
DNP/PhD	0	(0.0)
Length of Experience		
< 6 months	2	(6.9)
6 months-1 year	5	(17.2)
2-5 years	3	(10.3)
6-10 years	6	(20.7)
11-15 years	3	(10.3)
16-20 years	2	(6.9)
21-25 years	1	(3.4)
>25 years	7	(24.1)
Primary Nursing Unit		
Emergency Department	9	(31.0)
Intensive Care Unit	6	(20.7)
Medical/Surgical	8	(27.6)
Postpartum	5	(17.2)
Resource Pool	1	(3.4)
Code Blue or Rapid Response Team experience		
Yes	4	(13.8)
No	25	(86.2)

Chart Sample. A total of 459 medical records meeting the primary and/or secondary diagnosis criteria as previously described were reviewed to determine the effect of implementing

the Modified Early Warning Score. Records of patients discharged prior to the first classroom educational session numbered 239, while 220 charts were evaluated from patients admitted after the implementation of the MEWS tool in the electronic medical record. Of these, a total of 170 charts were identified that would have met criteria per the MEWS to trigger a change in the care plan. These were divided equally into pre-intervention and post-intervention groups, therefore leaving a total of 85 medical records in each group.

Sepsis was the most common primary diagnosis comprising nearly 37% of the sample. Congestive Heart Failure (15%), Acute Kidney Failure (11%) and Pneumonia (9%) were the next highest diagnoses. Concerning secondary diagnosis, the most common was Pneumonia (22%) followed by Sepsis (10%), Acute Kidney Failure (6%), and Congestive Heart Failure (7%). Diagnoses other than the items identified as being at risk for deterioration comprised 15% of pre-intervention and 48% of post intervention chart reviews, with respiratory failure being the most common listed diagnosis in 13% of primary and 21% of secondary diagnoses in the charts evaluated. On average, patients were elderly (M= 66.08 ± 16.3) pre intervention and (M= 67.68 ± 14.7) post-intervention. Inpatient stay ranged from 8 to 438 hours with an average of 115 hours both pre (M= 115.9 ± 94.1) and post (M= 115.4 ± 80.7).

Clinical Questions

Clinical Question 1: How does a simulation-based educational intervention impact nurses' knowledge about signs of pending clinical deterioration?

A paired samples *t*-test was used to test the hypothesis that a simulation-based educational intervention would increase nurses' knowledge about signs of pending clinical deterioration from baseline to post-intervention. The research hypothesis was supported. A

significant increase in knowledge quiz scores was demonstrated from baseline (M =14.24, SD= 3.124) to post-intervention (M= 16.10, SD= 2.526) t (28) = 4.029, p <.01.

Clinical Question 2: What effect will a simulation-based educational intervention have on nurses' self-confidence in recognition of and response to clinical deterioration?

Because the total scores of the Clinical Decision-Making Self-Confidence Scale post-intervention were not normally distributed, a Wilcoxon signed-rank test was used to test the hypothesis that an educational intervention concerning the use of the MEWS tool to recognize and respond to clinical deterioration would result in an increase in nurses' self-confidence from baseline to post-intervention. The research hypothesis was supported (see Table 2). Participants' scores increased significantly from an average of 5.8 points from baseline (M= 47.86, SD= 7.70) to post-intervention (M=53.66, SD=7.43, z=3.698, p <.01.). Examination of the subscale scores of the Clinical Decision-Making Self-Confidence Scale tool also showed significantly increased self-confidence at recognition (z=3.199, p <.01), assessment (z=3.512 p <.01), and evaluation (z=3.322, p <.01) of clinical deterioration events. When examining the effect of the intervention on the intervention subscale, the research hypothesis was not supported. Although normally distributed, the mean scores on the pre-intervention and post-intervention intervention subscales were identical (M=11.93). Due to this equality, no statistics were analyzed. Overall, the research hypothesis was supported.

Table 2

Clinical Decision-Making Self-Confidence Scale (CDMSCS)

Item	Not at all confident % Pre/Post	Somewhat not confident % Pre/Post	Somewhat confident % Pre/Post	Moderately confident % Pre/Post	Very confident % Pre/Post
1. How confident are you that you can recognize	0/0	6.9/0	24.1/10.3	51.7/24.1	17.2/65.5

signs and symptoms of a cardiac event?					
2. How confident are you that you can recognize signs and symptoms of a respiratory event?	0/0	0/0	17.2/6.9	55.2/34.5	27.6/58.6
3. How confident are you that you can recognize signs and symptoms of a neurological event?	0/0	3.4/0	31.0/13.8	55.2/55.2	10.3/31.0
4. How confident are you that you can accurately assess an individual with chest pain?	0/0	0/0	34.5/10.3	41.4/24.1	24.1/65.5
5. How confident are you that you can accurately assess an individual with shortness of breath?	0/0	0/0	20.7/6.9	37.9/34.5	41.4/58.6
6. How confident are you that you can accurately assess an individual with changes in mental status?	0/0	0/0	27.6/13.8	41.4/34.5	31.0/51.7
7. How confident are you that you can appropriately intervene for an individual with chest pain?	0/0	3.4/0	34.5/10.3	27.6/27.6	34.5/62.1
8. How confident are you that you can appropriately intervene for an individual with shortness of breath?	0/0	6.9/0	17.2/10.3	34.5/24.1	41.4/65.5
9. How confident are you that you can appropriately intervene for an individual with changes in mental status?	0/0	6.9/0	20.7/13.8	48.3/34.5	24.1/51.7
10. How confident are you that you can evaluate the effectiveness of your	0/0	0/0	27.6/6.9	44.8/27.6	27.6/34.5

interventions for an individual with chest pain?					
11. How confident are you that you can evaluate the effectiveness of your interventions for an individual with shortness of breath?	0/0	3.4/0	17.2/6.9	44.8/27.6	34.5/65.5
12. How confident are you that you can evaluate the effectiveness of your interventions for an individual with changes in mental status?	0/0	0/0	17.2/13.8	58.6/37.9	24.1/48.3

	x (SD)	Possible Range	Actual Range	*z*	*p*
Total Score				3.698	<.01
Pre	47.86 (7.698)	12-60	33-60		
Post	53.66 (7.432)	12-60	36-60		
Action Subscales					
Recognition				3.199	<.01
Pre	11.62 (1.879)	3-15	8-15		
Post	13.24 (1.806)	3-15	9-15		
Assessment				3.152	<.01
Pre	12.14 (2.031)	3-15	9-15		
Post	13.45 (1.920)	3-15	9-15		
Intervening				N/A	N/A
Pre	11.93 (2.520)	3-15	6-15		
Post	11.93 (2.520)	3-15	6-15		
Evaluation				3.322	<.01
Pre	12.17 (2.089)	3-15	8-15		
Post	13.52 (1.864)	3-15	9-15		
System Subscales					
Cardiac & Respiratory				3.597	<.01

Pre	32.14 (5.410)	8-40	22-40		
Post	36.38 (4.967)	8-40	24-40		
Neurological				3.328	<.01
Pre	15.72 (2.520)	4-20	11-20		
Post	17.28 (2.711)	4-20	12-20		

Clinical Question 3: What effect will the use of the MEWS tool have on nurse recognition of and response to clinical deterioration in simulation?

Correlation testing was used to test the hypothesis that use of the MEWS tool during a simulated patient deterioration event will be associated with greater performance during simulation. The hypothesis was not supported. There was a small positive but insignificant relationship between use of the MEWS and total scores on the Clinical Reasoning Evaluation Simulation Tool (CREST) (r =.341, p=.07). Use of the MEWS tool did not improve nurse performance during simulation (see Table 3).

Table 3

Clinical Reasoning Evaluation Simulation Tool (CREST) Scores

	x (SD)	Possible Range	Actual Range
1. Interpretation of patient's current situation from case information	4.10 (.772)	1-5	3-5
2. Performs physical assessment to gather cues	3.93 (.593)	1-5	2-5
3. Recognizes and interprets patient abnormalities	3.72 (.649)	1-5	2-5
4. Clusters cues together to identify relationships among them	3.83 (1.071)	1-5	2-5
5. Identifies appropriate problem(s) with reasoning	3.79 (1.013)	1-5	1-5
6. Identifies appropriate problem(s) with reasoning	4.17 (.848)	1-5	2-5
7. Performs action(s) to achieve desired outcomes	4.34 (.553)	1-5	3-5
8. Communicates effectively to escalate for help	3.86 (.953)	1-5	2-5

9. Evaluates effectiveness of action outcomes	3.79 (.861)	1-5	2-5
10. Performs effective reflection for ongoing improvement	4.03 (1.180)	1-5	1-5
11. Overall Clinical Reasoning Skill	7.83 (1.071)	1-10	6-10
Total Score r =.341, p=.07	47.41 (6.874)	11-60	33-60

Clinical Question 4: What effect will the use of the MEWS tool have on nurse recognition of and response to clinical deterioration in practice?

The research hypothesis that use of the MEWS tool would have an effect on nurse recognition of and response to clinical deterioration during their bedside practice was tested through Mann-Whitney U tests and descriptive statistics due to non-normal distributions. Results partially supported the hypothesis. A slight, insignificant decrease in the number of minutes between the nurses' first measurable indication of clinical deterioration and the next subsequent nurse documentation in the medical record was seen from pre-intervention (M= 109.55, SD= 89.67) to post-intervention (M=88.54, SD 93.08) (U =3036, z = -1.799, p = .07). Similarly, there was a small, insignificant increase in the number of vital signs obtained in the 24-hour period after MEWS trigger documentation from pre-intervention (M= 13.88, SD= 10.24) to post intervention (M= 16.58, SD= 10.24) (U= 4214, z=1.879, p= .06). Severe adverse events overall showed minimal decrease in the post-intervention period. There were 18 adverse events pre-intervention and 17 adverse events post-intervention. None of these measures supported the hypothesis.

However, other results showed indications that use of the MEWS did positively affect nurse recognition and response to deterioration. In pre-intervention chart reviews, 68% of nurses were found not to change their actions after documentation of signs of deterioration that would have triggered an action if the MEWS tool had been in use. Comparatively, post-intervention

chart reviews revealed only 34% of nurses did not change their actions. Nurse reassessment also increased from 12% pre-intervention to 42% post-intervention. Provider notification after reassessment increased slightly from 13% to 17% as well. Overall, the research hypothesis was partially supported (see Table 4).

Table 4

Nurse Response to Clinical Deterioration in Practice

	% Pre-Intervention	% Post-Intervention	% Change Pre- to Post-Intervention
Action Taken			
Routine Care/No Change in Actions	68.2	34.1	- 34.1
Reassessment Only	11.8	42.4	+ 30.6
Provider Notification Only	7.1	7.1	± 0
Reassessment and Provider Notification	12.9	16.5	+ 3.6

Clinical Question 5: How does a simulation-based intervention influence nurses use of deterioration screening tools in practice (MEWS for all causes and existing sepsis screening tool for sepsis)?

An independent samples *t*-test was used to test the hypothesis that implementation of the MEWS tool would significantly decrease the incidence of nurse failure to complete the existing sepsis screening tool. The research hypothesis was supported. During chart reviews, 60% of pre-intervention charts were found to have at least one omitted sepsis screen while only 24% of the post-intervention charts omitted a screening. Charts had significantly less omitted sepsis screen post-intervention (M= .24, SD= .427) than pre-intervention (M= .60, SD= .493) t (168) = 5.158, p= <.01. See Table 5.

Table 5

Sepsis Screen Completion

	x (SD)	*t* (*p*)	*n (%)*
Not completed		5.158 (<.01)	
Pre-Intervention	.60 (.493)		51 (60%)
Post-Intervention	0.24 (.427)		20 (23.5%)
Number of screens not completed			
Pre-Intervention			
0 (all completed)			34 (40.0)
1			17 (20.0)
2			13 (15.3)
3			5 (5.9)
4			8 (9.4)
5			3 (3.5)
6			3 (3.5)
7			0 (0.0)
8			1 (1.2)
9			9 (1.2)
Post-Intervention			
0 (all completed)			65 (76.5)
1			11 (12.9)
2			4 (4.7)
3			1 (1.2)
4			2 (2.4)
5			0 (0.0)
6			0 (0.0)
7			0 (0.0)
8			0 (0.0)
9			0 (0.0)
10			2 (2.4)

Simple completion is not the only aspect of the sepsis screening necessary to examine. In addition, incorrectly completed sepsis screens decreased from 73% pre-intervention (*M*= .73,

SD= .447) to 58% post-intervention (*M*=.*58*, *SD*= .497) *t* (168) = 2.110, *p*=.04. The most common types of incorrect documentation were failure to identify an existing or suspected infection followed by failure to mark values for all aspects of the tool to ensure that the electronic medical record could calculate a risk score. See Table 6.

Table 6

Sepsis Screen Accuracy

	x (SD)	*t (p)*	*n (%)*
Correctly completed		2.110 (.04)	
Pre-Intervention	.73 (.447)		23 (27.1)
Post-Intervention	.58 (.497)		36 (42.4)
Number of screens incorrectly completed			
Pre-Intervention			
0 (all correct)			23 (27.1)
1			19 (22.4)
2			13 (15.3)
3			10 (11.8)
4			8 (9.4)
5			4 (4.7)
6			3 (3.5)
7			1 (1.2)
8			1 (1.2)
9			3 (3.5)
Post-Intervention			
0 (all correct)			36 (42.4)
1			17(20.0)
2			6 (7.1)
3			8 (9.4)
4			4 (4.7)
5			5 (5.9)
6			5 (5.9)

7	1 (1.2)
8	2 (2.4)
9	0 (0.0)
10	1 (1.2)

The MEWS score was completed on average nearly 14 times per chart (*M*= 13.54, *SD* 11.44) in the post-intervention period. However, the average length of stay was 115.47 hours ± *SD* 80.662. As the MEWS tool is meant to be completed at least every four hours, the completion rate should have been closer to 28 times per chart. This lack of completion may have manifested the insignificant changes in patient outcomes previously mentioned as well as the documentation and vitals assessment rates.

Additional findings

When reviewing charts, the most likely rationale for the lack of changes to patient outcomes was that a lack of consistent use of the tool led to late recognition of the decline. Analysis was completed to see if more consistent use of the MEWS tool could have influenced the outcomes of the patients noted to have experiences severe adverse events. The mean highest charted MEWS score on the charts noted to have a severe adverse event post-intervention was 4.43 (*SD*= 2.878) with a range from two to nine. Three charts were noted to have no charted MEWS scores. However, the mean MEWS score calculated by the primary researcher on those same charts was 5.20 (*SD*= 2.530) with a range from two to eleven. Of the ten charts noted to have a severe adverse event that could have been predicted by the MEWS in the post implementation period, six remained at the study facility until discharge, three were transferred to an outside facility and one died.

Bivariate correlation was used to examine the relationship between the highest calculated MEWS score and the outcome of the severe adverse event. Because both variables were

normally distributed, Pearson's product moment correlation coefficient (*r*) was calculated. There was a statistically significant strong positive correlation between highest calculated MEWS score and severity of the severe adverse event outcome, $r(8) = .81$, $p = .01$. Higher MEWS scores were predictive of higher severity of severe adverse event outcomes.

Conclusions

A discussion of findings from this study will be examined in this chapter. Demographics of the nurse and chart samples are provided. The effect of a simulation-based educational intervention on nurse knowledge and self-confidence is presented. The effect of Modified Early Warning Score Tool use in simulation and practice is discussed. The impact of the intervention on nurses' use of deterioration screening tools is discussed. Strengths and limitations to the study are listed as are the implications to future research.

Participants in this study were predominately female, Registered Nurses who had previously experienced a patient deterioration event although the sample was diverse in terms of age, length of nursing experience, educational level and primary unit of employment. These results are similar to the findings of the U.S. Department of Health and Human Services, Health Resources and Services Administration's recent survey on the Registered Nursing workforce in the United States which indicates that male RNs comprised less than 10% of the RN workforce in the US as of 2018 but that overall diversity had increased within the nursing population (HRSA, 2018).

The charts evaluated indicated that sepsis and respiratory issues were the most common diagnoses to experience a deterioration event. This finding which correlates with the findings of Hall, Levant, and DeFrances in their 2013 study on trends in inpatient hospital deaths (Hall et al., 2013). Patients experiencing decline were mostly elderly patients who remained in the hospital nearly five days.

A researcher created knowledge quiz was used in this study to assess nurse knowledge about signs of pending clinical deterioration after undergoing a simulation-based educational intervention highlighting the signs of deterioration most commonly seen in the study facility.

Nurse scores on this test increased an average of 10% or 1.86 points which is slightly less than the 1.95-point increase seen in the Elder (2017) study. However, this figure still correlates with previous findings that simulation-based training has been shown to increase both knowledge and confidence in nurses when dealing with patients in crisis (Crowe et al., 2018; Elder, 2017; & Schubert, 2012).

The statistically significant increase in nurses' self-confidence in recognition of and response to clinical deterioration found in the current study also mirrors the findings of the Elder (2017) study. The mean increase in the current study of 5.8 points was slightly larger than the Elder (2017) study that found a mean increase in self-confidence scores of 4.97 points when also using the Clinical Decision-Making Self-Confidence Scale. The pilot study for the tool found similar increases on CDMSCS scores in the nursing student population (Hicks et al., 2009). However, no other studies could be located that used simulation-based education as an intervention to increase CDMSCS scores in the post-licensure population.

Less than 38% of nurses who participated in the simulated patient experience utilized the MEWS tool during the simulation despite the simulation occurring within two weeks of their classroom educational session and the tool being both on their badge cards and on the bedside table under the patient monitor. Therefore, it was not surprising that correlation testing revealed a small positive but insignificant relationship between use of the MEWS and total scores on the Clinical Reasoning Evaluation Simulation Tool (CREST). When questioned in debriefing on what prompted their decision making, ten nurses stated that they knew that there was going to be something wrong that they needed to talk to the provider about during simulation-based on the teaching on SBAR during the classroom sessions, six decided not to call the provider after their interventions improved the patient condition and two did not feel as if the patient presentation

was severe enough to warrant provider notification. Recognition of patient abnormalities was the CREST item with the lowest scores while performing actions to achieve desired outcomes was the CREST item that received the highest marks. This correlated with the further findings of this study that nurses at the study facility were prone to miss subtle clues of patient deterioration in actual practice with inpatients but quick to intervene once deterioration was noted.

During this study, use of the MEWS did not have a significant effect on timeliness of nurse documentation of recognition of deterioration nor vital sign documentation. There were also no significant differences in the overall number of severe adverse events from pre-intervention (N= 18) to post-intervention (N= 17). The delay in recognition was discussed in previous studies where between 42-65% of patients had a delay in recognition of deterioration in condition and subsequent increase in escalation of care (NCEPOD, 2005 & Sankey et al., 2016). However, once the decline was recognized, post intervention charts displayed a 34% increase in actions taken in response to deterioration including a 30% increase in nurse reassessment. Lack of tool completion was found to be a factor and was also mentioned as a limitation to using tools to detect deterioration in several previous studies (Jonsson et al., 2011; Kyriacos et al., 2014; Ludikhuize et al., 2011; Ludikhuize et al., 2012; Niegsch et al., 2013; Petersen et al., 2017; & Stewart et al., 2014). Therefore, the positive effect of the MEWS on nurse recognition and response to clinical deterioration could only be partially supported.

The potential for a simulation-based educational intervention to increase nurses' use of deterioration screening tools was supported in all measures during this study. Completion of the existing sepsis screening tool in the organization more than doubled and incorrect completion of the tool decreased by 15%. The most common types of incorrect documentation were failure to identify an existing or suspected infection followed by failure to mark values for all aspects of

the tool to ensure that the Electronic Medical Record could calculate a risk score. Incorrect and omitted documentation of findings was expected as it has been seen in several previous studies (Duncan et al., 2012; Petersen et al., 2017; & van Galen et al., 2016). However, the systemic inflammatory response system (SIRS) criteria that undergird this screen are controversial in nature themselves. A recent study published in *CHEST: The Official Publication of the American College of Chest Physicians* reports that none of the trials used to form the Surviving Sepsis Campaign were based on patients who were not already in a critical care unit such as the Emergency Room or Intensive Care Unit (Bhattacharjee, Edelson, & Churpek, 2017). The tool is not necessarily the issue, however. This inaccuracy was also mentioned in a systematic review of sepsis screening tools that found only one study using a tool that displayed high specificity and sensitivity to sepsis (Alberto, Marshall, Walker, & Aitken, 2017).

When reviewing the MEWS itself, it was completed approximately half the time it was supposed to be during the implementation period. This trend was likely influenced by the lack of attendance of approximately 30% of the staff nurses in the organization at the mandatory training. Accuracy was also an issue with a noted difference in the mean charted MEWS score (M= 4.43, SD= 2.878) as compared to the mean MEWS score calculated by the primary investigator when reviewing the chart documentation (M= 5.20, SD= 2.530). However, this inaccuracy was common in many other studies as well (Jonsson et al., 2011; Kyriacos et al., 2014; Ludikhuize et al., 2011; Ludikhuize et al., 2012; Niegsch et al., 2013; Petersen et al., 2017; & Stewart et al., 2014). Additional findings indicated that the MEWS score was accurate in predicting clinical deterioration in acutely ill inpatients as there was a statistically significant strong positive correlation between highest calculated MEWS score and severity of the severe

adverse event outcome. Although the charted MEWS did not always correlate with the actual measurement, the difference did not make a significant change in the outcome.

Strengths and Limitations

The greatest strength of this study was the ability to support simulation-based educational interventions in the post-licensure nursing population as well as the validation of the MEWS to detect acute patient deterioration. Although only 29 nurses were evaluated during simulation, all 85 nurses who attended classroom training also attended an individual simulation experience. Nurses' knowledge and self-confidence both increased after this simulation. Nurse response to deterioration and increased use and accuracy of existing screening tools was evaluated through the pre-and post-intervention chart reviews after implementation of the MEWS into the active medical record. Although accuracy of documentation remained an issue, the ability of the MEWS to predict patient deterioration was statistically significant even in such a small facility and sample size of severe adverse events.

Limitations of the current study included the small sample size of nurse participants as well as the small number of severe adverse events that occur at the study facility. Of those nurses who attended training but declined to participate in the study, the most commonly stated reason was fear of being videotaped. A recent study on attitudes toward video-assisted debriefing after simulation found that some undergraduate students felt that videotaping invaded their privacy and were concerned about the potential for reviewers of the video to be judgmental about their performance (Ha, 2014). Despite reassurance that the video would be deleted prior to leaving simulation, this concern could also have been a factor for those who chose not to participate in this study. If able, future studies might benefit from avoiding videotaping of participants as several studies have indicated that verbal debriefing by trained simulation staff

results in similar outcomes as a video assisted debriefing (Grant, Dawkins, Molhook, Keltner, & Vance, 2014; Ostovar et al., 2018; & Rossignol, 2017). It is also unclear if these same results would be obtained in a larger sample or with a greater degree of nurse participation. Inability to include all nurses in the educational sessions is also a limitation though the exact effect of this issue could not be determined. The previous training of nurses on acute deterioration could have been explored further and might have given more insight into the reasoning behind nurses choosing not to use the tool. Finally, the limited time frame between implementation and data mining could have been a factor in the small sample size of severe adverse events.

It is unclear if the tool will be sustained at the study organization as a change in documentation systems is ongoing and adjustments to the current system are on hold indefinitely. Some nurses have been afforded the ability to attend critical care training at the parent organization while those newly graduated nurses in the pre-admission setting like the Emergency Department have not yet been afforded that opportunity. Failure to receive specialized training could result in a higher rate of unrecognized clinical deterioration in the future if education is not ongoing after conclusion of this study. Although a facility-based educator has been hired, there remains no standard orientation process for the facility as a whole.

Implications to Future Research

This study illustrates the usefulness of the MEWS tool to detect clinical deterioration in hospitalized patients and the usefulness of simulation to provide a psychomotor reference to assist in response to deterioration in actual patients and increase both knowledge and self-confidence of bedside nurses. Future research should expand on the usefulness of simulation to provide education in post-licensure nurses as well as strategies to increase the use of Early Warning Score Systems such as the MEWS to predict potential for acute clinical deterioration.

Within the current study findings, re-education on the actions to be taken after MEWS trigger as well as the importance of accurate documentation may have some effect on the usefulness of the tool to detect deterioration earlier in the process.

Conclusion

The literature indicates a need for a system to assist nurses to detect and respond to acute clinical deterioration prior to severe adverse event. Diagnoses experiencing decline at the study facility mirror the common issues causing decline across the United States. The study findings indicate that the Modified Early Warning Score is accurate at predicting patient deterioration but is most useful when documentation is accurate. Therefore, strategies such as simulation to teach and encourage use of existing tools to assist nurses in detection of deterioration would be a necessary exploration in any organization that has documented delays in this process.

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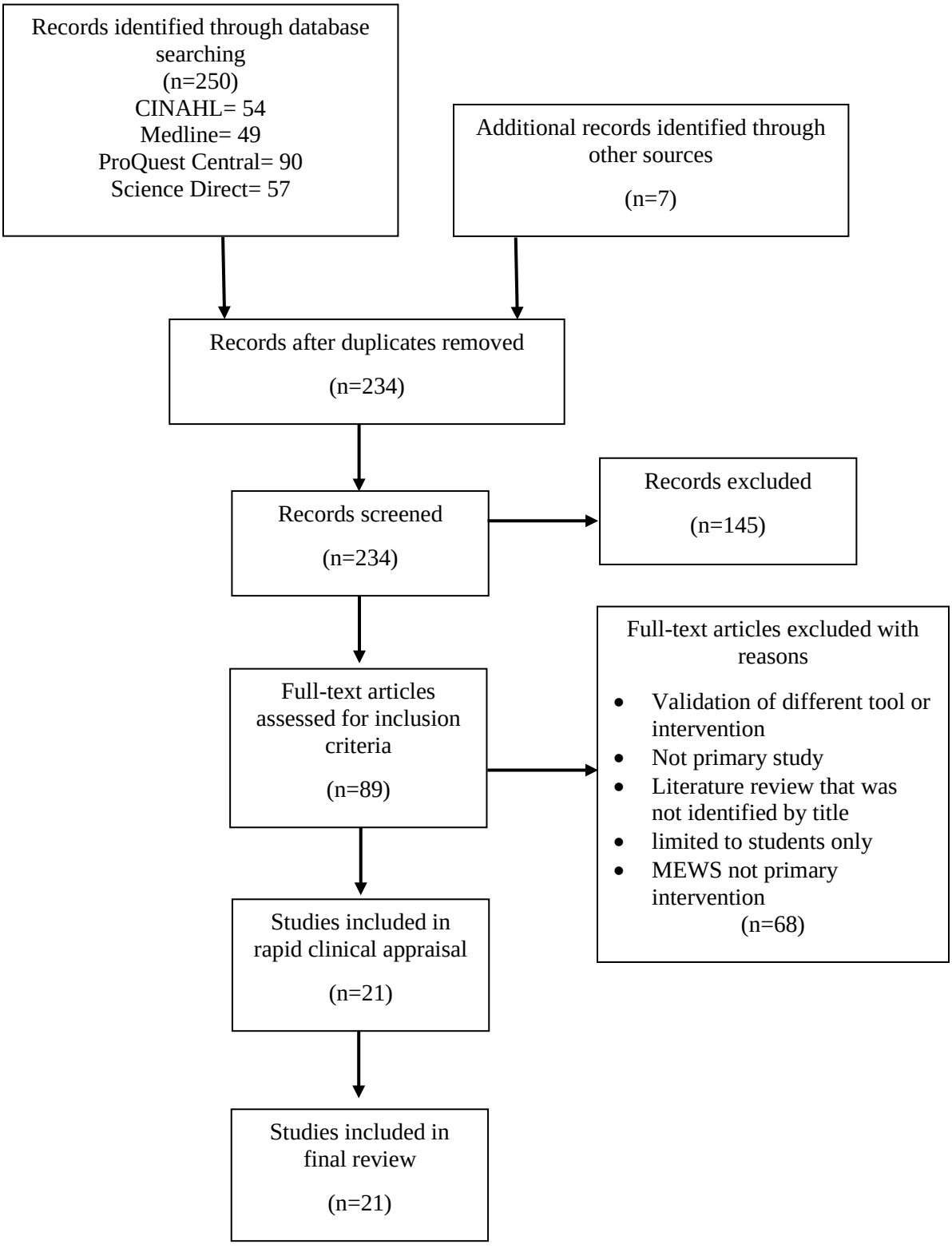
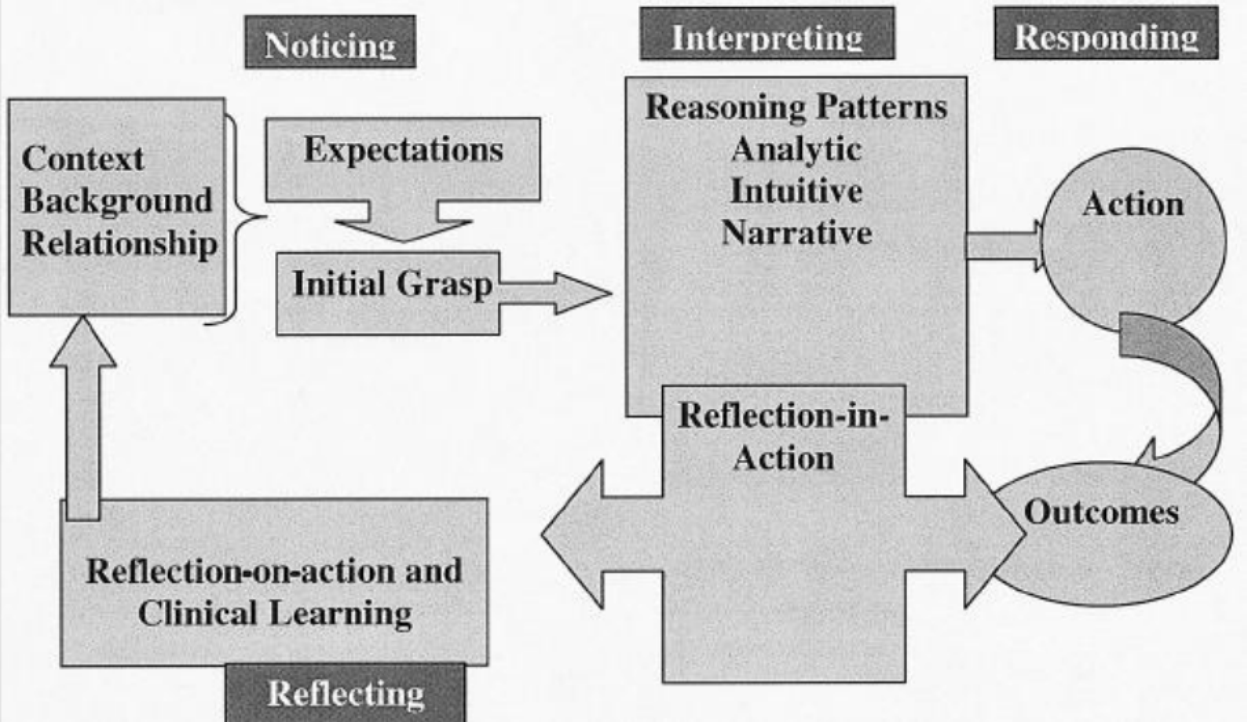
Appendix A
Prisma Diagram



Appendix B
Tanner Clinical Judgment Model



Tanner, C.A. (2006) Thinking like a nurse: A research-based model of clinical judgement. *Journal of Nursing Education, 45*(6). 204-211

Appendix C
MEWS Score Card and Decision Tree

MEWS (**M**odified **E**arly **W**arning **S**core)							
	3	2	1	0	1	2	3
Respiratory Rate (per minute)		≤ 8		9-18	19-20	21-29	≥ 30
Heart rate (per minute)		≤ 40	40-50	51-100	101-110	111-129	≥ 129
Systolic blood pressure	≤ 70	71-80	81-100	101-199		≥ 200	
Temperature ° F ° C		≤ 95.0 °F ≤ 35.0 °C	95.1-96.8 °F 35.1-36.0 °C	96.9-100.4 °F 36.1-38.0 °C	100.5-101.3 °F 38.1-38.5 °C	≥ 101.4 ≥ 38.6 °C	
Conscious level (AVPU)	**U**nresponsive	Responds to **P**ain	Responds to **V**oice	**A**lert	New agitation or confusion		
Complete the MEWS every shift and with any change in clinical condition (i.e. abnormal vitals or change in mental status) Scores 0-1: Monitor vitals and level of consciousness at least every 4 hours Scores 2-3: Contact provider about increase in score and monitor vitals and level of consciousness every 2 hours until MEWS stable for at least 4 hours or as per provider recommendation. Scores 4 or higher: Contact rapid response or Code team as appropriate							

Adapted from Institute for Healthcare Improvement (n.d.). Early warning systems: Scorecards that save lives. Retrieved 9 September 2018 from http://www.ihi.org/resources/Pages/ImprovementStories/EarlyWarningSystemsScorecardsThatSaveLives.aspx

Appendix D

Participant Identification _____

INFORMED CONSENT

Impact of a Modified Early Warning Score Tool on Nurses' Ability to Recognize and Respond to Clinical Deterioration

I, _____, agree to participate in the research, Impact of a Modified Early Warning Score Tool on Nurses' Ability to Recognize and Respond to Clinical Deterioration, which is being conducted by Talecia Warren, who can be reached at 478-696-1625 or talecia.warren@gcsu.edu. I understand that my participation is voluntary; I can withdraw my consent at any time. If I withdraw my consent, my data will not be used as part of the study and will be destroyed.

The following points have been explained to me:

1. The purpose of this study is to evaluate impact of the Modified Early Warning Score tool on the ability of bedside nurses to both recognize and react to clinical deterioration in the inpatient population.
2. The procedures are as follows: You will be required to participate in both a classroom learning session and a simulated patient experience as part of your annual training. Participation is expected to require approximately two hours of your time for which will be paid at your usual hourly rate by your employer as part of your annual education on your usual bi-weekly paycheck. If you decide to participate in the study, additional actions expected to take a total of 15-20 minutes of time during those existing sessions include:
    a. During the group classroom learning session- You will complete a demographic survey, a self-confidence survey, and an investigator-developed knowledge-based pre-intervention quiz. These will take place at the beginning of the classroom learning session. These items will be retained in paper form for three years after the study and then destroyed. The paperwork may only be viewed by the primary investigator and the other Georgia College faculty on the study committee (Dr. Leslie Moore, Dr. Laura Darby, & Dr. Sterling Roberts). No other personnel will have access to any identifying information.
    b. During the individual simulation- You will be evaluated on your performance during simulation by the primary investigator using a standardized evaluation tool. The simulation will be recorded to facilitate evaluation and debriefing. This video may only be viewed by the primary investigator and the other members of the study committee. The video will not be viewed by any other personnel and will be deleted in your presence at the end of your individual simulation session. No copies will be retained after you leave the simulation site. Unwillingness to be recorded will prevent the ability to participate in the study due to the need for the video to be used in the evaluation process. You will also be required to complete a post-intervention self-confidence survey and investigator-developed knowledge-based post-intervention quiz. These items will be retained in paper form for three years after the study and then destroyed. The paperwork may only be viewed by the primary investigator and the other Georgia College faculty on the study committee. No other personnel will have access to any identifying information.
    c. Involvement in this project requires participation in both sections of the study and completion of all study tools.
3. Cost for any expendable items will be borne by the primary investigator. Participation in the study will be at no financial cost to you.

4. Your name will not be connected to your data. Therefore, the information gathered will be confidential. Your participant identification number will be printed on all forms in your participant packet prior to being given to you.
5. You will be asked to sign two identical consent forms. You must return one form to the investigator before the study begins, and you may keep the other consent form for your records.
6. You may find that some questions are invasive or personal. If you become uncomfortable answering any questions, you may cease participation at that time.
7. This research project is being conducted because of its potential benefits to the nurses and patients of Navicent Health Baldwin. The expected benefits of this study include improved ability to recognize and respond to clinical deterioration and the opportunity to evaluate your clinical performance without actual patient harm.
8. You are not likely to experience physical, psychological, social, or legal risks beyond those ordinarily encountered in daily life or during your usual work performance by participating in this study.
9. Your individual responses will be confidential and will not be released in any individually identifiable form without your prior consent unless required by law.
10. De-identified information could be used for future research studies without any additional informed consent from you.
11. The principal investigator will answer any further questions about the research should you have them now or in the future (see above contact information).
12. In addition to the above, further information, including a full explanation of the purpose of this research, will be provided at the completion of the research project on request.
13. By signing and returning this form, you are acknowledging that you are 18 years of age or older. Please initial each of the following two lines and print and sign on the lines below.

    _____ (*Please initial)* I authorize for my performance during the simulated clinical experience to be videoed.

    _____ (*Please initial*) I authorize for the video recording of my performance to be viewed by the primary investigator and associated Georgia College faculty of the project. The content will only be used as a part of the research efforts of the primary investigator.

Signature of Investigator	Date
Printed Name of Participant	Date
Signature of Participant	Date

Research at Georgia College involving human participants is carried out under the oversight of the Institutional Review Board. Address questions or problems regarding these activities to the GC IRB Chair, email: irb@gcsu.edu

Appendix E

Participant Identification _____

Demographics Questionnaire

Please check the appropriate blocks below and fill in the blank if required

Age:

☐ 20-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60-69 ☐ 70-79 ☐ ≥80

Gender

☐ Male ☐ Female ☐ Prefer not to answer

Highest level of nursing education

☐ LPN ☐ ADN ☐ BSN ☐ MSN ☐ DNP/PhD

Length of nursing experience (Please round to the nearest whole number that represents your nursing experience).

☐ < 6 months ☐ 6 months- 1 year ☐ 2-5 years ☐ 6-10 years

☐ 11-15 years ☐ 16-20 years ☐ 21-25 years ☐ > 25 years

Type of primary nursing unit

☐ Emergency Department ☐ Intensive Care Unit ☐ Postpartum

☐ Medical/Surgical (4 Park Tower) ☐ Resource Pool

Any previous experience with initiating or responding to a Rapid Response or Code Blue?

☐ Yes ☐ No ☐ Unsure

Appendix F

Participant Identification _____

The Clinical Decision-Making Self-Confidence Scale

Please complete the following scale rating yourself on each item based on how you currently feel. Circle one item on each row.

	Not at all confident	**Somewhat not confident**	**Somewhat confident**	**Moderately confident**	**Very confident**
1. How confident are you that you can recognize signs and symptoms of a cardiac event?	1	2	3	4	5
2. How confident are you that you can recognize signs and symptoms of a respiratory event?	1	2	3	4	5
3. How confident are you that you can recognize signs and symptoms of a neurological event?	1	2	3	4	5
4. How confident are you that you can accurately assess an individual with chest pain?	1	2	3	4	5
5. How confident are you that you can accurately assess an individual with shortness of breath?	1	2	3	4	5
6. How confident are you that you can accurately assess an individual with changes in mental status?	1	2	3	4	5
7. How confident are you that you can appropriately intervene for an individual with chest pain?	1	2	3	4	5
8. How confident are you that you can appropriately intervene for an individual with shortness of breath?	1	2	3	4	5
9. How confident are you that you can appropriately intervene for an individual with changes in mental status?	1	2	3	4	5
10. How confident are you that you can evaluate the effectiveness of your interventions for an individual with chest pain?	1	2	3	4	5
11. How confident are you that you can evaluate the effectiveness of your interventions for an individual with shortness of breath?	1	2	3	4	5
12. How confident are you that you can evaluate the effectiveness of your interventions for an individual with changes in mental status?	1	2	3	4	5

Appendix G

Participant Identification _____

Clinical Reasoning Evaluation Simulation Tool (CREST)

The CREST is designed specifically to evaluate the clinical reasoning skills of a nurse or a nursing student in recognising and responding to clinical deterioration in a simulated environment.

There are 10 items, scored with a five-point Likert rating scale, that are grouped into 8 subscales. These are either rated based on questioning (**items 1, 4, 5, 6, & 10**) to elicit verbal responses or observations of a simulation performance (**items 2, 3, 7, 8, & 9**). A final global item, scored with a 10-point Likert rating scale, allows rating of the nurse/nursing student's performance as a whole.

The following steps are recommended:

1. **Reading time.** The individual should be given some time (e.g. 5 minutes) to read the case notes of the simulated scenario.

2. **Questioning.** The assessor rates ***item 1*** through face-to-face questioning.

3. **Simulation performance**. The assessor rates ***items 2, 3, 7, 8, & 9*** by observing the individual's simulation performance and use of the 'think aloud' strategy.

4. **Questioning**. The assessor rates *items **4, 5, 6, & 10*** through face-to-face questioning.

Participant Identification _____

Domain/Item	Questioning (Q)/ Observation(O)	1	2	3	4	5	Score
Considering patient situation							
1) Interpretation of patient's current situation from case information	**Q:** How have you interpreted the given information?	Unable to interpret relevant case information	Limited attempt to interpret relevant case information	Interprets case information to reveal some important patterns or deviations	Interprets case information to reveal most important patterns or deviations	Interprets case information thoroughly to reveal all important patterns or subtle deviations	
Collecting cues							
2) Performs physical assessment to gather cues	**O:** Observe performance of physical assessment	Unable to collect important cues relevant to the case	Collects a limited number of cues relevant to the case	Collects important cues relevant to the case with limited use of a systematic approach	Collects important cues relevant to the case using a systematic approach	Collects important cues relevant to the case using a thorough systematic approach	
Processing information							
3) Recognizes and interprets patient abnormalities	**O:** Observe through "think aloud" on the recognition and interpretation of abnormalities	Unable to recognize obvious abnormalities	Limited ability to recognize abnormalities	Recognizes patient abnormalities with limited interpretation	Recognizes patient abnormalities with some interpretation	Recognizes all patient abnormalities with clear interpretation	
4) Clusters cues together to identify relationships among them	**Q:** How do you link the signs and symptoms of the patient together?	Unable to make connections between cues	Limited ability to make connections between cues	Clusters main cues together with limited reasoning	Clusters main cues together with sound reasoning	Able to cluster main cues together with thorough reasoning	
Identifying problem/ issue							
5) Identifies appropriate problem(s) with reasoning	**Q:** What do you think had happened to the patient?	Unable to identify appropriate problems	Limited ability to identify appropriate problems	Identifies appropriate problems with limited reasoning	Identifies appropriate problems with sound reasoning	Identifies appropriate problems with thorough reasoning	

Liaw et al. (2018). Development and psychometric testing of a Clinical Reasoning Evaluation Simulation Tool (CREST) for assessing nursing students' abilities to recognize and respond to clinical deterioration. Nurse Education Today, 62, 74–79. https://doi.org/10.1016/j.nedt.2017.12.009

Participant Identification _____

Domain/ Item	Questioning (Q)/ Observation(O)	1	2	3	4	5	
Establishing goals							
6) States desired patient outcomes	**Q:** What did you aim to do for the patient and why?	Unable to identify desired outcomes	Identifies limited desired outcomes	Identifies desired outcomes with limited reasoning	Identifies desired outcomes with sound reasoning	Identifies desired outcomes with thorough reasoning	
Taking actions							
7) Performs action(s) to achieve desired outcomes	**O:** Observe actions taken to manage situation	Unable to perform appropriate actions	Performs limited appropriate actions	Performs appropriate actions with limited effectiveness	Performs appropriate actions with effectiveness	Performs appropriate actions with optimal effectiveness and efficiency	
8) Communicates effectively to escalate for help	**O:** Observe communication skills via phone call	Unable to communicate main issues	Limited ability to communicate main issue	Communicates main issues with limited use of ISBAR	Communicates main issues clearly and concisely using ISBAR	Communicates main issues clearly and concisely using ISBAR and with a sense of urgency	
Evaluating outcomes							
9) Evaluates effectiveness of action outcomes	**O:** Observe actions taken to evaluate outcome and adjust interventions	Unable to evaluate action outcomes	Limited evaluation of action outcomes	Evaluates the effectiveness of action with limited ability to adjust action plans	Evaluates the effectiveness of action with some ability to adjust action plans	Evaluates the effectiveness of action with clear ability to adjust action plans	
Reflecting on process and new learning							
10) Performs effective reflection for ongoing improvement	**Q:** What do you think were your strengths and weaknesses? Where do you think you could have done better?	Unable to reflect on strengths and weaknesses	Limited reflection on strengths and weaknesses	Reflects on strengths and weaknesses with limited ability to identify plans for improvement	Reflects on strengths and weaknesses with some ability to identify plans for improvement	Reflect on strengths and weaknesses with clear ability to identify plans for improvement	
11) Overall **On a scale of 1-10, rate the participants' overall clinical reasoning skill** 1 2 3 4 5 6 7 8 9 10 Unsatisfactory Outstanding							
Total score:							

Liaw et al. (2018). Development and psychometric testing of a Clinical Reasoning Evaluation Simulation Tool (CREST) for assessing nursing students' abilities to recognize and respond to clinical deterioration. Nurse Education Today, 62, 74–79. https://doi.org/10.1016/j.nedt.2017.12.009

Participant Identification _____

Appendix H

CREST Checklist

CREST Item 1) Interpretation of patient's current situation from case information Question: How have you interpreted the given information?

Deterioration risk factors and patient abnormalities identified in initial presentation symptoms

- ☐ age >65
- ☐ recent influenza,
- ☐ current smoker
- ☐ fever/chills,
- ☐ productive cough with rust colored sputum
- ☐ fatigue
- ☐ chest pain
- ☐ tachycardia
- ☐ tachypnea
- ☐ shortness of breath
- ☐ dyspnea on exertion
- ☐ fever
- ☐ need for oxygen
- ☐ lack of use of incentive spirometer
- ☐ uncompensated respiratory acidosis
- ☐ elevated WBC

Level 5= Recognizes 13 or more of the listed initial risk factors and abnormalities that indicate increased risk for acute deterioration.
Level 4= Recognizes 10-12 of the listed initial risk factors and abnormalities that indicate increased risk for acute deterioration
Level 3= Recognizes 6-9 of the listed initial risk factors and abnormalities that indicate increased risk for acute deterioration
Level 2= Recognizes 3-5 of the listed initial risk factors and abnormalities that indicate increased risk for acute deterioration
Level 1= Recognizes 0-2 of the listed r initial risk factors and abnormalities that indicate increased risk for acute deterioration

CREST Item 2) Performs physical assessment to gather cues Observation: Observe performance of physical assessment

Neurological Exam

- ☐ Asks name & DOB
- ☐ Checks patient orientation

Cardiac Exam

- ☐ Checks blood pressure
- ☐ Checks pulse
- ☐ Auscultates heart sounds

Respiratory Exam

- ☐ Checks respiratory rate
- ☐ Checks pulse oximetry
- ☐ Observes respiratory pattern
- ☐ Auscultates lungs
- ☐ Assesses sputum

Other assessment factors

- ☐ Assesses temperature
- ☐ Assesses pain
- ☐ Requests additional background history
- ☐ Assesses use of incentive spirometer

Level 5= Completes 13 or more of the listed aspects of physical assessment
Level 4= Completes 10-12 of the listed aspects of physical assessment
Level 3= Completes 6-9 of the listed aspects of the physical assessment
Level 2= Completes 3-5 of the listed aspects of the physical assessment
Level 1= Completes 0-2 of the listed aspects of the physical assessment

CREST Item 3) Recognizes and interprets patient abnormalities. Observation: Observe through "think aloud" on the recognition and interpretation of abnormalities

Verbal mention of patient abnormalities discovered in initial assessment

- ☐ Increase in tachycardia (104 to 119)
- ☐ Elevation in BP from baseline (112/72 to 148/88)
- ☐ Decrease in SpO_2 (95% to 87%)
- ☐ Increase in temp 100.6 °F to 101.0 °F (38.1 °C to 38.2 °C)
- ☐ Circumoral cyanosis
- ☐ Coarse crackles to lower right lobe
- ☐ Rust colored sputum

Level 5= Verbal mention during simulation of all listed physical abnormalities and their significance to the situation
Level 4= Verbal mention during simulation of 5-6 of the listed physical abnormalities and their significance to the situation
Level 3= Verbal mention during simulation of 3-4 of the listed physical abnormalities and their significance to the situation
Level 2= Verbal mention during simulation of 1-2 of the listed physical abnormalities and their significance to the situation
Level 1= No verbal mention during simulation of any of the listed physical abnormalities and their significance to the situation

CREST Item 4) Clusters cues together to identify relationships among them Question: How do you link the signs and symptoms of the patient together?

Cluster clues to deterioration

Worsening symptoms of respiratory issue

- ☐ increase in tachycardia
- ☐ increase in fever despite Tylenol
- ☐ decrease in oxygen saturation
- ☐ increased need for oxygen
- ☐ circumoral cyanosis

Causes for less respiratory reserve

- ☐ age >65
- ☐ recent influenza
- ☐ current smoker
- ☐ lack of incentive spirometer use

Stable symptoms of respiratory issue

- ☐ productive cough with rust colored sputum
- ☐ fatigue
- ☐ chest pain
- ☐ tachypnea (24 to 22)
- ☐ dyspnea on exertion
- ☐ uncompensated respiratory acidosis
- ☐ elevated WBC
- ☐ patient report of dyspnea on exertion

Level 5= Explains at least 5 connections between identified symptoms and risk for deterioration with thorough reasoning
Level 4= Explains at least 4 connections between identified symptoms and risk for deterioration with sound reasoning
Level 3= Explains at least 3 connections between identified symptoms and risk for deterioration with limited reasoning
Level 2= Explains at least 2 connections between identified symptoms and risk for deterioration with limited reasoning
Level 1= Explains at least 0-1 connections between identified symptoms and risk for deterioration ***or*** does not explain reasoning

CREST Item 5) Identifies appropriate problem(s) with reasoning **Question: What do you think had happened to the patient?**

Potential problems

- Lack of use of incentive spirometer led to worsening pneumonia, respiratory acidosis, crackles in lungs, elevated WBC
- Worsening pneumonia led to chest pain, fatigue, tachypnea, dyspnea on exertion
- Increase in blood pressure likely caused by anxiety of decreased respiratory status
- Symptoms of impending deterioration include increase in temperature and heart rate along with decrease in oxygen saturation and cyanosis
- Other potential problems as identified by participants

Level 5= At least 4 problems identified with thorough reasoning.
Level 4= At least 3 problems identified with sound reasoning.
Level 3= At least 2 problems identified with limited reasoning.
Level 2= Only 1 problem identified with limited reasoning
Level 1= No problems identified

CREST Item 6) States desired patient outcomes **Question: What did you aim to do for the patient and why?**

Potential outcomes

- Maintain patient safety
- Increase SpO_2 to >94% as ordered
- Increase lung expansion
- Promptly identify changes in patient status
- Ensure provider aware of patient deterioration
- Increase patient education on pneumonia

Level 5= At least 4 outcomes identified with thorough reasoning.
Level 4= 3 outcomes identified with sound reasoning.
Level 3= 2 outcomes identified with limited reasoning.
Level 2= 1 outcome identified with limited reasoning.
Level 1= No outcomes identified

CREST Item 7) Performs action(s) to achieve desired outcomes **Observation: Observe actions taken to manage situation**

Potential actions

- ☐ Raises siderail
- ☐ Places patient on oxygen
- ☐ Completes respiratory assessment
- ☐ Raises head of bed
- ☐ Increases oxygen until saturation >95%
- ☐ Encourages incentive spirometer use
- ☐ Encourages deep breathing exercises
- ☐ Educate patient on smoking cessation
- ☐ Completes MEWS tool
- ☐ Completes Sepsis Screening Tool
- ☐ Contacts provider
- ☐ Educate patient on treatment of pneumonia (increased fluids, antibiotics, rest periods)

Level 5= Performs at least 10 actions with optimal effectiveness and efficiency
Level 4= Performs 7-9 appropriate actions with effectiveness
Level 3= Performs 4-6 appropriate actions with limited effectiveness
Level 2= Performs 3-5 appropriate actions
Level 1= No actions taken

CREST Item 8) Communicates effectively to escalate for help **Observation: Observe communication skills via phone call**

Items to communicate to provider

Situation

- ☐ Nurse name
- ☐ Patient name

States concerns: ☐ SpO_2 ☐ HR ☐ RR ☐ Temp ☐ Crackles ☐ Cyanosis ☐ Sputum ☐ Dyspnea ☐ Pain level ☐ MEWS ☐ Sepsis screen score

Background

- ☐ Admitting diagnosis

Pertinent history:
☐ influenza ☐ smoker
☐ Tylenol given
☐ sputum results pending
☐ already on antibiotics

Assessment

- ☐ States concern about deterioration

Actions taken: ☐ increase oxygen ☐ raise head of bed ☐ use incentive spirometer ☐ teach breathing exercises ☐ Educate on pneumonia

Recommendation

- ☐ Requests MD assessment or further orders

Level 5= Communicates main issues clearly and concisely using ISBAR and with a sense of urgency
Level 4= Communicates main issues clearly and concisely using ISBAR
Level 3= Communicates main issues with limited use of ISBAR
Level 2= Limited ability to communicate main issue
Level 1= Unable to communicate main issues

CREST Item 9) Evaluates effectiveness of action outcomes **Observation: Observe actions taken to evaluate outcome and adjust interventions**

Evaluation actions

- Assess vitals at beginning of simulation to assess effectiveness of previous actions
- Rechecks oxygen level & respiratory rate after applying oxygen and elevating head of bed
- Titrates oxygen to desired effect
- Reassess lungs after breathing exercises
- Requests teach-back of education given

Level 5= Evaluates the effectiveness of action and adjusts plans until goals met
Level 4= Evaluates the effectiveness of action and adjusts plans until goals partially met
Level 3= Evaluates the effectiveness of action and adjusts plans until some goals met
Level 2= Evaluates the effectiveness of action and adjusts plans until some goals partially met
Level 1= Does not reassess after actions taken

CREST Item 10) Performs effective reflection for ongoing improvement **Question: What do you think were your strengths and weaknesses? Where do you think you could have done better?**

Level 5= Reflect on strengths and weaknesses with clear ability to identify plans for improvement
Level 4= Reflects on strengths and weaknesses with some ability to identify plans for improvement
Level 3= Reflects on strengths and weaknesses with limited ability to identify plans for improvement
Level 2= Limited reflection on strengths and weaknesses
Level 1= Unable to reflect on strengths and weaknesses

CREST Item 11) Overall **On a scale of 1-10, rate the participants' overall clinical reasoning skill**

If total CREST on items 1-10= 50 then 10
If total CREST on items 1-10= 45-49 then 9
If total CREST on items 1-10= 40-44 then 8
If total CREST on items 1-10= 35-39 then 7
If total CREST on items 1-10= 30-34 then 6
If total CREST on items 1-10=25-29 then 5
If total CREST on items 1-10=20-24 then 4
If total CREST on items 1-10=15-19 then 3
If total CREST on items 1-10=11-14 then 2
If total CREST on items 1-10=10 then 1

Appendix I
Post-Simulation Debriefing Discussion Topic Outline

Initial question to be discussed during debriefing	**Additional NLN scenario specific recommended points of discussion related to this question**	**Specific nursing area of focus for additional recommended points of discussion**
What do you believe were the objectives of this simulation? *(NLN general opening questions)*		
How have you interpreted the given information? (*CREST Item # 1)*	• What problems did you identify? • Give some specific examples of the patient's nursing diagnosis related to pneumonia. • Talk about the rationale guiding your thinking about the focused assessment • What information did you have about this patient at the beginning of the scenario? How did you use this information? • What other information in the patient's chart is related to the diagnosis of pneumonia? • How would you use the information in planning and prioritizing nursing care?	• General nursing • Patient Care Coordination • Evidence Based Practice • Informatics • Informatics • Informatics
How do you link the signs and symptoms of the patient together? (*CREST Item # 4)*	• How do you explain her shortness of breath? • How did you decided which oxygen device to use? • When would you choose to use other oxygen devices?	• Evidence Based Practice • Evidence Based Practice • Evidence Based Practice

What do you think had happened to the patient? (*CREST Item # 5)*	• Can you give a specific example from what you have read or learned in class about pneumonia or oxygenation that applies to this scenario?	• Quality Improvement
What did you aim to do for the patient and why? (*CREST Item # 6)*	• How did you prioritize your patient's problems in the scenario?	• Patient Care Coordination
Were you familiar with the supplies and equipment you used? How did this affect how you functioned in patient care? (*NLN simulation specific question*)	• What patient safety measures should be considered when oxygen is in use in acute care? • What infection control practices were followed during the procedure? Could this be improved?	• Safety • Safety
Describe your communication with a patient who is experiencing difficulty breathing. (*NLN simulation specific question*)	• Were questions and responses therapeutic based on her condition? • Describe the patient education you provided. What else would you include next time?	• Patient Care Coordination • Patient Care Coordination
What do you think were your strengths and weaknesses? Where do you think you could have done better? *CREST Item # 10*	• How did you feel throughout the simulation experience? • What do you think went well?	• General questions • General questions
How will you apply what you learned today to your clinical practice? (*NLN general closing question*)	• What did you learn from this experience? • If you were to do this again, how would you handle the situation differently?	• General closing questions • General closing question
Is there anything else you would like to discuss? (*NLN general closing question*)		

Appendix J
Pre-Intervention Chart Reviews Evaluation Tool

Entry number (Data line in SPSS)	Primary Diagnosis	Secondary Diagnosis	Presence of SAE	Actions taken to prevent SAE	Timeframe for action to prevent SAE	Frequency of VS documentation	Sepsis screening tool completion percentage	Accuracy of sepsis screening tool documentation

Appendix K
Post Intervention Chart Reviews Evaluation Tool

Entry number (Data line in SPSS)	Primary Diagnosis	Secondary Diagnosis	Presence of SAE	Actions taken to prevent SAE	Timeframe for action to prevent SAE	Frequency of VS documentation	Sepsis screening tool completion percentage	Accuracy of sepsis screening tool documentation	MEWS Documentation Frequency	MEWS documentation accuracy

Appendix L

Severe Adverse Event Documentation Form

Entry number (Data line in SPSS)	Time of Incident	MEWS score 4 hrs pre-event	MEWS score 8 hrs pre-event	MEWS score 12 hrs pre-event	MEWS score 16 hrs pre-event	MEWS score 20 hrs pre-event	MEWS score 24 hrs pre-event
Nursing action taken and timeframe							
Entry number (Data line in SPSS)	Time of Incident	MEWS score 4 hrs pre-event	MEWS score 8 hrs pre-event	MEWS score 12 hrs pre-event	MEWS score 16 hrs pre-event	MEWS score 20 hrs pre-event	MEWS score 24 hrs pre-event
Nursing action taken and timeframe							
Entry number (Data line in SPSS)	Time of Incident	MEWS score 4 hrs pre-event	MEWS score 8 hrs pre-event	MEWS score 12 hrs pre-event	MEWS score 16 hrs pre-event	MEWS score 20 hrs pre-event	MEWS score 24 hrs pre-event
Nursing action taken and timeframe							
Entry number (Data line in SPSS)	Time of Incident	MEWS score 4 hrs pre-event	MEWS score 8 hrs pre-event	MEWS score 12 hrs pre-event	MEWS score 16 hrs pre-event	MEWS score 20 hrs pre-event	MEWS score 24 hrs pre-event
Nursing action taken and timeframe							

Participant Identification _____

Appendix M

Nurse Recognition and Response to Acute Deterioration Knowledge Quiz

All scenarios adapted from the Institute for Healthcare Improvement's SBAR Training Scenarios and Competency Assessment

Use the following scenario to answer questions 1-3

> Mrs. S is a 72-year-old retired school teacher. She lives alone with her dog Ginger and is very independent. She was shoveling snow on Monday morning after the big storm. While shoveling she developed a crushing sensation in her chest. This is not the first time she has had chest pain. Mrs. S has a history of angina, though she has never had a heart attack. She takes an aspirin every day at home and keeps nitroglycerin tabs in her pocket "just in case". Mrs. S took a nitroglycerin tab and an aspirin and drove herself to the hospital. Mrs. S was admitted to the hospital on Monday afternoon with chest pain, rule out myocardial infarction. (Bronson Healthcare Group, n.d., p. 2)

1. Which focused assessment will be MOST important for this client?
    a. Cardiac
    b. Abdominal
    c. Respiratory
    d. Neurological

2. What information would be LEAST pertinent to relay to the healthcare provider in case of later decline
    a. Her pain started while shoveling snow
    b. She lives independently at home with her dog
    c. She was admitted with CP r/o MI but has never had an MI before
    d. She took nitroglycerin and aspirin before coming to the hospital

3. What risk factors does Mrs. S. have that increase your suspicion for myocardial infarction (MI)? Write your responses.

Use the following continuation of the scenario to answer questions 4-8

> Mrs. S has been a patient on cardiology for 2 days now. She has had no chest pain since Monday and her stress test was negative. She has been receiving NS at 42 ml/hr and expects to go home in the morning. At 2200, Mrs. S put her call light on. Her nurse Sue, RN, answered the call light. Mrs. S stated that she was having chest pain and rated it a 9/10 on the pain scale. Sue, RN, had the PCT check her vitals. Sue, RN, went to get her a nitroglycerin tab. Mrs. S blood pressure was 94/52 (MAP 66). Her HR was 120. Her breathing was labored at 36. Her temperature was 97.5 °F and her pulse ox was 85% on room air. (Bronson Healthcare Group, n.d., p. 2)

4. Which of Mrs. S's vital signs fall outside of the expected range of "normal"? ***SELECT ALL THAT APPLY.***
    a. Blood pressure
    b. Heart rate
    c. Respiratory Rate
    d. Temperature
    e. Pulse Oximetry

5. Would Mrs. S's current presentation require a sepsis screen?
    a. Yes
    b. No

6. If you completed a sepsis screen, what would the outcome be? ***Answer even if you chose no in the previous question.***
    a. No risk of sepsis
    b. Sepsis
    c. Severe Sepsis
    d. Septic Shock

7. What is Mrs. S's Modified Early Warning Scale (MEWS) score? ***Use the badge card you received for reference.***
    a. 4
    b. 5
    c. 6
    d. 7

8. What is the recommended action for this score?
    a. Continue to monitor
    b. Call the provider
    c. Call the Rapid Response Team.
    d. Call the Code Team

Use the following continuation of the scenario to answer questions 9-11.

> Sue gave Mrs. S a nitroglycerin tab sublingually. There was no relief to her chest pain and her blood pressure decreased to 80/52 (MAP 61). Sue, RN, placed Mrs. S on oxygen at 2L and her pulse ox improved to 91%. Mrs. S is very anxious and states she feels terrible. Sue, RN, increased her IV fluids to 100cc/hr and called the physician. (Bronson Healthcare Group, n.d., p. 2)

9. Was Sue correct to give the nitroglycerin tab & place Mrs. S. on oxygen?
    a. Yes, for both
    b. No, for both
    c. Yes, for giving nitroglycerin, no for applying oxygen
    d. Yes, for applying oxygen, no for giving nitroglycerin

10. What information would need to be part of the "situation" section of the SBAR report to the provider or rapid response team? ***SELECT ALL THAT APPLY.***
    a. Patient's history of angina
    b. Patient's admitting diagnosis
    c. Current vital signs & physical assessment
    d. Request for the provider to come to bedside

11. Based on Mrs. S's current MEWS score, how often will she need reassessment once immediate crisis passed?
    a. Every 8 hours
    b. Every 4 hours
    c. Every 2 hours
    d. At least hourly

Use the following scenario to answer questions 12-16.

> Mr. Jones is a 35-year-old and had a bowel resection 3 days ago. His admission vital signs were BP 120/80 (MAP 93), P- 98, R, 18, SpO_2- 96%, T-99.8. He is now on 4PT in room 4128. During morning assessment, it was noted that Mr. Jones required 50% Oxygen to maintain SpO_2 of 92%. His lung sounds were decreased in the bases, his cough was weak and ineffective. He required much coaching to use his incentive spirometer, and was only able to generate inspiratory volumes of 400 ml. His current vital signs are BP 105/67 (MAP 80), P- 102, R, 22, SpO_2- 92%, T-100.4. (Bronson Healthcare Group, n.d., p. 4).

12. Would Mr. Jones's current presentation require a sepsis screen?
    a. **Yes**
    b. No

13. If you completed a sepsis screen, what would the outcome be? ***Answer even if you chose no in the previous question.***
    a. No risk of sepsis
    b. Sepsis
    c. Severe Sepsis
    d. Septic Shock

14. What actions do you need to complete per the sepsis protocol based on your answers to number 12 and 13?
    a. None- he is at no risk for sepsis
    b. Obtain a lactic acid level & blood cultures then start antibiotics within 3 hrs of recognition
    c. Complete all of the items listed in B ***plus*** give a 30 ml/kg bolus
    d. Complete all of the items listed in B ***plus*** start Vasopressors

15. Where would Mr. Jones fall on the MEWS criteria?
    a. 2
    b. 3
    c. 4
    d. 5

16. What action would you need to take based on the MEWS score you calculated?
    a. Continue to monitor
    b. Call the provider
    c. Call the Rapid Response Team.
    d. Call the Code Team

Use the following scenario to answer questions 17-18.

Two hours later, Mr. Jones's vital signs are now BP 88/42 (MAP 57), P- 124, R, 26, SpO2- 89%, T-101.4.

17. Where does Mr. Jones fall now on the Sepsis Screening Tool?
    a. No risk of sepsis
    b. Sepsis
    c. Severe Sepsis
    d. Septic Shock

18. Where does Mr. Jones now fall on the MEWS tool?
    a. 4
    b. 5
    c. 6
    d. 7

Use the following scenario to answer questions 19-20.

The provider comes and orders a repeat CBC, CMP, Lactic Acid, portable Chest x-ray and a 2-liter bolus of Normal saline. Your patient weighs 165 lbs (75 kg).

19. Is this fluid order sufficient?
    a. Yes, it is over by 250 mL
    b. Yes, it is exactly the amount needed
    c. No, but it is close enough
    d. No, it is under by 250 mL

20. When should the next lactic acid be completed for this patient?

    a. 1 hour after the last one
    b. 2 hours after the last one
    c. 4 hours after the last one
    d. 6 hours after the last one