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UNIVERSITY OF NORTHERN COLORADO

Greeley, Colorado

The Graduate School

UNDERGRADUATE NURSING STUDENT SITUATION AWARENESS DURING SIMULATION

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy

Lynn Phillips

College of Natural and Health Sciences
School of Nursing
Nursing Education

December 2014

This Dissertation by: Lynn Phillips

Entitled: *Undergraduate Nursing Student Situation Awareness during Simulation*

has been approved as meeting the requirement for Degree of Doctor of Philosophy in College of Nursing and Health Sciences in the School of Nursing, Program of Nursing Education.

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ABSTRACT

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Graduate nurses encounter complex and rapidly changing patient care situations that require attentiveness, careful surveillance, and the recognition of subtle changes and patterns that will lead to appropriate decisions. Many researchers concur that new graduates are ill-equipped to meet these challenges, resulting in significant risk to patient safety. Situation Awareness (SA) is a skill that has been taught in the field of aviation to facilitate decision-making in complex, dynamic situations; however, there is little known about how nursing students develop SA. This mixed methods explorative study contrasted sophomore and senior nursing students' (n=33) measured levels of SA during simulations of deteriorating patients, and gathered information from the students regarding how they came to be aware of changes. The results indicate students do not have complete SA (avg. score 69%). There is also evidence of significant differences between sophomore and senior nursing students' scores on the comprehensive scale ($F(1,31) = 10.394$, $p = .002$) with senior scores significantly higher than sophomore scores. Students described how they became aware of the situation through developing expectations, determining salience and processing the information to create a meaningful whole. These themes support the proposed definition of situation awareness specific to

nursing. This study found that nursing students develop Situation Awareness during the course of their nursing program indicating the necessity for deliberate development of this important skill. These study results can be also used to improve nursing education by teaching students specific skills including recognition of changes in respiratory rate and habits of frequent reassessment for patients whose condition is changing. Together these skills will help address the lack of SA which impairs clinical judgment and contributes to unsafe nursing care. Recommendations include further study and measurement of nursing student SA as well as teaching strategies aimed at developing SA.

"*The range of what we think and do is limited by what we fail to notice. And because we fail to notice that we fail to notice, there is little we can do to change; until we notice how failing to notice shapes our thoughts and deeds*."

R. D. Laing

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CHAPTER I

INTRODUCTION

The purpose of this study is to examine the situation awareness (SA) of undergraduate nursing students. Comparison of sophomore and senior nursing students on both qualitative and quantitative measures offers a rich description of any differences in situation awareness between these two samples of undergraduate baccalaureate nursing students in order to uncover whether SA is a stable characteristic or changes over the course of a nursing program.

Significance

Novice nurses who are thrust into a complex and changing practice environment are often ill prepared to use sound clinical judgment and respond with necessary actions. Studies of practice breakdown where nurses do not perform to a minimum standard and studies of situations where nurses fail to rescue a patient from a preventable adverse outcome, confirm that lack of nursing vigilance and clinical judgment are major factors leading to near misses and actual patient harm (Bobay, Fiorelli, & Anderson, 2008; NCSBN, 2010; Schmid, Hoffman, Happ, Wolf, & DeVita, 2007).

Nursing Decisions

Nursing practice involves complex decisions that are often made in chaotic environments with limited time (Tucker & Spear, 2006; Potter et al., 2005; Ebright, Patterson, Chalko, & Render 2003). Patient conditions are not static; these frequent changes also contribute to the uncertainty and complexity of care delivery (Benner, 2004, Potter et al., 2005). In addition, nurses experience numerous interruptions and changes to their workload requiring frequent re-prioritization of activities (Tucker & Spear; Potter et al.). Tucker and Spear report that nurses only spend an average of 3.1 minutes on a single activity and then transition to the next important task. One workflow study indicated that the average duration of a nursing task specifically on a medical-surgical unit is only 62.4 seconds with 52% of the tasks occupying less than 30 seconds (Cornell, Riordan, Townsend-Gervis, & Mobley, 2011). This type of workflow requires rapid decision-making and the ability to quickly switch from task to task. A rapid and continuous process of changing priorities is referred to as cognitive "stacking" (Ebright, 2010). In order to correctly prioritize, nurses must quickly notice or be mindful of the changes in their patients as well as in their surroundings. Ebright further defines mindfulness as the ability to pay attention to and make sense of this information. Tucker and Spear also add that because 34-49% of nursing work involves coordination of care with other providers, nurses have to be mindful of the many activities of others as well. In summary, nurses must quickly notice and interpret changes in patient condition as well as the surrounding environment in order to make sound decisions.

Decision-making Errors

In part because of the complexity and dynamic changing environment, nurses and other healthcare providers sometimes deviate from the standard of practice or make judgment errors. Sometimes these errors, also called practice breakdowns, result in patient harm. Events that cause severe injury or harm are classified as sentinel events. In 2011, a total of 1,243 sentinel events in the United States were investigated by The Joint

Commission (The Joint Commission, 2012). A review of these events concluded that human factors were the most common root cause (Office of Quality Monitoring, 2012).

Studies of Practice Breakdowns

The National Council of State Boards of Nursing (NCSBN) has a vested interest in determining the root cause of practice breakdowns and protecting the public from these breakdowns. An analysis of the cases of nursing practice breakdown that were referred to Boards of Nursing revealed that the human factor involved in many cases was error in clinical judgment (NCSBN, 2010). Clinical judgment was sub-divided into eight areas by the Practice Breakdown Advisory Panel: Safe Medication Administration, Documentation, Attentiveness/Surveillance, Clinical Reasoning, Prevention, Intervention, Interpretation of Authorized Provider Orders and Professional Responsibility/Patient Advocacy. Of interest in this study is the standard of Attentiveness/Surveillance. The standard is defined as not only monitoring the clinical condition of the patient, but also as observing the surrounding context including other healthcare team members (NCSBN, 2010). These observations are the foundation for clinical reasoning and sound judgment. Practice breakdown and subsequent patient harm can occur when a) monitoring is not frequent enough, b) the nurse is not observant of changes, c) there is a lack of knowledge about what to observe or what the changes signify or d) fatigue, heavy workload or even personal problems interfere (Benner, Goettsche, & Bitz, 2010). Cases where the lack of monitoring led to patient injury and death have also been reported (Bobay, Fiorelli & Anderson, 2008, NCSBN, 2010).

A study of 59 nurses who were disciplined by the Texas State Board of Nursing found that 6.3% of the nursing practice breakdowns were related to clinical reasoning and 12.6% were related to lack of surveillance or attentiveness (Hester, Green, Thomas, &

Benton, 2011). Although these are smaller percentages than 28.9% for professional responsibility/advocacy and 22.6% for documentation, it is still important. These errors tend to occur earlier in a professional career and are more likely to occur with associate degree nursing graduates (Hester et al., 2011). The ratio of associate degree graduates to baccalaureate graduates for first time disciplinary actions was two to one.

Failure to Rescue

Practice breakdowns studied by NCSBN involve a subgroup of errors that can be classed as Failure-to-Rescue. Failure-to-Rescue is an indicator tracked by the Agency for Healthcare Research and Quality (AHRQ) that is measured by mortality associated with seven common hospital complications (AHRQ, 2011): pulmonary embolism or deep vein thrombosis, pneumonia, sepsis, shock or cardiac arrest and gastrointestinal bleeding. These complications are assumed preventable. From 2004 to 2008 preventable complication rates were 138 to 122 per 1000 admissions (AHRQ, 2011). The Healthgrades Patient Safety in Hospitals in America study cited Failure-to-Rescue as the most commonly occurring safety indicator with 103 deaths occurring after surgery per 1000 at-risk hospitalizations (Reed & May, 2011). Failure-to-Rescue is also a nurse-sensitive outcome that identifies the consequences of not recognizing patient deterioration and taking preventative steps (Schmid et al., 2007). Early research studies indicate that as the nurse to patient ratio increases, odds for failure to rescue increase (Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Aiken, Clarke, Sloane, Sochalski, & Silber, 2002). Aiken et al. (2002) attribute the decreases in patient mortality and morbidity seen with lower patient ratios to the ability of registered nurses to notice and intervene when patients begin to deteriorate. Researchers found that this nursing surveillance system is very effective, but can be compromised by increasing patient load and other workplace factors (Aiken et al., 2012). Nurses themselves reported that they are very good at preventing errors that may cause patient harm. According to Dykes, Rothschild and Hurley (2010), 345 nurse respondents reported preventing 18,578 medical errors which averaged about one error prevented per nurse per week. About 25% of errors were perceived by the nurses to be potentially lethal. The study highlights the role of the nurse in surveillance and prevention of adverse patient outcomes.

Subsequent studies have focused on patient level data to identify the specific cues that were not noticed or acted upon. Bobay (2008) reported five parameters significantly associated with Failure-to-Rescue. The parameters that showed subtle changes during the patient stay and were associated with failure-to-rescue were: respiratory rate, heart rate, temperature, serum sodium and urine output. Bobay suggests that these be the first cues that nursing students are trained to look for.

Novice Nurse Deficits

Benner (2004) describes the thinking of novice nurses or nursing students as rule based with difficulties identifying changes in patient signs and symptoms as well as the salience of these changes. Regarding new graduates or advanced beginners, Benner describes increased attentiveness to changes in patient condition, but continued deficits in connecting observations with recognizable patterns, prioritizing what is noticed in order of salience and recognizing subtle changes (Benner, 2004). Saintsing, Gibson and Pennington (2011) concluded from their literature review that novice nurses are more likely to commit errors. The 2004 National Council of State Boards of Nursing Practice survey reports that 53.5% of new graduate nurses have been involved in a patient error of some kind (Kenward & Zhong, 2006). Seventy-five percent of those errors involved medication administration. New graduates also have an increased number of patient falls (Kenward & Zhong, 2006; Smith & Crawford, 2003); are associated with delays in treatment (Smith & Crawford, 2003); and are also associated with increased wound infections and increased mortality (Morrow, 2009). New nursing graduates are frequently not prepared to recognize significant changes in patient conditions (Fero, Witsberger, Wesmiller, Zullo, & Hoffman, 2009). Deficits were recorded in the areas of initiating nursing interventions, recognizing urgency, and problem recognition (Fero et al., 2009). del Bueno (2005) reports that only 35% of new nursing graduates meet entry level requirements for clinical judgment according to standardized tests that employers often use as assessment tools for new hires.

Ebright, Urden, Patterson and Chalko (2004) interviewed novice nurses about near-misses as well as adverse events in the first year of practice and found that when faced with complex decisions novices often did not see the big picture and missed important cues. Novices did seek out experienced nurses to help them, and described time pressures and inadequate communication with others as contributing factors to the situation (Ebright et al., 2004). Initial research with senior nursing students measuring their awareness of important variables (e.g. vital signs, capillary refill) during a simulation suggests that students at this level are also missing important cues (Cooper et al., 2010).

Summary

Graduate nurses encounter complex and rapidly changing situations that require attentiveness, careful surveillance, and the recognition of subtle changes and patterns that will lead to appropriate decisions. Many researchers concur that new graduates are ill-equipped to meet these challenges resulting in significant risk to patient safety. More research is recommended regarding decision-making and the educational preparation of nurses Ebright et al. (2004).

Background

Problem and Assumptions

Novice nurses are required to quickly make complex decisions and are frequently not well prepared for this skill. The Clinical Judgment Model (Tanner, 2006) identifies noticing as the first step toward making sound clinical decisions. An underlying assumption inherent in this model is that increased ability to notice will positively affect clinical decisions. It is not assumed that improved noticing will always lead to improved decisions; because there are other factors in the model, however, good decisions do rely on collection and interpretation of salient cues. Very few research studies specifically focusing on noticing were found. Due to the significant overlap among the concepts of noticing, salience and situation awareness as discussed in chapter 2, the literature for these bodies of knowledge was examined for potential research tools and methods that would answer the question: "how do undergraduate nursing students gather and interpret information in the clinical setting?" The literature regarding situation awareness was the most helpful in answering this question. Measurement tools, a nursing definition of SA and some initial studies provided guidance in developing this research proposal. A gap in the literature regarding the development of SA in undergraduate nursing students gave further direction to this study. It is hoped that this research will contribute to understanding nursing student situation awareness and learning whether this skill is different between sophomore and senior nursing students. This exploratory study will provide information to allow educators to more effectively develop teaching strategies aimed at improving situation awareness for sophomore and senior undergraduate baccalaureate nursing students. The end goal is to devise teaching strategies to improve SA early in the educational process for nurses, which assumes that to some extent SA is a skill that can be taught and learned.

Nursing Education Changes Needed for Teaching Clinical Judgment

Throughout nursing education programs, clinical decision-making is taught using the nursing process. Textbooks, lectures and care plans are all designed to follow this reasoning process in order to make clinical decisions. This process is presented as linear and results in finding the “right” diagnosis for the patient. However, Tanner (2006) reviewed research studies and concluded that the nursing process does not adequately capture the factors in clinical judgment.

Both Benner (1999, 2004) and Tanner (2005, 2006) emphasize clinical experience and cognitive development as requisite for decision-making. This viewpoint for teaching decision-making is evident through the educational model of cognitive apprenticeship used in early diploma programs (Taylor & Care, 1999). This model is still in evidence today as the majority of coaching for decision-making occurs within the clinical setting (Benner, Sutphen, Leonard & Day, 2010).

In a study sponsored by the Carnegie Foundation, Benner et al. (2010) identified gaps in nursing education. Nursing students learned decision-making and a sense of salience through exposure in the clinical setting and dialogue with clinical instructors, however there were missed opportunities to discuss how to prioritize using rules or general guidelines (Benner et al., 2010). In addition, there was a lack of connection between learned facts in the classroom and clinical situations. This report recommends that nurse educators spend more time teaching clinical reasoning in the classroom and create more connections between the classroom and clinical setting. The Future of Nursing Report (Institute of Medicine, 2011) suggests that nursing education practices are outdated and specifically that decision making competencies must be taught using new strategies. There is some support from previous studies that nursing students can learn decision-making. Students who were taught decision analysis techniques chose priority clinical interventions more consistent with expert choices than students from the control group (Shamian, 1991). Nursing students who used a computer aided instruction program to learn cue recognition and sorting increased their decision accuracy (Thiele, Baldwin, Hyde, Sloan, & Strandquist, 1986). Specific teaching strategies recommended for linking the classroom more closely with clinical include case studies, Socratic questioning with “what if” questions, active engagement of the students in the learning process and simulation (Institute of Medicine, 2011; Benner et al., 2010).

Simulation

Simulation has been used for many years to teach medical students as well as to evaluate their learning (McGaghie, Issenberg, Petrusa, & Scalese, 2010). Simulation is also being used in many nursing programs. Katz, Peifer and Armstrong (2010) report that 78.9% of the responding baccalaureate nursing programs use high-fidelity simulation. Hayden (2010) reported on data from the National Council of State Boards of Nursing survey of all pre-licensure programs and found that high-fidelity or mid-fidelity simulation was used in 87% of nursing programs. High-fidelity simulation has been touted as a way to augment clinical practice utilizing learning experiences tailored specifically for the learning needs of the students in a controlled environment. According to Cook et al. (2012) using a meta-analysis combining 92 studies and 5608 participants, simulation is associated with improved outcomes compared to other teaching modalities. A small to moderate effect size was noted for outcome measures of knowledge and skills as well as satisfaction.

Simulation can be used as a teaching strategy with students who are learning clinical judgment (Lasater, 2007). This environment is advantageous to the development of clinical judgment since situations can be manipulated to create opportunities to practice making decisions (Dillard et al., 2009). The development and practice of clinical judgment has previously taken place during clinical experience, but these opportunities happen randomly and are not tailored to the current needs of the students. Su and Juestel (2010) found that simulation combined with coaching regarding critical thinking helped students learn to be more aware of their reasoning and apply critical thinking during the scenarios. However, a systematic review of nursing simulation studies found that although critical thinking may be improved through high-fidelity simulation, the effect of simulation on student clinical reasoning is inconclusive (Lapkin, Levett-Jones, Bellchambers, & Fernandez, 2010). Further research is needed in order to confirm that clinical judgment can be learned through high-fidelity simulation (Lasater, 2011).

Conclusion

Nursing education has relied on clinical experience and clinical coaching as the primary method to teach clinical judgment. This method is not consistent as clinical experiences are unpredictable. Part of the recommended reform in nursing education promotes using simulation as a strategy to bridge the gap between the classroom and the practice setting (Benner, Sutphen, Leonard & Day, 2010).

There are few studies and little information about how students develop clinical judgment (Lasater, 2011). A mixed methods study using descriptive statistics as well as content analysis of the student interview responses can help increase the body of knowledge surrounding SA, which is integral to clinical decision-making (Wright, Taekman & Endsley, 2004). Information about what cues students are aware of and whether they continue to develop SA skills as they complete clinical practice will help nurse educators plan future educational interventions to improve student SA and ultimately clinical judgment.

Specific Aims and Research Questions

The first aim of this study was to measure the Situational Awareness of sophomore and senior nursing students during simulations of patient deterioration.

Research Questions

Q1 Which cues are undergraduate nursing students most frequently aware of during a simulation of a deteriorating patient?

Q2 Which cues are undergraduate nursing students least often aware of during a simulation of a deteriorating patient?

Q3 Is there a difference in Situation Awareness scores or subscores measured during a simulation scenario between sophomore and senior students?

Q4 Is there a difference in Situation Awareness scores or subscores measured during a simulation scenario between students who have less than 2 months compared with those who have more than 2 months of healthcare experience outside the nursing program?

The second specific aim is to gain a better understanding of how students become aware of the clinical situation.

Qualitative question: How do undergraduate nursing students describe becoming aware of patient changes and other elements in the environment during a simulation of a deteriorating patient?

CHAPTER II

LITERATURE REVIEW

Definitions

To assist the reader in understanding the key terms in this discussion of pertinent literature, the following general definitions are provided:

Attention: the process by which a limited amount of information is selected for processing by working memory (Clark, 2008)

Clinical Judgment: "an interpretation or conclusion about a patient's needs, concerns, or health problems, and/or the decision to take action (or not), use or modify standard approaches, or improvise new ones as deemed appropriate by the patient's response" (Tanner, 2006, p. 204).

Clinical Reasoning: "a complex cognitive process that uses formal and informal thinking strategies to gather and analyze patient information, evaluate the significance of this information and weigh alternative actions" (Simmons, 2010, p. 1155).

Noticing: "a perceptual grasp of the situation at hand" (Tanner, 2006, p. 208)

Salience: "to discern what is more or less important in a clinical situation" (Benner, Sutphen, Leonard & Day, 2010, p. 25)

Situation Awareness: "a dynamic process in which a nurse perceives each clinical cue relevant to the patient and his or her environment; comprehends and assigns meaning to those cues resulting in a patient-centric sense of salience; and projects or anticipates required interventions based on those cues" (Sitterding, Broome, Everett, & Ebright, 2012, p. 89).

Overview

This chapter will explore the theoretical foundations for both clinical judgment and situation awareness. Relevant literature from nursing regarding the concepts of salience and attention are also discussed in relation to the concept of noticing. The situation awareness model described by Endsley (1995b) is presented and contrasted to more recent definitions from several fields of study. The presence of situation awareness in nursing is examined through fieldwork and conceptual analysis, followed by review of studies involving situation awareness in both medicine and nursing.

Theoretical Foundation for Clinical Judgment

There are many theoretical stances from which to view the subject of clinical decision-making or clinical judgment. Information processing theory (Simon & Newell, 1964) has had a powerful influence, shaping early conceptual models and continuing today. Embedded concepts of cognitive load and working memory have been suggested as important factors in medication errors (Potter et al., 2005), perioperative safety (Watson, 2010) , patient safety (NCSBN, 2010) and the ability to think critically (Cornell et al., 2011; Simmons, Lanuza, Fonteyn, Hicks & Holm, 2003). Current research into attention and cue recognition also find roots in information processing theory as will be discussed later in this chapter.

In the 1980's, researchers also began to study the clinical decision-making of expert nurses and uncovered a different set of constructs regarding the development of expertise and intuitive decision-making (Benner, 2004). The Dreyfus theory of skill acquisition (Dreyfus & Dreyfus, 1986) described cognitive development as progressing from novice to expert in five stages. This cognitive development parallels changes in how decisions are made. Decision-making at the novice stage is rule-based. Advanced beginners start to be aware of the context and use this information to modify rule-based decisions. Competent decision-makers apply prior experiences, context and consider whether rules are applicable in order to make decisions for which they feel personally responsible. Prior to this stage, personal accountability is not evident. Proficiency is the next stage. There is reliance on past experience and the beginning development of intuition that helps to make the decision process quick and accurate, yet decisions are not something that is done in an overt or step-wise fashion. Only in the case of novel situations, once intuition has identified a problem, in-depth analysis might be completed before a decision is made. The final stage is expert. This stage is characterized by decisions that are fluid and holistic, relying almost entirely on intuition. Benner used this theory of cognitive development and associated stages of decision making, and investigated whether these stages also applied to nurses. She concluded that the acquisition of nursing expertise follows essentially the same path, suggesting that as nurses gain expertise, their clinical judgment improves (Benner, 2004).

Clinical judgment models. These theories have been used to develop different models for clinical decision making in nursing. Examples include the Clinical Decision Making Model (Oneill, Dluhy & Chin, 2005), the Situated Clinical Decision-Making framework (Gillespie & Peterson, 2009) and the Clinical Judgment Model (Tanner, 2006). Thompson, Cullum, McCaughan, Sheldon & Raynor (2004) suggest that important characteristics of decision-making models include identification of links between decision characteristics and decision-making processes as well as sources of information. After review of these models guided by Thompson et al., the Clinical Judgment Model by Tanner (2006) was selected as the best fit for this study.

Tanner's Clinical Judgment Model. Tanner's (2006) review of research and scholarship on the topic of clinical judgment echoed many of the same ideas that Benner presented in her work. Clinical judgment is context based and develops along with expertise. Tanner reviewed the relevance of many years of research regarding critical thinking and concluded that this body of research failed to prove a relationship between critical thinking and clinical judgment, and has not been helpful in terms of measuring or identifying how to teach critical thinking (Tanner, 2005). Tanner suggests moving forward with research regarding clinical judgment in order to focus on decision-making skills needed by nurses in the clinical setting. Based on this thorough analysis of the literature, Tanner developed the Clinical Judgment Model to explain how nurses make clinical decisions (Tanner, 2006) (Appendix A). The first step is noticing. Nurse experience, values and knowledge influence what the nurse notices and his/her response. Interpretation of the information follows noticing. Clinical judgment often uses analysis, intuition and narrative thinking as methods for interpreting the information. Some type of action and outcomes follow interpretation. Reflection after the clinical judgment is an essential part of the process for growth to occur.

Of particular interest in this study is the first step, noticing. Tanner's (2006) description of noticing for the Clinical Judgment Model is "a perceptual grasp of the situation at hand" (Tanner, 2006, p. 208). Knowing the patient in terms of the patient's usual pattern of responses as well as personal knowledge about the patient has an influence on what the nurse notices. The social and cultural factors of the situation and the nursing care setting also affect noticing. Another important influence on what the nurse notices are the pre-existing expectations. These are formed from prior experiences as well as textbook knowledge and the patient knowing and pattern recognition described above. All these factors are the antecedents to the first stage of the Clinical Judgment Model called “Noticing.”

Salience and Noticing

Benner’s early theory of Novice to Expert states that the novice and advanced beginners do not yet have “aspect recognition” (1984). Benner, Hooper-Kyriakidis & Stannard (1999) also use the term Perceptual Awareness which is defined as “the skill of seeing" (p.568). This skill is described as requiring recognition and visual discrimination. Benner continues and develops this into the idea of “salience” as she describes progression to an expert nurse. This early work is expanded in Benner’s most recent study on nursing education which recommends teaching “salience, situated cognition and action” (Benner et al., 2010, p. 82). Effective clinical judgment depends on both perception and recognition of salience. The nurse's knowledge and experience in turn directs attention to the salient details and helps to prioritize problems that require further investigation and action. Benner, Goettsche & Bitz (NCSBN, 2010) often interchange the term “perception” with “noticing” or “seeing.”

Tanner’s descriptions of noticing and Benner’s description of salience are very similar; both are deeply rooted in an interpretivist, phenomenological tradition. The Clinical Judgment Model (Tanner, 2006) expands Benner’s term of salience into a multifactor term called “noticing.” However, the concept of noticing is not well developed in nursing literature. Searches for this term revealed few articles.

Noticing

A literature search for the string notic* and nursing found few relevant articles in CINAHL, Medline and Academic Search Premier for the previous 20 years. One early narrative report used the term “noticing” when describing expert nurses (MacLeod, 1994). Noticing was also used to describe the expert practice of psychiatric nurses (Johnson & Hauser, 2001). The only studies found that measured noticing used the Lasater Clinical Judgment Rubric (Johnson et al., 2012; Blum, Borglund, & Parcells, 2010; Dillard et al., 2009; Lasater & Nielsen, 2009a; Lasater & Nielsen, 2009b; Lasater, 2007). This tool is designed to evaluate clinical judgment as a composite measure of the four stages described by Tanner. There are three questions that pertain to noticing; these questions are scored individually and not usually reported as a separate noticing subscore. Students are rated as beginning, developing, accomplished or exemplary according to the descriptors used in the rubric. Exemplary noticing involves monitoring a wide range of data at the appropriate intervals, identifying even subtle deviations from normal and sufficiently focusing attention on the most important variables (Lasater, 2007). The Lasater Clinical Judgment Rubric offers the opportunity for instructors to grade noticing by selecting the appropriate level from the descriptors. This rubric has been used both during simulation and in the clinical setting (Dillard et al., 2009, Johnson et al., 2012, Mann, 2012). One concern with this first section regarding noticing is that student performance or verbalizations are the only data from which instructors infer what the student has noticed. This is an indirect measure and likely does not reflect all that the student has noticed. Conversely actions may be taken that are driven by factors other than what was noticed at the time, such as by habit.

The Lasater Clinical Judgment Rubric has also been used for student self-evaluation (Jensen, 2013; Lasater & Nielsen, 2009b). Student self-assessment has many useful purposes, however, self-assessment has been questioned as a valid measure of performance for both fields of medicine and nursing, with most studies reporting no correlation between the two measures (e.g. Baxter & Norman, 2011; Davis et al., 2006). Baxter and Norman (2011) reviewed nursing student reports of competence compared to instructor evaluation of performance on an objective structured clinical examination. Fifteen of 16 measures demonstrated a negative correlation between student and faculty scores (Baxter & Norman, 2011). Jensen (2013) compared faculty scores with student self-assessment scores on the Lasater Clinical Judgment Rubric after a simulation scenario. Student scores were higher, although not achieving significance. For the noticing subscale, students scored themselves higher with small negative correlations between faculty and student scores on the items “focused observations” and “information seeking.” The correlation between student and faculty scores on the item regarding “recognizing deviations” was reported as .19, with none of the correlations achieving significance (Jensen). With an n of 26 BSN students and 62 ASN students, this study may have been underpowered to detect significant correlations. No studies were found that used noticing as a single variable.

The literature search was broadened to include a search of the term “cue recognition.” This search also revealed few articles. Two studies suggest that undergraduate nursing students fail to notice salient cues in unfamiliar situations

(Endacott et al., 2010; Thiele et al., 1986). Cue recognition can be improved with computer-aided instruction (Thiele et al., 1986) and instructional modules (Colson, 1993). More recently cue recognition was deemed essential for clinical decision-making for flight nurses (Reimer & Moore, 2010).

Attention

Cues function to direct attention. Attention has been described as the process by which a limited amount of information is selected for processing by working memory (Clark, 2008). Attention is sometimes interchanged with vigilance; however vigilance refers to prolonged maintaining of attention (Wright & Fallacaro, 2011). It has been postulated that some nursing errors are related to inattentional blindness or the failure to notice something that is obvious (Watson, 2010). This can be due to attentional filters and cognitive load that draws attention at the expense of something else (Watson, 2010, Paparella, 2013). This lack of attention can be especially prominent with novice workers. Novices use a lot of working memory when encountering unfamiliar material. In contrast, experts have repeated tasks so often that they are automatic and do not require much working memory, freeing memory for other tasks (Clark, 2008). Research into attention and the effects on nursing decisions is in the beginning stages. Sitterding et al., (2012) report that situation awareness is one of the biggest factors that influence attention.

Situation Awareness

During a search of literature regarding decision making in other disciplines, a related concept, situation awareness (SA), was found in the field of aviation. The initial stage of this concept includes being aware of salient cues in the environment (Endsley, 2000), which is similar to the concept of noticing. Stubbings, Chaboyer and McMurray (2012) go even further and state that situation awareness is the first step of decision-making.

The concept of SA was initially developed within aviation to model decisions and to guide research on awareness of the many factors that need to be considered by flight crews when making decisions. Discussion of SA as necessary for military flight crews can be found dating back to World War 1 (Endsley, 1995b). Review of air-to-air combat data gathered during the Vietnam War suggested that a deficit of SA was responsible for 80% of aircraft losses (Watts, 2004). Since then, SA has been studied extensively as demonstrated by an annotated bibliography of 233 research articles contained within a report prepared by the SA Integration Team for the Air Force (Vidulich, Dominguez, Vogl, & McMillan, 1994).

A theoretical model of SA was developed Endsley (1995b) (Appendix B). This theory has been useful in other fields, particularly those that require decisions to be made in a dynamic, information-rich environment where there are time constraints and the problems are ill-structured (Uhlarik & Comerford, 2002). There have been numerous studies that support the overarching theoretical model as well as the relationships between the various concepts within the model (Endsley, 1995b, Endsley, 2000; Wright, Taekman, & Endsley, 2004; Vidulich et al., 1994). One important component of the model is that individual SA will vary according to experience and training as well as individual ability (Endsley & Bolstad, 1994). Various studies have supported this concept (O'Brien & O'Hare, 2007; Walker, Stanton, Kazi, Salmon, & Jenkins, 2009). This model has also been used as a practical guide to systematically investigate factors that contribute to increased human awareness when interacting with dynamic systems. Study results have been used to choose system designs that facilitate awareness, compare performance with different workloads and predict performance in the real world based on simulation performance (Endsley, 2000). An important distinction is that Situation Awareness involves the collection or attention to salient data and interpretation of the meaning of this data, but does not involve the decision or action that follows (Endsley, 1995b).

According to Endsley (1995b), Situation Awareness is "the perception of the elements in the environment, within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future"(p. 36). Situation Awareness has three stages- perception of cues, comprehension and projection for the future. There are also factors that act to modify these components and these are organized into a conceptual model (Appendix B). This cognitive model of SA separates the product, situational awareness, from the process used to arrive at this mental state (Salmon, Stanton, & Young, 2012).

There is another view of Situation Awareness that contrasts to the individual cognitive view. This technological/engineering view looks at SA as situated in a context and contained by monitoring equipment or other artifacts (Salmon et al., 2012). In this view, the environment contains the situation awareness data which is viewed by the operator. There is more emphasis on how data is physically presented and less focus on the cognitive process of the operator. Many publications by the military hold this perspective (Durlach & Bowens, 2010). Situation Awareness can be enhanced by making the displays easy to interpret and by analyzing and giving the user information that is already organized into Level 2 or 3 SA instead of Level 1. Endsley (2000) argues against this view stating that despite the existence of displays, an operator is still required to interpret them.

A third view of Situation Awareness is from a systems perspective. In this case SA does not reside within an individual but is distributed among the members of a team and within the context of a particular environment (Salmon et al., 2012; Stanton, Salmon, Walker, & Jenkins, 2010). In essence this view describes individuals as well as the environment contributing to SA, but this is not understood as a mental model held by a single individual or even a shared mental model between team members, but rather the whole picture is only comprehended at the systems level. Distributed SA is an important concept for nursing teams; however the focus of this research is the individual.

These different views of SA in part derive from different epistemological perspectives. From an information processing perspective, SA is contained in a mental representation that is constructed from a physical reality. This mental representation is time and context dependent but can be communicated to a researcher. Thus knowledge can be constructed. From the theoretical perspective of distributed cognition (Hutchins, 2010), SA is a representation of which each person or artifact shares a part, but the whole is bigger than the individual. From this perspective, SA is a dynamic interplay between people or teams and the environment. Various fields of study such as cognitive systems analysis and joint cognitive systems support this view (Blomberg, 2011).

Epistemologically knowledge is viewed as extended beyond the confines of the human brain and resides within the system (Blomberg, 2011). Blomberg argues that it is no longer pragmatic to study individuals and their cognition, since decisions are often made within dynamic systems. He advocates the unit of study should be the entire system, preferably in situ.

Both of the above views have relevance to nurses who are making decisions within dynamic and complex systems. It is important to know how the information present in the environment is interpreted within the individual, but it is also important to study the entire process. For this exploratory study, the focus is on an individual. Future studies of systems and distributed SA will also be needed.

Situation Awareness Theory Development in Nursing

The concept of Situation Awareness was recently studied in relation to nursing practice (Sitterding et al., 2012). Hybrid concept analysis was used to confirm that Situation Awareness is a concept that applies to nurses in acute care settings. Nurse interviews and analysis of critical incidents using the Critical Decision Model revealed all three stages of Situation Awareness are readily apparent in the cognitive work of nursing (Sitterding et al., 2012). Content analysis of these interviews led to the discovery of additional themes associated with SA in acute care nursing. These themes were included in a revised definition of SA for nursing: "a dynamic process in which a nurse perceives each clinical cue relevant to the patient and his or her environment; comprehends and assigns meaning to those cues resulting in a patient-centric sense of salience; and projects or anticipates required interventions based on those cues" (Sitterding et al, 2012, p. 89). This expanded definition combines the concepts of perception, cue recognition and salience that have been previously discussed. This definition of SA will be used for the study. The authors suggest that continued research to validate this definition is required and that research regarding SA may help to determine factors associated with inattentional blindness and nursing error. Further studies of Situation Awareness including the acquisition of SA and methods to improve SA in nursing were recommended.

There is some conceptual overlap regarding the concept of noticing and the three stages of situation awareness. Tanner (2006) describes noticing using phrases such as perceptual grasp, recognition of salience and selective attention. Sitterding et al. (2012) describe the first stage of situation awareness as perception and the second stage as comprehension and assigning meaning. It could be argued that in order to recognize salience, meaning must already be assigned. Cues must be both comprehended and recognized as salient. From this point of view the first two stages of situation awareness are encompassed by the single concept of noticing. The third stage of situation awareness, projection, more closely aligns with the Clinical Judgment Model (Tanner, 2006) concept of interpretation. Measurement of SA using existing tools involves all three stages, however there is also the ability to compare scores for the individual stages as well as for the total score.

Measurement of Situation Awareness

Situation Awareness can be measured by the Situation Awareness Global Assessment Tool (SAGAT) (Endsley, 2000). During a simulation, the scenario is frozen, control panels are blanked and the scenario participant responds to a series of questions regarding their perceptions at that moment (Endsley, 2000). Questions are asked regarding all three levels of Situation Awareness: perception, meaning and projection for the future. The scenario then continues. This freeze technique is employed several times during each scenario. Participant answers are scored as correct or incorrect by comparison to the actual situation or by an expert in the content area tested. Overall this technique has been rated as reliable with test-retest reliability ranging from .92-.98 over several different studies and fields (aviation and automobile driving). Validity has been suggested by the relationships depicted in the model having the predicted effects during testing. Higher cognitive loads led to decreased SA (Endsley & Rodgers, 1998; Gugerty, 1997). Situation Awareness scores were also predictive of performance during simulation (Endsley, 2000).

Some researchers have voiced concern that interrupting the simulation to answer the freeze-probe questions will alter the outcomes (Sarter and Woods, 1991; Endsley, 2000). Endsley (1995a) studied both the duration and the effect of the interruption and found that interruptions of one to two minutes had no effect on the outcomes compared to a control group without interruptions and groups with varying lengths of time before the freeze-probe questions were asked and the simulation was resumed. A pilot for the current study was completed with eight undergraduate nursing students in the experimental group who experienced two freeze-probe interruptions and five students in the control group who did not. There was no significant difference in terms of meeting the study outcomes, the time to request help (p = .42), or the time to administer naloxone (p = .44). This data must be interpreted with caution since the sample size was small.

The procedure for implementation of the SAGAT tool recommended by Endsley (2000) includes randomizing the queries for each freeze. The advantage of randomizing the queries is to decrease the bias of the participants who may come to anticipate the questions if they are repeatedly asked in the same order. In addition, Endsley notes that randomization enables comparison across trials. Endsley (2000) also recommends randomization of the stop times for the same reason, comparisons across trials. It is also suggested that the freeze-probe questions not start until after the first three minutes of the scenario and that sets of questions not be administered within a minute of each other. Other researchers have used various timing protocols. Comparison trials in nursing vary from one random stop (Cooper et al., 2010) to timed stops (Hinton, 2011), after completion of the scenario (Kinsman et al.,2012; Cooper et al., 2012) and during debriefing (Deckers, 2011). Studies comparing random stops to timed stops were not found, but one study suggested that if the freeze occurs at a predictable interval, outcomes can be influenced (Endsley, 1988).

Other methods to measure Situation Awareness have been tested. Observation rating scales typically involve an expert who watches and then assigns an SA score to the participant based on ideal performance. These instruments are fairly easy to administer either during or post trial. Disadvantages include the lack of ability to know what the participant considered or noticed that did not lead to an overt action. This forms a problem of validity. Salience, attention and interpretation are all cognitive functions that are not directly discernible and may not lead to the desired performance. Caution is advised when equating SA with performance (Uhlarik & Comerford, 2002). Some authors have added a confederate who asks questions during the simulation in order to obtain more information about what the participant is thinking. Unfortunately this practice has the possibility of artificially directing the participant to the important cues and may add to cognitive load, both of which alter SA (Endsley, 1995a).

Another type of measure is to ask the participant to recall and rate their Situation Awareness after completion of the scenario. In one example, cadets were asked to rate their SA following a grueling exercise that involved sleep and food deprivation (Matthews, Eid, Johnsen, & Boe, 2011). Military experts rated SA for the cadets much lower than they rated themselves. Endsley argues that a questionnaire administered at the end of the scenario is really only valid for SA at the end of the task due to problems with recall, and that self-reports of SA are subject to memory decay and to the influence of the performance outcome (Jones & Endsley, 2004). In addition, self-rating tools are criticized for lack of sensitivity and the fact that they do not correlate well with Situation Awareness Global Assessment Technique (Salmon et al., 2009). Another example of a self-rating tool is Situation Awareness Rating Technique. In a trial comparing Awareness Rating Technique with SAGAT, only SAGAT was correlated with performance. Situation Awareness Rating Technique was not correlated with performance or SAGAT, suggesting that this tool may measure something entirely different (Salmon et al., 2009). They suggest that if a task is relatively stable with known outcomes, then SAGAT is more appropriate to use. Situation Awareness Rating Technique may need to be used if the task cannot be interrupted or if there is little known about what the outcomes should be (Salmon et al., 2009). Process indices such as eye movement tracking and verbal protocol analysis when the operator thinks out loud, have also been used to measure SA (Salmon et al., 2009).

Based on this review of potential tools to measure situation awareness, SAGAT has demonstrated validity and reliability and is less affected by bias than self-rating tools. Situation Awareness Global Assessment Technique also has the advantage of measuring SA during the event, thus reducing recall errors. Cognitive functions are not readily observed by experts. Situation Awareness Global Assessment Technique relies on the responses of the participant about what they are thinking at the time, not on performance data or checklists as rated by an expert.

Situation Awareness in the Medical Field

There has been a surge of interest in SA within the medical field, primarily anesthesia, but also in general medicine. Lack of SA has been hypothesized to be associated with clinical outcomes (Fioratou, Flin, Glavin, & Patey, 2010; Singh et al., 2012). Situation Awareness is deemed one of the essential non-technical skills in the operating room (Mitchell et al., 2013). Two instances of adaptation of the Situation Awareness Global Assessment Tool for the medical field were discovered (Hogan, Pace, Hapgood, & Boone, 2006; Wright et al., 2004). In one study SAGAT successfully discriminated between medical students and experienced physicians in the management of simulated trauma patients (Hogan et. al, 2006). The other study reported on the development of SAGAT questions for simulations involving anesthesiology (Wright et al., 2004).

Team Situation Awareness

Team Situation Awareness refers to a group of people who share information from their individual situation awareness so that the collective situation awareness facilitates the function of the team (Abbott, Rogers, & Freeth, 2012). In some cases this definition is extended to distributed SA, depending on the view discussed previously as to whether SA resides within the individual or resides only in the system as a whole (Blomberg, 2011). Team situation awareness is thought to be associated with quality of care and effective teams. Observational studies and surveys suggest that healthcare teams have differing levels of Team SA and this may hinder functioning (Abbott et al., 2012; MacEachin, Lopez, Powell, & Corbett, 2009; Wauben et al., 2011). In addition, workflow and response to urgent situations is affected by Team SA (Abbott et al., 2012; Mackintosh, Berridge, & Freeth, 2009). Fioratou, et al. (2010) suggest that team SA, or as they term it, distributed SA, is vital in settings such as the operating room and should be studied in order to find ways to enhance team performance and protect patients. Kim, Xiao, Hu and Dutton (2009) concur and trialed video monitoring in the operating room to increase team SA. TeamSTEPPS is a teamwork training program that was developed by the Department of Defense in conjunction with the Agency for Healthcare Research and Quality and has been released for public use (King et al., 2008). This research-based program is envisioned as the national model for team training (King et al.). Since individual SA underpins Team SA, the focus of this paper is individual Situation Awareness.

Situation Awareness Research in Nursing

Stubbings et al. (2012) conducted an extensive literature search for nursing articles involving situation awareness and decision making from 1960 through 2011, finding seven articles. One study yielded two publications and one was a literature review that did not reference studies of SA in nursing, leaving a final sample of five studies. Three of these five articles included nurses, but focused on measures of team SA and were mentioned above. One of the remaining articles was by Wright and Fallacaro (2011) who studied Registered Nurse Anesthetist students to identify predictors of Situation Awareness. Measures of memory, cognition and automaticity were compared to SA as measured by a computerized program used by the military that asks the operator to scan an environment, prioritize tasks and make decisions (Wondrous Original Method for Battle Airmanship Testing in Complex Systems [WOMBAT-CS]). Of these variables, only cognition as measured by Raven's Standard Progressive Matrices correlated with SA (Wright & Fallacaro). Since there are no other studies of nurses or nursing students using the WOMBAT-CS, it is difficult to know whether SA measured by this tool approximates SA in the clinical setting.

Stubbings et al. (2012) described one other published study using SAGAT which measured the ability of nursing students to notice changes during simulation of two dynamic patient care situations, hypovolemia and shock (Cooper et al., 2010). Students completed an initial knowledge test. They then participated in two high-fidelity simulations and afterwards participated in a structured interview. In the midst of caring for the simulated patient, the scenario was frozen and questions regarding the student awareness of the situation were asked following the SAGAT technique developed by Endsley (1995a). Questions asked during the freeze included current vital signs (perception), the probable cause of any changes (comprehension) and what will happen if the situation progresses (projection) (Appendix C). A total SA score (percent correct responses) was calculated as well as domain scores for subsets of SA: global perception, physiologic perception, comprehension and projection. Global situation awareness was not mentioned by Endsley as a separate stage of SA, but is operationalized in this study as being aware of the surroundings as well as the patient condition. The study demonstrated poor awareness of many of the factors considered necessary for the management of a deteriorating patient (Cooper et al., 2010) with an average SA score of 58.95% correct. Physiologic perception scores were consistently higher than the other domains. Comprehension was low (29.4%) for the hypovolemia scenario and global SA was low (45.8%) for the septic shock scenario. The authors concluded that although the sample size of 51 students was under-powered to detect correlations between measures of performance and knowledge, this study provided important clues about how nursing students manage patients whose condition is deteriorating and highlighted some gaps in performance. As the first study of nursing students using a measure of SA, this provided the foundation for further research.

In addition to the quantitative study using Situation Awareness and performance scores, this research team also completed qualitative analysis of the reflective interviews upon student completion of the simulation scenarios (Endacott et al., 2010). Video of the scenario was used to help prompt student responses to structured interview questions. The videos were also scrutinized by the researchers. The text was examined using dimensional analysis procedures developed by Schatzman and further defined by Kools, McCarthy, Durham and Robrecht (1996). Findings indicated respiratory rate and capillary refill were seldom assessed by students (Endacott et al., 2010). Assessments were often not repeated after changes in the patient condition and knowledge of required nursing interventions indicated by the physiologic changes did not consistently translate into correct or timely nursing interventions. In addition, 12% of the students remained frozen during the initial part of the scenario, with no action at all. During the interview, students had difficulty supplying a rationale for their actions. The authors concluded that additional exposure and skills training during emergency situations is recommended in order for students to practice these skills. Further study with interrupting the simulation using guided reflection as a method to improve SA and performance is suggested.

Since Stubbings et al. (2012) published their review, there have been two more nursing studies using SA. Both of these studies are from the same group of researchers (Cooper et al.), who initially studied SA in nursing students. In one study, 35 student midwives (both graduate and undergraduate) completed two simulation scenarios that used standardized patients who were wearing birthing suits that could simulate a hemorrhage (Cooper et al., 2012). At the end of the scenario, students were questioned regarding their situation awareness for three domains: physiologic parameters, comprehension of the main problem and projection about what is likely to occur in the future. Answers were scored as correct or incorrect by experts on the scene. The SAGAT technique in this study differs slightly from the previous study where the simulation was frozen at random intervals and questions were asked during the simulation as opposed to this study when questions were asked at the end of each 8- minute scenario. Situation Awareness was scored as an average of 54% of correct answers across both scenarios. In general, physiologic parameters were answered correctly less often (28-33%) than comprehension and projection (57-70%). It is also intriguing that knowledge (measured by a pre-test) was not correlated with skill (measured by performance checklist), however knowledge was correlated with SA (r =.0359, p = .040). Again, this study may have been under-powered to detect other significant correlations. In general this study supports the findings from the previous study that nursing students have a considerable gap between what they know and how they apply this knowledge in a dynamic situation.

As a follow up to this study, 34 registered nurses from a rural hospital were studied in a similar manner (Kinsman et al., 2012). By this time the authors developed an educational program called FIRST^{2}ACT. As a part of the education program, two simulation scenarios involving deteriorating patient condition were completed and performance was scored by clinical experts. In this case actors portrayed the patients and the simulation was staged in situ on the patient ward of the participating rural hospital. Afterwards the participants viewed the video recording of their simulation scenarios, completed a self-critique and received feedback from the clinical expert. This process took $1\frac{1}{2}$ hours. Situation Awareness was not specifically mentioned in this study, but is included as an integral component of the FIRST^{2}ACT curriculum presented in a subsequent publication (Buykx et al., 2012) . Outcome measures for this study were frequency of patient observations by the nursing staff, appropriate use of rapid response teams and use of oxygen therapy and documentation of pain assessment. Chart audits were performed before and after the educational intervention and confirmed improvement in observation frequency and documentation of pain assessment which persisted for 10 weeks after the program. Frequency for rapid response team use was too low to analyze. This study was important in that practicing nurses were also found to have gaps in performance. These gaps can be successfully identified and can improve with coaching and self-critique of their own performance in simulated scenarios of patient deterioration.

Situation Awareness Dissertations

Several dissertations have explored Situation Awareness in relationship to nursing. Irani (2008) studied the relationship between stress, cognitive load, personality and SA for nursing students. In addition, an educational intervention using a 3-hour-long pre-recorded DVD was given to the intervention group. Methodological problems with the simulation scenarios and low reliability for the SA scores between scenarios obscured any significant associations between these variables. Recommendations from this study are to employ scenarios that are longer than five minutes and to pilot test the simulation scenarios for content that is sufficiently challenging to the nursing students.

Hinton (2011) studied first semester nursing students and nursing assistant students simulating medication administration after two five-hour sessions of SA training. Situation Awareness was measured three times during each of two simulations and reported as total scores and subscores for Levels 1, 2 and 3 SA. Situation Awareness (total) related to the task of medication administration did increase significantly after the first training session $F(2, 24) = 31.47$, $p < .001$, but not after training session two. The same results were found for each of the SA subscales. The sample size of 14 students and the mixed group of nursing assistant students with nursing students who have different educational backgrounds and roles regarding medication administration, pose significant limitations for the interpretation of this study.

A third dissertation used an iterative design model and an SA framework to improve student performance during high-fidelity simulation (Deckers, 2011). Twenty-one undergraduate nursing students participated in groups of three or four students per session. A goal directed task analysis of the scenario was completed and tasks were grouped into the three levels of situation awareness (perception, comprehension and projection). Task performances as well as time to completion of selected tasks were used as measures of SA. Students reviewed video segments after finishing the scenario and were asked about SA during the debriefing session. Students also completed journals. These entries were reviewed for information about increased or impaired situation awareness. Based on the initial round of simulations, changes were implemented in hopes of increasing SA. Results from this study confirmed student nurses frequently miss salient cues, in this case urinary output, capillary refill and physiologic symptoms of anxiety. Expert facilitation with detailed concept maps prior to the simulation led to improved cue recognition. Changes in role assignments led the participants away from task-oriented roles that contributed to tunnel vision and delays in care in favor of team-oriented roles. The new role definitions along with encouragement to talk out loud enhanced team performance as rated by an expert observer. Situation Awareness was measured during debriefing and provided a context for understanding student learning, but specific improvement in SA requires further investigation according to this author.

Conclusion

Tanner's Clinical Judgment Model describes noticing as a first step toward decision-making. However, there is little known about how nursing students develop this skill or how to measure noticing. A search of the human factors field found a similar concept, situation awareness, with an extensive history of theoretical development as well as a valid and reliable measurement tool, SAGAT. Wright et al. (2004) recommend further study in order to validate the use of SAGAT with the healthcare population as well as using this tool to evaluate educational interventions that improve situation awareness.

Theoretical support for Situation Awareness as present in nursing practice has been developed (Sitterding et al., 2012). Situation Awareness has been described as the first step for decision-making (Salmon et al., 2009; Stubbings et al., 2012), similar to the step of noticing in the Clinical Judgment Model (Tanner, 2006). Initial studies of nursing students and practicing nurses demonstrate that in the simulated setting of a deteriorating patient, situation awareness is not optimal and can contribute to inappropriate clinical decisions and nursing actions (Buykx et al., 2012; Cooper et al., 2011, 2012; Endacott et al., 2010). However, there were no reported studies of SA comparing students beginning a nursing program to those near the end of a nursing program, therefore, it is unclear how SA develops. Measurement of SA at different points in an undergraduate nursing program may increase knowledge about how students develop SA and thus contribute to understanding how students make decisions. Exploration of the concept of SA through a semi-structured interview after the scenario, added to data from de-briefing, may help educators gain information about the development of SA in undergraduate nursing students. Use of both quantitative measures and qualitative description will provide several viewpoints during this exploratory study.

CHAPTER III

METHOD

Research Design

This exploratory study used a mixed methods design. The quantitative portion was a quasi-experimental design comparing sophomore and senior baccalaureate nursing students using repeated measures of situation awareness during simulation scenarios. The qualitative portion included analyses of interview data from students about their noticing during the scenarios.

Setting

The setting for this study was the Simulation Learning Center at a midwestern university school of nursing. This facility has three simulation rooms staged to look like rooms on a medical-surgical unit. A high-fidelity mannequin (3G, Laerdal Corporation) was programmed to reliably produce the same effects for each scenario. Research assistants were trained to reliably respond as the physician or Rapid Response Team. Video and audio recordings of the scenarios were coded and stored on a secure in-house server. Debriefing and participant interviews occurred in adjacent debriefing rooms.

Sample

The target population is all undergraduate nursing students in the United States. The accessible population was a subset of baccalaureate nursing students enrolled in either senior classes or sophomore classes at the university (N= 164). Purposive sampling was used to achieve maximal variation between students with less clinical experience and those close to graduation. Therefore a convenience sample from sophomore students and last semester senior students was recruited. Qualitative studies generally have fewer participants than quantitative studies. Samples of 15 to 30 interviews are quite common for qualitative studies looking for patterns across the data (Braun & Clarke, 2013). Specifically for a medium scale project involving interactive interviews these authors recommend at least 20 participants. In general, data collection continues until saturation. For the quantitative component, a priori power analysis and sample size determination was conducted using GPower 3.0 software (Faul, Erdfelder, Lang & Buchner, 2007). Reviewing a logistic regression model with $\alpha = .05$, effect size d = .15 (assessing a moderate effect), and slopes and intercepts expected to vary between groups, the recommended sample size was 14 participants per group with an estimated power of .965. In order to assure an adequate sample size, this exploratory study aimed for a sample of 20 seniors and 20 sophomore students (approximately 24% of the available population).

Recruitment

Participants were recruited from a pool of nursing students enrolled in the chosen years of nursing education. Potential participants were contacted by e-mail or in-person and were invited to participate in this study. A $20 gift card to the bookstore was offered as an incentive for participation in the study. The gift card was given to the students upon completion of the study or upon withdrawal if the student preferred not to complete the study. Recruited students were not currently enrolled in classes taught by the primary researcher. No grade incentive or extra credit was offered for participation. If students were interested, the primary researcher explained the study purpose. Those willing to participate were provided informed consent and demographic data forms. Exclusion criteria were current licensure as a medical professional (EMT, Paramedic, LPN). Students who were Certified Nurse Assistants did participate. Students were also over 18 years of age and able to speak and write in English.

Protection of Human Subjects

The study and associated data collection forms were submitted for approval by the University of Northern Colorado Institutional Review Board (IRB) prior to contacting the students. A letter of access to the students at the study university was obtained prior to contacting the students. Informed consent was obtained and signed forms kept in a locked file cabinet in the researcher's office. Forms containing demographic information were identified only by participant number and kept in the same locked file cabinet. Electronic data including videos and interview transcripts were kept in a password –protected computer file with access only by the researcher and two research assistants and a transcriptionist.

Risks, Discomforts and Benefits

There were no physical risks encountered through participation in this study. Embarrassment or performance anxiety may have been present during the simulation scenario as is typical with the other simulation scenarios in which all students have previously participated. Students were informed that they were free to leave questions unanswered or withdraw from the simulation at any time. Students were informed that completion of the simulation may provide the student benefit of increased confidence when encountering similar situations in the clinical setting. Other anticipated benefits were of educational value and included trial of a modified version of the SA measurement tool during a nursing simulation.

Costs and Compensations

Other costs to the student involved the time spent, which was approximately two hours. Students were informed that there is no assured direct benefit to themselves, but study participation may help develop new educational strategies and assessment techniques for future students. A $20 gift card was provided to each student upon completion of the study or upon withdrawal.

Data Collection

Operational Definitions

Student level of clinical experience. Measured by both level in the nursing program and total experience in healthcare as measured by reported months of direct patient care activities.

Situation Awareness Score. Number of correct individual item responses to questions using the "freeze-probe" technique regarding assessment parameters at pre-determined points during the unfolding scenario. Subscores for each of the four subsections of the SAGAT tool (Appendix C) were also calculated as number of correct responses within each subsection (perception, comprehension, projection and global).

Procedure

Research assistants and inter-rater reliability. Two research assistants helped with operating the manikin and playing the roles of the Rapid Response Team, Charge Nurse, Physician or Respiratory Therapist. These assistants were master's prepared nursing faculty with more than two years of experience conducting simulations. The research assistants completed training modules required to validate competence with research involving human subjects. One of the assistants had prior experience with collecting research data. Research assistants also observed the scenario and during the freeze while students were answering the SAGAT questions, research assistants completed the SAGAT with the correct answers. Following the scenario they scored the student SAGAT answers as correct or incorrect. To achieve consistency in scoring, standard videos with prepared student answers were provided. Two research assistants and the primary researcher watched two practice videos and then independently scored SAGAT questions for four training videos. Inter-rater reliability using the Pearson Product Moment Correlation Coefficient was scored as .93. Further analysis of inter-rater reliability comparing Friedman's test and Chi square using $\alpha = .05$, the difference was not significant ($p = .779$), providing strong evidence that there were no appreciable differences between raters. See Appendix F for statistical analyses. Roles were practiced for each of the scenarios during pilot runs. In addition, role descriptions and allowable cues were provided (Appendix G). Research assistants also completed training as required by the university institutional review board for the role of research assistant.

Participant experience. After agreeing to participate, the students were scheduled to complete two consecutive high-fidelity simulation scenarios at a mutually convenient time. On arrival to the simulation center students consented to the study, received pre-briefing instructions (Appendix C) and completed demographic data (Appendix E). Students completed the scenarios individually in the role of the nurse taking care of a patient on a medical-surgical unit. There were no student observers. After completion of the first scenario and a five minute break, students were given pre-briefing information for the second scenario. The order of scenarios was determined randomly. Students in the same class were scheduled for their simulation within a short time frame in order to minimize contamination. They also signed a confidentiality form requesting that they not discuss the details of the case with anyone else. Participants were videotaped during the simulation. Students were stopped three times during each simulation to answer questions about what they were noticing using the freeze-probe queries developed by Cooper et al. (2011) (Appendix C). Students stepped out of the simulation room and answered the randomized questions on a computer screen. Students were instructed to answer quickly, and then return to the simulation room and continue the scenario.

After completing both simulation scenarios, students proceeded to the debriefing room for a post-simulation debriefing and interview. The semi-structured interview included questions about how the students noticed changes during the simulation (Appendix D). The simulation de-briefing used the “Debriefing with Good Judgment” technique (Rudolph, Simon, Dufresne, & Raemer, 2006). This technique is based on reflective practice and encourages the student to reflect on the simulation scenario. Student actions during the scenario are presumed to be based on their cognitive frames. The role of the debriefing facilitator is to be curious and ask the students about what they were doing and thinking in order to uncover the students’ internal frames. A dialogue followed the discovery period during which the instructor frames and the student frames and actions were discussed. It is hoped that the discussion will help the student internalize new ways of thinking (Rudolph et al.). During the de-briefing, video from both scenarios was reviewed. During the scenario video bookmarks were inserted into the recording after significant changes in vital signs and these bookmarked video segments were displayed and used as prompts for the debriefing discussion about what the students were noticing and thinking at the time. The simulation de-briefing was also videotaped and recorded. The total amount of time for the simulation, de-briefing and interview completion was about two hours.

Instruments

Situation awareness was measured by the Situation Awareness Global Assessment Tool (SAGAT) (Endsley, 2000). Criterion validity for this tool is reported by Endsley (2000) with SAGAT scores predictive of performance during simulation. Also, as predicted by the Model of Situation Awareness in Dynamic Systems, SAGAT scores decrease with increases in cognitive load (Endsley, 2000, 1995b). Test-retest reliability ranging from .92-.98 for SAGAT was demonstrated in the field of aviation (Endsley & Bolstad, 1994). Another study involving automobile driving reported reliability of .92-.96 (Gugerty, 1997).

The SAGAT used in the current study included two dichotomously scored scales of 12 items each (correct or incorrect) measuring both respiratory and shock situation awareness across three time periods (Table 1). The specific SAGAT queries used in this study were developed by Cooper et al. (2011), following the recommended technique by Endsley and subsequently adapted for use in the healthcare field by Wright, Taekman and Endsley (2004). The 12 queries were generated by clinical experts who completed a lengthy task analysis and identified the decisions that needed to be made and the situation awareness that was needed to make those decisions. These queries were examined by two other clinical experts in the current setting who agreed the questions were valid and appropriate with recommendations to change the wording in two instances: "bedside locker" was changed to "bedside stand" and required "investigations" was changed to required "tests." The global awareness questions were modified for the second and third repetitions to ask about other items in the room. No reliability data for these questions were reported in the study by Cooper et al. (2011) since the queries were answered once by each participant. The rules describing when to stop the scenario in order to complete the survey are in Appendix H.

Table 1

Items 1-12 on the SAGAT across four Subscales and three Time Periods

Physiological Perception Time 1 through Time 3	1. What is the BP at the moment? 2. What is the HR at the moment? 3. What is the respiratory rate at the moment?
Global Perception Time 1 through Time 3	4. Is Suction (oxygen, ambu bag) available? 5. What is on the bedside stand? (Who is pictured in the picture on the bedside stand?) 6. What is attached to the head of the bed (Is there water in cup, call light, book)?
Comprehension Time 1 through Time 3	7. Is the patient adequately oxygenated? List SpO2. 8. What is wrong with this patient?
Projection Time 1 through Time 3	9. If condition does not improve, what will happen to the HR? 10. If condition does not improve, what will happen to the RR (BP in shock scenario)? 11. What tests may be required? 12. What medications may be required?

In addition to the respiratory and shock scales, four subscales were assessed for both the respiratory and shock situations at three time periods. These subscales were Physiological Perception (items 1-3), Global Perception (items 4-6), Comprehension (items 7 and 8), and Projection (items 9-12).

Implementation of the SAGAT tool followed the procedures recommended by Endsley including preventing the participant from seeing the display screens, randomizing the queries, delaying the first stop until after the first three minutes and randomizing two of the three stop times. The first stop occurred at four minutes into the scenario. This was deemed necessary due to the number of freezes and the brevity of the scenario.

A researcher-designed demographic questionnaire was used to collect participant data regarding age, gender, months of direct patient care experience outside of nursing school and current level in the nursing program (Appendix E).

Data Analysis

In order to answer each of the research questions, descriptive and inferential statistical tools were employed. All data analyses were conducted using SPSS (PASW 21.0, 2013). Descriptive statistics were run on the demographic information, each of the two situation awareness scales (respiratory and shock) over three time periods, and the four subscales of physiological, global, comprehension, and projection over the three time periods. Item response frequency was reviewed and aggregate scores reflecting correct and incorrect answers were created using the 12 items on each of the two scales across three time periods and four subscales. One –way ANOVA tests were conducted to assess mean differences between sophomores and seniors on all scales and subscales across three time periods.

Reliability

Since the data collected were categorical, the internal consistency of the scale and subscale scores was examined by conducting a Kuder-Richardson 20 (KR-20), a special case of Cronbach's alpha coefficient indicating the lower bound of internal consistency (Cronbach, 1951). All scales and subscales demonstrated low-to adequate internal consistency (ranging from .373 to .723). Please see Table 2 for the reliability coefficients.

Table 2

Reliability Coefficients for All Scales and Subscales of Situational Awareness (SA) by Group

Scales	Item Numbers	Sophomore	Senior	N
Full Scale	Time 1-Time 3 SA Resp and SA Shock items 1-12	*0.772	*0.696	33
Respiratory Scale	Time 1-Time 3 SA Resp items 1-12	*0.780	0.579	33
Shock scale	Time 1-Time 3 SA Shock items 1-12	0.475	*0.644	33
Subscales				
Physiological	Time 1-Time 3 SA Resp and SA Shock items 1, 2, 3	0.574	0.497	33
Global	Time 1-Time 3 SA Resp and SA Shock items 4,5,6	0.563	*0.723	33
Comprehension	Time 1-Time 3 SA Resp and SA Shock items 7 and 8	*0.685	0.573	33
Projection	Time 1-Time 2 SA Resp and SA Shock item 9, 10, 11, 12	*0.723	0.373	33

Reliability ranges between 0 and 1, with coefficients closer to 1 indicating higher reliability.
** Indicates adequate reliability. Reliability > .9 – excellent, between .8 and .89 - good, between .6 and .79 – adequate, between .4 and .59 – moderate and < .39 is poor*

Validity

Exploratory Factor Analysis is based on a correlation or covariance matrix and it is assumed that the observed indicators are measured continuously, are distributed normally, and that the associations among indicators are linear. Since the SAGAT scores were measured dichotomously, researchers recommend a tetrachoric correlation estimator (Calkins, 2005; Guilford & Perry, 1951). The assumption is that dichotomous variables are imperfect measures of the underlying normally distributed latent continuous variable.

In the current study, due to the small sample size (*n*=33), tetrachoric correlations could not be computed; therefore, using SPSS (PASW, 21.0, 2013) factor analysis was conducted using maximum likelihood estimators and assessing eigenvalues > 1 (K. Traxler, personal communication, July 17, 2014).

Prior to testing for validity, Bartlett's test of sphericity was completed. This tested the hypothesis that the correlation matrix is an identity matrix, which would indicate that the variables are unrelated and therefore unsuitable for structure detection. Small values (less than 0.05) of the significance level indicate that a factor analysis may be useful with the data. For this data, Bartlett's test of sphericity was (χ 2 (276) =330.878, p = .013) indicating the results of factor analysis will be meaningful in identifying the underlying factor structures.

Qualitative Data Analysis

Qualitative data analysis proceeded with the data collected from the post-simulation interview and the debriefing session. Data were recorded and transcribed verbatim. The combined interview and debriefing transcripts were de-identified and coded by group, senior or sophomore. Each transcript was considered the unit of analysis. All transcripts were imported into an electronic program and analyzed using both manifest content analysis and latent content analysis (Hsieh & Shannon, 2005). Manifest content analysis began with identifying key words and quantifying the usage of these words in the text (Potter & Levine-Donnerstein, 1999). This approach was useful to determine what students noticed and how often noticing occurred. Subsequently the transcripts were analyzed using latent content analysis. The combination of both manifest and latent content analysis is called summative content analysis by Hsieh and Shannon

(2005). Latent content analysis began with reading the text as a whole. Subsequently line by line examination was used to choose exact words within the text as the initial meaning units. As new meaning units emerged, previous scripts were re-coded. Analysis continued until no further meaning units were uncovered. At this point the interview scripts were sorted by experience level. Data from the two groups were compared to uncover any differences in terms of meaning units. Latent content analysis continued with labeling the meaning units and sorting them into categories and categories into themes.

Data Handling Procedures

Situation Awareness data, video files, debriefing and interview transcripts and demographic surveys were assigned a participant number. A log separating participant numbers assigned to sophomores and seniors was kept for reference after the initial qualitative analysis is complete. All written data were stored in a locked private cabinet, accessible only to the primary investigator. Video files were stored on the study computer and password protected. Study data will be kept for three years before being permanently erased or shredded. Consent forms were stored in a locked cabinet on the UNC campus accessible only to the Research Advisor, Dr. Carol Roehrs, or members of the Institutional Review Board. The consent forms will be maintained at this location for three years after the study. The data were aggregated and reported only in terms of overall findings and conclusions. These may be submitted for publication in a professional journal. Final reports were e-mailed to the participants, if desired.

CHAPTER IV

FINDINGS

This chapter begins with descriptive statistics about the participants and then reviews each of the study questions and the associated findings. Instrument reliability and validity is also addressed.

Participants

Thirty-four students volunteered to participate in the current study, representing a response rate of 20%. One data set for SAGAT responses was lost due to technical problems as well as one interview recording (from a different student), leaving a sample size of 33 for quantitative analysis and 33 for qualitative analysis. The participants ranged from 20 to 47 years old (M_{age} = 25.75, *SD* = 6.78). Thirty-one females and three males completed the tasks assigned ($M_{female\ age}$ = 24.97, *SD* = 6.19; $M_{male\ age}$ = 33.67, *SD* = 8.96), comprising 16 sophomores and 18 seniors. The self-reported race/ethnicity of the participants included one African American, six Asian, two Hispanic or Latino, and 25 Caucasian participants.

Post-hoc Power Analysis

Post Hoc Power Analysis, using Gpower 3.1 software was completed (Faul, Erdfelder, Lang & Buchner, 2007). When conducting a fixed effects one-way ANOVA, with α =.05, d = .4, and n = 33, the actual power = .62. Cohen (1988) recommends a minimum power $\geq$ .80 when conducting research in the social, behavioral, and biomedical fields. These results indicate that any form of means testing (t-test, ANOVA, MANOVA) requires a larger sample size to detect differences between the groups with 95% confidence. Chi square Test of Independence is more robust with respect to sample size with the condition that individual cells contain at least five responses. In some cases subscale data, particularly comparisons of groups working in the healthcare field with those who do not, failed to meet these criteria. Due to these constraints, ANOVA was used for hypothesis testing with the understanding that existing differences may not be detected.

Quantitative Results

Q1 Which cues are undergraduate nursing students most frequently aware of during a simulation of a deteriorating patient?

Nursing students most frequently (94%) answered question 9 correctly, "If condition does not improve, what will happen to the HR?" In both scenarios, this projection question was correct if the students answered that the HR would increase. Overall students frequently answered question 7 "Is the patient adequately oxygenated? List SpO2" (84%) and question 8 "What is wrong with the patient" (80%) correctly as well. Question 8 was answered correctly 86% of the time for the Shock scenario and 75% of the time for the Respiratory scenario. Question 11 "What tests may be required?" was answered correctly 77% of the time and Question 12 "What medications may be required?" was answered correctly 74% of the time. See Figure 1 for total correct responses by group for all questions.

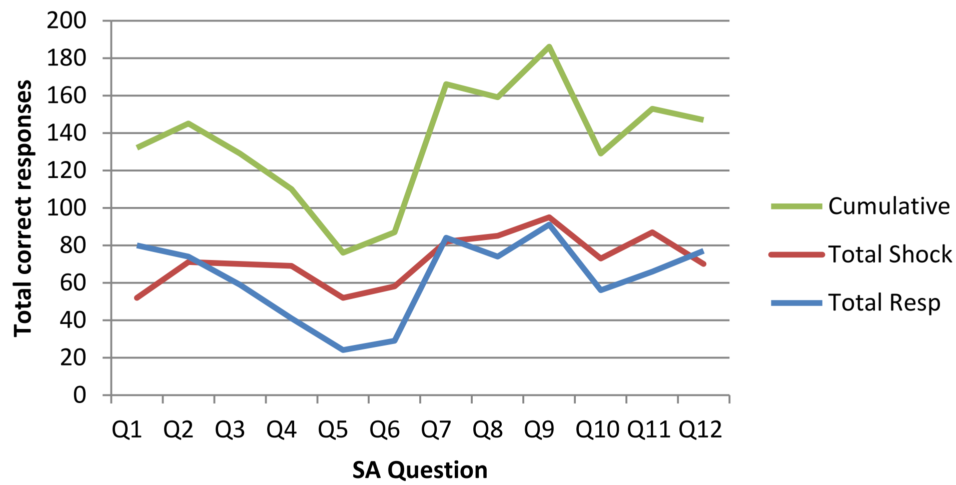

Figure 1. *Total Correct SA responses by scenario*

Across the subscales students were best at Comprehension (82% correct) and Projection (78% correct, see Figure 2). Students were less proficient at Physiological perception (68% correct) and Global perception (46% correct).

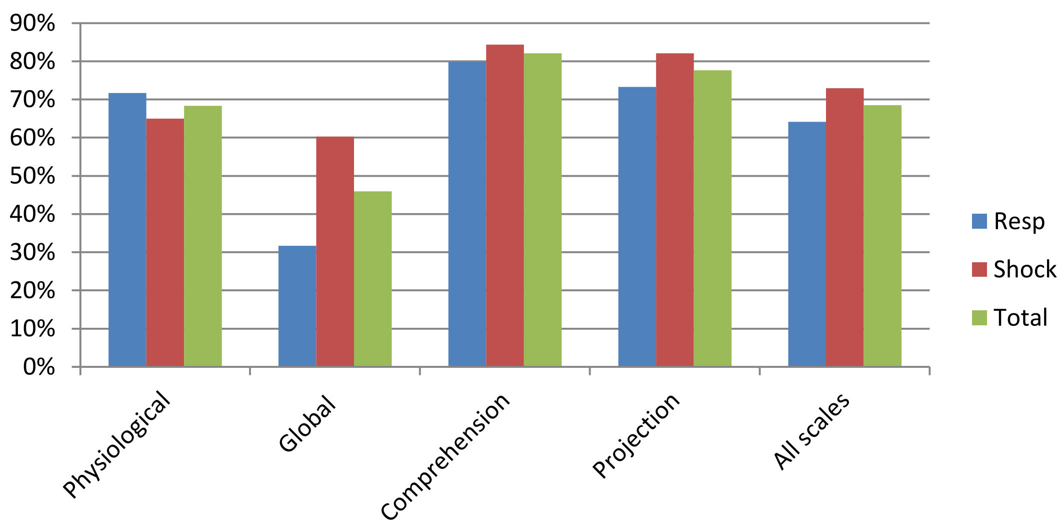

Figure 2. *Percent Correct SA Responses by Subscale*

Q2 Which cues are undergraduate nursing students least often aware of during a simulation of a deteriorating patient?

Across both scenarios, nursing students least frequently (38.4%) answered question 5 “What is on the bedside stand?” correctly. Students also infrequently answered question 6 “What is attached to the head of the bed?” (43.9%) and question 4 “Is suction available?” (56%) accurately. These questions are all from the global awareness subscale which scored the lowest of all the subscales. Also, in the shock scenario 52.5% of students missed the correct blood pressure, although only 19.2% of students missed the blood pressure in the respiratory scenario, bringing up the average number of students answering incorrectly to 33.3%. Overall the respiratory scenario was more difficult for the students with 36% of the answers incorrect compared to the shock scenario with 27% incorrect answers (see Figure 3).

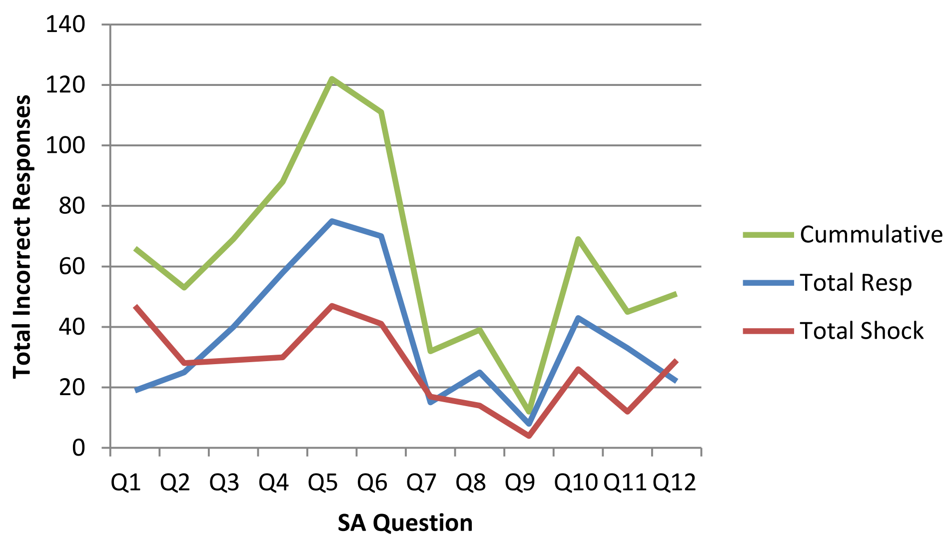

Figure 3. *Total Incorrect SA responses by scenario*

Q3 Is there a difference in Situation Awareness scores or subscores measured during a simulation scenario between sophomore and senior students?

Individual SAGAT items were dichotomous. Scores were subsequently averaged across items and treated as a continuous variable. Additional analyses were conducted to see if statistical assumptions were sufficiently met to allow further examination using ANOVA. Linear plots such as a normal Q-Q plot provided evidence that the data set was linear. Skew and kurtosis were also assessed. The skew on all total scale scores for sophomores ranged between -.279 and 1.77 and for seniors ranged between .130 and -1.866 which falls well within the range for normality. One variable, Projection average, was = -4.12 for seniors only, which is not within the range of normally distributed data and demonstrates extremely low scores on this domain (K. Traxler, personal communication, July 15, 2014). Since the sample likely had similar instructors or classes, the criteria for independence of sample observations was not met within groups but was met between groups (sophomores and seniors), however, the General Linear Models are robust to this violation and this is a limitation of any educational study. Equal error variance (homoscedacity) was tested using the plot of standardized residuals against fitted values (PP plots) and showed the data met these criteria. Meeting these assumptions provides support for continued interrogation of the data using ANOVA. The limitation of inadequate power does mean that there may be positive effects that remain undetected.

The results provide evidence of significant ($\alpha = .05$) differences (averaged over repeated SAGAT responses) between sophomore and senior nursing students' scores on the shock situation awareness scale ($F(1,31) = 14.19$, $p = .001$), the projection subscale ($F(1,31) = 26.17$, $p < .0001$) and the overall respiratory and shock comprehensive scales ($F(1,31) = 10.394$, $p = .002$) with seniors' average scores over time significantly higher than sophomores. No significance was found on the respiratory situation awareness scale or any other subscale. Please see Table 3.

Table 3

One Way ANOVA Examining Mean Differences Between Sophomores and Seniors on Situation Awareness Scales and Subscales Averaged Over Three Time Periods

Scales and Subscales		**degrees of freedom**	**F**	**p-value**
Respiratory Overall	Between Groups	1	3.167	.085
	Within Groups	31		
	Total	32		
Shock Overall	Between Groups	1	14.191	***.001**
	Within Groups	31		
	Total	32		
Physiological Overall	Between Groups	1	.022	.884
	Within Groups	31		
	Total	32		
Global Overall	Between Groups	1	1.122	.298
	Within Groups	31		
	Total	32		
Comprehension Overall	Between Groups	1	1.857	.183
	Within Groups	31		
	Total	32		
Projection Overall	Between Groups	1	26.174	*** <.0001**
	Within Groups	31		
	Total	32		
Total ALL SCALES	Between Groups	1	10.394	***0.002**
	Within Groups	31		
	Total	32		

* Indicates a significant Difference in Average Scores Between Sophomores and Seniors

Q4 Is there a difference in Situation Awareness scores or subscores measured during a simulation scenario between students who have less than 2 months of healthcare experience, compared with those who have more than 2 months outside the nursing program?

There were 12 students who had experience in the healthcare field in addition to nursing school. These students had worked from 10 to 300 months at the time of the study (avg. 21 months with the outlier of 300 months removed). Across the aggregated scales of Respiratory, Shock and Total SA, students who had outside experience scored higher than students who did not (see Figure 4). However, with α =.05 and using ANOVA, the data provide no evidence of any significant differences on scale and subscale scores averaged over time based on time of employment (less than or equal to two months and greater than two months). Please see Table 4.

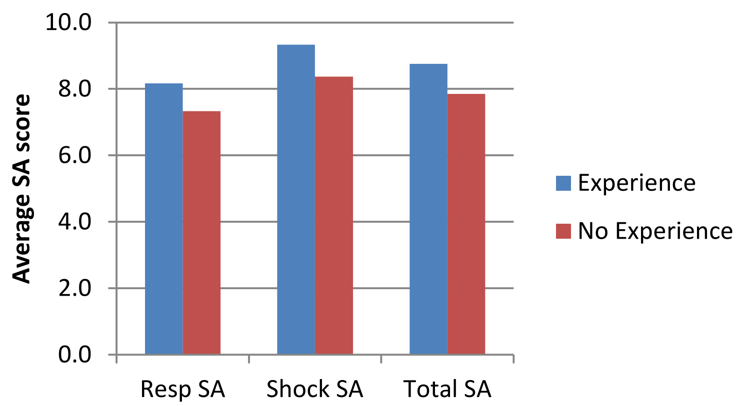

Figure 4. *Avg. Scale scores for students >2 months healthcare experience and those with < 2 months healthcare experience*

Table 4

One Way ANOVA Examining Mean Differences Between Time of Employment on Situation Awareness Scales and Subscales Averaged Over Three Time Periods

Scales and Subscales		**df**	**F**	**p-value**
Respiratory Overall	Between Groups	1	1.988	.168
	Within Groups	31		
Shock Overall	Between Groups	1	3.698	0.064
	Within Groups	31		
Physiological Overall	Between Groups	1	2.942	.096
	Within Groups	31		
Global Overall	Between Groups	1	1.614	.213
	Within Groups	31		
Comprehension Overall	Between Groups	1	1.359	.253
	Within Groups	31		
Projection Overall	Between Groups	1	1659.0	.207
	Within Groups	31		
Total ALL SCALES	Between Groups	1	3.894	.057
	Within Groups	31		

Reliability and Validity of the Modified Situation Awareness Instrument

Reliability. Reliability of the full scale and subscales over times 1-3 was assessed using the Kuder-Richardson 20 (KR-20). As previously reported the reliability coefficient for the full scale was 0.772 for sophomores and 0.696 for seniors, which is considered adequate. The remaining reliability coefficients indicated adequate or moderate reliability with the exception of the Projection subscale for seniors with a coefficient of 0.373 which is considered poor.

Validity. Using SPSS (PASW, 21.0, 2013) factor analysis was conducted using maximum likelihood estimators and assessing eigenvalues > 1. The situation awareness respiratory scale suggested four subscales (factors) account for an average over time of 58.35% of the variance in the model while the situation awareness shock scale suggested four subscales accounting for an average over time of 57.10% of the variance in the model. In both analyses, items 8 (What is wrong with this patient?) and 12 (What medications should be given?) provided no information to the model and should be removed. Due to the small sample size, individual items can not be assessed, but overall, the Exploratory Factor Analysis suggested four distinct factors, as hypothesized in the clinical research.

Qualitative Results

The qualitative results for this study are reported using both manifest and latent content analysis. The study question was “How do undergraduate nursing students describe becoming aware of patient changes and other elements in the environment during a simulation of a deteriorating patient?” The unit of analysis for this study included the combined semi-structured interview and the subsequent debriefing session.

According to Merriam-Webster (2014), the definition of notice is “to become aware of (something or someone) by seeing, hearing, etc.” Since students were not familiar with the term situation awareness, the phrase “became aware of” was translated as “notice.” During the interview and debriefing students described both what they were observing and the process of how they noticed these things. After analysis of the entire content, comparisons were made between sophomore and senior student groups. Differences between these groups were found at the code level. Therefore, descriptions of what the students were noticing and how they noticed are reported using manifest content analysis at the code level. Subsequently codes were organized into category and themes. The first reported results describe what the students noticed while the second part of this report will focus on how the students noticed.

What Students Noticed

In this study, the question “What do students notice” was asked in several different ways. Students responded to “What was the first abnormal finding”, “What were some other clues” and “Were you noticing or thinking about any other things related to the setting or situation? What were they?” Codes were collected into general categories of items that students noticed and categories were organized into themes. Two main themes were identified: patient variables, and context variables.

Student responses to these questions were most often medical signs or symptoms. These were used as the codes. For example, a student responded regarding the shock scenario, “Well the first thing he told me was that he was having a lot of pain so I guess that was abnormal.” This response was coded as “pain.” A student response to the respiratory depression scenario; “the first one that I noticed was her oxygen. It was at 88 or 89," was coded as "oxygen saturation" (SaO2) since that is the physiological sign to which the student was referring. Once a complete list of codes was extracted from the data, codes were then sorted into categories. Following are the codes for these questions about what was noticed first. They are presented according to scenario.

First Abnormal Finding and Other Clues

During the semi-structured interview in the course of debriefing, students were asked "what was the first abnormal finding that you noticed in the most recent scenario." This question was followed by asking if there were any other clues that helped them realize what was going on with the patient. Scenario 1, hypovolemic shock, was completed last by 15 students and 18 students completed the post-operative respiratory depression scenario (Scenario 2) last. Data were collected only about the most recently completed scenario.

First findings: scenario 1, hypovolemic shock. In this scenario the patient presents with gastrointestinal bleeding and abdominal pain. Hypovolemic shock rapidly develops. Across groups, students most frequently reported pain (10/15) and SaO2 (7/15) as the first abnormal finding. None of the seniors listed low blood pressure (BP) as the first finding, while half (4/8) sophomore students listed low BP as the first abnormal finding. A sophomore student responded, "The first abnormal that I noticed was his blood pressure. It was really low." Senior first responses varied widely, with stool color the only repeated statement, e.g. "The dark tarry stools that were really loose. That was probably the first big abnormal."

Seniors and sophomores listed a variety of other first noted symptoms (see Table 5). Seniors frequently reported low BP as supporting evidence (3/7) as well as high heart rate

(4/7). For example, one senior response was “His comment that he was dizzy. That's when I double checked his blood pressure and it had gone down and his heart rate had kind of gone up.” See Table 5 for student reports of other first abnormal findings listed in order of frequency. Of interest, two sophomore students also reported that the patient had not taken his morning Lisinopril yet had a low BP. One stated “and he had not had his Lisinopril which lowers the blood pressure but his blood pressure was low so that was [an] immediate red flag.” No seniors reported asking the patient if he took this home medication.

Table 5

Responses to “What was the First Abnormal Finding?” by group

Scenario 1 Shock				Both Scenarios	
Senior (n=7)	#	Sophomore (n=8)	#	All Students (n=33)	#
Stool color	2	Low BP	4	Pain	10
Dizzy	1	Pain	2	SaO2	7
Crackles	1	SaO2	1	Low BP	4
SaO2	1	High HR	1	High HR	3
Pain	1			Low Resp rate	2
High HR	1			Stool color	2
Scenario 2 Respiratory Depression				Cyanosis	1
Senior (n=10)		Sophomore (n=8)		Crackles	1
Low SaO2	5	Pain	4	Dizzy	1
Pain	3	High BP	1	High BP	1
Low Resp rate	1	Low Resp rate	1	Mental status change	1
Cyanosis	1	Mental status change	1		
		High HR	1		

First findings: scenario 2, respiratory depression. In this scenario, when the patient’s post-operative pain is treated with Morphine, the patient develops respiratory depression. Students most frequently noticed her pain first (7/18) followed closely by oxygen saturation (5/18) and then her respiratory rate (2/18). Some students explained that although they noted her pain, this was considered a usual finding after surgery so they reported her respiratory status as the first abnormal finding. For example, one student stated, “Everything else seemed normal except she was in a lot of pain. But that was understandable. So I would say the respiration rate.”

There were differences between the seniors and the sophomores. Seniors frequently reported the oxygen saturation as the first noted abnormal finding (5/10) while sophomores reported pain more frequently (4/8). No sophomores listed oxygen saturation as the first abnormal finding.

Other findings. Other clues listed by the seniors included change in mental status (8/10) and cyanosis (5/10). Sophomore responses were quite diverse including high heart rate (2/8), and low respiratory rate (4/8) but one student noted a high respiratory rate. See Table 6 for remaining responses. At times sophomore students were not sure that they were correctly interpreting the patient symptoms. This student sums it up, “Her oxygen level was starting dropping and I wasn’t sure if it was because of the morphine but I turned up her oxygen just in case.”

Table 6

Responses to "What were some other clues. . ." by group

Scenario 1 Shock				Both Scenarios	
Senior (n=7)	#	Sophomore (n=8)	#	All Students (n=33)	#
High HR	4	Pain	3	High HR	11
Low BP	3	Dizzy	2	Mental status change	10
Diarrhea	2	High HR	2	Low Resp rate	10
Stool color	2	SaO2	2	SaO2	9
Bowel sounds	1	Diarrhea	1	Pain	5
Pain	1	Stool color	1	Cyanosis	5
Mental status change	1	Bowel sounds	1	Low BP	4
Dizzy	1	Patient moaning	1	Stool color	3
Pt. report "something is wrong"	1	Low BP	1	Diarrhea	3
				Dizzy	3
Scenario 2 Respiratory Depression				Bowel sounds	2
Senior (n=10)		Sophomore (n=8)		Fatigue	1
Mental Status changes	8	Low SaO2	4	Sounding winded	1
Low Resp rate	6	Low Resp rate	4	Pt. report "something is wrong"	1
Cyanosis	5	High HR	2	Medical records	1
SaO2	3	Facial expression	1	High Resp rate	1
High HR	3	Pain	1	Facial Expression	1
Fatigue	1	PCA	1	Patient moaning	1
		Medical records	1	High HR	1
		High Resp rate	1	PCA	1
		Mental Status changes	1		

Noticing or Thinking about Anything Else

Scenario 1, hypovolemic shock. Students were asked "Were you noticing or thinking about any other things related to the setting or situation? What were they?" Overall, students reported they did scan the environment and notice changes (7/15). However, 4 of the 7 explained that answering the SA questions prompted them to look more closely at the environment the next time they were in the room. One student stated he/she noticed "that he did have water on his bedside table. A nice little reminder from the computer scenario testings." Another student explained, "I think the questions kind of cued like did I look at that?"

When comparing seniors to sophomores, seniors described noticing changes in the environment more often (5/8) compared to sophomores (2/7). Seniors also mentioned that items they noticed in the environment would be helpful in planning future nursing care (2/8). For instance one student stated,

> Well I noticed a lot of things like the pictures of his family that looked like him . . . and cultural considerations. It wasn't something I worried about right at the moment if he was bleeding out or had a problem but it was something I would consider throughout my nursing care.

Scenario 2, respiratory depression. Students in this scenario were also concerned about what supplies were in the room (4/18) and noticed changes in the environment (4/18). One student reported checking "that the environment was safe and that there was oxygen available and it was already on her, suction, things like that." Some seniors stated that they were thinking they could have been better prepared (2/10) and were also planning for the future by thinking about what supplies would be needed in the room (2/10).

Sophomores were primarily focused on providing post-operative care, but two did scan the setting. One student stated, "I was noticing that when I first came in there were flowers and a picture," while another reported, "I just noticed like her dressing on her stomach." Responses to this question also included items that were coded under the following section, "How students notice."

Themes and Categories for What Students Noticed

Codes were sorted into categories and the categories were placed into themes. The two main themes that emerged from this data were Patient Variables and Context (see Figure 4). Under patient variables were the categories of Vital Signs, Patient Assessment and Subjective Data. Students noticed abnormal vital signs including heart rate, respiratory rate, oxygen saturation and blood pressure. During assessment of the patient students noticed abnormal findings such as cyanosis, stool color, mental status changes and abnormal bowel sounds. Subjective data that students noticed included pain, dizziness, fatigue and the patient self-report that "something is wrong." Under the Theme of Context, categories of Environment and Medical Data emerged. Environment primarily referred to noticing items that had been changed in the environment intentionally between freezes. In addition students referred to looking to see if supplies that they might need were in the room. Medical data that the students noticed included the patient history and diagnoses as well as laboratory test results. Of note, some of the variables reported by students included how they noticed. These variables were added to the analysis of "How students notice."

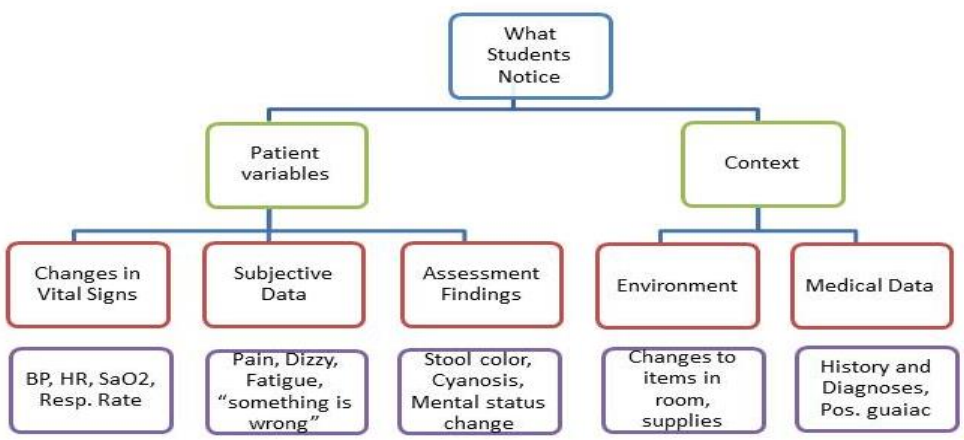

Figure 5. *What Students Noticed: Themes, Categories and Example Codes*

How Do Students Notice?

The second question is "How do students notice?" This question was asked several ways. Students were asked "How did you know which information to pay attention to?" and "Tell me how you came to know what the problem was." Students had difficulty explaining or describing how they notice. This required some metacognition which students were not used to, as demonstrated by one student who stated “I don’t know the thinking behind what I was doing all the time.” Nevertheless, some student descriptions were quite detailed allowing the creation of several themes and categories. A discussion of the meaning codes and differences between sophomores and seniors will be followed by a discussion of the themes and categories.

How Do You Know What to Pay Attention To?

Scenario 1, hypovolemic shock. Fifteen students out of 33 completed this scenario first and answered the questions. Students in this scenario relied on vital sign parameters to indicate important information (8/15). They also weighted the patient concerns as something to pay attention to (5/15). The patient history and diagnosis further directed their attention (5/15) as did prior knowledge of the problem or treatments (3/15). Both seniors (4/7) and sophomores (4/8) used abnormal vital sign information to focus their attention, as well as the patient history (3 seniors, 2 sophomores). One student from each group described that it was not a single piece of datum that drew their attention, but rather connecting the pieces to make a complete picture. For instance, a senior responded, “So it is not one piece of the assessment. It is all the pieces of the assessment truly coming together.” A sophomore student had a similar thought when he/she responded. “Yeah that and just connecting the pieces.” In contrast, another sophomore stated that he/she did not know the “thinking behind what I was doing.”

Scenario 2, respiratory depression. Eighteen students completed this scenario first. Students agreed that it was changes in the patient physical assessment, paying attention to the patient concerns and changes in the vital signs that were most helpful

(9/18 for each). Students explained they knew to pay attention to her respiratory status due to paying attention to the history and diagnosis given to them pre-scenario (3/18) and using prior knowledge about medications and side effects (6/18). When comparing seniors to sophomores, seniors paid more attention to patient assessment (6/10) and the patient concerns (8/10) and then looked at abnormal vital signs (5/10). The sophomores relied more on abnormal vital signs (5/7) and patient concerns (4/7). Of interest, only seniors talked about putting the whole picture together and not relying on single pieces of information to make informed decisions.

How You Came to Know What the Problem Was

Scenario 1, hypovolemic shock. Students were able to describe some of the cognitive processes they used to determine what the problem might be. Students relied on cues from abnormal vital signs (11/15), assessment findings (9/15) and patient history and diagnosis (2/15) to deduce the current problem of volume loss. Students also relied on prior knowledge but did not formally state this; it was implicit in their reasoning. For senior students the patient history and diagnosis combined with the positive guaiac test and low hemoglobin and hematocrit levels led them to the problem of gastrointestinal bleeding which caused them to anticipate a low blood pressure before arriving in the room. No sophomore students mentioned the lab results as helping them determine the problem. One sophomore student focused on the patient remote history of cholecystectomy and became puzzled about the current symptoms. The student reported consequently that to “overall understand maybe what the case was and why he was bleeding I didn’t really – I had trouble coming to that conclusion.”

Once in the room seniors (4/7) mentioned that it was several changes in combination that led them to realize what the problem was (average of 3 changes). Sophomore students (3/8) also mentioned several changes that added up to the problem of fluid deficit. In some cases sophomore students did not know what was going on and called the doctor for help or focused on the low SaO2 and two others were confused about an increased HR along with a decreased BP stating “those things like counteract to me. Like something is not right there. Something is not connecting. So I needed help.”

Scenario 2, respiratory depression. During scenario 2, students mainly focused on the patient’s mental status changes (12/18) and low respiratory rate (13/18) as clues to the patient’s underlying condition. Eight students (of 18) stated it was their knowledge of morphine and the side effects that led to determining the problem and other students alluded to this without stating it outright. Senior students were alerted to watch for respiratory depression due to the morphine but also were open to other possibilities. Three seniors stated they ruled out bleeding from the post-operative incision before making their decision and one hypothesized initially that the decreased level of consciousness and low respiratory rate was an effect of the anesthesia and another checked first for abnormal breath sounds. Sophomore students did not report thinking about any other causes. Seniors (2) and one sophomore stated they became concerned about respiratory depression when interventions to increase oxygen saturation were not working. Sophomore students had more difficulty relating the symptoms to the cause. One sophomore student stated that when they called for help they did not know what the problem was and another explained that although he/she noticed the change in mental status, they did not know if it was related to the morphine. Another sophomore stated that it was answering the SA questions that brought to mind the morphine. Seniors tended to group more symptoms together as evidenced by this student who stated,

> Looking at just the overall conditions of her orientation, circulation intact, peripheral circulation and things like that. So I think it was a number of things that had me linked. I guess that kind of substantiated that the threshold for that decision on morphine intoxication.

In contrast, sophomore students, on average, focused on two symptoms.

Noticing or Thinking about Anything Else

Scenario 1, hypovolemic shock. Students were primarily focused on what was changing in the setting as previously reported, however, combining the tasks of taking care of the patient as well as looking around the room caused considerable cognitive load for two students. They reported they were "overwhelmed" and that

> Those little things, they threw me off. Because I was trying to focus on my patient and what was wrong with him. But then there were all these other things going on too that I was trying to pay attention to.

These students were both sophomores. Students also discussed things that they did not notice such as the ambu bag being removed from the room (1 senior) and the position of the bed or whether there was water in the cup (2 sophomores).

Scenario 2, respiratory depression. Students (7/18) in this scenario reported being focused on providing standard post-operative nursing care. They reported checking the incision, watching for bleeding and considering other complications. For example, one student reported, "those are the two things post-op. Respiratory and ABC's and just to make sure if she is bleeding and her circulation is correct."

**How Students Notice: Themes
and Categories**

In addition to the above mentioned interview questions, the debriefing transcripts were also coded. These transcripts were helpful in describing the entire process of noticing as it was re-experienced when the students watched videos of portions of the scenarios. These codes supported codes uncovered from the interview. In forming themes and categories, all codes were considered. The process of how students notice can be described using three themes: Expectations, Salience and Information Processing. Each of the themes also has categories that describe the assigned codes (see Figure 6).

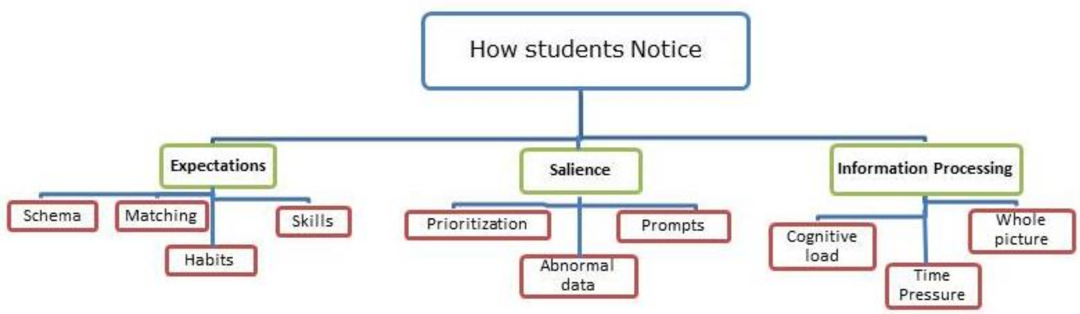

Figure 6. *How Students Notice: Themes and Categories*

Expectations

Students described several processes that they used when noticing. They explained that while reviewing the patient information they used schemas to form expectations about the patient and also began to prioritize what might be important to notice. “At this point I knew about like the history of what was going on and suspecting you know because of the positive guaiac I was expecting some sort of bleeding.” This student went on to explain the next step was to look at the vital signs because he/she expected to see changes there and also to look at the patient’s stool to see the stool color in order to determine the location and amount of bleeding. This process fits with Tanner’s clinical judgment model and the explanation that noticing is a function of expectations setting up the ability to notice whether the expectations are met or not (Tanner, 2006).

Schema. Students described schemas they used to set up expectations about what would be normal. This helped them to identify abnormal information. Students used their prior knowledge of disease processes, medications and usual post-operative patient recovery to determine what was expected.

> So I was just trying to figure out if it was a respiratory problem or a different problem. . . Thinking about stuff like pneumonia or things like that. But I don't – I think that wasn't my main concern because she was a post-op patient versus like a typical medical patient."

One student explained that he/she came to know what the problem was by "just knowing the side effects of Morphine."

Matching. Students often compared their assessment findings to an expected finding. One student explained, "So I wasn't too worried that her pain was at an eight because she was post-op." In some cases students were making comparisons with what they were observing to previous experiences or the previous scenario. In one instance, the student described trying to make the current symptoms match the previous case "I don't know. I just kept trying to compare it to the first scenario even though I knew the symptoms were way different." In this case the comparison delayed an accurate interpretation of the findings and subsequent treatment for the patient. Students also matched the current vital signs to the patient baseline as one student stated that the patient "doesn't normally have those blood pressure readings at home."

Habits. Students also reported they had developed habits which helped them to notice. Habits primarily refer to the sequence in which tasks are performed. For example, one student reported that it was her habit to scan the room first when, "I walked into the room. So I noticed that and then went onto the patient." Other habits that students reported were to take vital signs first and then do a patient assessment. As a part of taking the vital signs, students would start the automatic blood pressure, write down or memorize the other vital signs, then turn their attention to the blood pressure result.

Vigilance or the frequency with which students monitored the situation could also be considered a habit. Students described knowing that they needed to continue to pay attention or re-assess when there was a suspicion that things were not normal. One student called this being "alert," "I was curious and like alert to see if we were having a bleeding problem." Students also referred to "watching," as this student explained, "You might not be actively bleeding right now but I was watching to see if it changed." Other students referred to this as monitoring; "the rate was at ten so I was just going to stay and monitor."

Skills. Students reported performing a set of checks they were taught that are important to complete for post-operative nursing care. They went through a rote list of items and checked for any that were abnormal. For example: "So when I walked in the room, I was listening to her. So I was checking her level of consciousness and listening to her pain. I was looking for things that really jump out. I always think about - what we have always been drilled into is airway, breathing, cardiac, respiratory and on from there." This is a learned skill that organizes the search for abnormal information. Another student replied that he/she was able to rule out problems by completing the post-operative checks that were listed as, "because she wasn't bleeding from anywhere. Her output was about 200 which just coming from surgery is pretty good." Closely related is the skill of completing a head to toe assessment. Students reported that they knew to systematically look for changes “I think just the head to toe everything looked okay.” See Figure 7 for a representation of the categories and codes for the theme of Expectations.

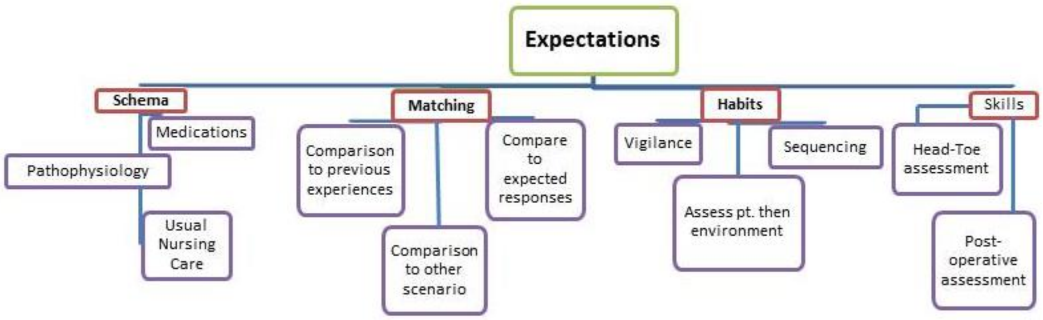

Figure 7. *Expectations: Categories and Codes*

Salience

Abnormal data. Students described processes they used to determine relative importance of items or salience. There were more than 100 instances of describing salience, the majority of which were centered on abnormal data or changes from before. For example, one student reported becoming concerned with the abnormal respiratory rate, “I was counting respirations too and it had gone from 12 to 8 and that bothered me, 8 is a bad number.” Another student stated, “His blood pressure dropped a lot from the past reading and then his heart rate went up quite a bit from the last reading as well.”

Students also focused on changes with assessment findings, “it seemed like she started getting a little more stuporous. So the change in her mental status cued me to check her respiratory status.” As before, students also explained that when they increased the oxygen to the patient and yet the oxygen saturation did not improve as expected, that was also a concern, “with the oxygen it wasn’t making any difference.”

Prioritization. Several students stated that it was important to first consider the patient’s viewpoint and subjective concerns before considering the objective findings.

For example one student reported "The most important thing is the patient, they tell you how they feel." Students also prioritized how the patient looked over the vital signs and indicated that they were aware equipment could be faulty or misleading. There were five references to not trusting the vital signs monitors including, "I can look at a low sat and if the patient's talking in full sentences then like you know that thing might be lying to me." Students also used time and urgency to direct their attention as this student explains, "pay attention to what was the most pressing and what seemed to be changing the quickest." Students also mentioned prioritizing by the ABC's: airway, breathing and circulation.

Prompts. In this simulation scenario students also prioritized by using prompts such as the physician order for Narcan in the respiratory depression scenario or by what the SA questions were asking them, "It was after taking those quizzes and they kept asking what the respiration was and I started paying attention to that." See Figure 8 for a diagram depicting the categories and codes for Salience.

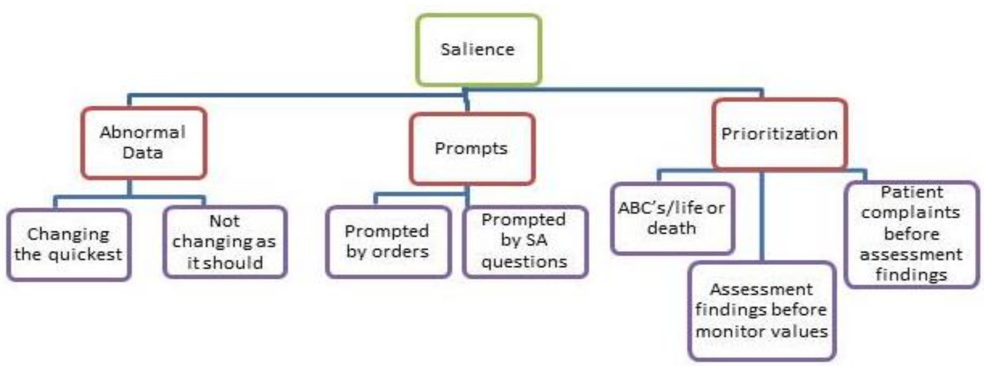

Figure 8: *Salience: Categories and Codes*

Information Processing

When students described how they noticed data there were also references to how they were thinking about the data they were noticing. The codes of "whole picture", "cognitive load" and "time pressure" emerged from these descriptions. These concepts were referenced by both seniors and sophomores and were present in both the interview questions and the debriefing transcripts. Analysis of this data did not support either combining these terms or further dividing them into smaller units, so the codes are presented also as the category.

Whole picture. Information processing involves the assembly of the individual pieces of information into a meaningful whole. Students were aware that they often combined items and in several cases referred to this as a "picture." One student stated,

> I guess it was kind of putting her vitals together and looking at just the overall conditions of her orientation, circulation intact, peripheral circulation and things like that. So I think it was a number of things that had me linked.

Cognitive overload. In some cases emotional responses and a sense of being overwhelmed or pressured due to lack of time inhibited processing. In these instances students had correct expectations and were aware of the salience of certain findings but were unable to engage their attention due to cognitive load, as in this example:

> Just those little things, they threw me off. Because I was trying to focus on my patient and what was wrong with him. But then there were all these other things going on too that I was trying to pay attention to. . . I would try and think about what to pay attention to before I went back in, but then it just completely went. . out the back door, when something went wrong with him.

Another student described the difficulty experienced when trying to pay attention,

> . . .still overwhelming, . . . like I am still trying to process in my head. Is this in the normal range? What else would I assess? So I am not even paying attention and like block out everything else.

Time pressure. In some instances students described the feeling that they must do something quickly or harm would come to the patient. The urgency of the situation made it difficult to notice. In one instance a student ran to the medication room to get the Narcan but did not notice it sitting in the medication drawer. The student described how he/she was so concerned about leaving the patient and that something would happen while she was away that she was not able to notice the medication vial, “While I was in the med room just “quick, fast!” that’s how I skipped the Narcan. I thought it was just Zofran when I was frantically looking.” A student also described the how the time pressure was building throughout the scenario,

> At that point I was really overwhelmed because I was – it started getting in my head that while I was taking the time to call the charge nurse and call the doctor it was still just getting worse and worse at a really fast pace. So I was afraid I wasn’t going to be able to do something in time.

Students felt as if there was too much to think about and the patient condition was progressing rapidly adding pressure that the decisions needed to be made quickly. For the categories related to Information Processing see Figure 9.

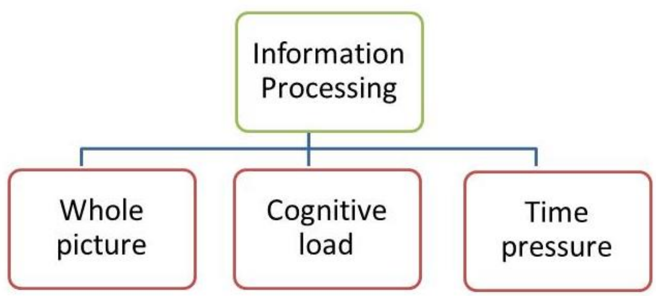

Figure 9. *Information Processing: Categories*

Not Noticing

During the process of describing noticing, students also were aware there were factors that negatively influenced noticing. Cognitive load and time pressure were reported to inhibit information processing and therefore noticing in general. Other factors mentioned by students as contributing to a lack of noticing included schemas and habits. Inattentional blindness was also described by students when they failed to notice something that was important.

Expectations

One student reported that it was difficult to change expectations from the previous patient, “I mean eventually came to morphine but I didn’t – it wasn’t the first thought in my mind probably because I was still thinking of the other patient that I just had.” Schemas can be very helpful to guide students’ attention; however faulty schemas can mislead students. In one case the student did not recognize the patient’s increasing somnolence as possibly related to respiratory depression, stating “she was getting sleepy. Yeah. But that for some reason didn’t make me think about – I was just oh maybe the medication is making her tired.” A lack of knowledge can also contribute to not noticing. For example, a student who did not have experience with a Patient Controlled Analgesia machine stated she did not consider the morphine as causing the symptoms explaining, “so maybe it wasn’t even on my radar.” Another student who was not familiar with this equipment stated; “I didn’t know what that machine was, the one next to her.” This lack of knowledge also delayed the connection between the Morphine and respiratory depression. Students sometimes had false expectations. For instance, one student “kept thinking, right or wrong, I kept thinking like aortic aneurysm. Because the amount of blood loss he is experiencing.” This concern for an aneurysm led to unnecessary assessments and inattentional blindness when the patient gave several cues to look in the commode (to see bloody stool), yet the student did not.

Habits

Other students reported lacking habits such as starting the automatic blood pressure but forgetting to check what the result was or placing the pulse oximeter on the patient but forgetting to look at the screen and read the result. Another student reported that when he/she took the vital signs, “Yeah I did them but I didn’t actually look at them.”

Inattentional Blindness

Inattentional blindness occurs when there is a failure to notice something that is salient to the decision. Students reported not seeing things in the room such as the resuscitation bag or the commode, or that the head of the bed was elevated. Some students stated they did not look in the cup on the bedside stand to see if there was water in it. One stated “that is something I really struggle with is like seeing things in the room.” Students recognized that they should have re-taken the BP when the patient complained of additional symptoms, “I forgot to take a blood pressure.” They also forgot to count the respiratory rate, “the one thing that I missed all along was the respiratory rate.” In some cases students were focused on the oxygenation level to the exclusion of respiratory rate;

> But I was just looking at her oxygen like we need to fix this oxygen. For some reason I was just like really tunnel vision focused on that. And so that was something that I needed to open my eyes to a little bit more was her like respiratory rate.

Sometimes the students read the BP result but did not view the value as important as this student relates, “Because that number didn’t really click as really low as something I should worry about then.” Thus, the factors for not noticing appear to be the inverse of factors that led to noticing. A diagram representing the themes associated with noticing and not noticing is presented in Figure 10.

Figure 10. *Themes Associated with Noticing and Not Noticing*

Similar experiences

One of the confounding variables for this study was healthcare experience outside the nursing program. The concern was that students who had previous experiences similar to the simulation scenarios would answer more SA questions correctly. The study data supports the premise that sophomore students in this study with previous healthcare experience answered more SA questions correctly than sophomores who do not have healthcare experience, but the senior students answered correctly with the same frequency regardless of healthcare experience.

Senior students had more experiences that were similar to the simulation scenarios than sophomore students (13 vs 5). Some students (8 seniors) described experiences similar to the shock simulation scenario, however the average SA score for the students with experience (9.4) compared to the average for the senior group (9.3). Senior students (5) who had experiences similar to the respiratory depression scenario actually scored lower (7.0) than the average of all seniors (8.1). However the reverse was true for the sophomore students. The four sophomores who had experience similar to the respiratory depression scenario scored higher (8.5) compared with the average of all the sophomores (7.2). One sophomore reported experience with GI bleeding and also scored higher (10.3) than the group average (7.9).

Summary

The data analyses were able to answer the study questions "What cues are undergraduate students most aware of" and "What cues are nursing students least frequently aware of" using total SA scores. Subscale results were also reported and indicate students are more proficient with projection and comprehension and least proficient with global situation awareness. Sophomore students were compared to senior students using ANOVA with the data supporting a difference between these groups on measures of situation awareness. Students who worked in the healthcare field outside of nursing school scored higher on measures of SA compared to students who have not worked in the healthcare field, but this difference was not significant when assessed by ANOVA.

In addition, transcripts of student responses to semi-structured interview questions combined with responses during the debriefing provided rich descriptions of how students noticed. Manifest content analysis was used to count the frequency of items noticed. Students frequently noticed abnormal vital signs, abnormal assessment findings and abnormal subjective responses from the patient. Students also noticed the context in terms of changing items in the room and the patient medical history, diagnoses and laboratory tests. Three themes: Expectations, Salience and Information Processing, were extracted through latent content analysis. These themes describe the process of how students notice. Support for these themes was provided by including verbatim excerpts of the transcripts. Students also described factors that impeded noticing including false expectations, lack of habits or skills, inattentional blindness, increased cognitive load and time pressure.

Reliability for the SAGAT tool was found to be moderate to adequate with the exception of the projection subscale for seniors. Initial validity for the research tool was also examined. Factor Analysis could not be completed for individual items, but suggests that the tool has four factors that are described by the subscales. Students were asked to self-report if they had previous experience with the particular research scenarios of hypovolemic shock and respiratory depression to assess for this confounding variable. Sophomores scores were higher than average if they reported experiencing a similar scenario previously. Descriptive statistics did not suggest a difference between the SA scores for senior students regarding previous exposure. Discussion and implications of these results will be completed in Chapter 5.

CHAPTER V

DISCUSSION

This chapter will review the study results then explore the relationships between the qualitative and quantitative findings as well as compare the findings to other recent studies. Discussion of the instrument used and comparison of the noticing themes to existing theoretical frameworks will be followed by implications for nursing education and further research.

The aim of this study was to describe and measure situation awareness (SA) in both sophomore and senior undergraduate nursing students. Situation awareness was measured by a modified Situation Awareness Global Assessment Technique at three time points during each of two scenarios. Results were aggregated across the entire sample and also compared between the two groups. In addition, students were interviewed to discover how they became aware of changes during a simulation of a deteriorating patient. Coded meaning units as well as the categories and themes serve to augment the quantitative results and create a rich understanding of the concepts of noticing and situation awareness.

Main Findings

The main findings from this study describe nursing students as lacking in situation awareness during the simulation of a deteriorating patient. Total scores for the students were 64% correct for the respiratory scenario and 73% correct for the shock scenario with an average overall of 69%. Nursing student Situation Awareness ranged from 94%

(projection about what would happen to the patient's heart rate) to 38.4% (global awareness of items on the bedside stand). ANOVA results provide evidence that senior SA scores are significantly ($\alpha = .05$) different with seniors' average scores over time significantly higher than sophomores. No differences between SA scores across all scenarios and subscales, were found for students who work in healthcare compared to students who do not work in healthcare. Additional description and discussion about these findings are provided below.

Situation Awareness

Respiratory depression scenario. Key items to notice for the respiratory depression scenario were changes in mental status and decreasing respiratory rate after administration of Morphine. Students were stopped three times during the scenario and asked what the respiratory rate was at the moment. This was scored as correct or incorrect to arrive at the SA score. Students correctly identified the respiratory rate at the moment 60% of the time. According to average total respiratory SA scores, there was not a significant difference between sophomores and seniors ($p = .085$) for this scenario. In the interview seniors reported that the first abnormal finding they noticed was low oxygen saturation and supporting information was the mental status changes. Sophomore students were focused on the low oxygen saturation and the later sign of decreasing respiratory rate.

Hypovolemic shock scenario. Key items to notice for the hypovolemic shock scenario were the decreases in blood pressure with corresponding increase in dizziness as well as the increasing heart rate. Students frequently noticed the increasing heart rate (SA score 72% correct), and blood pressure (SA score 71% correct). However, the average total Shock SA scores were significantly different between seniors and sophomores (p = .001). During the interview seniors reported many different first abnormal findings but were more consistent in identifying the increasing heart rate as an important supportive clue to the problem. Seniors also correlated this finding with a low blood pressure. Sophomore students stated they first noticed the drop in blood pressure but then were more concerned about the patient’s pain.

Comparing scenarios. As can be seen from the scores above, students had higher SA scores for the shock scenario (73%) than the respiratory depression scenario (64%). Student responses indicated that there was a delay in understanding the relationship between giving the morphine and the ensuing respiratory depression. Before the respiratory depression was identified, some students focused on increasing the oxygen saturation by increasing oxygen delivered to the patient. During the interview the themes of cognitive load and time pressure were more often associated with the respiratory scenario, possibly indicating this scenario was more challenging.

Subscale scores. Across the SA subscales students were best at Comprehension (82% correct) and Projection (78% correct). Questions such as what medications are required and what is wrong with this patient (comprehension) and what will happen to the heart rate or blood pressure (projection) were frequently answered correctly. Students were less proficient at Physiologic (68% correct for measures such as blood pressure, heart rate and respiratory rate) and Global awareness (46% correct). The general trends are consistent with the study by Cooper et al. (2010) (see Table 7). Results are not as similar when compared to recent study of senior nursing students (Bogossian et al., 2014). The overall average for students in the current study was higher (69% vs 41% in Bogossian et al.).

Table 7

Comparison of SAGAT scores across studies

	Physiological	Global	Comprehension	Projection	Average
Bogossian et al.	26%	32%	44%	59%	41%
Cooper et al. (2010)	77%	51%	44%	73%	59%
Current study	68%	46%	82%	78%	69%

It should be noted that the testing methods were different with the current study having the students seated at a computer in a separate room to answer the randomized questions instead of verbally responding to spoken questions. There may also be an effect of learning over time since the current students repeated the question set six times as opposed to once for the Bogossian et al. study. In addition the scenario length was 8 minutes for the Bogossian et al. study as compared to fifteen minutes for the present study. Standardization of these testing parameters may facilitate comparisons in the future.

Projection subscale. In this study students were able to project what would happen to the HR (99.94%) and what was wrong with the patient (81%). However, students found it easier to determine what was wrong with the patient in shock (82%) than what was wrong with the patient who had respiratory depression (73%). Students who described not paying attention to respiratory rate stated they had a difficult time determining what might be wrong with the patient and what they needed to do next.

Gaps in Situation Awareness

Global subscale. The most frequently missed items were all from the global subscale (Q5 38.4%; Q6 43.9%; Q4 56% correct). These questions asked about items in the room: Q5 What is on the bedside stand? Q6 What is at the head of the bed? (or other items), Q4 Is suction available? Students had much to say about why this occurred. Sophomore students explained that in some cases they did not know what the items were such as the oral airway or the resuscitation bag. Other students described how they had every intention of looking at the environment, but found that during the scenario their complete attention was absorbed by the patient, indicating a high cognitive load. A few students stated they saw no relevance to these items and therefore ignored them. "One senior reported "Yeah those questions that had nothing, seemed like they had nothing to do with my patient's problem. Like the pictures and the book and what was on the table." These comments combined with the low SA scores for global awareness may indicate gaps in the educational program with regards to assessment of the environment as well as the patient. Of the explanations, increased cognitive load was the most frequent over all students and will be discussed later in this report.

Vital signs. In the shock scenario students infrequently stated the correct blood pressure (BP) (52.5% correct). This was explained during the interview as due to not re-assessing the BP despite increasing severity of cues such as patient complaints of dizziness and an increasing heart rate. Students stated they forgot that the BP on the monitor did not update as the patient condition changed even though the time the BP was taken displayed next to the value. To forestall this error, reassessment of vital signs during acute situations could be practiced so it develops into a habit.

Students did notice oxygen saturation (84% correct) and described making treatment decisions based on this variable. Sophomore students reported becoming concerned as this level dropped, but not being aware of what to do next after increasing oxygen delivery via nasal cannula. In some cases the oxygen saturation level was the focus of attention to the exclusion of the respiratory rate, demonstrating inattentional blindness to rate. This delayed patient treatment. Practice with scenarios, case studies or synthesis questions that involve decreasing respiratory rate may be beneficial to some students.

Concepts of Cognitive load, Situation Awareness and Noticing

Cognitive load. Cognitive load theory was the basis for understanding how students process information. This theory assumes that working memory is limited but long term memory is not (Pollock, Chandler & Sweller, 2002). Schemas are developed to organize sets of knowledge in order to decrease the load on working memory. Once schemas are developed they can become automated through practice. This theory guides educators to use instructional design strategies to minimize extraneous memory load and maximize intrinsic load or actual learning. Students in this study eloquently describe cognitive load and the difficulty that a high input scenario created. Sophomore students more frequently mentioned cognitive load (5) than seniors (1). This information would lend support to developing simulation scenarios that perhaps begin with partial tasks and build to independent problem solving.

Situation Awareness. The themes derived from the student data in this study support both the concepts identified by Sitterding et al (2012) within the definition of nursing SA and the theoretical models presented by Endsley (1995b) and Tanner (2006).

The definition of situation awareness proposed for nursing and used in this study is “a dynamic process in which a nurse perceives each clinical cue relevant to the patient and his or her environment; comprehends and assigns meaning to those cues resulting in a patient-centric sense of salience; and projects or anticipates required interventions based on those cues” (Sitterding et al., 2012, p. 89). Sitterding et al. added the concept of salience to the definition of SA. This was not present in Endsley’s (1995b) model. Benner (2010) concurs that recognition of salience is an important skill lacking in novice nurses and contributes to difficulty noticing patient changes. The current study supports the addition of salience as an important concept for SA in nursing. Students are aware that they do allocate attention and can describe how they determine salience.

Sitterding et al. arrived at the definition of Situation Awareness through field study and interviews as well as through literature review. Among the themes identified by the nurses she interviewed were knowledge and cognitive overload as well as the stages of SA: perception, comprehension and projection. These themes were congruent with the categories of knowledge and cognitive load in the current study. The remaining themes of expertise, interruption management, task management, instantaneous learning and cognitive stacking may be more applicable to nurses caring for multiple patients.

The main themes of Information Processing and Expectations have previously been described by Endsley (1995b) as related to SA and appear in her theoretical model (Appendix B). Categories of Cognitive Load and Time Pressure found in this study were described by students as relating to their ability to process information. Stress and workload are the most closely related concepts used by Endsley but these are not located in the model as affecting information processing. The category of Schema includes prior knowledge which would logically be located in Endsley's category of Long-term Memory Stores. The remaining categories for Expectations: Habits, Skills and Matching could be correlated to Endsley's Training, Abilities and Experiences. In summary, themes that emerged from content analysis of student responses to how they noticed largely supported Endsley's Model of SA in Dynamic Decision Making (1995b). In addition the theme of Salience was strongly supported as contributing to SA in nursing decision-making as postulated by Sitterding et al. (2012). Further study of Cognitive Load and Time Pressure as related to Information Processing is recommended.

Noticing. The two concepts, noticing and situation awareness, have significant overlap with noticing being most closely aligned with the first two stages of situation awareness: perception and comprehension. This overlap is clearly demonstrated by congruence with the themes describing noticing and the concepts mentioned in the Clinical Judgment Model (Tanner, 2006). Previous to this study nursing literature reported little in terms of describing how students notice. Tanner (2006) described noticing as something that the nurse brings into the room that is composed of prior experiences, knowledge and the relationship developed with the patient. Lasater (2007) stated that facets of noticing that can be measured by the Clinical Judgment Model include focused observations, recognizing deviations from expected patterns and information seeking behaviors. The present study serves both to support these concepts and to add information about the process of how students notice early in a nursing baccalaureate program and in their final semester. Further study and comparison of both noticing and SA is recommended.

Measurement of Situation Awareness and Noticing

The instrument used to measure Situation Awareness developed by Cooper et al. (2010) was used according to the guidelines specified by Endsley (2000). In this study, the instrument demonstrates adequate reliability when using the scale over two scenarios with three repetitions in each scenario. Reliability for the subscales varies from low to adequate. Factor Analysis does indicate that the scale is composed of four distinct subscales which account for 57-58% of the variance but that items 8 (What is wrong with this patient?) and 12 (What medications should be given?) provided no information to the model and should be removed. It is also possible that the grading guidelines for these questions were not specific enough to discriminate between students who did know the answer and those who were guessing.

Validity for using the tool to measure situation awareness in nursing students was enhanced when the reported data did show a significant difference in performance between senior and sophomore students on the shock scenario despite a power analysis indicating that this sample size lacked power to detect actual differences. In addition students who had exposure to patient care outside of the nursing program were much more likely to answer SA questions correctly, as expected. Student reports that the global awareness questions posed the most difficulty for them also matched the actual results showing global awareness as the lowest of the subscales. Further testing of this instrument is recommended. If this instrument is used for students of different levels, a rubric indicating an adequate answer for each level is recommended rather than reliance only on expert judgment. In this study experts decided if the answer to these questions was correct at the given time in the scenario. In addition to collecting data, students reported that the time out to answer the SA questions and the questions themselves served to help them organize their thoughts and be more prepared to engage in the simulation scenario on return. The positive effect of using SAGAT during or after simulation in combination with debriefing has been reported by Cooper et al. (2010) and has been developed into a several step educational process that has been beneficial in improving performance (Buykx et al., 2012; Kinsman et al., 2012).

Previous tools to measure noticing relied on self-report (Jensen, 2013; Lasater & Nielsen, 2009b) or performance assessment by an expert (Dillard et al., 2009). The instrument used in this study was developed to measure situation awareness. Due to significant overlap between the concepts of SA and noticing, it is suggested that the use of SAGAT, in particular the measures of perception and comprehension, may be useful in measuring noticing.

Limitations

Limitations of this study included a homogenous sample, testing effects and simulation effects. The convenience sample of students and an insufficient sample size limit the generalizations that can be made as well as the power of the study which was inadequate for hypothesis testing. Students were from a single baccalaureate nursing program. Although student demographics closely approximated those reported for nursing students in the United States (NLN, 2012) there was not adequate representation of African American students.

The SAGAT instrument had not been tested for reliability since modification or with this new population of nursing students. Some wording in the scale was a bit confusing to the students. Bedside stand was often understood as overbed table. In particular the global SA subscale may not have accurately reflected student awareness since some of the students were unfamiliar with the items referenced. Reliability for the instrument, although adequate as a whole, was low for certain subscales. Since situation awareness is specific to each situation, reliability may need to be assessed using a larger, more homogenous sample for each scenario. Student self-report of situation awareness is prone to performance effects (Jones and Endsley, 2004). This may have influenced the student responses to the qualitative questions with students who viewed their performance as satisfactory reporting increased awareness or the reverse.

High-fidelity simulation has some limitations in terms of reproducing reality. Students were unable to observe facial cues, skin temperature or capillary refill and therefore had to ask for this data and rely on the manikin verbal responses. Some students have difficulty suspending disbelief and fully engaging in the scenario (Dunnington, 2014). Sophomore students also had limited exposure to simulation prior to this study. Some students did have prior exposure to similar situations to those presented in the scenario. This may have been a confounding factor, particularly for sophomore students. A study design that minimizes these limitations is recommended for future studies.

Implications for Nursing Education

Nursing students need to develop the skills of making patient care decisions in a complex and fast-paced environment. This study supports prior research indicating that senior students demonstrate gaps in their awareness of crucial information which is needed to make sound decisions. Sophomore students who are just beginning clinical experiences already have developed some schemas and some rules to guide their situation awareness although these were not as developed as the senior students who scored higher for the comprehensive SA scale and Shock SA. This exploratory study suggests that nursing student situation awareness may have component parts of expectations, recognition of salience and information processing. Continued study of Situation Awareness may help identify ways that this important skill can be taught and facilitated rather than SA being expected to develop solely through clinical exposure. In addition, teaching habits, particularly emphasizing frequent re-assessment during a changing situation and systematic scanning of the environment, may help prevent students from making decisions without the necessary information. When implementing any new teaching strategy it is important to be able to measure the effect. The SAGAT instrument requires further testing but has adequate reliability and beginning validity as a measurement tool. Due to the cognitive load experienced in simulation, it may also be beneficial to scaffold learning by stopping the simulation and allowing students time to reflect on what they have noticed so far and ask them to think about what they expect to happen next, before resuming the scenario, especially for beginning students.

Conclusion

Situation awareness is crucial for clinical judgment. This study measured levels of SA during a simulation of a deteriorating patient and interviewed the students regarding how they came to be aware of changes. The results indicate students are deficient in SA (avg. score 69%). There is also evidence of significant differences between sophomore and senior nursing students' scores on the comprehensive scale $(F(1,31) = 10.394, p = .002)$ with average scores for seniors being significantly higher than scores for sophomores (72.3 and 63.9% respectively). Interviews indicated that students became aware of the situation by setting up expectations, determining salience and processing the information to create a meaningful whole. These themes support the proposed definition of situation awareness specific to nursing. Errors in SA were related to not knowing, faulty schemas or the lack of habits or skills that led to false expectations and inattentional blindness. Cognitive load impeded SA and was reported more frequently by sophomore students.

Situation Awareness Global Assessment Technique was used as a direct measure of situation awareness during simulation. Construct validity for use of SAGAT to measure nursing student SA was enhanced when SAGAT total scores showed a significant difference between the populations of sophomore and senior students. Students also identified that freezing the scenario and presenting them with the SA questions gave them time to process and helped them prepare to re-enter the simulation.

Recommendations include further study to determine how students become proficient at SA as well as educational strategies that develop SA. Since SA is a cognitive process, real time measurement is preferable to post-scenario measurement and direct measures such as the SAGAT are preferable to indirect measures such as self-report or performance assessment. Further testing of SAGAT is recommended for this promising direct measure of situation awareness. Standardization of the process used to test SA is also recommended to facilitate comparative analysis.

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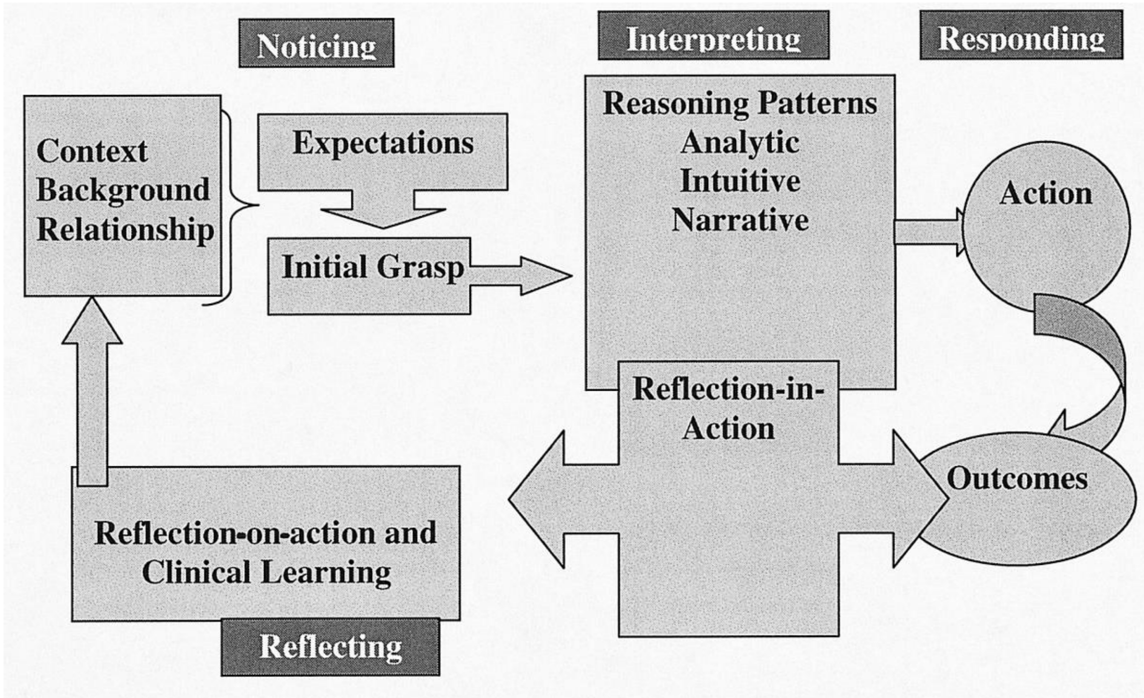
APPENDIX A

CLINICAL JUDGMENT MODEL



Tanner, C. A. (2006). Thinking like a nurse: A research-based model of clinical judgment in nursing. *Journal of Nursing Education*, *45*(6), p. 208. Reprinted with permission from SLACK Incorporated.

APPENDIX B

MODEL OF SITUATION AWARENESS
IN DYNAMIC DECISION MAKING

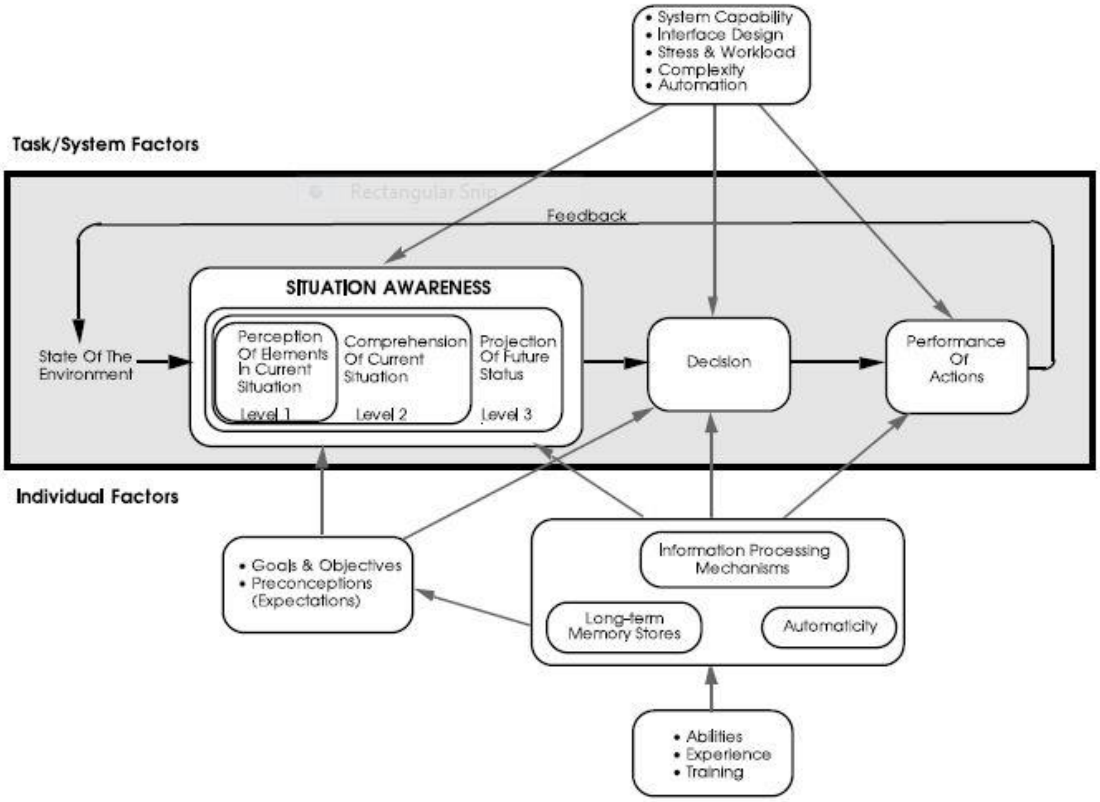


Figure 2. Model of SA in Dynamic Decision Making (from Endsley, 1995b)

Endsley, M. R. (1995b). Toward a theory of situation awareness in dynamic systems. Image. *Human Factors*, *37*(1), 35. Reprinted with permission.

APPENDIX C

NURSING STUDENT SITUATION AWARENESS DURING SIMULATION: INSTRUMENTS, SITUATION AWARENESS INSTRUCTIONS AND QUESTIONS

Instructions to the participants:
During this simulation there will be several "Freezes." You will be asked to stop what you are doing and step outside the room to answer some questions about what you are seeing and doing. The questions will appear in random order on a laptop computer located in the charting area. Do your best to answer each question in writing; there is no penalty for guessing. When you have completed the questions, the simulation will resume exactly where it was stopped. This may happen several times during the simulation. An example of a question you may be asked is "What are your current assessment findings for the cardiovascular system?"

SAGAT administration procedure:
SAGAT questions will be uploaded to a computerized course management system. Using secure logins the students will be given access to the quiz which will present the queries in random order for each set. Students will be encouraged to complete the questions quickly and will not be allowed to backtrack. Timing of the SAGAT queries will be at 4 minutes, for the first freeze and then randomized for the next two freezes over the next 8 minutes with the constraint that freezes will be at least 2 minutes apart.

SAGAT Queries
(developed by Cooper et al., 2011, used with permission)
First set for Respiratory Scenario

Physiological Perception

1. What is the BP at the moment?
2. What is the HR at the moment?
3. What is the respiratory rate at the moment?

Global Situation Perception

1. Is suction available?
2. What's on the bedside stand?
3. What is attached to the head of the bed?

Comprehension

1. Is the patient adequately oxygenated? List SpO2.
2. What is wrong with this patient?

Projection

1. If condition does not improve, what will happen to the HR?
2. If condition does not improve, what will happen to the RR?
3. What tests may be required?
4. What medications may be required?

Cooper, S., McConnell-Henry, T., Cant, R., Porter, J., Missen, K., Kinsman, L., Endacott, R & Scholes, J. (2011). Managing deteriorating patients: Registered nurses' performance in a simulated setting. *The Open Nursing Journal*, *5*, 120–126. doi: 10.2174/18744346011050100120

Note: Modified by Phillips, 2014.

Second Set for Shock Scenario
(developed by Cooper et al., 2011, used with permission)

<u>Physiological Perception</u>

1. What is the BP at the moment?
2. What is the HR at the moment?
3. What is the respiratory rate at the moment?

<u>Global Situation Perception</u>

1. Is suction available? (added questions: second time "Is oxygen available?" third time "Is an ambu bag available?")
2. Was there water in the glass? (added questions: second time "Was the patient call light in reach?", third time "Was there a religious book at the bedside?")
3. Who is pictured in the photo on the bedside stand?

<u>Comprehension</u>

1. Is the patient adequately oxygenated? List SpO2.
2. What is wrong with this patient?

<u>Projection</u>

1. If condition does not improve, what will happen to the HR?
2. If condition does not improve, what will happen to the BP?
3. What tests may be required?
4. What medications may be required?

Cooper, S., McConnell-Henry, T., Cant, R., Porter, J., Missen, K., Kinsman, L., Endacott, R & Scholes, J. (2011). Managing deteriorating patients: Registered nurses' performance in a simulated setting. *The Open Nursing Journal*, *5*, 120–126. doi: 10.2174/1874434601105010120

Note: Modified by Phillips, 2014.

Scoring sheets for the Situation Awareness Questions
Respiratory

Question	Answer	Right	Wrong
What medications may be required?	None, Pain medication or Narcan (depends on time of stop)		
What is the HR at the moment?	Within 10% of the current value on the monitor		
Is the patient adequately oxygenated/sats?	NO - SpO2 within 5% of current value on monitor (if stated)		
What's on the patient's bedside stand?	Flowers in a vase (a), tissue box (b), emesis basin (c)		
What tests may be required?	2 of –, Blood tests (any) (ABGs), CXR, CT		
What is attached to the head of the bed?	A get well card (a), yankaur suction (b), oral airway (c)		
If condition does not improve, what will happen to the HR initially?	Increase		
What is wrong with the patient	Opiod overdose		
What is the BP at the moment?	Within 10% of the current value on the monitor		
What is the respiratory rate at the moment?	Within 10% of the current value on the monitor		
Is suction available?	No (a), Yes (b), No (c)		
If condition does not improve, what will happen to the RR initially?	Decrease		

Shock

Question	**Answer**	**Right**	**Wrong**
What medications may be required?	Adrenaline (Epinephrine), Dopamine, Dobutamine, Lephophed, Milrinone, Nitroprusside		
What is the HR at the moment?	Within 10% of the current value on the monitor		
Is the patient adequately oxygenated/sats?	NO - SpO2 within 5% of the current value on the monitor		
a) Was there water in the glass on the bedside table? b) Was the patient call light in reach? c) Was there a religious book at the bedside?	a) No b) Yes c) Yes		
What investigations may be required?	2 of – blood tests, Ultra sound, ECG		
Who is pictured in the picture on the bedside stand?	A family group (a), an angel (b), a child (c)		
If condition does not improve, what will happen to the HR initially?	Increase prior to arrest		
What is wrong with the patient	Hypovolemia – related to dehydration,vomiting		
What is the BP at the moment?	within 10% of the current value on the monitor		
What is the respiratory rate at the moment?	within 10% of the current value on the monitor		
a) Is suction available? b) Is oxygen available? c) Is an Ambu bag available?	Yes (a) Yes (b) No (c)		
If the condition continues what will happen to the BP?	Drop / Decrease		

APPENDIX D

SEMI-STRUCTURED INTERVIEW PROCEDURE

Semi-structured Interview Procedure

Following the scenario, participants will be seated in the debriefing room. A research assistant will ask the questions, using follow-up probes as needed.

Instructions to student: This debriefing may be more structured and take a bit longer than other debriefings you have had. I am very interested in your experiences and have some questions for you. Remember you don't have to answer questions if you don't want to. We will also be looking at some short video segments of the scenarios and discussing them. Following that we will talk about the scenarios and the learning objectives.

Procedure:

1. Read instructions to the students
2. Emotional release, ask how the student is feeling
3. Ask the interview questions and follow up with probes as needed
4. Show 4 video segments and discuss
5. Continue debriefing using "Debriefing with Good Judgment" technique
6. Conclude with discussion of learning objectives and thank student
7. Provide gift card

Interview Questions

1. What was the first abnormal finding you noticed when you began assessing the situation in the last (most recent) simulation scenario?
2. What were some other clues that helped you to realize what was going on with your patient?
3. Tell me more about how you came to realize what the problem was?
4. How did you know which information to pay attention to?
5. Were you noticing or thinking about any other things related to the setting or situation? What were they?
6. If you have had similar experiences to either of the simulated scenarios with real patients, please describe how your experience was similar to these scenarios.

APPENDIX E

DEMOGRAPHIC DATA FORM

Demographic Data

Participant number ___________
Age ___________
Gender _________

Ethnicity (circle one)

African American	Asian	White
American Indian or Native Alaskan	Native Hawaiian or other Pacific Islander	Hispanic or Latino
		Other

Check "Yes" for the Nursing Courses you have completed.		
N2050 Pharmacology	□ Yes	□ No
N2100 Health Assessment	□ Yes	□ No
N2200 Fundamentals	□ Yes	□ No
N3200 Adult Health 1	□ Yes	□ No
N3210 Adult Health 2	□ Yes	□ No
N4290 Advanced Adult Health	□ Yes	□ No
N3100 Mental Health	□ Yes	□ No
Emergency Nursing Elective	□ Yes	□ No
Pediatrics/Obstetrics	□ Yes	□ No
Are you in the Accelerated Program?	□ Yes	□ No
Have you worked in any health-related capacity?	□ Yes # of months employed ___yrs ___ months	□ No
Please list your job title and the setting(s) where you worked		

APPENDIX F

INTER-RATER RELIABILITY

Inter-rater Reliability and Frequency Distribution of Rater Scores

	N	Mean	SD	Skew	Scores as Correct	Scored as Incorrect	Inter-rater Reliability
Rater 1	48	1.19	0.394	1.653*	39	9	
Rater 2	48	1.21	0.41	1.483*	38	10	0.936
Rater 3	48	1.19	0.394	1.653*	39	9	

** Note the skew for the scores presented by all three raters is positive since each rater assessed more correct than incorrect responses*

ANOVA with Friedman's Test

		Sum of Squares	df	Mean Square	Friedman's Chi-Square	Sig
Between People		19.889	47	.423		
Within People	Between Items	.014[a]	2	.007	.500	.779
	Residual	2.653	94	.028		
	Total	2.667	96	.028		
Total		22.556	143	.158		

Grand Mean = 1.19

a. Kendall's coefficient of concordance W = .001.

APPENDIX G

SIMULATION SCENARIOS

Simulation 1: Respiratory

Date: 7/18/2013
Scenario Name: Lynnette Banks
Course: Research study
Student Level: any
Expected Simulation Run Time: 15 min
Debrief Time: 30 min

Admission Date: 8/20/XX **Today's Date:** 8/20/XX **Brief Description of Client** **Name:** Lynnette Banks **Gender: F** **DOB** 02/22/70 **Weight:** 60 **kg** **Height:** 162 **cm** **Religion:** **Major Support:** **Phone:** **Allergies:** Phenergan **Immunizations:** **Attending Physician/Team: Dr. Barnes** **Past Medical History:** **History of Present illness:** Abdominal Hysterectomy this am **Social History:** **Primary Medical Diagnosis**: Uterine fibroids with menorrhagia **Surgeries/Procedures & Dates:** Tonsilectomy 1975	**Objectives:** 1. Assess and identify abnormal findings 2. Communicate to the appropriate healthcare team using SBAR 3. Request necessary orders/assistance based on accurate nursing diagnoses 4. Prioritize nursing interventions **Pre-simulation Learning Activities [i.e. independent reading (R), video review (V), lecture (L)]** None **Guided Study Questions:** None **Report Students Will Receive Before coming to Simulation Center:** You will be participating in two scenarios. In each scenario you will be asked to assess a patient on a medical-surgical unit. Depending on the patient's situation, you may need to perform nursing tasks or call other healthcare providers. If a needed task is beyond your current scope of practice, you can call a charge nurse or other healthcare team member to help you. For both scenarios, you will be working independently. Whatever you see is "real" so be sure to respond. **References:**

Setting and Supplies (choose all that apply to this simulation)

Setting/Environment

- ☐ **ER**
- ☒ **Med-Surg**
- ☐ **Peds**
- ☐ **ICU**
- ☐ **OB unit**

Simulator Manikin/s Needed:

Laerdal 3G ☒ Note: **turn OFF monitor**

Laerdal SimMan ☐

Laerdal Sim Junior ☐

Props: [ie decorations, get well cards, wigs, clothing] flowers in vase on bedside stand, get well card taped to head of bed. Tissue box in control room

Manikin Moulage-

- ☐ Bilat. leg edema to knee
- ☐ Abdominal distention
- ☐ Wounds- (please describe)
- ☐ Dressings(please describe) ABD pad mid abdomen (transverse) taped with 1 inch tape
- ☒ Fluids

  sweat urine foley 200ml clear yellow blood
- ☐ Emesis (describe)
- ☐ Smells
- ☐ Sounds

Equipment attached to manikin:

- ☒ IV tubing with primary line LR fluids running at 125 mL/hr
- ☐ Secondary IV line running at mL/hr
- ☐ IV pump
- ☐ Foley catheter mL output
- ☒ PCA pump running- Morphine 1mg/mL
- ☒ O2 nasal cannula 2Lpm
- ☒ Monitor attached
- ☒ ID band
- ☒ Other: Allergy band Phenergan

Equipment available

- ☐ **Bedpan/Urinal**
- ☐ **Foley kit**
- ☐ **Straight Catheter Kit**
- ☒ **Incentive Spirometer**
- ☐ **Defibrillator/Pacer**
- ☐ **AED**
- ☐ **Other:** Yankauer, oral airway in control room

Medications and Fluids

- ☐ **IV Fluids:**
- ☐ **Oral Meds:**

1.

2.

3.

4.

- ☐ **IVPB:**
- ☒ **IV Push: Narcan 0.4mg/ml**
- ☐ **IM or SC:**

Diagnostics Available (Please attach any images you would like available)

- ☐ **Labs**
- ☐ **X-rays (Images)**
- ☐ **12-Lead EKG**
- ☐ **Other:**

Documentation Forms

- ☒ Healthcare Provider Orders
- ☒ Medication Administration Record
- ☒ SBAR Report
- ☐ Shift Assessment
- ☐ Code Record
- ☐ Anesthesia / PACU Record
- ☐ Other:

Recommended Mode for Simulation

Manual ☐

Pre-programmed

Name Research Respiratory

NLN pre-programmed

Name

Student Information Sheet

Setting: **Place: Surgical unit of a local hospital** **Time Day shift**	**Patient Data:** **Name** Lynnette Banks **DOB 02/22/70** **Female** ☒ **Male** ☐ **MR # 15863 Allergies Phenergan** **Wt. 60 kg Ht. 162 cm** **Physician Dr. Barnes** **Chief Complaint: heavy menstrual bleeding** **Medical History Takes iron for anemia related to heavy menstrual bleeding.** **Surgical History Diagnosis of fibroid uterus and menorrhagis requiring total abdominal hysterectomy** **Social History Married, two children** **Home Medications: Ferrous Sulfate 325 mg po daily** **See MAR for currently ordered medications.**
Your Role: ☒**Nurse: You can do all of the things a registered nurse can do. You need orders for procedures and medications just as in the clinical setting.** ☐ **Student Nurse: You will need to report your findings to your primary nurse and discuss the plan of action.**	
Objectives: 1. Assess and identify abnormal findings 2. Communicate to the appropriate healthcare team using SBAR 3. Request necessary orders/assistance based on accurate nursing diagnoses 4. Prioritize nursing interventions **Tasks to complete:** Initial post-op assessment	
Report: Post-operative report **Given by:** Post Anesthesia Unit Nurse **Details** Patient had a total abdominal hysterectomy under general anesthesia without complications. Estimated blood loss was 400 mL. She has an abdominal dressing that is dry and intact. Currently her IV is LR infusing at 125mL/hr. She is breathing spontaneously at 14 breaths/min. BP stable at 124/84. Foley catheter with 200 mL yellow urine. Last pain medication was Morphine 1 mg via her Patient Controlled Analgesia pump.	

Instructor Notes:

1. State 1 Expected Learner Actions: Instruct patient to use PCA pain medication

Teaching points: Check patient response to opioids

2. State 2 Expected Learner Actions: Use BVM until Narcan is available

Teaching points: Differentiate low respiratory rate from low oxygenation

Notes regarding branching:

1. If the student calls the code team, the code team leader will respond stating that the rest of the team is on their way.
2. If the student calls for help from the charge nurse or primary nurse, they will take a brief report and request the student call the RRT since they are busy
3. If the student calls the physician, the physician will instruct the student to call the RRT since she is in surgery.

Roles:

Patient (manikin)- distressed about pain initially. Responds to questions with brief answers due to focus on pain. Increasing frequency of moaning and increasing loudness until reminded to use PCA. Then progressively more somnolent with delayed responses and sentences that trail off.

Charge nurse (phone only)- brief responses. Seems harried with many things to do. Interrupts if given unnecessary data.

Code team leader/ Rapid Response Team leader- Arrives 1 minute after called. Requests report if not immediately given a report. Polite but very focused on facts and guides students to give report in SBAR format if they are off track. If Respiratory Rate is < 10, and this is not given in report, requests current vital signs. If student is frozen, suggests student obtain a BVM. Assist student to use BVM correctly and while ventilating patient, guide student to process what is needed next.

Debriefing Plan:(specific method, with/without video) No debriefing after first scenario. 3-5 min break in debriefing room prior to scenario #2

Scenario Progression Outline

Timing (approx.)	Manikin Actions	Expected Interventions	May Use the Following Cues
0-3 min	**Moaning in pain Hypoactive bowel sounds Clear breath sounds RR 14-12 over minutes 2-3 SpO2 93% HR 92 BP 124/84 Temp 37 C**	**Introduce self, wash hands, identify patient, obtain vital signs, assess LOC, abd. dressing and pain**	**Role member providing cue: manikin Cue: It really hurts, riding the gurney was so bumpy! Moan If asked: Abdomen, 8/10, non-radiating**
3-6 min	**RR 12-10 over minutes 5-6. SpO2 90% HR 98**	**Encourage patient to self-administer Morphine PCA**	**Role member providing cue: manikin Cue: Moaning in pain with increasing intensity and requesting pain medication until pain medication given. May ask "What is that button for?" if students do not suggest using PCA**
6-8 minutes or after MS PCA dose is given	**RR 10 SpO2 89%**	**Perform neuro assessment, repeat vital signs**	**Role member providing cue: manikin Cue: "I'm sleepy (tired voice), slowed response to questions**
8-10 minutes	**RR to 5 over 2 minutes SpO2 to 82% over 2 minutes HR 110**	**Recognize decreased RR and O2. Increase O2 and call for Resp. Therapy or Rapid Response Team Call for ambu bag**	**Role member providing cue: manikin Cue: very delayed response, words trail off without finishing thought Operator states they will page RT or RRT. Takes 1 minute to respond to room**
10-15 minutes	**Remains as above until BVM started then O2 trends to 93% over 2 min and HR to 90 over 2 min**	**Initiate BVM or RT/RRT arrives Give SBAR report to RT/RRT Recognizes need for Narcan**	**Role member providing cue: RT/RRT Cue: Prompts student to start BVM. Asks"What do you think caused this situation?**
Stop point	**15 minutes or student goes to retrieve Narcan from medication room**		

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Simulation 2: Shock

Date: 7/19/13 | **Scenario Name: Raul Cardoza**
Course: Research | **Student Level: any**
Expected Simulation Run Time: 15 min | **Debrief Time: 30 min**

Admission Date: 8/22/XX **Today's Date: 8/22/XX** **Brief Description of Client** **Name: Raul Cardoza** **Gender: M DOB 9/28/1962** **Weight: 76 kg Height: 160 cm** **Religion: Major Support:** **Phone:** **Allergies: Demerol** **Immunizations:** **Attending Physician/Team: Dr. Simon** **Past Medical History: HTN controlled with Lisinopril and diet** **History of Present illness: Diffuse abdominal pain for 3 days becoming more acute. Nausea but no vomiting. 4 loose stools today, dark black with a foul odor.** **Social History: Smokes ½ pack/day. Divorced with two grown children.** **Primary Medical Diagnosis: Rule out GI Bleed** **Surgeries/Procedures & Dates: Cholecystectomy 5 years ago**	**Objectives:** **1. Assess and identify abnormal findings** **2. Communicate to the appropriate healthcare team using SBAR** **3. Request necessary orders/assistance based on accurate nursing diagnoses** **4. Prioritize nursing interventions** **Pre-simulation Learning Activities [i.e. independent reading (R), video review (V), lecture (L)]** **None** **Guided Study Questions: None** **Report Students Will Receive Before coming to Simulation Center:** You will be participating in two scenarios. In each scenario you will be asked to assess a patient on a medical-surgical unit. Depending on the patient's situation, you may need to perform nursing tasks or call other healthcare providers. If a needed task is beyond your current scope of practice, you can call a charge nurse or other healthcare team member to help you. For both scenarios, you will be working independently. Whatever you see is "real" so be sure to respond. **References:**

Setting and Supplies (choose all that apply to this simulation)

Setting/Environment

☐ **ER**
☒ **Med-Surg**
☐ **Peds**
☐ **ICU**

Simulator Manikin/s Needed:

Laerdal 3G ☒ Note: **turn OFF monitor**
Laerdal SimMan ☐
Laerdal Sim Junior ☐

Props: [ie decorations, get well cards, wigs, clothing] Pitcher and cup on the overbed table without water in it. Family photo in frame on bedside stand. Picture of an angel and a child in control room. Religious book in control room.

Manikin Moulage-

☐ Bilat. leg edema to knee
☐ Abdominal distention
☐ Wounds- (please describe)
☐ Dressings(please describe)
☐ Fluids
sweat urine blood

☐ Emesis (describe)
☒ Smells Fecal odor
☐ Sounds
☒ Other Commode with 50 mL reddish black, coffee ground liquid

Equipment attached to manikin:

☐ IV tubing with primary line fluids running at mL/hr
☐ Secondary IV line running at mL/hr
☒ IV pump (at bedside, not attached)
☒ Foley catheter dark orange 50 mL output
☐ PCA pump running
☐ IVPB with running at mL/hr
☒ 02
☐ Monitor attached
☒ ID band

Equipment available

☐ Bedpan/Urinal
☐ Foley kit
☐ Straight Catheter Kit
☒ Ambu bag **Place in control room**
☐ Defibrillator/Pacer

Medications and Fluids

☒ IV Fluids: Normal Saline 1000 mL
☐ Oral Meds:
1.
2.
3.
4.
☐ IVPB:
☐ IV Push:
☐ IM or SC:

Diagnostics Available (Please attach any images you would like available)

☒ Labs
☐ X-rays (Images)
☐ 12-Lead EKG
☐ Other:

Documentation Forms

☒ Healthcare Provider Orders
☒ Medication Administration Record
☒ SBAR Report
☐ Shift Assessment
☐ Code Record
☐ Anesthesia / PACU Record
☐ Other:

Recommended Mode for Simulation

Manual ☐
Pre-programmed
Name Raul Cardoza
NLN pre-programmed
Name

Student Information Sheet

<table>
<tr><td>Setting:
Place: Medical unit of a local hospital
Time: day shift</td><td rowspan="4">Patient Data:
Name Raul Cardoza DOB 9/28/1962

Female ☐ Male ☒

MR # 80988 Allergies Demerol

Wt. 76 kg Ht. 160 cm

Physician Dr. Simon

Chief Complaint: Acute Abdominal pain and diarrhea for 3 days

Medical History HTN controlled with Lisinopril and diet

Surgical History Cholecystectomy 5 years ago

Social History Smokes 1/2 pack/day. Divorced

Home Medications: Lisinopril 20 mg po daily

See MAR for currently ordered medications.</td></tr>
<tr><td>Your Role:
☒Nurse: You can do all of the things a registered nurse can do. You need orders for procedures and medications just as in the clinical setting.
☐ Student Nurse: You will need to report your findings to your primary nurse and discuss the plan of action.</td></tr>
<tr><td>Objectives:
1. Assess and identify abnormal findings
2. Communicate to the appropriate healthcare team using SBAR
3. Request necessary orders/assistance based on accurate nursing diagnoses
4. Prioritize nursing interventions

Tasks to complete: Initial Assessment</td></tr>
<tr><td>Report:
Given by Emergency Room Nurse
Details Patient was admitted with acute abdominal pain. Abdominal X-ray was negative. Guiac test was positive for blood in the stool. Complete Blood Count shows Hg 8.8 (low) and Hct 25(low). Foley catheter was inserted with 50 mL urine returned. Patient is stable and will be admitted to the medical unit awaiting endoscopy. HR 90, RR 18, BP 112/68. Last given Morphine 2 mg IV for pain 5 minutes ago.</td></tr>
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Instructor Notes:

State 1 Expected Learner Actions: Recognize hypovolemia

Teaching points: Signs and symptoms of hypovolemia

State 2 Expected Learner Actions: Place patient flat, call for fluids

Teaching points: Cerebral hypoperfusion, independent and collaborative treatment

Notes regarding branching:

1. If the student : sits the patient up more the manikin should respond with passing out- no further responses until flat.

Roles:

Patient (manikin)- mildly anxious about admission and concern about what the problem might be.. Responds to questions, talkative. Acknowledges pain but minimizes it. Increasing frequency of dizziness with progression to syncope if the head of bed is not lowered. Feels much better if IV fluids are given.

Charge nurse (phone only)- brief responses. Seems harried with many things to do. Interrupts if given unnecessary data. After receiving report directs student to call physician.

Physician- (phone only)- polite but re-directs students to SBAR format by asking "Who are you? Who are you calling about? What is your main concern?" If students report low BP, asks what is urine output and cap. refill. Requests students call back if they do not have this information. Gives orders to start Normal Saline bolus ASAP and check BP in 20 min. Checks that the head of bed has been lowered.

Code team leader/ Rapid Response Team leader- Arrives 1 minute after called. Requests report if not immediately given a report. Polite but very focused on facts and guides students to give report in SBAR format if they are off track. If students are frozen, suggests re-take vital signs. Verbalizes the trend of decreasing BP and increasing HR. Asks what could be causing this. Suggests students call physician when the hypovolemia is identified.

Tips to keep the scenario flowing

Debriefing Plan: 45 minute debriefing with video segments and semi-structured interview. Setting: separate debriefing room.

Instructions to student: This debriefing may be more structured and take a bit longer than other debriefings you have had. I am very interested in your experiences and have some questions for you. Remember you don't have to answer questions if you don't want to. We will also be looking at some short video segments of the scenarios and discussing them. Following that we will talk about the scenarios and the learning objectives.

Phase 1: Encourage student to verbalize emotions experienced with the beginning statement: How are you feeling?

Semi-structured interview questions:

1. What was the first abnormal finding you noticed when you began assessing the situation in the last (most recent) simulation scenario?
2. What were some other clues that helped you to realize what was going on with your patient?
3. Tell me more about how you came to realize what the problem was?
4. How did you know which information to pay attention to?
5. Were you noticing or thinking about any other things related to the setting or situation? What were they?
6. If you have had similar experiences to either of the simulated scenarios with real patients, please describe how your experience was similar to these scenarios.

Phase 2: Show the 4 video segments and inquire if the students can recall what they were thinking at the time.

Phase 3: Use the Debriefing with good judgment method with statements such as "I noticed that ___, I am curious what you were thinking?

Phase 4: Dialogue about the 4 objectives

Scenario Progression Outline

Timing (approx)	Manikin Actions	Expected Interventions	May Use the Following Cues
0-3 min	Semi-fowlers position. HR 90, RR 18, BP 112/68, Temp 37 C Bowel sounds hyperactive	Introduce self, wash hands, identify patient, obtain vital signs, assess LOC, urine outuput, commode contents and pain	Role member providing cue: manikin Cue: I just had another bowel movment
3-6 min	HR trend to 98 over 2 minutes, BP trend to 104/60 over 2 minutes	Assess for signs of hypovolemia- cap refill, pulses	Role member providing cue: manikin Cue: "I feel a bit dizzy"
6-8 min	HR trend to 120 over 2 min. BP trend to 90/52 over 2 minutes	Lower the head of the bed	Role member providing cue: manikin Cue: "I feel really dizzy, like I might pass out."
8-10 min	HR trend to 132 over 2 min BP trend to 80/46 over 2 min.	SBAR to MD to report patient change in status and request fluids	Role member providing cue: manikin Cue: "I need help, something is really wrong"
10-15 min	If fluids are given, BP trend to 110/78 over 3 min. HR trend to 90 over 3 min	Re-assess Vital signs	Role member providing cue: manikin Cue: "I feel much better now"
Stop point	Receive order for fluids or 15 minutes		

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APPENDIX H

RULES FOR THE RANDOM SIMULATION STOPS

Rules for the Random Simulation Stops

Rule 1: First stop at 4 minutes
Rule 2: Minimum 2 minutes between stops
Rule 3:
 If time 2 = 6, time 3 can = 8 through 13
 If time 2= 7, time 3 can = 9, through 13
 If time 2 = 8, time 3 can = 10 through 13
 If time 2 = 9, time 3 can = 11 through 13
 If time 2 = 10, time 3 can = 12 or 13
 If time 2 = 11 time 3 = 13 only
Rule 4: No stop < 2 minutes before end
Rule 5: End scenario at 15 minutes

APPENDIX I

INSTITUTIONAL REVIEW BOARD APPROVAL

UNIVERSITY *of*
NORTHERN COLORADO

Institutional Review Board

DATE:	December 4, 2013
TO:	Lynn Phillips, MSN
FROM:	University of Northern Colorado (UNCO) IRB
PROJECT TITLE:	[524029-3] Undergraduate Nursing Student Situation Awareness during Simulation
SUBMISSION TYPE:	Revision
ACTION:	APPROVED
APPROVAL DATE:	December 4, 2013
EXPIRATION DATE:	December 4, 2014
REVIEW TYPE:	Expedited Review

Thank you for your submission of Revision materials for this project. The University of Northern Colorado (UNCO) IRB has APPROVED your submission. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on applicable federal regulations.

Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require that each participant receives a copy of the consent document.

Please note that any revision to previously approved materials must be approved by this committee prior to initiation. Please use the appropriate revision forms for this procedure.

All UNANTICIPATED PROBLEMS involving risks to subjects or others and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to this office.

Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of December 4, 2014.

Please note that all research records must be retained for a minimum of three years after the completion of the project.

If you have any questions, please contact Sherry May at 970-351-1910 or Sherry.May@unco.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Northern Colorado (UNCO) IRB's records.