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ABSTRACT

THE EFFECTS OF PATTERN RECOGNITION BASED SIMULATION SCENARIOS ON SYMPTOM RECOGNITION OF MYOCARDIAL INFARCTION, CRITICAL THINKING, CLINICAL DECISION-MAKING, AND CLINICAL JUDGMENT IN NURSING STUDENTS

by

SUSAN A. WALSH

In the United States nearly 1 million annual new and recurrent myocardial infarctions (MI) occur with 10% of patients hospitalized with MI having unrecognized ischemic symptoms. Inexperienced nurses are expected to accurately interpret cardiac symptom cues, possibly without ever having experienced care of patients with MI, yet have been shown to be less able to classify symptom cues and reach accurate conclusions than experienced nurses. The purpose of this study was to test an educational intervention using theories of pattern recognition to develop CT in MI and improve nursing students' clinical decision-making and clinical judgment using high fidelity patient simulation.

This study used a quasi-experimental three group pre-/post-test design and qualitative data to triangulate information on critical thinking, clinical decision-making, and clinical judgment in MI. A sample of junior baccalaureate in nursing students (N = 54) from a large metropolitan university were divided in pairs and randomized to one of two control groups. Data were collected with instruments which measured pattern recognition in MI, critical thinking in MI, and self-perception of clinical decision-making. In addition, diagnostic efficiency and accuracy were measured. Triangulation on clinical decision making with semi-structured interviews using 'thinking aloud' technique was conducted. Data were analyzed as qualitative data and compared among groups.

Students who were given prototypes for MI using simulation significantly improved critical thinking as measured by pattern recognition in MI ($t(3.153(2)$, $p = .038$) compared with the non-simulation control group. Qualitative findings showed that students receiving the experimental simulation with a non-MI scenario and feedback-based debriefing had greatest gains in clinical reasoning which included development of clinical decision-making using analytic hypothetico-deductive and Bayesian reasoning processes and learned avoidance of heuristics. Students receiving the experimental simulation learned to identify salient symptom cues, analyzed data more complexly, and reflected on their simulation experience in a way which students reported improved learning. Students who were given MI only simulation scenarios developed deleterious heuristics and showed fewer gains in clinical reasoning, though both simulation groups demonstrated greater critical thinking ability than the non-simulation control group.

Findings support the use of simulation to improve clinical reasoning including pattern recognition and clinical decision-making, and emphasize the significance of simulation scenario construction and debriefing to achieving learning outcomes. The findings could be used to guide further research to improve critical thinking, clinical decision-making, and clinical judgment in nursing students using simulation.

Funding for this study was provided by the American Association of Critical Care Nurses and Philips Medical Systems and a testing grant from Elsevier, Assessment.

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TABLE OF CONTENTS

Section Page

Section Page

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CDMNS	Clinical Decision-Making in Nursing Scale
CDM	Clinical decision making
CJ	Clinical judgment
CT	Critical thinking
HESI™	Health Education Systems, Incorporated
HFPS	High fidelity patient simulation
SBAR	Situation, Background, Assessment, Recommendation (Diagnosis)
WPRT	Welk Pattern Recognition Tool

CHAPTER I

Introduction

Intelligence and thinking are integral to professional nursing, but little is understood about the complex processes principal to how nurses critically think, make decisions, and decide on a plan of action in relation to patient problems. Experienced clinicians, including nurses, engage in rapid thinking and are able to generate highly accurate decisions about patients (Kahneman, 2003), a thinking ability which nurse educators and communities wish to develop in students and novice nurses. Making improvements in nursing student critical thinking (CT), however, has been a difficult academic outcome to achieve, despite considerable research and a major focus topic for nursing education (American Nurses Association (ANA), 2008; Commission on Collegiate Nursing Education (CCNE), 2008; National League for Nursing Accrediting Commission (NLNAC), 2005).

CT studies have concentrated on a number of attributes and skills which the critical thinker must develop (Facione, 1990; Scheffer & Rubenfeld, 2000) but few have examined the neurobiology by which problems are solved (Kaakinen & Arwood, 2009), nor elaborated on aspects of the CT process which are most important for clinical nursing. However, the cognitive foundation for CT may be brain-based category learning and pattern recognition (Ashby & Maddox, 2005) which is developed in nurses as recognition of symptom cues (Benner, 1984). Repeated exposure to patterns (symptom cues) through clinical experience may develop clinical expertise which informs decisions and judgments.

Diagnostic accuracy interpreting symptom cues underlies appropriate nursing decision making, clinical judgments, and interventions, and, furthermore, inaccuracy may result in poor patient outcomes (Lee, Chan, & Phillips, 2006; Lunney, 2008). Conditions which occur rapidly and have potential for severe disability or death should be accurately recognized by nurses, but diagnostic ability among nurses varies widely (Lunney, 2008). Novice nurses and nursing students may be less likely to recognize serious clinical conditions, such as myocardial infarction (MI), due to lack of exposure to patterns of disease.

Research is needed to understand how CT develops in novice nurses and nursing students. A quasi-experimental research study is proposed using a conceptual model of CT as a theoretical basis. This study will examine the effects of psychological theories of pattern recognition based high-fidelity patient simulation scenarios (HFPS) on MI symptom recognition, CT, clinical decision making (CDM), and clinical judgment (CJ) in nursing students.

Statement of the Problem

Clinical experiences for nursing students are designed as immersion experiences for development of clinical reasoning skills (CCNE, 2008). However, students do not always have access to a variety of learning experiences for skill development (Hicks, Coke, & Li, 2009), and students may not experience changing clinical situations. Nursing competency at the bedside is sustained by a combination of psychomotor and thinking skills in application of a clinical knowledge base and experience (Fesler-Birch, 2005). According to the ANA (2008) a competent nurse uses CT and CDM to make judgments about patient problems. Nurses state that competency includes "instant recognition of the abnormal, including ...changes not commonly seen or apparent to a novice" (Kearney, 2009). However, del Bueno (2005) reported as many as 65% of new graduate nurses were not competent critical thinkers upon entry into practice.

In the United States (US) the estimated annual incidence of MI is approximately 610,000 new and 325,000 recurrent (American Hospital Association (AHA), 2009). Ballew & Philbrick (as cited in Eisenberg & Mengert, 2001) reported 370,000 to 750,000 patients will have an in-hospital cardiac arrest, often triggered by MI, which suggests a high likelihood that nurses will experience caring for patients with MI in acute care settings. Annually, over 129,000 US educated students become newly licensed nurses (National Council of State Boards of Nursing (NCSBN), 2008) who presumably enter the workforce and subsequently encounter hospitalized patients experiencing MI. Schelbert et al. (2008) reported 10% of in-hospital patients with MI had unrecognized ischemic symptoms, in part, from failure of health care providers to recognize and classify symptom cues as MI.

Without ever having seen a patient having a heart attack, or with little experience in care of patients with MI, new nurses are expected to use CT to accurately classify symptoms, common and uncommon, and make decisions for appropriate interventions. However, with current educational practices, clinical CT ability in students and new nurses may not be sufficiently developed to allow for accurate diagnosis of MI.

Significance of the Study for Nursing

The American Heart Association (AHA) reports a national annual prevalence of heart disease in the US of 80 million, with a mortality of 846,500 (2009). In addition to heart disease, risk of MI increases with age, inactivity, hypertension, diabetes, obesity, and tobacco use (AHA, 2009). Thirty-three percent of the population has high blood pressure, 66.6% a body-mass index (BMI) of 25 or greater, 30.8% suffer from obesity, and 33.6% either are diabetic or pre-diabetic (AHA, 2009). Twelve percent of the population is over age 65 (Centers for Disease Control (CDC), 2009). The magnitude of these statistics indicates a nation at risk for myocardial infarction.

An aging at risk baby boomer population will strain the healthcare system with its requirements for complex care when nurses, also part of the boom generation, retire from practice (Buerhaus, Staiger, & Auerbach, 2000). The convergence of retiring nurses and increased demand for bedside clinicians relative to increased healthcare needs of the populace signify an influx of inexperienced nurses to the bedside. However, inexperienced nurses are less able to critically think and achieve accurate diagnostic conclusions (Benner, 1984; del Bueno, 2005; Girot, 2000; Tanner, Padrick, Westfall, & Putzier, 1987) potentially compromising patient safety. The possibility for missed MI or inappropriate interventions due to underdeveloped CT processes is a consistent concern in healthcare, but the prospect of greater incidence of errors because there are more inexperienced nurses at the bedside is troublesome.

Deliberate development of CT ability by enhancing pattern recognition of clinical symptoms could facilitate effective CDM and CJ, and improve patient outcomes. Pattern recognition is the initial step in the CT process, as all perception must be cognitively classified to have meaning (Bruner, 1957). Understanding the meaning of clinical signs and symptoms creates understanding for the nature of the problem so that resolution processes through CDM and judgment for action (CJ) can begin.

Using HFPS, a system which replicates a realistic hospital environment in a laboratory setting using a sophisticated life-like mannikin, allows pattern recognition theories to be designed into patient care scenarios, which not only improves control for the study, but also facilitates the use of theories in a way not possible with actual patients in clinical settings. Results from this study, therefore, will add to the body of knowledge of using simulation for nursing education.

Teaching pedagogies to date have not consistently produced CT results (Ironside, 2003), perhaps because methods of instruction are not specifically aimed at how the brain naturally learns. However, CT competence in care of patients is an expected outcome of nursing education (American Association of Colleges of Nursing (AACN), 2008; National League for Nursing Accrediting Commission (NLNAC), 2005). This study will examine the use of two pattern theories, prototype and information-integration processing, to enhance CT in developing diagnostic accuracy in junior nursing students, and improve CDM and CJ in MI. In addition, the study may potentially contribute to nursing by clarifying relationships between CT, CDM, and CJ, explain the relationship of CT to experience, theoretical knowledge, and situational information, and explicate the CT process.

Research Questions

The following research questions are proposed:

1. Do students who use prototype and information-integration processing based pattern recognition HFPS to learn symptoms of MI perform differently on measures of symptom pattern recognition, diagnostic accuracy , and time to diagnosis than students using textbook based presentation of MI symptoms using HFPS?
2. Do students who use prototype and information-integration processing based pattern recognition HFPS to learn symptoms of MI perform differently on measures of CT, CDM, and CJ than students using textbook based presentation of MI symptoms using HFPS?
3. Do students who have didactic class and HFPS perform differently on measures of CT, CDM, and CJ to learn symptoms of MI than those who have didactic class alone?
4. Is there a difference in CT ability for students having didactic class only compared with students who have didactic class and simulation?

Study Hypotheses

H1: Nursing students who participate in pattern recognition based HFPS will be better clinical reasoners as indicated by significantly higher scores for MI symptom pattern recognition, CT in MI, and self-perception of CDM than students who participate in textbook based HFPS or students who participate in didactic class alone.

H2: Nursing students who participate in pattern recognition based HFPS will accurately identify MI diagnosis based on symptom cues significantly more often than students who participate in textbook based HFPS.

H3: Nursing students who participate in pattern recognition based HFPS will significantly improve time to diagnosis compared to students who participate in textbook based HFPS.

H4: Nursing students who participate in pattern recognition based HFPS will better articulate the process of CDM and CJ than students who participate in textbook HFPS or didactic class alone.

Assumptions

Assumptions on which this study was based are the following:

1. Humans classify all input into perceptual categories.
2. Category labeling must occur before decisions which guide behavioral human response can be made.
3. The brain unconsciously selects the best category classification system for learning depending upon the perceptual task.
4. Prototype and information-integration processing are effective for accurate classification of ill-defined categories such as symptoms of MI.
5. Category learning can occur with exposure to three exemplars from the category or related category.
6. CT can be taught to, and learned by, nursing students.
7. CT, CDM, and CJ can be measured.

Conceptual Framework

The ability to critically think has been proposed as a defining characteristic between novice and expert nurse performance, which potentially affects clinical decisions, actions, and speed of detection for life-threatening conditions (Banning, 2008; Benner, 1984; Etheridge, 2007; Martin, 2002). Explaining how clinicians think when challenged with clinical problems has been posited a number of ways, including Martin's (2002) critical thinking theory, Croskerry's (2009) model for diagnostic reasoning, and Edward's (2007) critical thinking: A two phase framework. Each explains clinical thinking in terms which could be described as an aspect of the overall process: Problem identification, clinical decision-making, and clinical judgment. CT has been identified as not only a thinking process, but also expressed as acquisition of the thinking skills necessary for judgments to be made (Banning, 2006; Facione, 1990).

The framework for this study is based upon what is known about CT. Many definitions representing several epistemological positions (CT as judgment, skill, attitude, or tool) (Ennis, 1989; Facione, 1990; Glaser, 1941; Paul, 1995; Scheffer & Rubenfeld, 2000) are associated with the CT concept (Turner, 2005). The American Philosophical Association (APA) Delphi study (Facione, 1990), a major work towards clarifying the concept, indicated CT is not only a thinking skill but that good critical thinkers have personality traits or dispositions which enhance CT ability (Facione, 1990). A nursing Delphi study (Scheffer & Rubenfeld) concluded similarly about the nature of CT. However, there were some nursing specific differences which were identified (Scheffer & Rubenfeld), such as use of standards, use of intuition, and creativity.

Based on extant literature, a conceptual framework for clinical reasoning was developed (Figure 1). The framework redefines CT as conscious and unconscious application of cognitive skills (for example, analysis, deduction, and logic) to make a clinical diagnosis and execute an applied global thinking process of clinical reasoning. The conceptual framework for clinical reasoning draws on work by Facione (1990), Scheffer & Rubenfeld (2000), Benner (1984) (experiential model from novice to expert), Schon (Kinsella, 2007; Schon, 1992) (reflecting-in-action and reflecting-on-action), and includes pattern recognition and decision-making theories. In addition, the model provides an articulation point for simulation learning theories.

Figure 1. Conceptual Framework for Clinical Reasoning

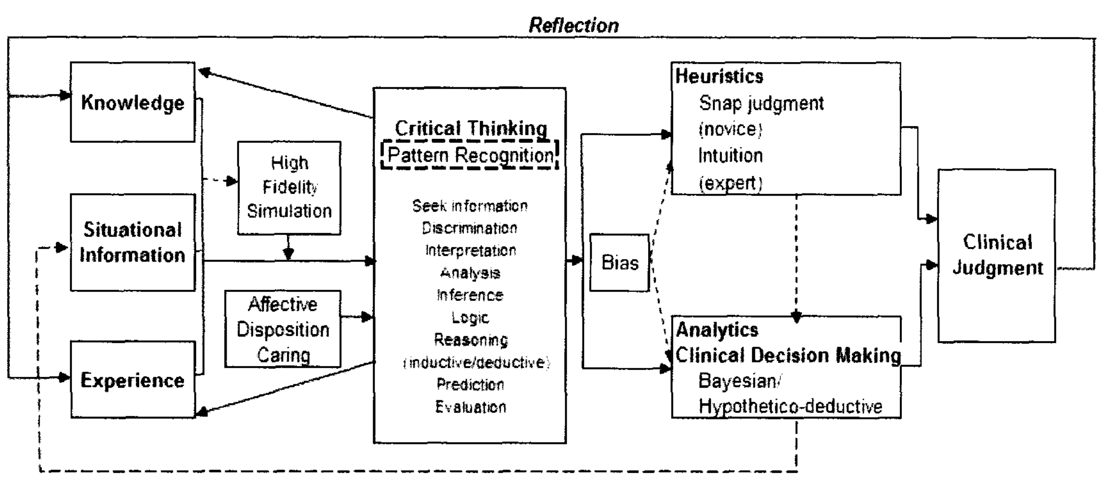


Figure1. Schematic representation of relationships between major study variables of pattern recognition, critical thinking, clinical decision-making, and clinical judgment.

Conceptual Framework for Clinical Reasoning

The conceptual framework for clinical reasoning explicates relationships among the major clinical constructs of CT, CDM, and CJ. Clinical reasoning is described as logical, cogent, and purposeful thought which culminates in a judgment as the basis for clinical care. Thinking processes supporting CJs are complex and dependent upon a clinician's nonanalytic and analytic abilities, susceptibility to bias, disposition towards thinking, thinking ability, knowledge, experience, and situational information. The conceptual framework for clinical reasoning describes how elements of thought culminate in a clinical decision, and how thinking and judgments can augment a clinician's base of knowledge and experience to improve the likelihood of accurate future judgments.

Within the clinical mileu are patient situations requiring decisions. Each clinician can only perform in that moment in time based on the information available and the current state of knowledge and experience encapsulated within the clinician's memory. Information about a clinical problem can be expressed in a number of variable situational cues which are in dynamic flux with the arrival of newer information, necessitating cognitive agility to recognize cues and assign saliency in relation to the problem at hand. How the clinician responds is based on complex cognitive interactions with knowledge, experience, situational information, cognitive ability, and cognitive and affective disposition.

Reasoning. Thinking is natural and effortless, but when encountering a problem, thinking must be cogent, logical, and goal directed (Laucken, 1995); the opposite of scattered and purposeless. When thought is directed toward purpose, then thinking has been become more than thought, but an act of reasoning.

The process of clinical reasoning is a system of thought directed towards achieving a clinical result; a judgment which directs the clinician in providing care. Most clinical events are framed as 'problems', often diagnostic, to determine the nature of the patient condition for treatment. Options for intervention are considered followed by a final assessment for action.

The cognitive process of clinical reasoning uses practitioners' knowledge within the domain, previous experience, and situational information to provide neurophysiological input for pattern recognition and content for thought. Additionally, the practitioner brings a range of CT skills and ability, a disposition inclined/disinclined to produce excellence, susceptibility to bias or not, and a character which favors doing for the benefit of others.

Knowledge. Discipline specific knowledge is necessary for CT (Ennis, 1989; Kataoka-Yahiro & Saylor, 1994; Kenimer, 2002; Khomeiran, Yekta, Kiger, & Ahmadi, 2006). Glaser (1941) postulated that development of any CT ability is related to successful acquisition of knowledge and facts in the subject about which the thinking occurs. Within nursing knowledge are norms and expectations about patient health, and rules and standards against which to judge situational information, for example pulse or respiratory rate. Nursing theoretical knowledge comes from the humanities and sciences providing content for thought about a patient problem (Kataoka-Yahiro & Saylor).

A novice clinician's knowledge base is prototypical, or textbook derived, in part, from classroom learning (Harjai & Tiwari, 2009; Welk, 2002) where a learner learns a set of diagnostic rules (Eva, Hatala, LeBlanc, & Brooks, 2007). Though knowledge is the subject about which CT occurs, knowledge is acquired when connections and insights are made when thinking.

Situational information. Patient situations provide contextual cues within the clinical scene. Situational information includes information about a clinical occurrence which has aroused the need to critically think. Situational information may be assessment data, such as heart sounds and vital signs; psychosocial data, such as patient and family verbalizations, vocalizations, and expressions; and clinical data such as health histories, lab, and test results. Situational data is temporally supplied without evaluation or weighting as to its salience for the situation at hand. Though definitive diagnostic tests may be available, such as autopsy, complete data are not usually available at the time the diagnostic decision must be made. Therefore situational data is data which can be known about the problem at a point in time.

Psychomotor ability is sometimes associated with CT skill (Fesler-Birch, 2005; Zekonis & Gantt, 2007), but as means for situational data collection, such as taking a blood pressure, and is therefore considered subsumed in situational information. Lack of psychomotor ability can affect CT if, for example, the nurse lacks sufficient skill to accurately take a pulse or blood pressure, because incomplete or inaccurate situational information is obtained. Situational data which is inaccurate or does not pertain to the situation at hand may lead to inaccurate problem identification.

Experience. Benner (1984) discussed clinical experience as necessary for development of nursing expertise. Furthermore, Benner (1984) described expertise as situational, for example, an expert intensive care nurse would not be able to transfer expertise to an obstetric unit. Experience is more than being present in a clinical environment, but being cognitively engaged enough to challenge existing knowledge and refine ideas (Benner).

Experiential understanding of a patient situation is augmented and refined in two ways: an unconscious search for patterns to enhance category learning (pattern recognition) (Ashby & Maddox, 2005), and reflecting-on and -in the reasoning process (Benner, 1984; Schon, 1992). Pattern recognition theories can explain how clinical experience can affect nursing expertise. Exposure to more situations improves category learning until expertise is attained. Inability to transfer expertise to differing clinical settings suggests underdeveloped pattern recognition for novel clinical problems. Pattern recognition may explain how repeated experience of similar types improves recognition of clinical problems.

Assignment of pattern cues (input) to categories (pattern recognition) is based on prior experience (Medin, Altom, & Murphy, 1984). New input is cognitively evaluated against existing category templates stored in memory, as experience, in a constantly refining transaction. Greater experience categorizing cues improves accuracy of identification. Experience, therefore, is cognitive practice for learning (Kataoka-Yahiro & Saylor, 1994).

Affective dispositions and caring. Inclination and motivation to use CT skills is affected by dispositional attributes (Facione, 1990; Scheffer & Rubenfeld, 2000) and caring (Walsh & Minick, 2009). Possessing ability to understand a problem or make a decision does not imply the will or concern for accuracy needed for clinical reasoning. When health outcomes are at stake, making accurate diagnoses and selecting an optimal course of action require traits such as intellectual integrity, flexibility, and interest in the welfare of others.

Affective dispositions are not part of critical thinking or reasoning processes, but good critical thinkers (and reasoners) have personality characteristics which enhance their abilities to use aspects of deeper thinking (Facione, 1990). Certain individual affective attributes associate with positive CT outcomes (Facione, 1990; Scheffer & Rubenfeld, 2000). Characteristics such as inquisitiveness, perseverance, open-mindedness, maturity, self-confidence, integrity, creativity, flexibility, reflectiveness, and inclination to organized thought enhance CT ability (Facione, 1990; Facione, Facione, & Giancarlo, 2000; Scheffer & Rubenfeld, 2000).

Emotional involvement in patient situations can facilitate use of CT (Sedlak, 1997) including patient caring. Caring, both directly and indirectly, about patient welfare enhances willingness to expend intellectual energy to achieve an optimum solution (Baxter & Rideout, 2006; Walsh & Minick, 2009).

Critical thinking. In the literature CT can be described as conceptually analogous with its attributes, such as 'inference' and 'analysis', or synonymous with its referents such as 'diagnostic reasoning', 'problem solving,' and 'clinical judgment' (Edwards, 2007; Turner, 2005). Though definitions indicate a process of higher order thinking (Facione, 1990; Paul, 1995), multiple perspectives and terminology obfuscate the meaning of CT. The general term 'CT' has no single definition, but refers to any act of deeper thinking focused on recognizing problems, deciding on solutions, and/or making judgments.

The conceptual framework for clinical reasoning views CT narrowly, as the induction phase in which a clinical problem is identified (diagnosed) (Edwards, 2007; Lasater, 2007). The transaction between environment and memory to form meaning (Estes, 1994) and understanding occurs via a process of pattern recognition. CT represents the phase of mental processes in which the transaction occurs and by which the nature of a problem is known. Pattern recognition is the premise for all clinical CT in nursing (Benner, 1984; Kahneman, 2003). CT is a brain based process of reasoning in which knowledge, experience, and situational information support a metacognitive process of problem identification by searching for pattern meaning.

How the brain extracts meaning from scenes is theorized (Ashby & Maddox, 2005), but skills of higher order thinking may perform operations which manipulate input. Laucken (1995) described cognition as not only goal directed, but requiring *means*. CT skills are means for thinking, including seeking information, discrimination, interpretation, analysis, inference, inductive and deductive reasoning, logic, prediction, and evaluation (Facione, 1990; Scheffer & Rubenfeld, 2000). The operations of CT lead to creation of new knowledge as insight, and thinking as experience. CT skills are used to manipulate, examine, and reconstruct situational input into representations for understanding.

CT is discipline specific with topical requirements for thinking. As previously stated, three components are requisite for clinical CT in nursing: Experience, knowledge, and situational information (context) (Bakalis, 2006; Fesler-Birch, 2005; Kataoka-Yahiro & Saylor, 1994; Kenimer, 2002; Twycross & Powls, 2006; Turner, 2005; Walsh & Minick, 2009). While CT provides means for cognition (Laucken, 1995), experience, knowledge, and context provide subject and content for thinking.

CT skills provide means for the clinical reasoning process and flow through the CDM and CJ phases. Therefore, CT skills should not be ascribed to the CT phase of problem identification only, but as operations for thinking in CDM and CJ.

Pattern recognition. Successfully negotiating an environment is dependent upon accurate interpretation of stimuli transmitted via the senses in the context of memory

(Ashby & Maddox, 2005; Bruner, 1957; Estes, 1994). Associating environmental cues with a category transforms input into perceptual awareness. Pattern recognition theories suggest that rapid organization and retrieval of memories is category based, allowing recognition of environmental features and ability to generalize about novel experiences (Reed, 1972).

In nursing, patterns such as a patient's shortness of breath or anxiety can be classified into categories of disease. Clinical pattern recognition occurs when a group of symptoms is associated with a diagnostic category (Buckingham & Adams, 2000). Pattern recognition is essential to nursing CT because decisions about how to respond to a situation depend on recognizing the problem (Benner, 1984; Welk, 2002), an ability which distinguishes experts from non-experts (Gagne, 1985). Appropriate responses to a situation are made when pattern cues are accurately interpreted (Ashby & Gott, 1988). A number of models have been theorized to explain category learning but studies suggest the brain appropriately utilizes the model which yields the most accurate category classification for the task at hand (Ashby & Maddox, 2005; Maddox, Filoteo, Hejl, & Ing, 2004; Peissig & Tarr, 2007; Reed, 1972; Scott, Tanaka, Sheinberg, & Curran, 2008).

Categorization of patient diagnoses is difficult because category limits are not always clearly defined. For example, symptom 'chest pain' may belong to the diagnostic category 'MI', but may also belong to 'hiatal hernia', 'pneumonia', 'rib fracture', and 'cancer' (McCance & Huether, 2005) . However, diagnoses have typical associated symptoms which, when present, indicate the likelihood of a diagnosis (Welk, 2002). In addition, each diagnosis also has a number of associated symptoms which may not be typical, but when present, increase the likelihood of a diagnosis.

A number of symptoms may be present with the diagnosis MI. Welk (2002) identified 5 typical and 14 associated symptoms with MI (Appendix A). When five typical (essential) symptoms are present (chest pain, restlessness, diaphoresis, nausea and vomiting, and anxiety) the diagnosis of MI is likely. Presence of associated symptoms (e.g. shortness of breath, dizziness, crackling lung sounds) do not necessarily indicate MI, but when found with any of the associated five essential symptoms, the diagnosis of MI becomes more likely (Welk, 2002). Occasionally, idiosyncratic or atypical conditions are found, for example, a person with MI has no chest pain. Because symptoms of MI vary depending on the individual, MI is considered an ill-defined category. For ill-defined categories prototype and information-integration processing pattern recognition systems may yield the most accurate classification (Homa & Chambliss, 1975; Homa, Proulx, & Blair, 2008).

Prototype pattern recognition requires exposure to a number of exemplars belonging to the category. For example, for category 'dog' there must be exposure to a number of different dogs. From exposure to exemplars of 'dog' the brain extracts an 'average', or prototype model which contains patterns such as 'four feet', 'wagging tail', and 'snout' (Hayes-Roth & Hayes-Roth, 1975; Homa & Chambliss, 1975; Medin, et al., 1984). If future exposures to dog exemplars have the cues 'four feet', 'wagging tail', and 'snout' the new exemplars will be classified as a 'dog'. If an exception pattern occurs, for example, a three-legged dog, an effective prototype is flexible enough to classify the exemplar as 'dog' based upon the remaining patterns of 'wagging tail' and 'snout' (Erickson & Kruschke, 1998).

Accurate categorization of exemplars also occurs if, instead of exposure to a number of exemplars, there is only exposure to the prototype (Homa & Chambliss, 1975; Medin, et al., 1984). A prototype contains all the essential features for the category. For example, for the diagnostic category 'MI' the prototype contains the five essential symptoms of MI (Welk, 2002).

When categories are ill-defined, or have great over-lap with similar categories, prototype formation is enhanced by classifying patterns for categories which are complex, containing a large number of essential patterns, and with exposure to a greater number of exemplars belonging to the category (Ashby & Maddox, 2005; Homa & Chambliss, 1975). Category learning is also improved when learners are exposed to exemplars containing common, common and distinctive, and idiosyncratic patterns (Homa & Chambliss, 1975; Scott et al., 2008). Furthermore, exposure to a contrasting category enhances prototype formation because category limits can be ascertained (Erickson & Kruschke, 1998; Homa & Chambliss). Idiosyncratic patterns, however, belong to a single case making incorporation into the prototype more difficult and more easily forgotten (Homa & Chambliss).

Initial categorization of cues has a powerful effect on subsequent prototype classifications (Hayes-Roth & Hayes-Roth, 1975). Therefore, the order in which exemplars are presented affects prototype pattern recognition. However, category learning can occur even when there is exposure to few exemplars, suggesting another category system is in effect (Ashby & Maddox, 2005).

Information-integration systems integrate new information with what is already known by computing weight or value along at least two dimensions at a predecisional stage (Ashby & Gott, 1988; Ashby & Maddox, 2005; Maddox et al., 2004). Information-integration processing may be useful in determining salience of situational information by assigning value to patterns such as symptoms. Accurate information-integration processing is highly feedback dependent, however, (Maddox, Ashby, & Bohil, 2003; Maddox, Love, Glass, & Filoteo, 2008). Delayed feedback during integrative-information category learning may have a negative effect on accuracy (Maddox et al., 2003; Maddox et al., 2008).

Both prototype and information-integrative systems require feedback (verbal or other) for optimal accuracy (Ashby & Maddox, 2005; Maddox et al., 2008; Shohamy, Myers, Kalanithi, & Gluck, 2008), though a prototype from a single prototype can be extracted without feedback (Maddox et al., 2008). Reward centers in the brain release dopamine during feedback which may strengthen recently active synapses and initiate error correction (Maddox et al., 2008; Shohamy et al., 2008). Unexpected reward has the greatest effect on learning (Maddox, et al., 2004; Shohamy et al., 2008). However, lack of reward when one is expected has a negative effect (Shohamy et al.). Debriefing, which is often performed after HFPS, may enhance learning by providing feedback.

Expert clinicians are able to recognize a clinical problem through pattern recognition, but cannot easily articulate how the diagnosis is made, often calling it 'intuition' (Benner & Tanner, 1987; Kahneman, 2003; Rovithis & Parissopoulos, 2005). Because experience is essential to category formation (Scott et al., 2008) novices do not easily recognize patterns of disease.

Following diagnosis in the CT phase, nurses determine a course of action using CDM. Options are examined with analytic or non-analytic methods relative to potential consequences and outcomes (Kahneman; Tversky & Kahneman, 1981). Which acts or options are considered rests on the definition of the problem in the CT phase. Novices, without a reservoir of knowledge, experience, and ability to focus on salient cues in the situation, may use 'short cut' heuristic CDM, contributing to possible judgment errors (Kahneman; Kahneman & Tversky, 1996). Experts use heuristics for CDM but are able to do so with fewer errors in judgment (Kahneman, 2003). Expert and novice nurses may alternatively use analytic methods for CDM when a heuristic solution does not come easily to mind, or to validate a heuristic decision. Heuristics, which describe unconscious 'short cuts' or 'rules of thumb' for making decisions, tend to be unconsciously performed, while analytic processes are likely to be conscious (Elstein & Schwarz, 2002; Hutchinson & Gigerenzer, 2005; Kahneman 2003).

Clinical Decision Making

The diagnostic phase of CT has a profound effect on which treatment options will be considered and which judgments are best under the circumstances, making the task critical and essential. One must have an idea of the nature of the problem before appropriate decisions and interventions can be made.

Solutions to patient problems are frequently not determinate, but must be inventive, original, and adaptive to the situation, drawing on both knowledge and experience. Making clinical decisions about patient problems is a function of professional nursing, but the science of decision-making has not been fully elucidated (Kahneman, 2003). A proposed two tier processing system (Alter, Oppenheimer, Epley, & Eyre, 2007; Harbison, 2005) describes two styles of CDM. System 1 is quick, effortless, and intuitive, versus System 2 which is slow, effortful, and analytical (Alter et al; Harbison, 2005).

Heuristic Decision-Making. System 1 is heuristic which short-cuts the thinking process (Alter et al., 2007; Groves, O'Rourke, & Alexander, 2003; Kahneman, 2003). Answers rapidly come to mind, though accuracy is more a function of experience and expertise, rather than thinking ability. In experts, heuristic decision-making is intuitive, occurring below the threshold of consciousness (Benner, 1984). Intuition is a highly accurate decision making process for rapid apprehension of a clinical situation where problem and solution are identified, based on experience and knowledge, and acted upon without conscious thought (Benner, 1984; Shohamy et al., 2008). However, since novices lack experience, use of heuristics leads to 'snap judgment' and possibly deleterious patient outcomes owing to inaccurate decision-making (Kahneman, 2003; Tversky & Kahneman, 1981).

Analytic Decision-Making. When answers do not immediately come to mind, or difficulties arise, System 2 analytic reasoning is more likely to be used (Alter et al., 2007; Kahneman, 2003). Accessibility of thought is affected by emotional arousal which influences how quickly answers come to mind (Kahneman, 2003). Practitioners may use analytic CDM as an initial process or secondarily to validate intuition. Analytic CDM may be described as Bayesian or hypothetico-deductive (Beach, 1975; Kadane, 2005). Novices should be encouraged to use analytic reasoning rather than heuristic until expertise is attained.

Bayesian Decision-Making. Bayesian decision making theory explains how decisions are made in high risk situations where events are singular and lack an unequivocal solution (Kadane, 2005; Tversky & Kahneman, 1981). Because patients and their problems are essentially unique, a single solution may not adequately address a problem type. Therefore, since there are no universal solutions, the best decision is one on which most experts would agree (Beach, 1975).

Bayesian decisions are made by examining the situation from multiple viewpoints (multilogical thinking) (Paul, 1995) and weighting possible options (Tversky & Kahneman, 1981). Opinions are affected by previous experience and available information (Harbison, 2005). As further evidence is updated, beliefs [hypotheses] are modified (Harbison). To this aim, several hypotheses for solution may be entertained. While formulating alternative hypotheses there may be an awareness of incomplete information or questioning the diagnosis. Bayesian decision making does not require all information before a decision can be made, but adapts based on new information introduced during the decision-making process (Taylor, 2000). The decision-maker revisits the patient situation, regathers data, and resumes CT and CDM, perhaps by redefining the problem.

Hypothetico-deductive decision-making. Hypothetico-deductive reasoning, based on information processing theory, uses gathered data and knowledge to generate multiple hypothetical solutions (Higgs & Jones, 2000; Lee, et al., 2006). Greater numbers of hypotheses correlate with accuracy of decision making (Lee). In Bayesian decision-making all relevant data are gathered and evaluated before a decision is made. In hypothetico-deductive reasoning plausible hypotheses are formulated (inductive reasoning) and tested from data available (deductive reasoning) (Higgs & Jones). Hypothetico-deductive reasoning depends on accurate data collection (situational information) which may require the clinician to re-gather data during evaluation of multiple hypotheses (Lee).

Bias. Bias potentially enters any CDM potentially increasing errors in judgment. Factors unrelated to the outcome which affect decisions are termed bias (Kahneman, 2003). Introducing bias into decision making may lead to suboptimal CDM and CJ. While heuristic CDM is intuitive and below the level of consciousness (Paul & Heaslip, 1995; Shohamy et al., 2008) and can be highly accurate, it is subject to bias in the form of priming and framing effects. Priming effects activate cognitive associations between inputs making some thoughts accessible over others, in other words, antecedent experiences to an event influence perception of the current event (Kahneman, 2003). Framing effects are viewpoint dependent and often influenced by core beliefs (Tversky & Kahneman, 1981). Framing effects are alterations in language which influence perception. For example, two statements which have essentially the same meaning may cause different perceptions based upon viewpoint: "My headache is worse today than yesterday" vs. "Yesterday my headache was not as bad as today" (Kahneman).

Other biases such as early closure of data gathering, preparing hypotheses too early, confirmation bias (only accepting data which confirms a preformed opinion), anchoring bias (temporarily increasing attribute importance), and representativeness bias (resemblance to a known category) may also negatively influence CDM and CJ (Buckingham & Adams, 2000; Kahneman, 2003).

Clinical Judgment

A CJ occurs when the CDM process is concluded culminating in a decision. When clinicians cannot form a diagnosis in the first phase, CDM will be used to determine a diagnosis, followed by re-activation of the CDM mode to decide on an action. A clinical decision may be singular or prioritize a series of actions as a final judgment.

The final decision for action, or the CJ, signifies prioritization or elimination of competing hypotheses in favor of a first choice. The CJ may be an intervention or action, such as notifying the physician. Through reflection on the CJ (decision outcome) experience and knowledge are increased, further developing expertise. Buckingham & Adams (2000) state that expertise occurs when one is able to recognize patterns.

Reflection. Reflection, in accordance with Schon's definitions (1992) for reflection-in-action and reflection-on-action, uses reasoning processes to examine the situation at hand (reflection-in-action) causing self-correcting learning which augments experience and knowledge (Schon). Reflection-in-action is not stopping to think, but constant conscious and unconscious psychological and motor adjustments made while thinking which refine knowledge and experience (Schon). Reflection-in-action is often not verbalized, but an unconscious self-dialogue to make sense of a situation which is often not realized or remembered, leaving only the result of understanding (Schon).

When pattern cues are not recognized, subconscious reflection-in-action may be employed to make meaning of situational information, drawing on experience and knowledge to reach understanding for the problem. Reflection-in-action is often the result of surprise such as when routine responses cause an unexpected outcome (Kinsella, 2007). Reflective thought draws upon CT skills to answer internal questions such as "What is going on?" and is used during discovery mode to make sense of a problematic phenomenon (Schon, 1992).

Reflection-on-action occurs after CJ at the culmination of the reasoning process as consciously thoughtful review of the event to affirm or disconfirm what was learned (Kinsella, 2007). Reflection-on-action promotes refinement of knowledge and experience by reviewing what 'worked' and what 'did not work' when arriving at a solution for a problem (Schon, 1992).

Conceptual Terms

The following conceptual terms are defined as used in this study:

Bias – A factor which affects the outcome of decision-making unrelated to the problem.

Category – Diagnostic label for a group of related symptoms, e.g. myocardial infarction.

Category learning – Neurobehavioral memory classification system which allows inferences to be made about novel stimuli.

Clinical decision making – A thinking process which can be analytic, nonanalytic, or both, to sort and/or prioritize hypotheses under consideration when solving clinical problems.

Clinical judgment – Decision for action to solve a clinical problem.

Critical thinking – 1) A brain based process of reasoning through which knowledge, experience, and situational information are used to support a metacognitive process of problem identification by searching for pattern meaning (recognition) (conceptual framework for clinical reasoning).

2) Any act of deeper thinking focused on recognizing problems, deciding on solutions, and/or making judgments (general definition representative of the literature).

Experience – Situational engagement characterized by refinement of understanding and knowledge due to exposure to patient situations.

High fidelity patient simulation – Faithful reproduction of a patient care area using a life-like human mannikin.

Knowledge – Discipline specific theoretical or didactic content which is used for solving patient problems.

Pattern – Input for classification. Clinical patterns may present as patient symptoms or contextual cues such as vital signs and lab data.

Pattern recognition – Identification of patterns as belonging to a category, such as a disease or condition.

Problem-solving – A complex process which begins with realization of a clinical problem and culminates in a clinical judgment.

Reasoning – Application of cognitive thinking skills of seeking information, induction, deduction, logic, analysis, interpretation, discrimination, inference, prediction, and evaluation applied in any phase of the process to determine actions about patient problems.

Reflection – Thoughtful review of problem solving process which contributes to experience and knowledge.

Situational information – Information gathered through the senses and using psychomotor skill about a patient event at a point in time. Includes history, tests, reports, and assessment.

Symptom/symptom cue – Pattern for a disease.

Summary

The conceptual model of clinical reasoning proposes that patient outcomes can be affected by nurse ability to recognize diagnostic patterns of disease. Diagnostic expertise is a function of adequate discipline specific knowledge and accrual of related and particular clinical experiences. Nursing students and novice nurses may demonstrate adequate knowledge by successfully passing their licensing exam, but are limited in experience upon graduation, not only in general care of patients, but during rapidly changing and life-threatening conditions, such as MI. Limited experience retards development of clinical diagnostic expertise.

The Institute of Medicine (IOM) reported that leaders and managers of hospitals cite skill deficits in CT (2003) in the nursing workforce. Nursing education leaders value CT in relation to public health (AACN, 2008; NLNAC, 2005). Strategies which investigate improving CT should be evaluated.

Using HFPS to simulate clinical experiences, diagnostic pattern recognition can be improved using brain based learning methods such as prototype and information-integration processing systems, purposefully built into patient care scenarios. Intentionally appealing to natural neurobiological learning processes within the brain can potentially foreshorten time to expertise, thus improving diagnostic expertise, effective CDM, and accurate CJs.

CHAPTER II

Review of the Literature

Chapter II will discuss review of the literature which will include topics useful for understanding conceptual terms of pattern recognition and category learning, critical thinking (CT), clinical decision making (CDM), clinical judgment (CJ), and research related to pedagogies for improving CT, including simulation. The literature review directs and supports the study.

Pattern Recognition and Category Learning

Human category learning is a brain-based cognitive function necessary for survival so that identification and recognition of perceptual stimuli can occur (Bruner, 1957), for example, 'dog', 'tree', 'friend', 'foe' (Ashby & Maddox, 2005). A perceptual category contains stimulus cues (patterns) belonging to the same group (Ashby & Maddox). When a cue is encountered categorization memory systems allow experience with previous cues to be applied to present situations (Estes, 1994). When cues are categorized, the process is called 'pattern recognition'. Pattern recognition is essential to learning because life situations are rarely identical, requiring a flexible perceptual process which quickly interprets changing sets of perceptual stimuli (Estes). In clinical situations pattern recognition occurs when a cluster of symptom cues is associated with a diagnostic category (Buckingham & Adams, 2000).

Mechanisms for brain based decisions on category assignment are not well understood though a number of psychological theories of category learning have been proposed: Rule based, prototype, information-integration processing, and models applied to weather prediction task data (Ashby & Maddox, 2005; Erickson & Kruschke, 1998; Peissig & Tarr, 2007). Pattern recognition is not diagnostic symptom matching (Benner & Tanner, 1987), but a conscious and unconscious mental effort to find associations between situational input which, when taken together and in context, can be realized as a pattern of disease. Though a disease may have a cluster of distinctive signs, there are often associated common signs which overlap other disease presentations, rendering disease diagnostic label assignment a complex cognitive process.

Humans use multiple category systems depending on the task at hand (Ashby & Maddox, 2005; Poldrack & Foerde, 2008). The optimum model for pattern recognition is one which produces greatest accuracy in category assignment (Maddox, et al., 2004). For easily defined categories with clear membership, rule-based categorization is effective (Ashby & Maddox). However, for ill defined categories with no clear boundaries, such as disease categories which may not have only distinctive and common symptom cues, but idiosyncratic cues, prototype and information-integration models are associated with greater categorization accuracy (Homa & Chambliss, 1975; Homa, et al., 2008). The presence of distinctive, common and distinctive, and idiosyncratic cues renders myocardial infarction (MI) an ill-defined category.

The weather prediction task system is useful for classifying probabilistic cues (pattern cues which do not belong to a single category, but could belong to one category at one time, and another category at another) (Ashby & Maddox, 2005). However, the weather prediction task requires integration of cues for optimal performance, which is essentially an information-integration system (Ashby & Maddox). Therefore, the weather prediction task will not be considered separately.

Prototype Category Learning

Prototype category learning is a theory which explains learning based on an averaged prototype extracted from exemplars within the category (Homa & Vosburgh, 1976). Rather than storing multiple exemplars for comparison, the brain extracts common elements forming a prototype. Prototype category recognition can be learned in two ways: Exposure to the prototype, or exposure to multiple exemplars of category membership from which a prototype is extracted (Hayes-Roth & Hayes-Roth, 1975; Homa & Chambliss, 1975; Medin et al., 1984). A prototype represents an average of all exemplars and may represent none in actuality. For example, a prototype dog has four legs, a snout, and a tail that wags. Experiences with multiple category exemplars (all kinds of dogs) will cause the learner to abstract the prototype just as well as presenting multiple examples of prototype dogs, which have all three features of legs, snout, and tail. An exemplar is classified as a category member if it is more like the prototype for that category than any other category (Medin et al., 1984). However, when an exception pattern (idiosyncrasy) occurs, for example, a three legged dog, an effective prototype will allow category generalization, though classification of exception patterns is more difficult to achieve (Erickson & Kruschke, 1998; Homa & Chambliss).

Sufficient experience with category exemplars allows the learner to find the commonalities within the category (prototype) and learn category limits by contrasting and comparing with other categories (Homa & Chambliss, 1975). In a study of category learning undergraduate psychology students (n = 54) were given distortion patterns (variations on a prototype) in a nine grid matrix of ink dots. Participants were asked to classify dot patterns into two, four, or six categories (Homa & Chambliss). Participants required to discriminate among larger numbers of categories (n=6) were significantly more accurate in category assignment than those discriminating between fewer categories (n = 2) ($p < .05$) (Homa & Chambliss). Number of exemplars within each category did not significantly affect category learning when differentiating among fewer categories (two) ($p > .05$), but when differentiating among many categories (four to six) more exemplars within a category improved prototype formation and classification of novel exemplars (Homa & Chambliss). When abstracting the prototype, both distinctive and common attributes become prototypical. With experience, the category is refined until selected attributes provide an effective, parsimonious solution for category identification (Homa & Chambliss).

Maddox et al. (2004) conducted a study to examine effects of category size on rule-based (RB) and information-integration (II) processing systems. Twenty-four paid volunteers were given instructions to categorize visual stimuli in four conditions: RB (2 or 4 categories) and II processing (2 or 4 categories). Participants were told to take as much time as needed to be accurate. Information-integration processing system enabled greater accuracy in classification than rule-based for a large number of categories ($t(23) = 2.08, p <.05$) (Maddox et al., 2004). In addition, analysis showed that when learning two categories, accurate response time was significantly faster for the RB categories, but when four categories were used, II was significantly faster ($t(23) = 3.78, p < .01$) (Maddox et al., 2004).

Novel cues are unconsciously judged against category prototypes in memory until sufficiently matched against a prototype (Hampton, Estes, & Simmons 2005; Vanpaemel & Storms, 2008). Goldstone, Steyvers, & Rogosky (2003) described prototype formation as concept development occurring in inter-related webs which are mutually defined through comparison and contrast (Maddox et al., 2003). In experiments with undergraduate psychology students (n = 62, n = 66) participating as a course requirement, students identified category membership for images of two faces distorted five times from prototypes (Goldstone et al., 2005). In Experiment 1 all ten images were given at once; Experiment 2 categories were presented sequentially. Accuracy of classification was the dependent variable. In Experiment 2 there was slight classification bias for the most recently seen category; however, both experiments showed that accurate classification was mutually dependent between categories. That is, accuracy was a function of recognizing Category B as 'Category B' and, in addition, as 'not Category A' (Goldstone et al.).

When categories have ill-defined boundaries exposure to a greater number of categories and exposure to a larger number of exemplars within each category improves categorization (Homa & Chambliss, 1975). Prototype category recognition is also improved when categories are complex with many pattern cues, and when learners are exposed to three types of patterns within the category: common, common and distinctive, and idiosyncratic (Homa & Chambliss, 1975; Scott, et al., 2008). Experiments by Medin et al. (1984) suggest that a mixture of experiences with exemplars and prototypes increases accuracy in category classification of higher order relationships.

Medin et al. (1984) studied 96 undergraduate psychology students who were given 16 stimulus cues with attributes along four dimensions (color, form, size, and number). Attributes were weighted differently for Category A than for Category B. Students were given either prototypes for the categories alone, or prototypes plus exemplars. Those given both prototypes and exemplars had significantly greater classification accuracy than those given the prototype alone ($p < .01$) (Medin et al.).

Homa & Vosburgh (1976) examined 72 students' (paid $1.50/hour) ability to classify distorted prototype patterns. Students were tested immediately after, at one week, and after 10 weeks post experiment. Results indicated that students who were exposed to patterns which closely matched the prototype were less able to transfer learning, no matter the number of examples given (Homa & Vosburgh). However, students given mixed levels of distortion showed ability to transfer learning ($p < .01$), especially when category size was increased ($p < .01$). Researchers postulated that further exposure to varied levels of exemplars would continue to enhance learning (Homa & Vosburgh). Furthermore, exposure to mixed levels of distortion compared to low levels of distortion had less deterioration of learning over time (Homa & Vosburgh).

For disease category MI there are 19 symptom cues (Welk, 2002). Five cues are distinctive (symptoms necessary for recognition of the disease) and 14 cues are common (nonessential symptoms that, if eliminated or changed, would not change the pattern of disease) (Welk, 1994; Welk, 2002). A "textbook picture" of disease has distinctive signs of MI only, which constitutes the prototype (Welk, 1994; Welk, 2002). Exemplars of MI could be distinctive symptoms from the 'textbook' prototype, non-essential common symptoms, or a mixture of distinctive and common symptoms.

Study findings (Homa & Chambliss, 1975; Homa & Vosburgh, 1976) suggest that nursing student diagnostic accuracy for symptoms of MI may be improved by exposure to an MI prototype plus exemplars with distinctive and common symptoms, and contemporaneous exposure to at least one other diagnostic category. Furthermore, learning may be enhanced by providing experience with a diagnostic category which has overlapping symptomatology with the category of interest (MI), such as pneumonia, which also presents with chest pain, anxiety, and shortness of breath.

Initial category classification of cues has a powerful effect on subsequent classifications (Hayes-Roth & Hayes-Roth, 1975) therefore, presenting common and distinctive symptoms in the first scenario of an HFPS series may enhance category learning and diagnostic accuracy. Idiosyncratic examples may confound pattern finding (Homa & Chambliss, 1975) and therefore, idiosyncratic symptom cues for MI will not be included in this study.

Information-Integration Processing System Learning

Ill defined categories are more difficult to learn than linearly separable rule-based categories (Homa & Chambliss, 1975) or those with family resemblance (similarities within the category, e.g. categories of cars or birds) (Knowlton & Squire, 1993). Exposure to many exemplars is usually required when extracting an effective prototype (Ashby & Maddox, 2005). However, humans do not need to be exposed to great numbers of exemplars to be able to correctly categorize which suggests another model is responsible for pattern recognition (Ashby & Maddox, 2005).

Information-integration processing system is theorized to pre-decisionally assign weight and value to incoming information before testing against categories in memory

(Ashby & Maddox, 2005; Maddox et al., 2004). An evaluation is made about each pattern cue based on its perceived attributes. For example, symptom cue 'chest pain' could be evaluated on attribute 'location' by assigning higher value for substernal pain versus pain located in another part of the chest when categorizing as MI. The optimum rule for classification for the information-integration processing system is not verbalizable (easily explained) because it occurs innately (Maddox, et al., 2008).

Blair & Homa (2005) reported ease of categorical integration of novel cues depends upon selection of a cue's 'informative dimensions' for classification. Estimation of salience and weight of cue attributes determines accuracy of classification, and furthermore, classification expertise is a function of ability to identify which attributes are useful for informing a category decision. For example, symptom cue 'chest pain' could have attributes 'location', 'intensity', and 'quality', each which can be weighted not only in relation to importance for category MI, but also in relation to one or more attributes (Zeithamova & Maddox, 2006). If, for example, for cue 'chest pain' the attributes 'intensity' = 10/10 *and* 'quality' = crushing, then symptom 'chest pain' may be assigned highest value for classifying as MI.

Blair & Homa (2005) conducted two experiments with psychology students ($n = 102$ and $n = 87$) who participated in experiments which showed students could evaluate new cue dimensions to improve classification accuracy ($p < .001$). Interestingly, the researchers found that valuable cues were discarded in favor of more economical cue sets (fewer informative dimensions) at the expense of accuracy (Blair & Homa, 2005).

Blair & Homa (2005) based their study on work by Lewandowsky & Kirsner (2000) which examined use of information-processing in novices and experts. Control of bush fires requires prediction of fire movement based on a number of variables such as wind speed, slope, and ambient temperature (Lewandowsky & Kirsner). Fourteen experts averaging 18.1 years experience, and 24 novices, participated in two experiments. Experts were given variables for four fires which performed in a standard manner and one fire which behaved contradictorily (fire moves against prevailing winds). Participants were asked to predict fire movement on topographical maps given the fire detection point (Lewandowsky & Kirsner). Experts were able to accurately predict fire movement, even when given contradictory variables, indicating adjustments were made in cue salience and weight depending on context (Lewandowsky & Kirsner).

In nursing, diagnostic accuracy is context driven because patient situations constantly change (Levin, Lunney, & Krainovich-Miller, 2004). Salience of symptom cues and attributes varies according to situational patient/environment interactions and depends on availability of accurate and valid data (Levin et al., 2004). Information-integration processing system theory suggests experience with exemplars improves selection of salient symptom cues and attributes (Blair & Homa, 2005), an observation Benner (1984) made in describing development of CT. Benner's (1984) model states that a hallmark of CT in nursing, when developing from novice to expert, is recognizing salient information, which marks the advanced beginner.

Accuracy in category assignment with information-integration processing system is highly feedback dependent (Maddox et al., 2008). Delayed feedback may have a negative effect on category assignment (Maddox, Ashby, & Bohil, 2003; Maddox et al., 2008) reducing diagnostic accuracy. However, information-integrative systems, and to some degree prototype systems, need feedback to achieve optimal accuracy (Ashby & Maddox, 2005; Maddox et al., 2008; Shohamy, et al., 2008).

Maddox et al. (2008) demonstrated the effects of feedback in an experimental study with 107 students (course credit or paid). Students were randomized to four groups: Rule-based or information-integration processing, with full or partial feedback. Partial feedback was provided as correct or incorrect performance on category assignment. Full feedback provided additional information on performance to include accuracy of category condition. Results showed category condition X feedback was significant ($F(1,103) = 9.90$, $p < .01$). Full feedback enhanced rule-based learning which operates on a Bayesian feedback model using all available information to distinguish between competing hypotheses (Maddox et al., 2008). However, an information-integration processing system responds to the "valence of feedback" (success or failure) (Bernard, 1992; Maddox et al., 2008, p. 586) for learning reinforcement.

Reward centers release dopamine during feedback which may have the effect of strengthening recently active synapses in the brain and initiate error correction (Maddox et al., 2008; Shohamy et al., 2008). In psychologic experiments examining prototype and information-integration processing systems feedback was immediate, with delayed feedback sometimes defined as greater than 10 seconds (Maddox et al., 2008). Lack of reward when one is expected can act as negative feedback (Shohamy et al.). However, dopamine has the strongest effect when reward is unexpected (Maddox et al., 2004; Shohamy et al., 2008). The importance of feedback on certain types of category learning may explain why debriefing after simulation is an important teaching stratagem.

Clinical Application of Pattern Recognition

Cognitive studies for category learning are limited by small sample sizes (<200) and lack of generalizability related to unidimensional (visual) variables, small numbers of categories (2-6) and small category sizes, frequent use of psychology major subjects, and lack of real-world application. However, a few studies have used pattern recognition as a theoretical basis for teaching diagnostic symptom recognition.

Gluck & Bower (1988) compared conditioned response learning to other cognitive models, including pattern recognition and exemplar matching [template matching], in two experiments. Non-medical university students (n = 19, n = 24)) were asked to review 250 fictitious patient charts for four symptoms (stomach cramps, discolored gums, bloody nose, and puffy eyes) as one of two fictional diseases. Training given which identified symptoms as probabilistic for a diagnosis (ill-defined categories) varied between experiments. The researchers concluded that when one disease is more likely than another, conditioned responses and template matching, which correlate highly (r = .95), were more likely to over-estimate incidence of rare disease than pattern recognition (Gluck & Bower).

Welk (1994) conducted a quasi-experiment pilot study (n = 25) with baccalaureate in nursing (BSN) students to examine if students who were exposed to typical narrative examples performed differently on measures of pulmonary edema recognition than students who read textbook excerpts. Typical narrative pattern cues for pulmonary edema were essential signs and symptoms plus two demographic variables (age and gender) (nonessential signs) (Welk, 1994). Textbook excerpts contained essential pattern cues for pulmonary edema only. Results showed that students who read typical examples of pulmonary edema performed significantly better than students who read textbook excerpts ($t(23) = 1.99, p < .05$) indicating students learned to recognize the disease pattern (Welk, 1994). Welk indicated that use of 10 typical examples versus 4 textbook examples may have contributed to study results.

Welk (2002) conducted a larger study with BSN students (n=162) to examine effects of pattern recognition in MI. Twelve 100-word case studies were developed. Six case studies presenting five essential symptoms of MI only (previously described) were placed in one packet. Symptom synonyms were used, for example, 'nausea and vomiting' were also presented as: nauseous, vomits up coffee, severe indigestion, sick to stomach, or queasy. Six 100-word case studies containing a variety of essential and nonessential (common) symptoms, with no attempt at consistency, were placed in another packet (Welk, 2002). Participants, who had no previous coursework about MI, randomly received one packet or the other.

Students who read case studies of essential symptoms of MI only more accurately identified essential ($p < .001$) and nonessential ($p < .001$) symptoms of MI on a researcher made pattern recognition scale ($\alpha = .78$) than students reading case studies with nonessential symptoms (Welk, 2002). However, both groups correctly identified an average of 4/5 MI situations ($t(160) = 1.37, p = .172$) on a researcher made 10-item post-test (heart attack/no heart attack) ($\alpha = .56$) (Welk, 2002). Welk (2002) concluded that six examples were sufficient for students to learn the prototype pattern of MI and that students acquired the category of essential symptoms of MI by exposure to typical exemplars.

Manias, Aitken, & Dunning (2003) examined novice nurses (n = 12) working in an acute care setting on decision-making style. Observation qualitative data were collected about graduate nurses' decision-making during medication administration. Researchers observed for evidence of hypothetico-deductive reasoning, pattern recognition, and intuition. Results showed that graduate nurses used hypothetico-deductive reasoning (25 observations), followed by pattern recognition (10 observations), and intuition (2 observations) when solving patient medication administration problems. In this study pattern recognition was defined as the ability to make a judgment based on limited cues and was exhibited by applying previous knowledge of patient conditions to new situations.

Williams, Klamen, & Hoffman (2008) conducted a study with four cohorts of medical students by year (admitted (n = 73), first (n = 73), second (n = 69), third (n = 70) to examine acquisition of diagnostic pattern recognition (DPR) ability and clinical data interpretation (CDI) using Bayesian analytic reasoning during medical education. A 111 item scale (59 DPR items, 52 CDI) was administered annually (DPR Cronbach's alpha ranged .58-.73 for cohorts, .92 for all students; CDI Cronbach's alpha ranged .57-.69, .75 for all cohorts).

Results showed that students gained DPR and CDI ability all three years of medical education (FDPR = 323.62, $p < .000$; FCDI = 44.41, $p < .000$.), but gains leveled off the third year (Williams et al., 2008). DPR ability improved greater than CDI, and gains for both DPR and CDI were less during the first year. By the third year DPR performance increased 87%, CDI 44%.

Williams et al. (2008) noted that questions in the scale were written to elicit DPR or CDI responses, however, the authors stated that operationalization was difficult to achieve. Williams et al. also considered that students may have used other forms of reasoning not captured, and lack of experience may explain lower gains in DPR and CDI ability in the first year. Williams et al. postulated that fewer gains in the last year may indicate changes in learning patterns as students realize that conditions may not match prototypes.

Pelacci, et al. (2009) conducted a quasi experimental study about performance in emergency triage with 128 second year medical and third year nursing students. Sixty-four participants were given the standard curriculum of 16 hours of disaster triage training using illustrated clinical cases (before 2005). Sixty-four participants (since 2006) were given the pattern recognition curriculum which, in addition to illustrated clinical cases, presented 'typical patterns of disease' (Pelacci et al., 2009, p. 890). Two hour tutoring sessions were given to each group; however, the pattern recognition group tutoring was with patterns.

Pattern recognition was defined as presentation of typical signs and symptoms found during mass casualty incidents (MCI), consistent with prototypes. For example, 'explosion, dyspnea, and hemoptysis' were presented as the pattern for a pulmonary blast injury. Simulated human patients with make-up applied by military soldiers who attended a special course were triaged. The control group triaged 145 simulated patients, and the experimental group 192. Measurement was appropriate, under-, or over-triage as determined by course trainers. Analysis with chi square showed the pattern recognition group performed significantly better than the control group ($p < 0.01$). The pattern group correctly triaged 70.8% of the simulations compared to 48.3% for the control group. Furthermore, the pattern group had less over-triage (24.5%, 45.5% respectively), but the same rate of under-triage (9%) as the control group. Pelacci et al. (2009) speculated that students who were not confident over-triaged for fear of missing a life threatening event.

Students were recruited from 5 medical schools and 17 nursing schools (Pelacci et al. (2009). Groups did not interact during simulation, and types of injuries were randomly assigned to participants. Twenty prcent of MCIs were emergent conditions for each group. The number of trainers, level of expertise, and inter-rater reliability were not discussed. It is interesting to note that in some cases a prototypical cue was contextual ('explosion') as well as physical. The authors recognized that study results could be attributed to operation of another decisional process as pattern recognition was not measured.

Though in medicine pattern recognition is considered a nonanalytic form of reasoning (Eva, 2004), in nursing Benner & Tanner (1987) stated pattern recognition is a perceptual ability to find configurations and relationships. In the context of this study, pattern recognition is not reasoning, but a process of awareness, insight, or realization for the nature of a patient problem. Should pattern recognition fail, CT skills of reasoning are applied during clinical decision making to examine differential diagnoses followed by analysis for appropriate intervention.

Summary

Human organisms receive vast amounts of stimuli to be interpreted and understood for survival (Bruner, 1957; Ashby & Maddox, 2005). Several theories suggest that perceptual information is conceptually organized and interpreted by neurophysiologic category systems and retained in memory as learning. Experience with pattern cues refines category definitions which facilitates future accuracy in pattern recognition. Competing systems may operate to categorize novel cues with precedence for systems which are fast and accurate (Ashby & Maddox, 2005; Maddox et al., 2004; Reed, 1972). Two systems, prototype and information-integration processing system, may be especially useful when learning ill-defined categories, such as disease conditions, including MI, though most investigative studies are limited to visual learning.

Advances in brain based learning research offers possibilities for providing educational instruction intended to alter neural networks (Posner & Rothbart, 2005; Scott et al., 2008). Benner (1984) and Welk (2002) describe pattern recognition as the initial process of CT for nurses. Instructional strategies which enhance diagnostic pattern recognition have the potential to improve diagnostic accuracy and patient outcomes (Chase & Leuner, 1996; Levin et al., 2004; Lunney, 1998).

Critical Thinking

A 1983 report by the National Commission on Excellence in Education described a nation at risk because its young had not been taught 'higher-order' thinking (HOT) skills, an assessment which stimulated academic interest in CT. However, discussions about CT revealed differing perspectives. Glaser, in seminal work in 1941, called CT thoughtful consideration of problems using the application of logical inquiry and reasoning (Glaser, 1941). Richard Paul defined CT as, "thinking about thinking" (1995), and Ennis proposed a definition of CT as "reasonable reflective thinking focused on deciding what to believe or do" (1993, p.180).

In 1990 the American Philosophical Association (APA) published results of a Delphi study employing 46 participants who had experience and expertise in CT to arrive at a consensus definition (Facione, 1990). While not equating CT with good thinking, the report identified cognitive skills (Appendix B) and affective dispositions (Appendix C) which mark the good critical thinker (Facione). Furthermore, the report noted that CT is not a body of knowledge, but a set of thinking skills which could be applied to disciplines as well as every day life (Facione). However, for CT skill to be applied within many disciplines there must be domain specific knowledge such as criteria and methods (Facione). CT skill is one of several HOT skills which include problem-solving, decision-making, and creative thinking, though further research is needed to explain relationships among HOT skills (Facione).

Affective dispositional traits do not characterize CT but are presented as personal "habits of mind" which are conducive to use of CT skill (Facione, 1990, p. 11). Greater development of affective CT dispositions (one or more traits) facilitates application of CT skill in other situations beyond every day life (Facione).

Defining CT: Construct Clarity vs. Confusion

A problem in CT research has been lack of accepted intra- and interdisciplinary definitions despite efforts to reach consensus (Ennis, 1993; Facione, 1990; Scheffer & Rubenfeld, 2000; Simpson & Courtney, 2002). Though Turner (2005) documented 27 synonymous terms for CT in the literature, researchers often define CT as a set of cognitive skills and affective dispositions, based on work by the APA Delphi Report (Facione, 1990).

CT has been studied in nursing from a number of perspectives to delineate its conceptual boundaries, determine factors which influence its development, and evaluate its significance as a variable in academic and clinical performance. In 2006, Crowe & O'Malley reported 490 articles published over a ten year span focusing on CT and nursing. Reviewing literature on critical reflection Teekman (2000) found inconsistencies and "unsubstantiated philosophical shifts" (p. 1126) in usage of the term 'critical', which may also apply to the term 'critical thinking', causing lack of a single definition (Brunt, 2005a; Simpson & Courtney, 2002; Zygmont & Schaefer, 2006). Lacking a consensus definition, defining what constitutes CT research is difficult, as a wide variety of terminologies may refer to the same concept, including diagnostic reasoning, clinical judgment, nursing process, problem-solving, and decision-making (Turner, 2005).

Qualitative and quantitative designs have been employed to study CT, but their choice as methodologies do not appear to derive from specific epistemological viewpoints. Often no theoretical framework is specified (Beckie, Lowry, & Barnett, 2001; Carter & Rukholm, 2008; Chau, Chang, Lee, Ip, Lee, & Wootton, 2001; Giddens & Gloeckner, 2005; Jones, 2008; Khosravani, Manoochehri, & Memarian, 2005; Profetto-McGrath, 2003; Rush, Dyches, Waldrop, & Davis, 2008; Shin, Lee, Ha, & Kim, 2006; Velde, Wittman, & Vos, 2006) though assumptions about CT can be understood by authors' inclusion of CT definitions, stated or implied assumptions, or instrument selection.

However, when a concept is not well understood or defined a qualitative approach, particularly phenomenological, may aid in explicating the nature of the phenomenon

(Patton, 2002). Myrick (2001) used qualitative design to examine how preceptorship promoted CT in fourth year baccalaureate student nurses. Grounded theory approach was used to generate several models explaining the relationship between themes of 'enabling' [opportunities to use CT] which is supported by 'climate' [for learning] and 'bringing about' [encouraging development of CT], and critical thinking. CT development was found to be incidental or purposeful during preceptorship. Incidental CT development was most common, and found in preceptor role-modeling, guiding, prioritizing, and decision-making.

Twibell, Ryan, & Hermiz (2005) used an ethnographic qualitative design to understand faculty perceptions of teaching CT to baccalaureate nursing students in clinical settings. Faculty understood CT as 'putting it all together' (p. 71) using a number of techniques to foster thinking: Asking questions, reviewing written work, clinical conferences, and student journaling. The nature of CT was understood as requiring synthesis and assigning meaning, which the authors felt was not supported by Scheffer & Rubenfeld's (2000) work (Twibell et al.). Twibell et al. found that synthesis was an over-arching component for CT, a concept which was discarded in early rounds of the Scheffer & Rubenfeld study. In addition, the researchers described a relationship between CT and subsequent patient intervention, noting that student decisions about plans of action were empiric evidence of CT (Twibell et al., 2005). Furthermore, study participants did not clearly differentiate between CT, problem-solving, decision-making, and clinical judgment, often using terms interchangeably, leading the researchers to conclude that nurse educators could benefit from concept clarification (Twibell et al.).

Other qualitative CT studies have explored perceptions of learners and practitioners in relation to instructional practices and/or barriers and aids to attaining CT (Carter & Rukholm, 2008; Etheridge, 2007; Henrichs, Rule, Grady, & Ellis, 2002; Lasater, 2007; Rush et al., 2008; Schoening, Sittner, & Todd, 2006; Torre, Daley, Stark-Schweitzer, Siddartha, Petkova & Ziebert, 2007). However, phenomena need to be adequately developed and understood as concepts before theories can be proposed (Walker & Avant, 2004). While few healthcare qualitative studies examined the nature and boundaries of the CT concept, the qualitative method could assist with reaching understanding and consensus about CT.

The preponderance of CT studies in the last ten years were quantitative design to examine whether CT is important to clinical decision-making, clinical judgment (CJ) (Bowles, 2000; Hicks, Merritt, & Elstein, 2003; Kautz, Kuiper, Pesut, Knight-Brown, & Daneker, 2005; Martin, 2002), academic success (Giddens & Gloeckner, 2005; Palese, Saiani, Brugnolli, & Regattin, 2008; Ravert, 2008), associates with teaching strategies or curricular changes (Herdrich, & Lindsay, 2006; Jones, 2008; Maskey, 2008; Velde et al., 2006) or how it compares among groups (Shin et al., 2006, Rogal & Young, 2008). Others examined CT as a moderating variable for self-confidence (Brown & Chronister, 2009; Lohse, Nitzke, & Ney, 2003) and communication (Jones, 2008), and or to determine the relationship of demographic variables such as age, grade point average, National Councils Licensure Examination (NCLEX) pass rates, and nursing experience on CT (Angel, Duffey, & Belyea, 2000; Bowles, 2000; Hicks et al., 2003).

CT in Nursing

In nursing the APA Delphi Report (Facione, 1990) definition of CT was not universally accepted, in part, because questions remained regarding whether CT is a general ability or a discipline specific skill requiring a particular body of knowledge (Scheffer & Rubenfeld, 2000; Tanner, 2005), and about how CT, clinical judgment, and nursing practice relate (Bandman & Bandman, 1998; Daly, 1998; Haffer & Raingruber, 1998; Mottola, 2001). Clinical experience may be considered essential to nursing CT (Benner, 1984) and, in fact, may be requisite to development of nursing CT skill (Etheridge, 2007; Kataoka-Yahiro, & Saylor, 1994; Martin, 2002; Rashotte & Carnevale, 2004; Zygmont & Schaeffer, 2006).

The original Delphi Report (Facione, 1990) listed interpretation, analysis, evaluation, inference, deductive and inductive reasoning as CT skills with associated subskills. Nursing conducted a Delphi study in 2000 (Scheffer & Rubenfeld) which found CT to be both skill and affective disposition, as in the APA Delphi Study (Facione). Nursing describes CT skill as seeking information, analyzing, discriminating, predicting, applying standards, reasoning logically, and transforming knowledge (Scheffer & Rubenfeld, 2000). The semantical differences belie great similarities as both Delphi reports list not only skills, but subskills which use similar terminology. For example, nursing identifies evaluating as a subskill of applying standards, and logical reasoning as having inducting and deducting subskills, all of which are found in the Delphi Report (Facione; Scheffer & Rubenfeld) (Appendix D).

CT dispositions are described as character traits which predispose to use of CT and increase CT success (Facione, Giancarlo, & Facione, 1995). The APA Delphi Report

(Facione, 1990) identified six dispositions: Seeks truth, analyticity, open mindedness, systematicity, CT self-confidence, inquisitive, and maturity (Facione). The nursing Delphi report concurred with dispositional 'habits of mind' but identified 'intuition' and 'creativity' as unique to nursing. Intuition is unconscious insight or understanding without rationale (Benner & Tanner, 1987). Creativity was not included in the original Delphi Report (1990) but was considered an attribute in support of general education (Facione et al., 1995).

Nursing agreed that CT does not refer to intellectual capacity, but described CT as the ability to weigh input for relevance (finding meaning in data), evaluate competing solutions, to be truthful in seeking and accepting information, flexible in accepting new ideas, inquisitive (asking 'Why?" or "What if?"), alert to context (consideration of the whole situation and changes in circumstance which call for modification in thinking), creative in finding answers, accept intuitive flashes of insight, self-confident (belief in CT ability), make connections through inference, logical (draw reasonable conclusions), reflective (self-correcting) and analytical (finds relationships and deep understanding) (Allen, Rubenfeld, & Scheffer, 2004; Alfaro-Lefevre, 2009; Facione, 1990; Scheffer & Rubenfeld, 2000). While these characteristics represent the ideal critical thinker, individual traits vary from person to person, and even situation to situation (Scheffer & Rubenfeld, 2000).

The CT process has also been termed goal-directed decision making leading to judgment requiring contextual cues and reflective, metacognitive, and multilogical thinking (Ennis, 1993; Facione, 1990; Facione et al., 1995; Ennis, 1989; Paul, 1995; Scheffer & Rubenfeld, 2000). The problem appears to be less lack of extra and intradisciplinary agreement about the concept of CT, but rather how to describe a complex multimodal thinking process with skills, subskills, dispositions, theoretical, practical, and contextual aspects.

One study was found which defines CT as diagnosis. Cruz, Pimenta, & Lunney (2009) conducted a pre-/post test study to examine accuracy of Brazilian nursing diagnoses' as a reflection of CT ability. Nursing diagnosis was defined as 'naming' interpretation of patient data. Nursing diagnosis is considered essential to quality of nursing care as the diagnosis serves as the basis for intervention.

Thirty-nine nurses were given 16 hours of classes (in English with consecutive translation in Portuguese) over four days describing and discussing how to apply 7 concepts of CT and 10 habits of mind, from work by Scheffer & Rubenfeld (2000), to clinical situations. Two case studies were given pre- and post test which were scored on a 7-point scale devised by Lunney (1992) with an inter-rater reliability reported at .96 from a previous study (Lunney, 2001). Validity of the case studies was established by four nursing experts. Case studies were translated into Portuguese by investigators and reviewed by a professional Brazilian translator. Names in the case studies were changed to Brazilian names.

Results showed scores were significantly improved after taking the CT class (case study 1, $z = -2.63$, $p = .008$, case study 2, $z = -2.04$, $p = .042$, both $z = -3.34$, $p = .001$). Some nurses made no improvements or made lower scores; overall, accuracy for case study 1 improved 20.5% and case study 2 38.5%. Cruz et al. (2009) focused on reasons for lack of 100% mastery such as heuristics referred to overconfidence, hindsight, and premature closure, and use of the same case studies for pre- and post testing. An issue not discussed was language, as the presentation was dual language, and no back translation of the instrument was conducted.

Discussing CT is difficult in nursing literature because there is no one agreed upon definition or theory. Romeo (2010) conducted a literature review on quantitative CT studies' usefulness of CT findings as a predictor of success on the NCLEX. Romeo (2010) concluded in absence of universal theoretical and operational definitions for CT a framework for curriculum development is lacking.

CT models and frameworks used in nursing. A theoretical framework guides quantitative research by providing logical structure and tying findings to existing knowledge (Burns & Grove, 2005). But lacking clear conceptual boundaries, CT does not easily fit into frameworks. When a theoretical framework is identified, Benner's clinical model of novice to expert is most often cited in research (Cirocco, 2007; Fero, Witsberger, Wesmiller, Zullo, & Hoffman, 2009; Martin, 2002; May, Edell, Butell, Doughty, & Langford, 1999; Wilgis & McConnell, 2008; Zurmehly, 2008). However Benner's model does not specifically define CT, but describes it in terms of pattern recognition, experience, and skill (Benner, 1984).

Researchers have employed Tanner's work, which is consistent with Benner's (Lasater, 2007), or experiential frameworks (Kolb Theory of learning, Perry's stages of intellectual development) (Angel et al., 2000; Ravert, 2008). Kolb's Theory could be especially useful in CT research as it unites experience, reflection, cognition, and behavior (Kolb, 1981) consistent with Benner's model of nursing clinical expertise (1984).

Study frameworks which specifically support CT as a cognitive skill are fewer, such as Kautz et al. (2005) use of the Outcomes Present State Test Model (OPTM) of cognitive development and Self-Regulation Learning (SLR) theory. The combined model uses structure and process of self-regulated learning to facilitate development of CT (Kautz et al., 2005). Martin (2002) developed a framework which combined Benner's model and Paul's definition of CT (metacognitive multi-logical thinking (Paul, 1995) which includes both cognitive and dispositional elements. One study used Subjected Expected Utility Theory (SEUT) which is a normative decision-making theory for making decisions when data are incomplete, conflicting, or ambiguous (Hicks, et al. 2003; Rew, 2000).

Benjamin Bloom's cognitive taxonomy has been used as an organizing framework (Jones, 2008) though Ennis suggested the taxonomy was as vague as the term 'higher order thinking' (Ennis, 1985). Ennis (1985) stated no consensus exists on which levels of the taxonomy represent CT, and in addition, terminology was not explanatory enough to establish meaning (Ennis, 1985).

Khosravani et al. (2005) used the nursing process as an organizing framework. The authors used steps of the nursing process (assessment, diagnosis, planning, and evaluation) to analyze data from a research made data collection tool. CT is believed to be used by nurses during the nursing process (Jones & Brown, 1991), but in addition to cognitive skill, possessing certain dispositional traits predisposes one to use CT (Facione, 1990; Scheffer & Rubenfeld, 2000).

Scale selection as indication of epistemological position. Though nursing studies may lack specific CT frameworks, underlying assumptions about CT may be revealed in instrument selection. A number of scales have been commonly used in CT research though measurement has posed a challenge for empirical studies related to CT because the construct lacks clarity. Two general (non-nursing) cognitive skill CT scales (Watson-Glaser Critical Thinking Appraisal (WGCTA) and the California Critical Thinking Skills Test (CCTST) have been used extensively in nursing CT research. Both are reliable and valid (CCTST: Cronbach's alpha .66 and .67 in two samples (n = 1196) (Facione & Facione, 1994); WGCTA: split-half reliability .80 (n = 169) (Watson & Glaser, 1980 as cited in Bondy, Koenigseder, Ishee, & Williams, 2001), and derive from similar definitions for CT.

The CCTST is a general 34-item 45 minute multiple choice scale which obtains construct validity from the APA Delphi report findings. Five subscales measure analysis, evaluation, inference, and inductive and deductive reasoning (California Academic Press, 2009). Though the APA Delphi Report (Facione, 1990) found CT to be cognitive and affective, the CCTST assesses only cognitive skills. A separate scale, the California Critical Thinking Dispositions Inventory (CCTDI) measures affective skills related to willingness to think (California Academic Press, 2009).

Psychometric analysis of the CCTST suggests the scale does not measure individual performance or have stability reliability (test-retest) in nursing (Bondy et al., 2001; Leppa, 1997). In addition, the analysis subscale did not conform during factor analysis suggesting lack of construct validity with the Delphi Report and the need for further scale refinement or blueprinting (Bondy et al.). Furthermore, reliability in a nursing population is questionable as previous studies with nurses have shown reliabilities on the total scale of $\alpha = .68$, but ranging from .19 to .51on subscales (Bondy et al., 2001; Leppa, 1997) with the lowest values for the analysis scale ($\alpha = .21$ and .19, respectively). Students taking the test also complained about vocabulary and wording which may affect results when using the CCTST for pre/post test design (Bondy et al.; Leppa).

The general 80-item 40 minute WGCTA is based on a slightly different set of attributes than the CCTST with five subdomains: Inference, deduction, interpretation, recognition of assumptions, and evaluation of arguments, though there is domain overlap in inference, deduction, and evaluation (Facione, 1990; Pearson, 2009). One subscale, 'recognition of assumptions' did not correlate with the CCTST on any measure ($\alpha = .01$ - .17, $p > .05$) though inference ($\alpha = .36$, $p < .001$), deduction ($\alpha = .22$, $p < .05$), and evaluation did correlated with the WGCTA on these measures suggesting congruence of domain ($\alpha = .22$, $p < .05$) (Bondy et al., 2001). Despite reported reliability of the WGCTA scale, there are concerns about contributions of successful guessing (Wagner & Harvey, 2006). While a moderate correlation between the CCTST and WGCTA scores indicate concurrent validity ($\alpha = .43$, $p < .001$), further analysis found shared variance of 18% between the two scales, supporting a contrary opinion (Bondy et al.). Bondy et al. suggested that the WGCTA is not an "ideal instrument" (p. 322).

Results from studies using the WGCTA and CCTST are mixed. Adams (1999) in a literature review reported 19 studies which used the WGCTA between 1977 and 1992 noting that nine reported a significant increase in CT and six no change. In literature reviews Walsh & Seldomridge (2006) and Worrell & Profetto-McGrath (2007) reported inconsistent results with the CCTST and WGCTA, concluding that further research is needed. Some researchers question appropriateness of general CT scales for healthcare disciplines citing lack of epistemological relevance, short time frames under which CT is measured, or suggesting CT can neither be taught or measured (Daly, 2001; Martin, 2002; Renaud & Murray, 2008; Riddell, 2007; Staib, 2003; Zygmont & Schaefer, 2006).

A nursing specific instrument, the Performance Based Development System (PBDS) measures clinical CT performance (del Bueno, 1990). The company website, Performance Management Systems, Incorporated (Performance Management Systems, Incorporated (PMS), 2007) states over 500 hospitals subscribe to the service. Two studies used PBDS measurement systems to evaluate CT (Fero et al., 2009; Johannsson & Wertenberger, 1996). PBDS is a number of semi-customized videos about patient situations, viewed by a nurse, who answers 4-5 questions assessing four areas: clinical decision-making, priority setting, problem solving, and care planning (PMS, Johannsson & Wertenberger). Testing occurs over 4-6 hours and responses are written and evaluated by the company (PMS). The instrument author states that expert nurses established content validity (del Bueno, 1990). Johansson & Wertenberger concluded PBDS may not accurately measure CT as scoring is marked 'acceptable' for weak rationales.

The Ennis-Weir Critical Thinking Essay and the Cornell Critical Thinking Test Level X (71 items) are general CT tests which also have been used to measure CT, taking 40 and 50 minutes, respectively which have acceptable reported reliability (.82 and .86 interrater; .67-.90) (Brunt, 2005b). While both scales measure more than one aspect of cognitive CT (Ennis, 1993) and have been used in CT research, neither assesses dispositional aspects of CT. In particular, the Ennis-Weir Essay is better constructed for formulating and evaluating arguments, and can be used as a teaching tool (Ennis, 1993). The Cornell CT Test has not been used in nursing research (Brunt, 2005b). Usefulness of these tools in the healthcare or nursing population, therefore, may be limited.

CT as an affective skill. The CCTDI scale, also based on the Delphi Report (Facione, 1990), is a 75-item 20 minute Likert scale which measures affective CT traits (Cronbach's alpha .90-.91, n = 1019) (Facione, Facione, & Sanchez, 1994). The CCTDI has seven subscales which describe aspects of disposition to use CT: Truth-seeking, open-mindedness, analyticity, systematicity, CT self-confidence, inquisitiveness, and maturity of judgment (California Academic Press, 2009). The CCTDI exhibited high reliabilities during construction which was corroborated in further research (Bondy et al., 2001). In addition, the instrument correlates well with its companion CCTST (α = .66 and .67) (Facione, Facione, & Sanchez, 1994). Walsh, Seldomridge, & Badros (2007) conducted a principal components factor analysis which reduced the instrument from 7 to 4 factors, and improved variance from 27% to 44.95% when items were reduced from 75 to 25, indicating need for further research. Bondy et al. (2001) concluded the CCTDI sufficiently reliable for nursing, but more evidence for validity and meaning of scores is needed.

Caring is rarely mentioned as a dispositional trait for CT, perhaps because general CT measurement scales were developed with general student populations. In a qualitative study of 13 physical education trainees Daniel (2001) found that in addition to higher order thinking skills, caring was a characteristic of CT. Nine baccalaureate in nursing (BSN) students participating in a qualitative study also said caring was an important aspect of CT as a characteristic which encourages expenditure of intellectual energy to solve patient problems (Walsh & Minick, 2009). In addition, corollaries of emotion and self-awareness may be theoretically related to cognition and CT (Kahneman, 2003; Laucken, 1995)

Affective dispositional traits determine internal motivation to apply intellectual energy to solve a problem and make a decision using CT (Facione, et al., 2000). Changes in any one or more CT trait could affect CT behavioral outcomes.

Nurse researchers have used other instruments (concept maps, care plans, case studies, exams) (Angel et al., 2000; Chau et al., 2001; Forneris & Peden-McAlpine, 2007; Hsu & Hsieh, 2005; Jones, 2008; Maskey, 2008; Schoening et al., 2006; Wilgis & McConnell, 2008) or developed new tools for CT measurement (Cirocco, 2007; Martin, 2002; Radhakrishnan, Roche, & Cunningham, 2007; Schoening, et al., 2006). Validity, reliability, and psychometrics are rarely addressed for these instruments, which coupled with small sample sizes, introduce questions of study validity and generalizability.

Mixed method studies, those with both qualitative and quantitative analysis of the same variables, can be useful to completely investigate or understand dimensions of a phenomenon (Speziale & Carpenter, 2007). Lasater (2007) used a qualitative-quantitative-qualitative approach to refine a student assessment rubric during clinical simulation. The initial qualitative approach was observational to identify best and worst behaviors, followed by a quantitative analysis of a scoring rubric scale with behavioral descriptors refined from the qualitative study. At the end of the study qualitative analysis of data from a focus group identified themes about simulation (Lasater). Triangulation enabled the researchers to focus on attributes of clinical judgment and articulate its relationship with CT.

Summary

Though many nursing studies use the APA Delphi (Facione, 1990), or the nursing specific Scheffer & Rubenfeld (2000) definitions, no framework exists which completely unites cognitive skill, dispositional traits, and clinical aspects such as problem solving, decision-making, or judgment. Furthermore, factors which affect measurement of CT are not fully understood, because CT as a concept still lacks clarity. However cognitive skill, affective disposition, psychomotor skill, caring, knowledge, education, decision making style, learning style, context and experience have been explored as factors affecting CT behavior.

Clinical Decision Making

The literature has acknowledged complexity in the term 'critical thinking' by identifying two phases: a diagnostic phase of data collection and processing (CT), and a management phase of treatment options and interventions (CDM and CJ) (Edwards, 2007; Salantera, Eriksson, Junnola, Salminen, & Lauri, 2003). Clinical decisions are high-stakes judgments about health conditions made with significant consequences for patients and practitioners. The outcome (decision) has been considered part of the CDM process (Thompson, 1999), but more accurately describes an outcome event. CDM has been called a proxy term for CT (Turner, 2005), but even when identified as a separate process, CDM has been described as clinical reasoning, diagnostic reasoning, clinical judgment, and clinical inference (Thompson).

Theoretical models which explain clinical CDM have used decision-making theory from psychology, primarily information processing based on hypothetico-deductive reasoning, and intuitive decision making (Banning, 2006; Benner, Tanner, & Chesla, 1996; Croskerry, 2009; Lauri & Salantera, 2002; Thompson, 1999). Several other theories have also been proposed, including a hybrid models which join intuitive and hypothetico-deductive reasoning (O'Neill, Dluhy, & Chin, 2004), Bayesian decision making theory (Elstein & Schwarz, 2002), and pattern recognition (Elstein & Schwarz).

Non-Analytic Intuitive Heuristic Forms of Clinical Decision Making

Heuristics are thoughts which come to mind with little reflection or analysis (Kahneman, 2003) and are intuitive in nature, being not logically defensible or consciously made (Lauri & Salantera, 2002). In CDM literature prototype pattern recognition is described as a heuristic form of reasoning (Buckingham & Adams, 2000; Elstein & Schwarz, 2002). The view that prototype pattern recognition is part of CDM may be predicated on problem identification as the initial step of CDM (Bandman & Bandman, 1998). Kahneman (2003) suggested intuitive judgment occupies a position between perceptual categorization and 'deliberate operations of reasoning' (p. 697) which proposes pattern recognition as a diagnostic (CT) and judgment (CDM) heuristic.

In novices, intuitive decisions are rule based (if chest pain, then check for left arm pain), but with experience, available cues are unconsciously examined and correlated with known relevant cues which highly associate with specific outcomes, by-passing the enabling rule by means of direct neuronal connections, which renders highly accurate decisions (Benner, 1984; Buckingham & Adams, 2002; Dieckmann & Rieskamp, 2007). When heuristics are used by novices, decisions are less accurate than those made by experts (Croskerry, 2009; Kahneman & Tversky, 1996).

Norman, Young, & Brooks (2007) conducted a study of medical residents, general practitioners, and medical specialists' non-analytic decision-making (n = not reported). Novice and expert practitioners used non-analytic decision-making which was subject to 'representativeness' bias, that is, previous examples influenced decision-making, but experts gathered more salient data for decision-making (Norman et al., 2007). The authors concluded that experience improved non-analytic decision-making (Norman et al.,).

West, Toplak, & Stanovich (2008) found, in a study of 793 undergraduate students, that CT ability correlated with ability to avoid bias ($p < .001$). The authors concluded that declarative knowledge and CT skill were necessary to do well in heuristic decision-making, but the ability to mitigate use of heuristics in favor of analytics depended on cognitive ability and ability to reflect (West et al., 2008).

A phenomenological study of nursing students' perceptions of decision-making ($N = 21$) (Garrett, 2005) found that students focused on the consequences of the decision and on the value of clinical experience rather than the process of CDM. Students believed knowledge and experience associated with CT rather than cognitive ability (Garrett). While students described CDM as patient focused, concerns about quality of patient care and effects of clinical decisions on personal circumstance were also elicited (Garrett).

Hoffman, Aitken, & Duffield (2009) conducted a descriptive study of novice and expert intensive care nurses' cue retrieval during CDM using thinking aloud (TA) and verbal protocol analysis. Hoffman et al. (2009) examined number and clustering of cues of novice ($n = 4$) and expert ($n = 4$) intensive care nurses during post-operative care of patients with abdominal aortic aneurysm repair.

CDM was classified as proactive (actions to prevent a problem) or reactive (actions to repair a problem). Expert nurses collected more cues than novices when caring for patients (89 vs. 49 in 2 hours) and collected more proactive cues (81%) than reactive cues (55%) (Hoffman et al., 2009). Expert nurses clustered more cues together than novices, while novices used a linear pattern of thinking when CDM. Hoffman et al. noted that while focusing on too few cues can affect CDM, so can focusing on the wrong cues. While 'wrong cues' were not investigated, the statement suggests that expert nurses are more adept at identifying salient cues for CDM than novices.

Intuitive decision making is experiential and context bound which increases likelihood of bias errors (Croskerry, 2009). Intuitive decision making is more effective when typical cues are presented, versus atypical, and is more emotionally driven than analytic decision-making (Croskerry). An advantage to heuristics is decision speed, but when a solution is not recognized, or the situation ambiguous, analytic decision making, though consuming more time, is used (Croskerry).

Analytic Decision-Making

While intuitive decision-making is effortless, analytic decision-making is deliberate and effortful (Kahneman, 2003). Pattern recognition and template matching heuristics are relied upon for rapid solutions when diagnostic problems are 'easy', but when 'difficult', conscious analytic decision-making is used (Elstein & Schwarz, 2002; Kahneman & Tversky, 1996). Analytic decision making may serve as a check for heuristic decision-making (Kahneman & Tversky).

Hypothetico-deductive decision-making. In hypothetico-deductive decision-making relevant data are collected to generate hypothetical solutions (Elstein & Schwarz, 2002). Data are further gathered to test hypotheses to determine an optimum solution; however, the best solution may not be included in the initial set of hypotheses, requiring re-evaluation/re-collection of data and reformulation of hypotheses (Elstein & Schwarz, 2002; Vertue & Haig, 2008).

A study of 27 pediatric nurses examined nurses' decision-making about patient scenarios using 'thinking aloud' technique (Twycross & Powls, 2006). Results showed that nurses used hypothetico-deductive decision-making, but that experts nurses used forward reasoning (select a solution and collect data to prove or disprove) while novices used backward reasoning (attempt to gather all data possible before making a decision) (Twycross & Powls, 2005). Riley (2003) critically examined an experienced nurse's decision-making to remove a patient's chest tube after heart surgery. Hypothetico-deductive reasoning was used, but results were determined not be replicable, leading the author to suggest other CDM skills augmented decision-making, such as intuition (Riley). While no single CDM theory supported the complex decision to remove the chest tube, greatest utility in CDM was achieved through discussion among peers (Riley).

Redden & Wotten (2001) examined critical care and gastrointestinal (GI) surgical nurses' decision-making (n = 10) using three patient scenarios and semi-structured interviews. GI nurses used hypothetico-deductive reasoning to recognize problem cues, but could not name the problem (Redden & Wotten, 2001). Critical care nurses used both hypothetico-deductive reasoning and pattern recognition to identify critical cues and accurately identify the problem (Redden & Wotten). Analysis showed that groups were significantly different (p value not reported) in average years of experience (GI nurse 6 years, critical care nurse 15 years) and average specialty years (4.4 years, 6.7 years, respectively, (Redden & Wotten) which limits generalizability of the study. However, the authors suggested differences in knowledge, specifically pathophysiology, and modes of cognition between the specialty areas could explain study results (Redden & Wooten).

Vertue & Haig (2008) state hypothetico-deductive reasoning is analytically weak because it relies on a large amount of prior knowledge to generate hypotheses. In addition, hypothetico-deductive reasoning is a linear descriptive model which explains how decisions are made, not how decisions should be made (Thompson, 1999).

Bayesian decision-making. In clinical situations it is rarely feasible to have complete information at the time a decision must be made. When consequential decisions are based on partial data, solutions are not fixed, and when the optimal answer is contextual (the best decision for this time and place) Bayesian decision-making yields the most good and the least harm (Elstein & Schwarz, 2002; Kadane, 2005). Bayesian-decision making is also effective when atypical exemplars are encountered (Fletcher & Fox, 2006).

Bayesian decisions are based on beliefs about hypotheses supported by existing information about likelihood of events (e.g. MI) as estimated probabilities (Elstein & Schwarz, 2002; Eva, 2004; Harbison, 2005; Kruschke, 2008; Thompson, 1999). The valuation of cues (pieces of information) (Dieckmann & Rieskamp, 2007) is dynamic and constantly re-evaluated in the presence of new information, which in turn alters probability estimates on a sliding scale (Harbison, 2006; Kruschke, 2008). The Bayesian viewpoint takes into account multiple decision makers who rule-in or rule-out hypotheses based on available data, where the best decision has the highest likelihood of agreement with other decision makers, even when the situation is not ideal (Kadane, 2005;

Kruschke, 2008). Learning Bayesian-decision making is enhanced with full feedback (Maddox, et al., 2008).

Dual Process Decision Making

Evans (2006) proposed that decision making is not cognitively competitive between systems, but that heuristic and analytic decision making systems can cooperatively exchange information (Bonner & Newell, 2010) to attain an optimal decision. When heuristic and analytic systems are in conflict (providing two different decisions) a dual process mechanism works cooperatively for decision making. Heuristic representations are submitted to analytic processes to form a final judgment (Evans, 2006). Bias may affect dual process decision making as with other forms of decision making (Evans).

In a series of studies conducted with 51 undergraduate students (experiment 1) and 100 graduate students (experiment 2) problems were given which would cause harmonious or conflicted decisions between the decision making systems (heuristic or analytic). Time to decision indicated the length of time for cognitive processes to occur, longer times associating with processing in both systems occurring. Experiment 2 also included a subtask to increase the working memory load, which was hypothesized to increase time needed for analysis.

In experiment 1 harmony trials the correlation between nonoptimal response (errors) and time was not significant ($r = -.040$, $p > .01$) (Bonner & Newell, 2010). In experiment 2 nonoptimal response negatively correlated with response time ($r = -.272$, $p = .006$). The authors concluded that conflict occurs when heuristic and analytic systems decisions are not congruent (Bonner & Newell, 2010) though further research is needed to understand if processing is serial or parallel.

Multi-Method Decision-Making

Selected strategies for CDM depend on the cognitive task (Dieckmann & Rieskamp, 2007). However, a review of decision-making literature in nursing (Lee et al., 2006) concluded nursing CDM could not be explained by a single theory. Knowledge, experience, discipline specific training (e.g. diagnostic labels), complexity of diagnostic task and contextual cues, and psychosocial-cultural factors such as role, attitude, mood, and relationships affect decision-making (Lee). The authors concluded that CDM is analytic and rational, but also intuitive, and critiqued simulation studies as not sufficiently realistic to induce authentic psychosocial interactions and cognitive thinking (Lee). The authors also suggested that greater emphasis be placed on other aspects of CDM than reasoning (Lee).

Lauri & Salantera (2002) developed a nursing decision making instrument which was tested with an international sample of nurses (n = 1460). Results showed that nurses used both intuitive and analytic decision making which varied within and among different fields of nursing (Lauri & Salantera). Bucknall (2003) conducted qualitative interviews of 18 critical care nurses to investigate environmental influences on clinical decision making. Findings indicated that decisions were greatly influenced by the context in which they were made which included patient situations, resource availability, and personal relationships (Bucknall, 2003). Bucknall found that social interactions among clinicians affected decision-making both positively and negatively.

In two experiments researchers gave three groups of non-medical undergraduate students (n = 108) EKG rhythms for diagnostic interpretation. One group was instructed to search for EKG patterns but given a false cue as bias, another group was given instructions to use analytical and non-analytical reasoning, and the third was given no specific instruction (Eva et al., 2007). The group given instructions for multiple decision making strategies reported greatest diagnostic accuracy ($F(1,56) = 9.06$, $p < 0.01$) (Eva, et al., 2007). Researchers concluded students who were taught decision-making strategies made more accurate decisions (Eva et al., 2007).

Bias

As in intuitive and hypothetico-deductive reasoning, Bayesian decisions can be affected by cognitive biases such as availability (how easily a choice comes to mind – usually recent experience), representativeness (over estimating likelihood), anchoring (fixation on a solution without due consideration of competing hypotheses), and order effects (the order in which information is presented affects decisions made) (Elstein & Schwarz, 2002). Bias interferes with reason leading to illogical conclusions (Eva et al., 2007).

Summary

CDM is a reasoning process for selecting solutions among alternatives (Lee et al., 2006; Thompson, 1999). Heuristics provide short-cuts in thinking and can be highly accurate, but are experience based (Eva, 2004; Kahneman, 2003; Norman et al., 2007). Experienced decision-makers do not choose consciously among options because only a single choice comes to mind (Kahneman). Alternatives not selected are not cognitively represented and the decision is not doubted (Kahneman). Heuristic thought processes are represented and the decision is not doubted (Kahneman). Heuristic thought processes are unconscious (Eva, 2004), and therefore intuitive, which may be less valued in CDM as evidenced by teacher statements such as 'be objective' and 'examine evidence', though persistence of heuristic decision-making speaks to positive adaptation in rapid decision-making (Croskerry, 2009; Eva, 2004; Eva et al., 2007).

Analytic decision making is conscious, deliberate, and subject to doubt because incompatible thoughts can occur about the same subject during metacognitive and multilogical thinking (Eva, 2004; Kahneman, 2003; Paul, 1995). Though hypothetico-deductive and Bayesian decision making theoretically explain how rational decisions are made, clinical practitioners make decisions based on task complexity, clinical experience, and may rely on more than one decision making strategy (Carraccio, Benson, Nixon, & Derstine, 2008; Lauri & Salantera, 2002; Lee et al., 2006; Thompson, 1999).

Clinical Judgment

Clinical judgments are situation specific outcomes for patient problems (Lasater 2007; Tanner, 2006). Analytic and non-analytic processes culminate in CJ, however intuitive CJ is a decision to act based on sudden awareness and understanding of a situation as a whole, though the process leading to CJ is difficult to articulate (O'Neill et al., 2004). Paul & Heaslip (1995) state skilled CJ is evidence of nursing expertise. Clinical practitioners use information to make CJs (Cioffi, Purcal, & Arundell, 2005) concluding the CDM process.

Studies reviewed examined CT as a problem solving process culminating in a decision or judgment. Baxter & Rideout (2006) conducted a qualitative study with baccalaureate in nursing (BSN) students (n = 12) to determine, in part, how students determine a clinical decision is needed. Findings showed students decisions were greatly influenced by patients who provided cues, both verbal and nonverbal, and alerted students how to determine the need for a decision (Baxter & Rideout).

Bowles (2000) examined the relationship between CT and clinical judgment in BSN students (n = 65) using the CCTST. Kuder-Richardson 20 (KR-20) for the instrument was reported at .68 and .70 (pre and post tests), which the authors reported acceptable. Nursing judgment was measured by the Clinical Decision Making in Nursing Scale (CDMNS) (Cronbach's alpha reported by the instrument author .83). Pearson correlation between the CCTST and CDMNS showed a weak positive relationship ($r = .21$, $p = < .05$) and regression analysis showed four per cent of the variance in the CCTST was explained by the CDMNS ($r^2 = .04$). The results suggest that CT has a significant, though small, effect on clinical judgment.

Summary

Weak decision-making and clinical judgments may associate with poor patient outcomes (Buckingham & Adams, 2000; Lee, et al., 2006; Muller-Staub, Needham, Odenbreit, Lavin, & van Achterberg, 2008). CT, CDM, and CJ skills are considered fundamental to nursing practice (American Association of Colleges of Nursing (AACN), 2008; American Nursing Association (ANA), 2009) and essential to competent nursing.

Educational Strategies to Improve CT

Pedagogic approaches to CT have mixed and inconsistent results. Researchers postulate lack of a consensus definition for CT, inadequate measurement tools, unprepared faculty, and intrinsic difficulty in teaching and learning CT as contributing factors (Riddell, 2007; Staib, 2003; Worrell & Profetto-McGrath, 2007; Zygmont &

Schaeffer, 2006). Strategies such as case studies and problem-based learning, reflective logs (journaling), experiential learning, concept maps and nursing care plans, video vignettes, group dynamics, Socratic questioning, role playing, and simulation have been used to teach CT. Despite some successes, no single strategy has produced consistent gains in CT ability.

Case Studies and Problem Based Learning

Case studies have been used extensively in nursing education as an effective means to unite theory with practice (Palmer et al., 2008; Speziale & Jacobsen, 2003). Narratives present a clinical problem to be solved by either individuals or groups (Sandstrom, 2006; Yuan, Williams, & Fan, 2008). Focused questions within the case study, or provided by the instructor, guide learners to critically think by engaging and encouraging multilogical thinking (Palmer et al., 2008; Sandstrom, 2006). For problem based learning (PBL) a student–centered approach during group discussion guides CT (Yuan et al., 2008).

In a literature review examining teaching strategies for CT in nursing, Staib (2003) found few research studies. Among 17 articles, two discussed using the case study method by presenting discussion and examples case studies used to enhance CT. Mottola & Murphy (2001) was not a study, but discussed a CT theory based learning activity called the 'Antidote Dilemma'. Incorporating Paul's principles of CT, which include principles of identifying and removing bias, avoiding prejudice and one-sided thought, and the art of self-directed, in-depth rational learning, the learners were given a problem of the management of a clinical problem (Mottola & Murphy, 2001). The authors suggested educators could listen for evidence of CT, or develop a Likert scale for measurement. Study authors concluded, based upon their experience using the case study to teach CT to nurses, that CT was most likely to occur when supported by others and practiced (Mottola & Murphy, 2001).

Jones & Sheridan (1999) reported development of a case study to teach pediatric novice nurses CT. Educational outcomes based on works by King were guided by principles of audience (description of for whom case study is intended), behavior (observable actions and behaviors expected of the nurse), condition (the condition under which the behaviors are to be observed), and degree (level of achievement). A case study and learner questions guided the activity (Jones & Sheridan) Nurses were expected to use self-reflection to examine values, beliefs, and practices (Jones & Sheridan). The authors concluded that because nurses have limited clinical experience prior to graduation, case studies as part of a clinical orientation are effective for developing knowledge and CT (Jones & Sheridan).

Yuan et al. (2008) conducted a similar review (1990 – 2006) of studies examining the effectiveness of PBL to foster CT. Ten studies met the criteria: six descriptive, two quasi-experimental, one non-randomized control study, and one randomized control trial. Outcomes were measured by researcher made tools or the California Critical Thinking Skills Test (CCTST), a valid and reliable measure for general CT (Facione & Facione, 1994). Eight studies reported positive gains in CT ability, though one reported mixed results and another no improvement. In the largest study in this review (n = 228) Magnussen, Ishida, & Itano (2000) conducted a quasi experimental study of nursing students' CT as a result of a curriculum based on PBL by collecting data at program entry and exit. Data were collected with the valid and reliable general CT tool, the Watson

Glaser Critical Thinking Assessment (WGCTA) (Cronbach's alpha 0.69 to 0.85) (Magnusson, Ishida, & Itano, 2000). There was no statistical difference pre and post program in nursing student CT ability. However, when the results were stratified, significant changes were found in high and low scorers. High pretest CT scorers had lower post test scores, while low pretest CT scorers showed gains in CT ability. A number of factors may have contributed to the result, including lack of effort by high achievers for an exam which carried no credit (Magnusson et al., 2000). The researchers also suggested greatest gains in CT perhaps occur for low scoring critical thinkers (Magnussen et al., 2000). The researchers noted that Flannelly & Inouye (1998), in a similar study of inquiry-based learning, also reported similar findings for low WGCTA scorers. However, Yuan et al. (2008) concluded a lack of evidence supported PBL to teach CT.

In a randomized control study, Jones (2008) examined the effect of PBL among 60 second year associate degree nursing students using nursing care plans, reflective journals, and observed clinical communication interactions among student, patients, and staff. Half (n= 30) received PBL instruction beginning in the third week of clinical experiences until the end of the study. All students in the experimental group felt their CT ability was enhanced (Jones, 2008). One rater evaluated both groups, which may be a weakness of the study. In addition, there may have been mixed interventions as reflective journals and nursing care plans were used to evaluate CT, both of which can be used to teach CT.

Few studies specifically examine the effect of case study/PBL method on CT. Though results are inconsistent, there may be a positive association between use of case study/PBL method and CT development. Because these methods rely, in part, on validation of student thinking by the educator, variability of success is related to ability of the educator.

Reflective Logs (Journaling)

Reflection is the recall and review of clinical events in order to gain insight for CT (Sedlak, 1997). Students record thoughts about clinical experiences, recount emotions, and discuss skills in narrative form with the goal of gaining insight into thinking and clinical decisions (Ibarreta & McLeod, 2004; Sedlak, 1997).

In a qualitative study of beginning nursing students (n = 7) Sedlak (1997) reviewed journals written during a 12 week clinical experience, observed participants during clinical experiences, and conducted interviews, to describe the CT of nursing students. Verbal and written guidelines were given for journaling. Sedlak (1997) concluded beginning students did think critically. In an article Ibarreta & McLeod (2003) the experience of introducing weekly journaling during clinical experiences for second semester nursing students and its effect on CT ability were discussed. Guidelines and examples were given for journaling. The authors reported the concept of CT emerging from student evaluations of the experience, but students also felt that more direction and feedback to validate their CT would be helpful. In a Canadian clinical descriptive study (n = 34) (Cirocco, 2007), a researcher made tool was used to collect data on reflective practices and whether such practices influenced CT. Canadian nurses from Ontario are required to submit evidence of self-reflection and peer feedback on their nursing practice to renew licensure (Cirocco). A self-reflective tool is provided by the College of Nurses of Ontario (CNO). The CNO tool was used by 71% of the sample (n = 24). The remainder of the sample used other reflective practices (Cirocco). Frequency of reflective practices varied, with 56% reporting once per annum. Cirocco reported 32% of the sample felt strongly that reflective practices did not improve CT. Chi square analysis showed that frequency of self-reflection with any tool did not associate with CT, however the researcher postulated the small sample size may explain these results (Cirocco).

Articles about reflective logs report inconsistent CT outcomes. Lack of standard training for using self reflection logs, lack of standard measurement tools and baseline data, and paucity of research studies do not support reflective journaling as a means to teach CT, despite theoretical belief that recall and reflection strengthen CT skill (Lerch, Bilics, & Colley, 2006).

Experiential Learning

Clinical experience improves CT and development of CT skill (Benner, 1984) in a way which acontextual classroom learning can not (Forneris & Peden-McAlpine, 2007). One type of clinical experience is the preceptorship, where students are placed with experienced nurses, usually near the end of the nursing program, in order to achieve course and program outcomes (Myrick, 2002).

In a review of undergraduate preceptorship in nursing education literature, Udlis (2008) cited only one research study, an unpublished doctoral dissertation, which examined the relationship between preceptorship and CT using the WGTCA. Results indicated no difference in student CT ability ($n = 48$) resulting from the preceptor experience (Udlis, 2008). A quasi-experimental study (Sorenson & Yankech, 2008) examined 15 pairs of new graduate nurses and preceptors who were given a 3 hour course on facilitating CT with a control group ($n = 16$ pairs). No statistical differences were found between the groups except for one measure of the CCTST, evaluation ($p = .039$), which the researchers believed to be related to the intervention (Sorenson & Yankech). Myrick (2002) conducted a qualitative study to examine CT among six pairs of baccalaureate nursing (BSN) students during their supervised orientation with preceptors. Results indicated that preceptors indirectly, rather than purposefully, stimulated CT through role modeling and questioning. Results from this study suggest that increasing a preceptor's ability to question students regarding CT and CDM may improve student CT ability. In a small case study of six preceptor/new graduate nurse pairs, Forneris & Peden-McAlpine (2007) implemented a contextual learning intervention which incorporated several teaching modes: reflective journaling, interviews, coaching, and group discussion. Results showed new nurses intentionally employed reflection and used critical questioning. These results could be attributed to not only experiential learning, but perhaps the incorporation of additional CT teaching modalities (journaling, coaching, and discussion).

Few studies have investigated CT and clinical teaching. Angel et al. (2000) conducted a longitudinal quasi-experimental study of 142 junior nursing students assigning students to either structured ($n = 72$) or unstructured ($n = 70$) clinical health pattern assessments in a nursing course. Outcome measures of CT were conducted by a researcher made questionnaire and case study tool which was scored by the researcher with a predetermined rubric. None of the students showed improvement in CT. No other studies examining clinical teaching and CT outcomes were found.

Experiential learning through preceptorships may improve CT, though variables such as preceptor knowledge, clinical experience, level of education, CT training, and inconsistency of clinical experiences affect CT outcomes for students (Myrick, 2002; Sorenson & Yankech, 2008; Udlis, 2008). Studies examining the influence of nursing faculty on CT during clinical experiences were not found in the literature; however, barriers to effective CT outcomes with preceptors would most likely apply to clinical faculty as well.

Concept Maps and Nursing Care Planning

Concept maps are tools often used for clinical evaluation of nursing students. A concept map is graphic depiction of related concepts using node and stick diagrams to demonstrate a framework of propositions and conceptual relationships (All, Huycke, & Fisher, 2003; Hsu & Hsieh, 2005). Concept maps improve conceptual thinking, and thus, critical thinking (Hsu & Hsieh, 2005). Furthermore, concept maps can also be schematic depictions of nursing care plans (All et al., 2003).

Daley, Shaw, Balistrieri, Glasenapp, & Piacentine (1999) investigated the use of concept mapping to improve CT in senior BSN students ($n = 18$). Three concept maps were completed during clinical conferences, after one practice session. The concept maps were scored independently by two researchers using a predetermined rubric (interrater reliability = .82) Results showed statistically significant improvement between first and last concept maps ($p = .001$), which the authors stated was evidence of CT. Wilgis & McConnell (2008) investigated CT in graduate nurses ($n = 14$) during a two-day orientation using a pre/post test design. After instruction on concept mapping, participants were given case studies from which to draw concept maps at the beginning and end of the orientation. A standard instrument was used to score maps with established reliability when the same faculty who taught the course scored maps ($\alpha =$

.70). Results showed significant improvement in composite scores (p = .008). Two subscales (linkages and interventions) showed greatest improvement (no statistical data was performed). Hsu & Hsieh (2005) examined CT in 43 two-year program nursing students. After a training session, 7 teams of students created six concept maps over 16 weeks of course work. A standard scoring system showed improvement in total scores for all groups (no statistical correlations were performed). The authors state improvement in concept mapping scores is related to CT because acquiring knowledge during the mapping process requires CT (Hsu & Hsieh).

Preparing learners to use concept maps to improve CT is currently in use for students and nurses (All, et al., Ferrario, 2004; Taylor & Wros, 2007; Vacek, 2009). Thought concept mapping appears to positively affect CT by encouraging deeper thinking, lack of clear measurement tools specific to CT reduces certainty. Further research on the relationship of concept mapping to CT is warranted.

Video Vignettes

Chau et al. (2001) examined the effectiveness of eight researcher-made CT video vignettes of specific clinical situations using a pre-test/post-test design. The CCTST (KR-20 = .72, subscales .30-.61) and a researcher-made knowledge test were used to collect data from 83 first and second year BSN students. In addition, six interviews were conducted. CT guidelines were developed for each vignette for faculty to stimulate discussion. Results showed no improvement in CT scores, though knowledge increased in the first year group (Chau et al.). The researchers acknowledge student lack of exposure (4/13 classes) to video vignettes and the acontextual nature of the CCTST for nursing as possible reasons for findings (Chau et al). The researchers suggested replicating the study with a control group and longitudinal design to capture changes in CT.

Johansson & Wertenberger (1996) also used video vignettes in a pilot study to measure CT. Students were given a sample and ten short medical or surgical videos, which ranged in difficulty. Content validity was determined by expert nurses. Students were shown the videos in groups of 3-4 over a four hour span, first viewing six videos followed by a "What if?" exercise, and then the remaining videos. A 30-minute debriefing session was conducted eight weeks later. Four CT measures were collected with a Performance Based Development System (PBDS) tool, which included a component to measure CDM; this instrument had not been previously used with nursing students. The PBDS tool proved difficult to interpret; however, the researchers supported the effectiveness of video vignettes to teach CT (Johannsson and Wertenberger, 1996).

Video vignettes may be a form of experiential learning which enhances CT. However, research specifically examining the impact of video vignettes on CT is lacking.

Group Dynamics

In a quasi-experimental study Khosravani et al.(2005) investigated using group dynamics to improve CT with senior nursing student (n = 60). A researcher made 12-item questionnaire and report forms based on the nursing process were used. Content validity of the questionnaire was determined, and internal consistency reported at 99.95. Interrater reliability for the report forms was 0.88.

Experimental groups had eight to ten group dynamic session (1-1.5 hours) two days per week with two day intervals. A group leader facilitated discussions on concepts selected from family health by soliciting student views from different perspectives, examining roles of the community health nurse, and identifying appropriate solutions to problems. Results showed that mean clinical report scores were higher for students in the experimental group ($p = .0001$) indicating greater CT ability (Khosravani et al.). The authors indicate inquiry based learning and 'skillful practice' can improve nursing student CT, suggesting the attributes of experience and Socratic questioning may have contributed to findings. In addition, modeling of expert CT thought processes may also have affected results.

Socratic Questioning

Asking higher cognitive level questions with systematic questioning to draw conclusions and engage students in active learning is termed Socratic questioning (Oermann, 1997). Used in classroom and clinical settings in many practice disciplines, Socratic questioning is reported to be effective in promoting CT ability (Boswell, 2006; Loy, Gelula, & Vontver, 2004; Oermann, 1997).

Profetto-McGrath, Smith, Day, & Yonge (2004) conducted a study of nurse educators and students during context-based seminars to determine level of questioning employed by students and educators. Thirty nurse educators and 314 BSN students (years 1-3) participated in thirty 90 minute seminars which were audiotaped, transcribed and analyzed with the Questioning Framework (interrater reliability based on two transcripts: .92 and .94) (Profetto-McGrath et al., 2004). Results showed that the greatest percentage of questions from students and educators were primarily at the lowest cognitive levels (57.8% knowledge level). For all groups, except Year 1 educators, only 1% of questions were at higher cognitive levels of analysis, synthesis, and evaluation. Year 1 educators used 4.8% analysis questions. The authors concluded that given the relationship between the use of higher cognitive level questions and CT, limited use of high level questions could affect student CT development.

Loy, Gelula, & Vontver (2004), in a quasi-experimental study of 62 third year medical students, examined the effectiveness of workshop training to ask higher level questions on CT ability. CCTST scores were higher in the intervention group, with significant gains in inference and deductive reasoning ($p = .003$, $p = .001$, respectively) leading the investigators to conclude that teaching students with higher order questioning improves CT skills.

Barnum (2008) conducted a qualitative study regarding the use of 'strategic questioning' with 8 instructor and 24 student participants in an athletic training clinical teaching setting. During 39 days of study, instructors asked 712 questions of which 17.00 % were at the analytic cognitive level or above. The most successful strategy for improving CT was 'funneling', or asking strategic questions from low to high cognitive level assisting learners to process increasingly complex information in sequence to draw inferences and conclusions. Low level, or nonstrategic questioning, was termed 'grilling and drilling' by students (p. 288) and did not foster CT. Barnum (2008) suggested that funneling questions was potentially more important than asking high level cognitive questions alone.

Phillips & Duke (2001) examined the level of questioning used by nursing faculty and preceptors during clinical training. Three scenarios were provided to the participants ($n = 28$) who were asked to identify questions they would use for teaching. Results showed that nursing faculty, who had more experience and academic training, asked questions at a higher level than preceptors. However both groups asked a preponderance of low level questions (65. 1% faculty vs. 87.4% preceptors) (Phillips & Duke, 2001). Application level questions and above were considered higher cognitive questions as rated by Craig and Page's Question Classification Framework (Phillips & Duke, 2001). Though there were no associations made with student CT outcomes, the researchers believe that lack of questioning ability may limit student CT ability. Similar results were found by Sellappah, Hussey, Blackmore, & McMurray (1998) who also used Craig and Page's Conceptual Framework.

Socratic questioning, especially in the clinical area, may improve CT and CDM (Oermann, 1997; Velde, et al., 2006). However, the ability of nursing educators to provide such questioning, for reasons which remain unknown, is insufficient. The effect of educating educators in Socratic questioning may reveal the usefulness of this technique, but further questions regarding which questions types constitute high cognitive levels and the efficacy of funneling require further research.

Role Playing

During role play a student participant assumes the role of patient during patient-nurse interaction scenarios (Gates, Fitzwater, & Telintelo, 2001). Students find role play an effective means for evaluating critical thinking (Leung, Mok, & Wong, 2008) but few studies examine effectiveness of role play to teach critical thinking.

Van Eerden (2001) developed case study based CT role play scenarios for evaluation. Inquiry, critical analysis, and synthesis were identified as elements of CT to be evaluated by faculty. Further analysis for interrater reliability is being conducted. Students reported an advantage of role play was the ability to practice CT skills (Van Eerden).

An article by Johnson, Zerwic, & Theis (1999) discussed use of video-recorded role play and an audio role play with a 'physician' for nursing students (n = 51). A six-point Likert scale evaluated the activity. Students stated they were able to use CT (M = 5.47, SD = 0.94) when role playing.

Active learning and CT are closely tied (Youngblood & Beitz, 2001) which may belie the supposition of the effectiveness of role playing to teach CT. As with other multimodal strategies, role playing can include several CT teaching methods, such as case studies, within the activity.

Simulation

Simulation refers to high fidelity human patient simulation (HFPS) in realistic environments which replicate actual clinical settings and patient situations. Aside from high fidelity simulation with manikins, simulation also may include use of standardized patients (actors simulating altered health states) and virtual reality (Srinivasan, Hwang, West, & Yellowlees, 2006).

Ravert (2008) studied CT in BSN students using a pre/post test design with two experimental groups (HFPS, n = 12; non-HFPS, n = 13) and one control group (n = 15). Experimental groups followed the usual course of study plus five 1 hour enrichment sessions (HFPS = simulation; non-HFPS = discussion). The control group had the usual course of study. Simulation was not described. The CCTST measured CT outcomes at the beginning of the study and after the end of enrichment sessions. All groups improved in CT, but not statistically significantly.

Schoening et al. (2006) studied 60 second semester junior BSN student using a researcher made pre-term labor simulation scenario. Simulation occurred in four phases:

orientation, training, simulation, and debriefing. Students completed a 4-point Likert self-evaluation tool at the completion of simulation, which included a comment section and reflective journals. Results showed students self-rating of effective CT as 3.68 (1-4 scale, 4 strongly agree).

Rush et al. (2008) conducted a study using HFPS with RN-BSN distance learners (n = 33) by recording a faculty enacted scenario which was delivered via two formats: television broadcast of video with questions recorded into the scenario, and a DVD recording of the same, with questions, for individual online use. Students viewed the television scenario as a group and were able to stop action during questions to work out solutions. On line viewers worked individually, submitted answers to questions on line, and were provided collated feedback by the instructor a week later. Both groups' debriefing sessions were recorded and transcribed for analysis using Scheffer & Rubenfeld's (2000) framework for CT in nursing. Results showed that using simulation fostered critical thinking habits and skills (Rush et al., 2008).

Other articles which include simulation do not directly measure CT but discuss acquisition of CT skill as a consequence of simulation (Bearnson & Wiker, 2005; Hawkins, Todd, & Manz, 2008; Palmer et al., 2008; Rhodes & Curran, 2005). Until 2001, no studies examined simulation with nursing students (Ravert, 2008). The benefit of simulation on CT may be the use of multiple CT teaching modes in one format: the case study, Socratic questioning, problem based learning, and video vignettes can all be included in simulation. However, most current articles and studies omit detailed descriptions of scenario construction and application. Variables such as numbers and roles of students, scenario design, scenario fidelity, and reliability, and the role of the educator during scenarios are often not discussed.

Educational Strategies to Improve CDM and CJ

Clear distinctions between terminology such as CT, CDM, and CJ currently do not exist, though there is a sense that they represent separate constructs (Fowler, 1997; McDonald, 2002; Tanner, 2005). The following review examines teaching strategies for CDM and/or CJ as defined by the researcher.

Experiential Learning

Baxter & Rideout (2006) used purposeful sampling to study 12 BSN students' clinical decisions during a 7 hour clinical rotation over 12 weeks. Data were collected using journals and unstructured (students) and semi structured (two faculty) interviews. Results showed that allowing students to seek help when making a decision enhanced practice of CDM skills (Baxter & Rideout).

Kautz et al. (2005) examined methods to improve student CDM through a structured learning program during nursing student clinical rotations. The Outcome Present State Test (OPT) model of clinical reasoning and self-regulated learning (SRL) were used to develop student metacognition, self regulation and self monitoring during clinical experiences. Data were collected from an OPT work sheet and Clinical Reasoning Web which were completed weekly; students were given faculty feedback ($n = 23$). The Clinical Reasoning Web (CRW) has similarities to concept mapping. Two faculty raters evaluated the CRW. Results showed significant improvements in CDM ($p = .007$) (Kautz et al.). Kautz et al. concluded that the use of both models enhanced development of cognitive skills.

Experiential learning in the form of clinical practice may or may not be associated with improved CDM or CJ. Though CDM may be enhanced through practice, barriers related to student fear when asking for help with CDM may be a barrier. Studies with larger samples are needed before results can be generalized.

Simulation and Role Playing

Several studies examine use of HPS to teach CDM and CJ. Feingold, Calaluce, & Kallen (2004) conducted a study using simulation which measured CDM in 65 BSN students. Detailed adult care scenarios that included patient report, lab data, physician orders and monitoring parameters were provided during simulations which were conducted twice a semester (at the beginning and end). Data were obtained by scoring an observational checklist (researcher rated) and satisfaction survey. Most students (87.7%) reported simulation as an adequate test for CDM skills.

Cioffi et al. (2005) conducted a study of 36 midwifery students using two simulation scenarios. Simulation was described as a 'miniaturized sphere of reality' and but more closely resembled role play. The study examined the speed at which students reached clinical decisions. Data collected by verbal protocol showed students using simulations reached assessment decisions more quickly than those who did not, collected more clinical data, reported fewer inferences, and had higher confidence (Cioffi et al.). In this study ability to make best clinical decisions was not measured, though the authors state that simulation provides an experiential strategy to teach decision making.

Summary

Research in the area of CT, CDM, and CJ is limited by lack of consensus definitions and models explaining relationships between major constructs and concepts.

A situation exists where a number of researcher-made instruments, with little reported psychometrics, are being used to measure elements of CT. Furthermore, tools are based on diverse theoretical or conceptual models which may, or may not, be adaptable to differing situations. However, the literature reports numerous studies investigating all aspects of CT, CDM, and CJ in the practice disciplines, including measuring student and clinician ability to think, whether programs of learning can affect its development, and if any relationships between CT, CDM, and CJ exist (Adams, et al., 1999; Daly, 2001; Etheridge, 2007; Giddens, & Gloeckner, 2005; Martin, 2002).

Fewer studies report application of pedagogy to improve competence in these areas. Though competence in CT, CDM, and CJ is an expected nursing attribute, lack of targeted research regarding effective educational strategies may be an outcome of construct complexity and need for a unifying conceptual framework.

CHAPTER III

Methodology

This chapter presents the research study methodology including design, selection of sample, protection of subjects, research method, measures, and instruments. The plan for data analysis is discussed.

Overview

A research study was conducted to examine effects of an educational intervention using high fidelity patient simulation (HFPS) scenarios designed to enhance critical thinking (CT) and clinical reasoning through pattern recognition of myocardial infarction (MI) symptom cues in a sample population of baccalaureate in nursing (BSN) students. A three group study design of two control groups (with and without HFPS) and an intervention group (with simulation) was used. Dependent variables measured were pattern recognition in MI, CT in MI, clinical decision-making (CDM), clinical judgment (CJ), and time to diagnosis. Students provided qualitative data by explaining their clinical reasoning during video-taped interviews using 'thinking aloud' (TA) technique. The following chapter will discuss study methodology, instruments, and proposed data analysis.

Feasibility Study

A feasibility study was conducted with eligible junior BSN students (N = 12) in a large urban university in summer 2009 to test the intervention, examine measurement tools, and refine study methodology. Twenty-three eligible students were recruited from a large urban school of nursing for a proposed sample size of 12 (6 student pairs). Ten students (5 pairs) completed the study (43% attrition).

Students who stated a reason for not participating in the study indicated time constraints during studies as the greatest barrier. All participants were given a $10 gift card from Target store for participation. Students indicated that the gift card was an inadequate incentive ("What can I do with $10 at Target?"). Therefore, for the dissertation study, incentives for the gift card were increased, commensurate with time commitment for participation, to $20 Target gift cards for nonsimulation groups and $40 for simulation groups. In addition, students who participated in simulation received course credit for a senior practicum in the following semester. However, students said that an opportunity to participate in simulation was a greater incentive.

Students self-selected study groups. However, most students preferred a simulation group and did not select the nonsimulation control group. In the dissertation study, all students were given the opportunity to participate in study simulation, however no simulation or post-test data were collected from students in the nonsimulation control group. Students who self-selected a partner (friend pair) and group were more likely to participate and complete the study (4 out of 4 friend pairs completed compared to 1 out of 2 randomly assigned (stranger) pairs completed).

Alternative days and dates were given to meet with the researcher for informed consent and pre-test procedures. Two student pairs chose dates different from their partner to participate, which was a barrier for data collection, particularly 'thinking aloud' data where students discuss CT and clinical reasoning in pairs or groups. Two students provided single interviews. In the dissertation study students were encouraged to find friend partners and required to participate with their study partner.

Students were debriefed with audio-taped recordings which ran the length of simulations, about 15-30 minutes. Students varied in interest in reviewing recordings especially after viewing the first debriefing, usually appearing uninterested until the point a clinical problem developed. Some participants asked to forward the recording to the point where the clinical problem developed, or asked for the recording to be stopped as no more benefit could be obtained, sometimes as soon as 5 minutes into the second or third debriefing. In the dissertation study students were requested to view the entire first debriefing (15-30 minutes), then ask to select at least 5 – 10 minutes of the second and third debriefing recordings to view.

Qualitative data were collected with few problems owing to redundant recording systems for audio-visual data. Transcription and analysis of one student interview indicated questions were useful in understanding CT and clinical reasoning.

Instruments performed as expected except for a researcher made CT in MI tool and scoring for the decision-making scale. The CT in MI tool was developed to capture specific CT data in caring for patients with MI, however, after analysis and review, the customized CT tool developed through Elsevier, Review & Testing (HESI™) overlapped content area with the researcher made scale. The customized HESI™ exam was designed to capture CT in nursing, but contains items which measure CT and CT in MI. In addition, the researcher made tool had restricted range of data for several items, rendering statistical analysis difficult.

The Clinical Decision Making in Nursing Scale (CDNMS) appeared to perform well during the feasibility study, however, it was noted some items appeared negatively worded. Instructions published in the literature did not indicate any items should be reverse coded (Jenkins, 1983; 1985; 1988; 2003). Further investigation with a researcher who communicated directly with Dr. Jenkins for a dissertation study revealed that 18 of 40 items should be reverse coded (M. Baumberger-Henry, personal communication, September 29, 2009). When correct scoring was applied to the CDMNS pretest subscales reliability for the instrument increased from .645 to .815 in this sample (N=11).

Total time to complete study instruments (60 minutes) was less than anticipated by approximately 30 minutes in this sample. Total time for simulation was 3.5-4 hours, as anticipated, including orientation, scenario intervention, and post-testing. Using the stop watch for time to diagnosis appeared effective, except when the researcher neglected to stop time during one scenario. However, debriefing recordings display scenario time, which provided a second means for obtaining data.

Students stated that realism of the scenario environment is important to functioning in simulation, and further stated that scenarios presented had a high degree of realism. In addition, students noted that instructions during orientation to treat the situation as 'real' were helpful. However, in an effort to be cost effective supplies were re-used, leading to equipment failures, for example, the nitroglycerin (NTG) patch lost adhesion causing it to fall into the blankets where students could not see it. During the dissertation study orientation to the simulated environment included instructions to view the environment as 'real'. In addition, fresh supplies were used for each scenario as needed.

In all simulations participants assigned to the medication nurse role did not completely engage in medication tasks, including administering intravenous (IV) medication, monitoring IV therapy, and giving scheduled and as needed medications. Participants in the medication nurse role engaged in changes in the 'patient' condition with the primary nurse during scenarios. The dissertation scenarios were written so that each scenario had at least one medication which would need to be given, either scheduled or to treat symptoms such as pain or nausea.

It was found that two people could run the simulator and conduct the study effectively, though the researcher neglected to give participants the 'patient' chart once, and another time the scenario clock was not set to scenario time. Scenario templates included instructions for conducting each simulation, include setting the scenario clock time and providing the 'patient' chart.

Having many audio/video recordings made accurate identification of participants in scenarios difficult because visually each recording began with the same view of the simulated environment. Therefore, for the dissertation study, audio-visual recordings were identified by participant study numbers stated and/or shown at the beginning of each recording.

Students reported positive feelings about participating in the simulation portion of the study, "I think this should be given to every nursing program" and "This should be part of the training, no 'ifs', 'ands', or 'buts'. I feel like now I'm one step ahead of my classmates." Participation in simulation elicited strong feelings; however, no student appeared to be emotionally distressed when simulations were completed.

Study Design

A quasi-experimental pre-test/post-test design was conducted with a convenience sample of 27 student pairs (N = 54). Qualitative and quantitative data were obtained.

Sample and Setting

A convenience sample of 54 baccalaureate students from a large urban school of nursing who met inclusion criteria was recruited. Inclusion criteria were junior status in the first adult health clinical course in the nursing program, currently enrolled, and meeting school conditions for retention. Students who were taking the course for a second time were excluded. Junior level students were selected to control for clinical experiences which could contribute to pattern recognition which were not study related. Participant gender and minority status were considered when recruiting to obtain a sample representative of the setting and nursing. The study was located on two university campuses in computer and simulation labs.

Seventy-four students were to be invited to participate in anticipation of refusal or attrition (10-15% over target) (Burns & Grove, 2005). Effect size in CT studies has not been discussed in the literature; however, though sample sizes are small (usually less than 200), many have significant findings. Therefore, a power of 80% with a large effect size and significance set at .05 was used in this study (Cohen, 1992). Consult with a statistician, Dr. Frances McCarty, determined the study would be sufficiently powered as described with a total sample size of 66 participants (personal communication, August 28, 2009).

Protection of Human Subjects

Institutional review boards (IRBs) conducted expedited reviews for the study at both university institutions; amendments were filed for a change of protocol for the dissertation study. Informed consent (Appendix E) was obtained after explaining the study to potential study participants. Students understood after the consent process that student identities would be protected by identifying data with a code kept separately from the data, in a locked file cabinet. Students were also informed that because data were collected in pairs, information learned about another student during the study should be kept confidential. One of the study instruments was available only through internet access and required an e-mail account. Coded study e-mail accounts with no personal identifying information were created for each student to access the on-line pre- and post-tests.

Electronically recorded data from debriefing and 'Thinking Aloud' discussions were transferred to a password protected and firewalled computer hard drive. Until this was done, any recording equipment and data was locked in a file cabinet. Debriefing recordings made during simulation on a university owned computer video system were transferred to a portable ('flash') drive and transferred to a password protected and firewalled computer. Original debriefing recordings on the university owned computer (redundant system) were erased. Recordings on the portable drive, once data were transferred, were also erased. Data on the redundant video camera were transferred by firewire to a firewalled and password protected computer, as needed. All study recordings were erased from the video camera hard drive once needed files were transferred.

'Thinking aloud' discussion data were transcribed by a research assistant. Student recordings were identified by code only. Pseudonyms were assigned for each participant. Any hard copies of transcribed data were kept in a locked filing cabinet. Electronic copies were kept on a computer hard drive with password and firewall protection.

Research assistants completed the Collaborative Institutional Training Initiative (CITI) training, or equivalent, on protection of human subjects, confidentiality, and appropriate data storage. Research assistants do not have access to code book information. Audio/video electronic tapes will be destroyed one year after data analysis is performed. Any identifying information such as student names or hospital locations was removed from transcripts and any identifying information will be removed from any presentations or papers that result from the study.

Access to Participants

Junior baccalaureate nursing students from Georgia State University in the initial medical-surgical course of the program were approached for recruitment in this study by the researcher. Appropriate permissions were obtained from course administrators and faculty to allow the researcher to meet with students during a regularly scheduled class. Students were asked to identify friends who might like to participate in the study as a partner, and word of mouth was used to recruit other class members.

The purpose of the study was described to the students. It was explained that a study is being conducted about teaching nursing students to recognize symptoms of a heart attack and improve their ability critically think, make clinical decisions, and clinical judgments about patient care by using simulated patient care experiences in a laboratory setting. It was explained that some students would be asked to participate in simulations and some would not. Students were told they would work in pairs and could choose to participate with a friend from the class. Time needed to participate in the study was from 90 minutes to 5.5 hours over one or two days, depending on whether or not a student participated in the simulation portion of the study. Students were asked to provide personal demographic information such as age, race, gender, and grade point average. Students were informed they would be asked to provide information in the form of questionnaires and during audio/video taping about how they recognize symptoms of heart attacks, make clinical decisions, and make a clinical judgment. Students participating in simulations were also told they would be audio/videotaped as they participated in scenarios and audio/videotaped again as they discussed their decision making process after the simulation intervention. Confidentiality of student information was discussed.

Incentives were offered to participants to compensate for time and effort. Students participating in the non-simulation control group were given a $20 Target gift card. Students participating in simulation were given a $40 Target gift card, and, in addition, course credit towards the senior practicum which was approved by program faculty. All nursing students, including students not participating in the study, could earn senior practicum credit by participating in an approved activity. Participation in study simulation was an approved activity.

It was explained to potential participants that if they participated in simulation a nursing uniform, of a type normally worn for clinical experiences related to the nursing program, would need to be worn during the simulation to enhance realism. The simulation portion of the study was conducted at a state of the art simulation lab at an off campus location at Clayton State University in Morrow, Georgia, a distance of about 17 miles by car from Georgia State University. Any questions from the nursing students about the study were answered. After questions were answered blank 3 X 5 cards were given to all students. Any student interested in participating in the study placed their name and contact information on the card. Those uninterested in the study left the card blank. All cards were collected by the researcher. The researcher wrote personal contact information on the classroom board if students decided later to participate.

Sixty-six students completed index cards indicating interest in the study. The researcher met with the class, with faculty approval, two additional times, following the outlined procedure, to recruit students and encourage those who had indicated interest during the initial recruitment to follow-up with participation in the study. Two more students were recruited, totaling 68 students indicating interest in the study.

Informed Consent

The researcher requested volunteers for a study about learning symptoms of myocardial infarction, critical thinking, clinical decision-making, and clinical judgment using high fidelity simulation. The purpose of the study was described to the students. Risks and benefits were discussed, including the right to withdraw from the study at any time. Students were told they might benefit from practicing critical thinking, clinical decision-making, and clinical judgment in a safe setting. Students were told they would work in pairs to foster discussion. If a student indicated interest by completing the 3 X 5 inch index card, the researcher arranged a meeting by email or telephone.

No more risk than participants would expect in their daily lives was anticipated in this study. However, students could have been psychologically distressed by simulation of an emergency patient situation, though no simulated patient will 'die'. Students were debriefed after each scenario, which included discussion of feelings. If any participant remained distressed after debriefing, the researcher would remain with the student until the distress is resolved. If needed, the researcher would consult with the dissertation chair, Dr. Grindel. The student could have been referred to a counselor at Georgia State University, if appropriate.

Measures

The independent variable for this study is critical thinking on MI. Dependent variables are symptom pattern recognition CT, CDM, CJ, diagnostic accuracy, and time to diagnosis. Decision-making data was also be collected by qualitative methods.

Instruments

Quantitative measures for the study measured pattern recognition in MI, CT in MI, CDM, CJ, diagnostic accuracy, and time to diagnosis. The following scales and measurements were used.

Symptom pattern recognition: Welk Pattern Recognition Tool. Developed by Welk (2002), the Welk Pattern Recognition Tool (WPRT) (Appendix F) was designed to measure nursing student MI symptom pattern recognition. The author established content validity using simple frequency count for signs and symptoms of MI in five medical and nursing texts (Welk, 2002). Welk (2002) determined five essential symptoms (distinctive cues) indicate MI (symptoms which were identified by all five texts), and 14 nonessential symptoms are associated with MI, (symptoms not found in every text). Presence of nonessential cues indicates the possibility of MI (also termed 'common cues') (Welk, 2002). However, the more non-essential cues present the greater likelihood of the diagnosis of MI (Welk, 2002).

The WPRT is a 19 item scale that takes about 20 minutes to complete (Welk, 2002). Cronbach's alpha was reported at .78 in a sample of sophomore nursing students (n = 160) from five BSN programs. Scoring is mathematical correct/total with no passing score (D. Sugg Welk, personal communication, March 7, 2008). Scoring can be reported as a percent score and used for statistical analysis. In addition, row totals were observed to analyze accuracy of symptom identification (F. McCarty, personal communication, August 28, 2009). The tool is used with permission (Appendix G).

The WPRT was developed from textbooks published from 1989-1991; these books may not have current information. Welk (2002) states, however, the tool should not be used as a teaching plan but serve as a means for differentiating pattern recognition ability. Searches in Medline and CINAHL databases do not show any studies, other than the author's, which has used the WPRT to measure pattern recognition. This fact may limit generalizability of any findings in the proposed study. Studies which have measured or examined pattern recognition have used qualitative methods ('thinking aloud', Redden & Wotten, 2001; Simmons, Lanuza, Fonteyn, Hicks, & Holm, 2003; 'sense-making', Teekman, 2000; qualitative interpretivist approach, Torre et al., 2007).

Critical Thinking in MI: HESI™ Custom Exam. A customized CT in MI exam was developed from a proprietary test bank owned by Elsevier, Review and Testing. Test bank items are written according to the NCLEX blueprint and reviewed by content expert nurse educators and clinicians (Morrison, Adamson, Nibert, & Hsia, 2004). The pool of potential test bank items has an estimated internal consistency reliability in nursing student populations ranging from .86 to .99. Data were drawn from items in the text bank which were administered from 180 to 47,320 times each (Morrison et al., 2004). Customized exams are drawn from test bank items which evaluate the content domain indicated by the researcher and test bank owners affording scale validity (Morrison et al., 2004).

All HESI™ test items are CT items written at the application level or above, using Bloom's taxonomy and principles of CT developed by Paul (Morrison et al., 2004; Morrison & Free, 2001). Bloom's taxonomy classifies higher order thinking skills in a linear categorization process based upon complexity and difficulty of thinking tasks (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). Application level questions are more than remembering or explaining, but use of information in familiar and novel situations (Bloom et al., 1956).

Fifty items were selected by the researcher from a pool of 81 items recommended by Elsevier faculty who reviewed study information. Items selected were used to measure CT and CT in MI in pre and post-tests. The number of items for the CT in MI scales was established by a previous HESI™ CT exam (25 items) no longer offered (Morrison et al., 2004; P. Wilson, personal communication, September 28, 2009). The company noted that the stand alone CT exam was less often used because all HESI™ exams produce a CT score (P. Wilson, personal communication, September 28, 2009).

The customized HESI™ pre and post test exams are computer based 25-item four choice multiple choice tests which take 30-45 minutes to administer. To assess reliability of the exam, a Kuder-Richardson (KR) – 20 statistical test was performed on feasibility study post-tests which showed a reliability of .54 ($n = 10$) (P. Wilson, personal communication, September 28, 2009). For new instruments, this is below an acceptable KR-20 of .70 for a new scale (DiIorio, 2005). However, the calculation was obtained from scores from a sample of 10 students. Furthermore, while increasing item numbers (DiIorio, 2005) may improve internal consistency reliability, it should be noted that the obsolete HESI™ CT exam produced a coefficiency of .93 on 25 items (P. Wilson, personal communication, September 28, 2009).

Scores on the customized HESI™ exams range from 0 – 1500 which are produced from the HESI™ Predictability Model (HPM), which factors item difficulty in scoring (Morrison et al., 2004). Higher scores indicate greater critical thinking (P. Wilson, personal communication, September 28, 2009). A conversion percent score based on a weighted average of all items and the average weight of items answered correctly is also provided (Morrison et al., 2004).

All item choices are correct but rank ordered according to CT ability, making an interval scale (Nibert, Adamson, Young, Lauchner, Britt, & Hinds, 2006). Each item has a stem question with four possible solutions. Test items require multilogical thinking and a high degree of discrimination among alternatives to evaluate CT ability (Morrison & Free, 2001). Item distracters are plausible to enhance discrimination (Morrison et al., 1996).

HESI™ customized exams have been used by researchers in dissertation studies examining differences in knowledge and/or critical thinking (Howard, 2007; Pickens, 2007; Schumacher, 2004). Howard examined differences in knowledge and CT in diploma and BSN students (n = 49) who used HFPS versus a case study scenario. The custom HESI™ exam showed the HFPS group scored significantly better than those who did not, using both the HESI™ score ($p = .037$) and conversion score ($p = .018$) for analysis. Pickens (2007) used a customized HESI™ exam to in a pre/post-test quasi-experimental study of nursing students ($n = 11$) to examine the relationship between concept mapping and CT, finding concept mapping significantly improved CT ($p = .022$). Schumacher (2004) used a 60-item customized HESI™ exam to examine CT ability and learning outcomes in nursing students using HFPS ($n = 36$). Statistically significant differences were detected using the customized HESI™ exam critical thinking scores (Schumacher, 2004). [Note: The customized CT in MI HESI™ exam is proprietary; therefore no copy is included in the Appendix].

Clinical Decision Making: Clinical Decision Making in Nursing Scale. The CDMNS (Appendix H) is a self-report perceptual scale of decision-making in nursing (Jenkins, 1983). The tool is based on work by Janis & Mann (1977), who studied decisions in high-value situations (e.g., deciding to go to war). Janis & Mann identified seven criteria, which, when met, increased the likelihood a decision-maker's objectives would be attained. In a dissertation study, Jenkins (1983) collapsed the seven criteria into four subscales.

Ten items for each subscale were developed from review of the literature (Jenkins, 1983; 1985). For example, in Subscale A, Jenkins cites work by other researchers to support item 27, "I select options that I have used successfully in similar circumstances in the past" (1983, p. 94). Scale items and scoring for the CDMNS are provided in Table 3-1.

Table 3-1

Subscales and Scoring for the Clinical Decision Making in Nursing Scale

Subscale	Items	Reverse Code
A: Search for Alternatives and Options	1, 3, 6, 7, 16, 22, 27, 30, 32, 37	6, 22, 30, 32
B: Canvassing of Objectives and Values	2, 9, 10, 14, 21, 31, 33, 35, 38, 40	2, 21, 31, 40
C: Evaluation and Reevaluation of Consequences	13, 17, 18, 23, 25, 26, 28, 29, 34, 39	13, 23, 25, 34, 39
D: Search for Information and Unbiased Assimilation of New Information	4, 5, 8, 11, 12, 15, 19, 20, 24, 36	4, 12, 15, 19, 24

Note. 22 items are positive and use the frequency anchors 'Always' (5) to 'Never' (1). Remaining items are negative and use the frequency anchors 'Always' (1) to 'Never' (5).

Subscale A evaluates self-perception of seeking alternative solutions when faced with a clinical problem (Jenkins, 1985). Good decision-makers consider a number of options when making a clinical decision, from simple to complex (Jenkins, 1985). Subscale B evaluates perceived self- adherence to objectives inherent in the decision making situation and values affected by the decision (Jenkins, 1988). Subscale C measures self-perception of evaluating and re-evaluating perceived risks and benefits of a choice (Jenkins, 1985). Good decision makers consider positive as well as negative consequences of a clinical decision (Jenkins, 1988). Subscale D measures self-perception of searching for information and understanding information as it is presented (Jenkins, 1985). Good decision-makers accept new information or judgments of experts, even if the new information or the judgment does not support the decision under consideration (Jenkins, 1988).

Piloting of the scale was conducted with 32 senior baccalaureate in nursing (BSN) students and a focus group which resulted in refinement of directions and elimination of 23 items (Jenkins, 1983; 1985; 2003). Each item was evaluated for validity by faculty (N = 5) with experience in decision theory for "representativeness, sense of construction, appropriateness, and degree of independence from other items" (Jenkins, 1985, p. 225). Faculty established content validity using a matrix eliminating items scoring less with than 70 percent agreement (Jenkins, 1983; 1985).

A second volunteer group of 10 BSN students from each level (sophomore, junior, and senior) (n = 30) piloted the 44 item instrument. Reliability was calculated from scores for the 44 item scale (Jenkins, 2003). Items with the lowest intercorrelations were eliminated; reducing the scale to 40 items (Jenkins, 1983; 1985). Cronbach's alpha for the final scale was .83 (Jenkins, 1983; 1985; 1988; 2003). The final tool is a 40-item 1-5 Likert scale which takes about 20-25 minutes to complete (Jenkins, 1983). Scores ranged from 40 - 200, with higher scores indicating positive perception of decision making (Jenkins, 1988; 2003).

A stratified sample of BSN student students having clinical experiences (sophomores, n = 27; juniors, n = 43; and seniors, n = 41) tested the final instrument (n=111). Reliability was established at $\alpha = .85$ in this sample. For the feasibility study coding as published by Jenkins (1983; 1985; 1988; 2003) produced a reliability of .645

for the pre-test (n = 11). However, published scoring directions for the CDMNS did not indicate any items as negative or reverse coded:

> Items on the CDMNS are rated from 5 (Always) to 1 (Never) by the nurse or nursing student to reflect perceptions of his/her own behavior while caring for clients. Item ratings are summed to obtain a total score. The final tool has 40 items. Therefore, a potential score range of 40 to 200 exists, with higher scores indicating higher perceived decision making (Jenkins, 1988, p. 194).

Contacting a researcher who spoke with Dr. Jenkins directly for her dissertation yielded complete scoring instructions (Table 3-1). When rescored with complete instructions reliability increased to .815, which is acceptable (DiIorio, 2005).

Other studies and dissertations using the CDMNS reported reliabilities from .43 to .88 (Cruickshank, MacKay, Matsuno, & Williams, 1994 (n = 630; $\alpha = .48$); Girot, 2000 ($\alpha = .78$, n = 50); Stover, 2000 ($\alpha = .43$; n = 64); Thiele, Holloway, Murphy, Pendarvis, & Stuckey, 1991 (n = 82; $\alpha = .84$-.88). The wide range in reliabilities should be considered in relation to lack of complete published scoring directions. The scale is used with permission (Appendix I).

Clinical Judgment: Physician Reporting - SBAR Reporting System. The SBAR reporting system (situation, background, assessment, and recommendation) was developed to improve communication among clinicians (Haig, Sutton, & Whittington, 2006). The SBAR system provides a standard framework for rapidly conveying information about a clinical patient problem. Each simulation scenario presents a patient problem which will necessitate contacting the 'physician'. The SBAR framework standardizes reporting and requires statement of the patient problem in diagnostic terms.

Haig et al. (2006) reported nurse discomfort with the 'recommendation' portion of the system when contacting physicians. Authors reported recommending practice with a peer prior to making the physician call. During HFPS scenarios students were asked to use the SBAR reporting system when contacting the 'physician' using a prop telephone.

The 'recommendation' portion of SBAR reporting was used to elicit student perception of patient symptom cues presented during simulation as MI or not MI. Accuracy of the recommendation was used to measure CJ. Scoring was a simple ratio [number correct divided by three (number of simulations) correct/total].

Critical Thinking Process Data: Thinking Aloud. Thinking aloud technique is a qualitative method for collecting data about thinking while study participants complete a task (Mazor, Canavan, Farrell, Margolis, & Clauser, 2008). Verbal protocol analysis with thinking aloud technique has been an effective means of collecting data concerning CT and CDM (Cioffi et al., 2005; Daly, 2001; Tywcross & Powls, 2006; Simmons et al., 2003).

Thinking aloud data were collected from study simulation groups after debriefing the third simulation scenario. Non-simulation comparison groups were interviewed in pairs, or as a group, as participants preferred, after pre-test data collection. Student responses to questions were audio/video recorded for each pair/group, then transcribed and analyzed as descriptive qualitative data. Standard questions were used to elicit discussion of the decision making process (Appendix J).

Thinking aloud is usually conducted while action is being performed as distortion or fabrication may occur when time elapses between the event and verbal protocol (Mazor et al., 2008; Wilson, 1994). However, concurrent reports may be incomplete when examining cognitive processes because they are not easily verbalizable. Subjects are not asked to justify or explain their decisions, but to recite the thought process (Mazor et al.). Therefore, for the purposes of this study, thinking aloud data collection occurred after the final HFPS debriefing for simulation participants.

Audio data were transcribed verbatim by the research assistant using assigned participant pseudonyms. Interpretation began with the first transcript, which was used to inform other interviews. General reading for an overall impression was followed by line-by-line coding in an iterative process to find meaning in student statements (Patton, 2002). Codes were analyzed and organized into patterns and themes to understand students' CDM (Patton). Comparisons and contrasts were then made between each study. Peer assistance and member checking was used to establish validity and reliability (Patton).

Time to diagnosis. Time to diagnosis, in seconds, was recorded by stopwatch and verified by the recorded tape for each simulation. Start time began when the last symptom of the scenario was given until the diagnosis was reported during SBAR communication. However, at least one pair of students reported the diagnosis before all symptoms were given in a scenario. Therefore, a second time was recorded for all simulations from first symptom to diagnosis, as well.

Study Administration

Table 3-2 shows study instrument administration related to variable, instrument, format, time to complete and use by study group. Non-simulation control data was collected once.

Table 3 – 2

Study Instrument Administration Schedule

Variable	Measurement Tool	Format	Minutes to complete	Non-Simulation Control	Typical Simulation Control	Pattern Simulation Experi-mental
Symptom Pattern Recognition	Welk Pattern Recognition Tool (WPRT) for MI	Paper/ Pen	20 minutes	Pre-test	Pre-test/ Post-test	Pre-test/ Post-test
Critical Thinking in MI	Health Education System, Inc. (HESI™) CT Customized Exam	Comput-er based	30-45 minutes	Pre-test	Pre-test/ Post-test	Pre-test/ Post-test
Clinical Decision Making	Clinical Decision Making in Nursing Scale (CDMNS)	Paper/ Pen	20-25 minutes	Pre-test	Pre-test/ Post-test	Pre-test/ Post-test
Clinical Judgment	SBAR reporting Situation/Back-ground/Assess-ment/Recom-mendation	Verbal	5 minutes	N/A	Post-test	Post-test
Clinical Decision-Making Process	Thinking Aloud	Verbal	20-30 minutes	Pre-test	Post-test	Post-test
Time to Diagnosis/ Diagnostic Accuracy	Stop watch	Time in seconds/ Verbal	N/A	N/A	Each simulation	Each simulation

Demographic variables. Demographic variables were collected with a demographic data sheet (Appendix K) to a) describe the sample, and b) understand potential sources of bias such as age, gender, race, grade point average (GPA), having a previous college degree, or curricular, extra-curricular or professional clinical experience caring for patients with MI. In addition, students were asked if an elective critical care course was taken, which could include additional information on MI.

Procedure

Students enrolled in a first semester junior medical surgical BSN course were the population of interest. Permission was obtained from nursing school course administrators and faculty to allow the researcher to present an approved 90 minute guest lecture on the topic of MI which had embedded within 20 minutes of content on symptom recognition in MI needed for the research study. Students were unaware of the researcher role until after the lecture was presented when recruitment began.

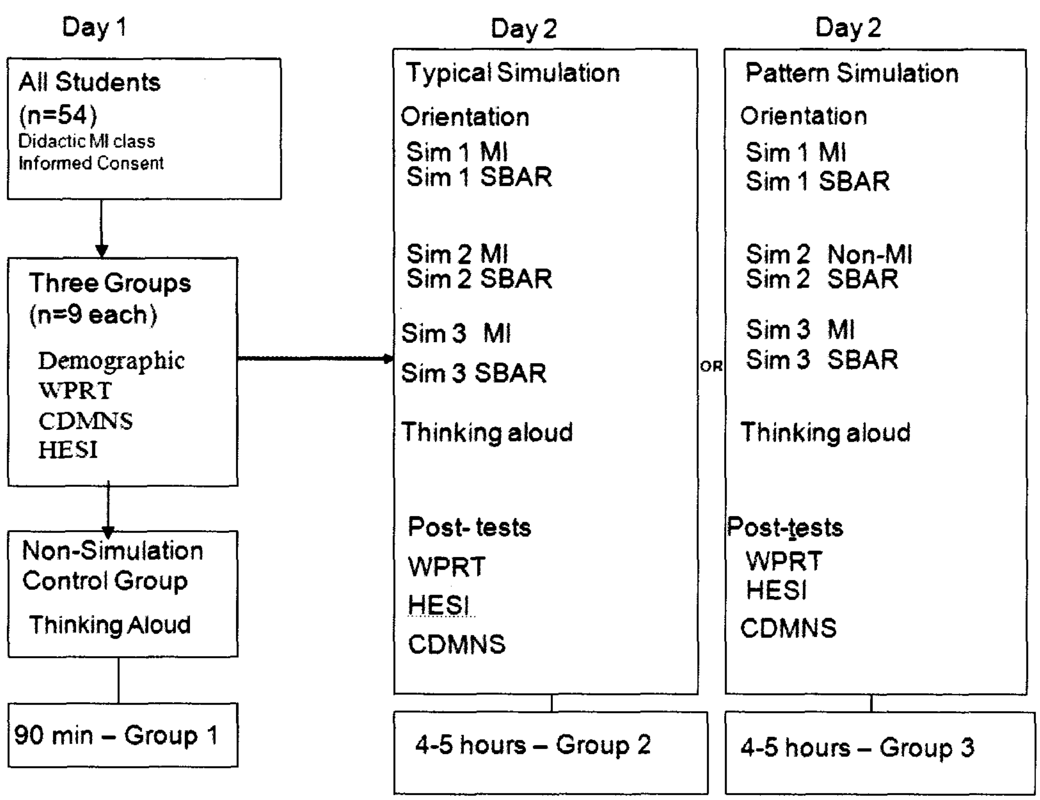
After IRB approval, eligible students who expressed an interest in the study were contacted to meet at an agreed upon date and time with their self-selected or researcher-selected partner. Students met in groups in a reserved on-campus nursing computer lab to review the Informed Consent form (Appendix E) and discuss the purpose, risks, benefits, right to withdraw from the study at any time, and estimated time commitment. Students were told a possible benefit from practicing critical thinking might be learning to recognize symptoms of MI in a safe setting. Students were informed that after demographic and pre-test measures were obtained groups in simulation would meet a second time at an HFPS lab at another university, 17 miles by car from the home institution, at a mutually agreed upon time.

Students were informed they would be randomly assigned to one of three groups: Non-simulation (control Group 1), typical simulation (control Group 2), and pattern simulation (experimental Group 3). Group 1 participation was expected to be about 90 minutes, and Groups 2 and 3 an additional 4-5 hours. It was explained that the non-simulation control group students (Group 1) would participate in demographic and pre-test measures (Figure 2) followed by audio/visual recording of 'thinking aloud' data, in pairs or groups, as convenient for participants. After collection of 'thinking aloud' data, Group 1 participants were told they would be given a $20 gift card from Target store. At this point, it was explained, study participation would end for Group 1 participants. Group 2 and 3 participants, it was explained, would participate in simulation, followed by collection of 'thinking aloud' data and administration of post-test scales. After participation Group 2 and 3 students would receive $40 gift cards from Target store and a certificate which documented participation in simulation to obtain senor practicum credit.

Students who were randomly assigned to Group 1 were told they could opt to participate in the same simulations as for the study, but no data would be collected and no further monetary incentives given. Students were told they could receive credit for the senior practicum experience for non-study simulation.

Consent forms were reviewed with the researcher and signed by students indicating consent to participating in the research study. Students retained a copy of the consent for their records. Large manila envelopes with the demographic data sheets, WPRT, and CDMNS, and log-in information for the custom HESI™ exam were coded with study numbers. As students came to the nursing computer lab, the first arriving member of a pair received packets for both partners. Study numbers attached to the packets were randomly assigned to group by a computer program. Students were informed of group assignment only after demographic and pre-test data were collected. Figure 2 explains procedural flow in the study.

Figure 2. *Study Procedural Flow Chart*



Note. WPRT = Welk Pattern Recognition Tool, CDMNS = Clinical Decision-Making in Nursing Scale, HESI™ = Health Education Systems, Inc. custom critical thinking in MI scale, MI = myocardial infarction, SBAR = Reporting system acronym (Situation, Background, Assessment, Recommendation), min = minutes.

Simulation

Control and intervention simulation groups (Groups 2 and 3) participated in demographic and pre-test measures followed by scheduled simulation at a mutually agreed upon time with the partner and researcher at a HFPS lab. Students were told working with a partner would facilitate CT and discussion during the study. Student pairs in typical (n = 9) and pattern (n = 9) simulations participated over two days, requiring an additional 4-5 additional hours.

Simulation emulates a live patient care experience in a hospital. The HFPS laboratory setting used modeled a medical surgical patient care room complete with SimMan® simulated patient, patient tables and tray, lighting, curtain, containers for disposed needles, and non-sterile gloves (assorted sizes). A head wall unit with oxygen and suction ports was available for use. Bedside chairs with an extra pillow, blanket, towel and wash cloth were available. A sink with running water and soap was part of the simulated environment, as well as alcohol-based hand cleanser. A 5 x 5 foot three tier supply cart was positioned near the foot of the Hill-Rom™ functional patient bed stocked with prop and scenario supplies such as emesis basin, digital thermometer, and IV tubing. A standard hospital medication cart with bins and equipment, including alcohol pads, was stocked with 'medications' for each scenario. On the medication cart was a simulated glucose monitor kit. An operational Plum™ intravenous (IV) pump was used with scenario IV fluids as appropriate. A scenario clock set to scenario time was above the bed.

The simulator was a full-body mannikin with life-like breathing, heart beat, blood pressure, bowel, and breath sounds. The mannikin 'speaks' via a microphone operated by the researcher or has pre-recorded sounds (e.g., vomiting) and phrases ("I don't feel well") which can be played on command. The simulator cannot move its arms, legs, or head. Some peripheral pulses were palpable (left brachial, radial, and bilateral femoral).

There were no palpable pedal pulses. Moulage (make-up) was used to simulate pallor and serosanguinous drainage, and a plant mister was used to simulate diaphoresis (sweat). The mannikin wore a hospital patient gown, armband, allergy band, and dressings or moulage to add realism to scenarios as appropriate

Vital signs (blood pressure (BP), pulse, and, respiratory rate) were set by the simulator operator. In addition changes in breath sounds and heart rhythm could also be changed on command. A monitor screen displayed a digital read out SpO2 for pulse oximetry when a probe was placed on any mannikin finger. The display becomes blank when the probe is removed. Three lead electrocardiogram (EKG) cables which could attach to the mannikin were used to emulate telemetry. An over bed tray was positioned to one side of the bed with a 'patient' food tray complete with hospital water pitcher and cup, plastic fruit, pre-printed boxes representing milk and cereal, a coffee cup, and utensils. An open generic box of white tissues was also on the table.

A bedside computer set to the Google™ home page and a nursing drug reference book on the medication cart was available as outside resources, as well as personnel from other 'departments' and the 'house supervisor' nurse who were reached by simulated telephone calls.

Students were assigned one of two roles: Primary nurse, who assessed and communicated with the physician, and medication nurse who gave medications and completed tasks as directed by the primary nurse. Students had each role once; the third scenario primary nurse was determined by a coin toss. Students self-selected who had which role for the first scenario, but if a decision could not be reached, a coin was tossed.

HFPS scenarios began with simulated audiotaped morning reports for each scenario. A Camtasia™ computer recording program was used to simulate a nursing report made by the researcher using a Power Point™ background to display photographic representations taken from the internet for age, race, and gender of the simulated patient. The simulated report was modeled on change-of-shift reports used by nurses consisting of background, situation, and relevant patient data. During each recorded report there was a short tutorial (about 2 minutes) on SBAR reporting to the physician (Situation, Background, Assessment, and Recommendation) and a written explanation at the front of the patient chart.

A patient 'chart' using a three ring hospital clamshell binder was created for each simulation patient. All pages had simulated patient identification labels with patient name, medical record number, birth date, and physician name. Freeware hospital forms available on the internet were used with data filled in, including face pages, physician's orders, progress notes, medication administration record, vital sign flow sheet, and laboratory reports with tests and results as appropriate for each scenario. For simulated patients admitted through the emergency department (ED) there were ED forms filled, and procedure or diabetic forms as appropriate.

Students were oriented to the simulator and environment and given a hands-on opportunity to practice with the simulator before the study began. The simulation environment was generic during orientation, with no identifiers for simulated study patients present. The students were shown how to use the IV pump, oximetry probe, and patient bed. A two head teaching stethoscope was used to assist students in identifying blood pressure and heart tones when needed. Students were shown the extent of the simulated environment, and asked to treat the situation as if it was real by not talking to the researcher (behind one-way glass) or attempting to walk around the glass. The researcher and research assistant who prepared the simulations, operated the simulator, and recorded simulation on two over-head cameras by remote for debriefing, wore white lab coats during the study. If, for any reason, the researcher or assistant needed to enter the simulated environment, it was as a character appropriate to the environment. If entering the simulated environment was necessary (for example, for equipment failure) then the researcher or assistant left the simulation booth discreetly by an outside door and entered via the door used for the 'patient's' room, departing by the same route. Otherwise, the researcher and research assistant were not visible during scenarios.

Because not all conditions can be replicated in a simulated environment, students were told they could ask for data after attempting to obtain it by usual means, then asking for the data. For example, if the student wanted to know the 'patient's' temperature, the student would need to put the thermometer in the patient's mouth, and then ask for a temperature reading.

To contact the 'physician' a prop telephone was placed on the medication cart. Students were instructed to announce the call by saying, "Ring, ring!" and then stating the department or person called. A portable-white erase easel had a list of four digit non-functioning phone extensions for calling the lab, pharmacy, EKG, telemetry, dietary, and physician. In addition, there was a listing for the house supervisor nurse, reachable by dialing '0', who could serve as a resource and answer questions. For example, when a student forgot how to operate the IV pump, the 'house supervisor' explained. The researcher played all roles, including the patient, physician, and house supervisor.

Response to telephone calls was realistic; for example, if the student called the pharmacy for a lab test, the pharmacist would say the lab should be called to answer the question.

When students indicated orientation was sufficient simulation was begun. Door signs were placed on all outside doors to prevent inadvertent entry of non-simulation visitors. Students were taken to a separate room and instructed to listen to the recorded report once, without pauses or stopping, and then look at the patient chart. Blank paper for notes was provided, as well as any missing equipment such as pens or a stethoscope. Students were told that after finishing reviewing the chart they could enter the simulation room. Students were instructed to take as much time as needed, and that no one would come to tell them when to start; they were to begin simulation when ready. Simulation started when the students entered the simulation room. Students were told not to leave the simulated environment during simulation. If the chart was left in the report room, or equipment not found, the house supervisor should be called. Students were told they would be notified when the scenario was ended, but simulations would take no longer than 30 minutes. Students could take up to 15 minute breaks between scenarios.

Student pairs begin simulation by caring for the 'patient'. During each simulation a serious patient situation arose which required the primary nurse to notify the 'physician'. If the medication nurse called the physician, rather than the primary nurse, the physician asked to speak with the primary nurse. Students who did not use SBAR reporting were prompted by the 'physician'. If the primary nurse did not notify the 'physician' regarding the patient situation by 30 minutes scenario time, the physician called the primary nurse and prompted for SBAR reporting and likely diagnosis.

After each scenario verbal and video debriefing followed a standard format, with additional feedback provided to the experimental group (Appendix O). Performance feedback related to identifying important assessments, salient symptoms, diagnostic accuracy, and type of decision-making was given to the pattern simulation group only. The typical group (Group 2) received feedback that was informational or factual only. All study participants were encouraged to express any feelings aroused by simulation.

The simulation scenario ended with a call to the physician and reporting of a diagnosis. Simulation continued for another minute or two after the diagnosis to avoid cueing that the diagnosis was the purpose of the simulation. Students were allowed to work through the scenarios as patient symptoms gradually worsened until a call was made. The simulated patient was not allowed to 'die'. After debriefing the third scenario 'thinking aloud' questions were asked (Appendix J), followed by post-test measures.

Simulated Patient Scenarios

Six patient scenarios were developed for the study; five MI and one with overlapping symptomatology. The typical simulations (Appendix L) presented textbook cases of MI which provide prototype distinctive pattern cues (Welk, 1994). Three scenarios of five typical (prototypical) MI symptoms (scenarios Berger, Dinkins, and Oakes) were given to the control simulation group. All simulated Group 2 patients were male, Caucasian, and over age 40 years.

The pattern simulation experimental group (Group 3) also participated in three simulated patient scenarios (Appendix M). Scenarios were based on theories of pattern recognition and included two exemplar based (typical) scenarios but with five essential and three non-essential signs of MI (Welk, 2002) and one non-MI scenario with five overlapping symptoms for MI (chest pain, shortness of breath, anxiety, restlessness, and a sense of impending doom). The non-MI scenario was a patient hospitalized with pneumonia who has an anaphylactic reaction to a prescribed antibiotic. All simulated Group 3 patients were male, two were Caucasian, one African-American, and one was aged less than 40 years (non-MI simulated patient).

Simulated patients in each group (typical (Group 2) and pattern (Group 3) had complementary counterparts in the opposite group. All scenarios were lightly scripted to present similarly for each study pair. Each simulated patient had a personality (steady, jocular, or dour) with a matching counterpart in the complementary scenarios. Participant actions, however, caused some variability among scenarios.

For each simulation scenario symptoms were written on paper and placed in a bag. For Group 2, five typical symptoms were each written on separate papers. For Group 3, all 19 symptoms (5 typical + 14 nonessential) were written on separate pieces of paper were placed in a bag. The bag was shaken 20 times, and then papers drawn out one-by-one. Symptoms were presented in the scenarios in the order drawn from the bag. For Group 3, when age, gender, or race was drawn, the symptom was returned to the bag and another symptom drawn. Symptoms were presented during simulation in the order drawn.

Because moulage for diaphoresis and pallor needed to be applied before simulation began the 'patient' stated he was 'hot' and asked for the blanket to be removed, or stated he felt 'fine, if diaphoresis or pallor was noted before the symptom was officially presented. When it was time for diaphoresis or pallor to be present, the patient made statements such as "I'm just sweating", or "I feel as if I'm going pale." Symptom presentations are noted in Appendix O.

Symptoms were started after the primary nurse appeared to have completed a clinical physical assessment on the 'patient', or at about the 20 minute point in the scenario, whichever came first. Symptoms were presented in random order (procedure previously explained) over a period of about 5 minutes. At the first symptom Phase II vital signs were programmed. At the last symptom Phase III vital signs were programmed (see Appendices L and M). Symptoms were repeated twice during the five minute presentation of symptoms, followed by repeating of symptoms in the order originally given during the remainder of the scenario. However, the vomiting preprogrammed sound was played during the call to the 'physician' so that the medication nurse did not speak with the patient while the primary nurse was on the 'phone' with the doctor, because the researcher played both roles.

For the non-MI scenario in Group 3 symptoms began with administration of the prescribed antibiotic. The patient had a cross allergy for the antibiotic, so as soon as the IV was started, symptoms began. If students noted the allergy, then another antibiotic was prescribed (already available on the medication cart) which caused the anaphylactic reaction and progression of symptoms.

Simulation intervention. The intervention for this study was providing pattern recognition based simulation scenarios to improve pattern recognition for recognition of symptoms of MI. The interventions are shown in Table 3- 5. The intervention for the pattern recognition intervention Group 3 consisted of more symptoms, a both essential (typical) and non-essential symptoms, and feedback.

Table 3-3

Study Pattern Recognition Intervention

Typical	Pattern
3 Scenarios All MI	3 Scenarios 2 MI + 1 Non-MI
5 Essential Symptoms of MI Random order	5 Essential Symptoms of MI + 3 Non-essential Symptoms of MI Random order
	Non-MI 5 Overlapping symptoms with MI Random order
Debriefing feedback Factual Informational	Debriefing feedback (positive) Data Collection Data Saliency Analytic Reasoning Review missed data/errors in thinking (negative)
Diagnostic feedback withheld	Accuracy of diagnosis disclosed

Note. MI = myocardial infarction.

Scenario validity. Two expert medical-surgical nurses familiar with care of patients in MI reviewed scenarios for difficulty, complexity, knowledge needed, realism, and appropriateness for junior nursing students. The experts were familiar with nursing education as a clinical student preceptor or faculty.

Scenarios were considered appropriate for subjects' level of nursing knowledge, and contained realistic patient situations and events. Scenarios were considered to be generally equivalent (Oakes = Weissmuller, Berger = Johnson, Dinkins = Golden), but were found to be more equal in complexity and difficulty when considered as a group (control simulations = experimental simulations).

Data Analysis

Quantitative data was entered into a Predictive Analytics Software (PASW) (formerly Statistics for Social Sciences Software (SPSS) version 17.0 database for analysis. Data were cleaned and checked for missing items. Missing data were imputed as supported by a consultant statistician. Data were treated as interval.

Tests for skew and kurtosis were conducted to determine use of parametric or non-parametric tests. Descriptive statistics were used to describe the sample including means and standard deviations. Group means were analyzed using ANOVA to determine if groups were significantly different on variables of age, race, gender, grade point average, previous college degree, previous clinical experience, and critical care elective. (Significance was set at $p \leq .05$).

Student pair data was analyzed for correlations (F. McCarty, personal communication, August 28, 2009). If correlations between student pairs were $> .80$, data was not be treated as independent observations (F. McCarty, personal communication, August 28, 2009) which would affect statistical analysis by increasing risk of Type I error. Reliabilities were calculated for instruments. Subscale scores for the CDMNS were calculated and group means analyzed with a t-test.

Research questions were answered using ANOVA. If significant, post hoc tests were conducted. Diagnostic accuracy was analyzed with t-tests.

Qualitative data was analyzed as previously described, using peer assistance and member checking to establish rigor. Reflection to determine researcher bias was conducted and explored. Triangulation by comparing qualitative findings with quantitative findings was conducted.

Summary

A three group quasi-experimental pre/post test study design with a qualitative analysis of interview data was conducted to examine the effects of teaching nursing student recognition of symptoms of MI using pattern of presentation of MI symptoms in HFPS scenarios on variables of CT, CDM, CJ, pattern recognition, and diagnostic speed and accuracy. After IRB approval, a sample of 54 junior level baccalaureate student pairs was recruited to participate in the study. Students participated in pairs (n = 27 pairs), either self-selected or assigned, which were randomized to group: Control (no simulation – Group 1), Control (simulation – Group 2), and Intervention (simulation – Group 3).

Data were analyzed to answer the research questions using PASW software. Statistical data analysis included descriptive statistics, chi square, t-tests, and ANOVAs. Descriptive qualitative analysis was used for 'thinking aloud' data.

CHAPTER IV

Results

Overview

A research study was conducted to examine the effects of pattern recognition-based simulation education of symptom recognition of myocardial infarction on critical thinking (CT), clinical decision-making (CDM), and clinical judgment (CJ) in junior baccalaureate nursing students. The results are reported in this chapter. Findings include the study response rate, description of the sample, reliability of the instruments, and analysis of data in relation to study hypotheses.

Subject Response Rate

Eligible junior baccalaureate nursing students were recruited from a large metropolitan university using a method previously described. Sixty-eight students indicated interest in the study. Five students did not respond to emails and telephone calls; three students said they were busy with jobs, meetings, and school; two students opted out when their researcher-assigned study partners were late or did not arrive; two students could not be scheduled; and two students were not eligible. The total response rate was 79.41%. Of the remaining 54 students, all consented to participate and completed the study.

Description of the Sample

Demographic data were collected after obtaining consents followed by pre-testing. After pre-tests students were randomized to group: Group 1 nonsimulation control, Group 2 simulation control, and Group 3 experimental simulation.

Participants in the research study were predominantly female (N = 46, 88.9%), young (*M* = 28.66 years, SD 9.21, range 20-56), and had a high grade point average (GPA) (*M* = 3.55, SD 0.288, range 2.30 – 4.03). The sample was ethnically diverse including 6 Asian (11.11%), 12 African American (22.22%), 1 native African (1.85 %), 20 Caucasian (37.04%), 8 two or more races (14.82 %), 5 other (9.26%), and 2 no response (3.70%). Students of other races were: Jamaican, Haitian-American, Caucasian-Puerto Rican, and Black. Some students had college degrees prior to entering the nursing program (N = 24, 44.44%) in the sciences, accounting, English/arts, health, religious studies, and criminal justice. Four held an associate degree (7.41%), 18 (33.33%) a bachelor degree, and 2 (3.70%) a masters degree.

Students had experience in direct patient care in 1-3 nursing courses, including a current course, with most having 2 or 3 courses (1 course N = 4, 7.4%, 2 courses N = 34, 63%; 3 courses N = 16, 29.6%). Most students did not have experience caring for patients with heart conditions outside of nursing courses (N = 50, 92.59%), though two students were licensed practical nurses (LPN) or licensed vocational nurses (LVN) (3.70%). Fours students (7.41%) said they had experience in direct care of patients with heart conditions outside of nursing courses, including one of the LPN/LVNs. One student had taken or was taking an intensive care unit (ICU) elective nursing course (N = 1, 1.85%).

Demographic variables were also examined by group. Group demographic data are summarized in Table 4-1.

Table 4-1

Demographic data by Group (Group n = 18, Total N = 54)

Group	Age* (*M*, SD)	Gender (N, %)	N (race)	GPA (*M*, SD)	N (Experience**)
1	32.5(11.04)	F (15, 83.3%)	1 (Asian) 6 (AA) 6 (C) 1 (2 or more) 4 (other)	3.48 (0.37)	15 (None) 1 (LPN or LVN) 2 (care heart patients) 1 (ICU elective)
2	28.0 (11.9)	F (15, 83.3%)	2 (Asian) 5 (AA) 1 (NA) 5 (C) 2 (2 or more) 2 (other) 1 (NR)	3.60 (0.27)	17 (None) 1 (LPN or LVN) 0 (care heart patients) 0 (ICU elective)
3	25.5 (6.1)	F (16, 88.8%)	3 (Asian) 2 (AA) 9 (C) 4 (2 or more) 0 (other)	3.57 (0.12)	16 (None) 0 (LPN or LVN) 2 (care heart patients) 0 (ICU elective)

Note. Age in years, N = number, F = female, GPA= grade point average, AA = African American, NA = Native African, C = Caucasian, NR = no response, LPN = licensed practical nurse, LVN = licensed vocational nurse, care heart patients = previous direct care for patients with heart conditions, ICU = intensive care. **Experience totals > 18 = multiple selections.

In addition previous college or university degree was examined between groups. Most students had no previous degree (Group 1 = 9, Group 2 = 12, and Group 3 = 9). In Group 1 nine students had previous degrees (2 associate, six baccalaureate, and 1 masters). In Group 2 six students had previous degrees (0 associate, 5 baccalaureate, 1 masters). In Group 3 nine students had previous degrees (2 associate, 7 baccalaureate, 0 masters).

Statistical tests were conducted to examine baseline differences between groups on age, gender, race, experience, and GPA. Gender data were dummy coded. Interval data were examined for normal distribution and error bar charts plotted. Data for age was normally distributed but data for gender were skewed (-2.038) and GPA was kurototic (6.969). Analyses of variance (ANOVA) were conducted to determine equality of groups. Categorical data were examined with chi square after race and number of clinical courses data were collapsed. The variable 'race' was collapsed to two variables (Caucasian; non-Caucasian) and the variable 'number of clinical courses' was collapsed to two variables (1 or 3 courses; 2 courses) to meet the cell frequency assumption. A person in Group 1 had taken an ICU course, and in Groups 1 and 3 two persons had direct care experience for patients with heart conditions. Significance was set at $p < .05$ for the study.

Analysis showed no baseline differences between groups for age (F (2) = 2.854, p = .067), gender (F (2,) = .139, p = .870), GPA (F (2) = .966, p = .388), or previous degree (F(2) =.266, p = .799) There were also no differences between groups related to race (X^2 (6, N = 54) = 4.033, p =.672) and number of clinical courses (X^2 (2, N = 54) = 2.541, p = .406).

Instruments and Reliability of Scales

Data were prepared for analysis by cleaning and checked for normality and outliers. Internal consistency reliability was computed with Cronbach's alpha after missing scores were imputed. Cases with scales missing more than 20% data were removed from computations. For dichotomous scales Kuder-Richardson-20 was calculated. Predictive Analytics Software (PASW) (formerly Statistics for Social Sciences Software (SPSS) version 17.0 was used for analysis of data. Reliability of instruments for this study is reported in Table 4-2.

Research instruments measured pattern recognition (Welk Pattern Recognition Tool (WPRT), CDM (Clinical Decision-Making in Nursing Scale (CDMNS), and CT in MI (HESI™ custom exam). High scores on instruments indicated greater pattern recognition, self-perception of clinical decision-making, and ability to critically think in MI.

Table 4-2

Reliability of Scales

Scale	Number of Items	Score Range	Coefficient*
WPRT	19	0-100	.797
CDMNS (total)	40	40-200	.807
Subscale A	10	10-50	.235
Subscale B	10	10-50	.502
Subscale C	10	10-50	.748
Subscale D	10	10-50	.141
HESI™ pre-test	25	0-1500	.297
HESI™ post-test	25	0-1500	.421

Note. *Cronbach's alpha or Kuder-Richardson 20, WPRT = Welk Pattern Recognition Tool, CDMNS = Clinical Decision-Making in Nursing Scale, HESI™ = HESI™ custom exam.

The WPRT and CDMNS had adequate reliabilities. Coefficients for the CDMNS subscales ranged from .141 to .748. The HESI™ custom exam pre- and post-tests had low reliabilities for this study. However, the HESI™ pre and post-tests items were also used by Elsevier in proprietary instruments for assessment of nursing students (associate and baccalaureate) during the data collection period. Elsevier, Review & Testing, analyzed the reliability of the items used in the proprietary instruments using aggregate data from nursing students and found reliability for the pre-test items of .99, and for post-test items of .96 in their sample. The low reliabilities of the HESI pre- and post-tests in this study may be because of the low number of test participants (N=54 pre-test, N = 36 post-test)). Average difficulty was calculated by Elsevier, Review & Testing, for the HESI™ custom exam pre-test which was .68 and average difficulty for the post-test was .72.

Time to diagnosis and diagnostic accuracy data were collected. 'Thinking aloud' data were qualitatively analyzed and compared between groups.

Data Analysis

The study used a three group design, using two control groups: One without simulation (Group 1) and one with simulation (Group 2), and an experimental group (Group 3) who received pattern recognition-based simulations and a feedback-based debriefing. All study participants attended a didactic class in which essential and nonessential symptoms of MI were presented. Essential symptoms of MI were typical signs present when an MI was occurring. Nonessential signs, when found in the presence of essential signs, increased the likelihood that the diagnosis was MI. Essential signs are not only typical of MI, but are also the prototype for MI (Welk, 2002). Both simulation groups (Groups 2 and 3) received simulations of patients having a typical (prototype) MI which had five essential signs. Group 2 received three scenarios of MI. However, the experimental group (Group 3) received, in addition to the prototypical signs, three additional nonessential signs of MI during two MI scenarios. Furthermore, Group 3 had one non-MI scenario, which presented five symptoms, which overlapped symptoms for

MI. Group 3 received, in addition to standard debriefing, reward-based feedback during simulation debriefing. Group 2 received standard simulation debriefing only (review Table 3, Chapter III).

Quantitative and qualitative data were collected to answer study hypotheses using the WPRT, CDMNS, and HESI™ scales, measurements of time to diagnosis and diagnostic accuracy during simulation, and semi-structured student interviews with a 'thinking aloud' technique. Quantitative data were analyzed with chi squares, paired and independent T-tests, and ANOVAs. Group 1 scores were treated as post-test scores for the didactic class.

Correlational analysis of pre- and post-test scores on scales did not show correlations between student pairs greater than .80 on pretests (WPRT $r = .120$ ($p = .553$), CDMNS $r = .057$ ($p = .777$), HESI™ $r = .317$ ($p = .107$) or post-tests (WPRT $r = .277$, ($p = .162$), CDMNS $r = -.281$ ($p = .289$), HESI™ $r = .188$ ($p =.348$). Therefore data were treated as independent observations.

Findings Related to Study Hypotheses

Hypothesis 1. Hypothesis 1 stated nursing students who participate in pattern recognition based high fidelity patient simulation (HFPS) will be better clinical reasoners as indicated by significantly higher scores for MI symptom pattern recognition, CT in MI, and self-perception of CDM than students who participate in textbook based HFPS or students who participate in didactic class alone.

Score means, standard deviations (SD), and ranges were calculated for each instrument (Table 4-3). Two cases were eliminated from Group 2 WPRT post-test calculations because more than 20% of the data (7 and 8 items) was missing.

Table 4-3

WPRT, CDMNS, and HESI™ *Score Means, Standard Deviations, and Ranges by Group (n = 18, total N = 54)*

Scale	Group 1* M(SD)	Group 2 M(SD)	Group 3 M(SD)
WPRT			
Pre-test		68.42(16.35)	66.37(14.79)
Post-test	71.64(13.77)	83.55(13.57) **	81.58(15.24)
Range pre-test		42.11 - 100	42.11 - 100
Range post-test	52.63 – 94.74	57.89 - 100	52.63 - 100
CDMNS			
Pre-test		155.94(13.52)	155.70(11.42)
Post-test	155.51(9.77)	158.83(13.84)	154.53(13.51)
Range pre-test		131-180	138-180
Range post-test	134-175	125-186	127-184
HESI™			
Pre-test		735.00(213.66)	729.28(169.48)
Post-test	805.83(228.15)	805.00(141.27)	812.17(182.79)
Range pre-test		415 – 1176	569 - 1104
Range post-test	409 -1288	534 – 980	539 - 1080

Note. Group 1= control no simulation, Group 2 = control simulation, Group 3 = experimental simulation. WPRT = Welk Pattern Recognition Tool, CDMNS= Clinical Decision-Making in Nursing Scale, HESI™ = HESI™ custom exam. * Group 1 tested once. ** N = 16 (missing data).

Other WPRT missing data were imputed by group mode for essential symptoms of MI, and an opposite value entered on the same variable under non-essential. Imputations were verified by hot-deck imputation (Fox-Wasylyshyn & El-Masri, 2005) with similar results. WPRT row totals were observed to ensure one entry for each symptom of MI. No double item entries were noted on any WPRT scale. For the

CDMNS group mean scores were imputed for missing values. There were no HESI™ values missing. Results are reported in Table 4-3.

Pre-test study group scores on variables of interest were examined by ANOVA. No significant differences between groups at baseline were found (WPRT $F(2)$=.563, p = .573; CDMNS $F(2)$ = .996, p = .994; HESI™ $F(2)$ = .777, p = .465), including CDMNS subscales A, B, C, and D ($F(2)$= .276, p =.760; $F(2)$= .042, p =.959; $F(2)$= .105, p =.901; $F(2)$= .188, p =.829, respectively).

ANOVA analysis of post-test group scores showed significant differences among group mean scores on the WPRT (Table 4-4) but no differences between group means were observed for the CDMNS and HESI™ scales ($F(2)$= .462, p = .633), ($F(2)$= .007, p = .993, respectively).

Post hoc analysis of the WPRT with least significant differences (LSD) showed significant differences between Group 1 (no simulation control) and Group 2 (typical simulation control), and between Group 1 and Group 3 (pattern simulation experimental) on pattern recognition of MI . Analysis of score means suggest that both simulation groups had significantly greater ability to recognize the pattern of MI compared to the non-simulation group. An independent samples t-test showed no significant differences between mean scores for simulation groups (t(32) = .397, p = .694). Paired t-test analysis of pre/post test scores, however, showed significant improvement in pattern recognition for both simulation groups. Improvement in simulation mean scores was nearly identical between groups (Group 2 improved 15.13 mean points versus to 15.21 mean points for Group 3 (Table 4-3).

Table 4-4

ANOVA Welk Pattern Recognition Tool

(N = 54)

Item	*F*(df)	p-value
Between Groups	3.513(2)	.038
Control (Group 1)		
Typical Simulation (Group 2)		.019
Pattern Simulation (Group 3)		.041
Typical Simulation (Group 2)		
Pattern Simulation (Group 3)		.688

Note. ANOVA = analysis of variance.

The CDMNS and HESI™ scales indicated no significant differences among groups on post-test measures for self-perception of CDM and CT in MI, and no significant change in pre/post test scores for the simulation groups. Though changes in scores were not significant, comparison of pre- and post-test mean scores for the HESI™ showed greatest gains in Group 3 (82.89 vs. 70). Self-perception for CDM appeared unaffected by either type of simulation. There were no significant mean differences on the CDMNS; however, Group 2 mean scores increased (2.89 points) while Group 3 mean scores decreased (-1.17 points).

Table 4-5

Paired t-Test Pre- and Post-Test Mean Scores for WPRT (N = 36, n = 18 per group)

Item	t(df)	p-value
Group 2**	-3.28(15)	.005*
Group 3	-3.69(17)	.002*

Note. **n = 16. WPRT= Welk Pattern Recognition Tool (pattern recognition).
*Significance $p < .01$.

CDMNS subscales were also analyzed between Groups 2 and 3. Results are reported in Table 4-6. CDMNS subscales measure self-perception of search for alternatives and options when making a clinical decision (subscale A), canvassing objectives and values (subscale B), evaluation and reevaluation of consequences (subscale C), and search for information and unbiased assimilation of new information (subscale D).

Table 4-6

CDMNS Subscales Between Group Measures for Groups 2 and 3 (N = 36, n = 18 per group)

Scale	*M*(SD)	t(df)	p-value
Subscale A Post-test		-0.134(34)	.895
Group 2	39.56(4.05)		
Group 3	39.39(3.42)		
Subscale B Post-test		0.924(34)	.362
Group 2	40.23(3.14)		
Group 3	39.11(4.09)		

(Table 4-6 continued)

(Table 4-6 continued)

Subscale C Post-test		1.127(34)	.268
Group 2	39.56(4.62)		
Group 3	37.83(4.55)		
Subscale D Post-test		0.957(34)	.345
Group 2	38.67(3.48)		
Group 3	37.67(2.74)		

Note. CDMNS = Clinical Decision-Making in Nursing Scale. Group 2 = control simulation, Group 3 = experimental simulation. Significance $p < .05$.

Group 2 had greatest gains in mean scores for search for alternatives and options (subscale A), though not significantly. However, Group 3 showed significant reductions of mean scores in evaluation and reevaluation of consequences (subscale C). Subscale C measures self-perception of evaluation of risks and benefits of a choice, with consideration of negative as well as positive consequences. The results suggest that Group 3 may have lost confidence in the ability to evaluate and re-evaluate consequences because of perceived awareness of greater numbers of potential consequences. The diagnostic task for Group 2 was essentially MI/not MI, while for Group 3 the task was MI/not MI/other diagnosis. When confronted with many potential diagnostic consequences, the students in Group 3 may have realized the difficulty of the task and therefore had greater doubt in their ability after simulation.

Subscale C had the greatest reliability of the four subscales ($r = .748$). Analysis within groups shows no significant mean differences between group scores (Table 4-7).

Analysis of results. Results suggest that simulation had a significant positive effect on pattern recognition for MI from the post-didactic class baseline. However, the study intervention did not significantly improve pattern recognition over simulation which presents typical symptoms for MI only.

Table 4-7

CDMNS Paired t-Test Pre/Post Subscale Analyses Groups 2 and 3 (n = 18 per group)

Scale	*M*(SD)	t(df)	p-value
Subscale A			
Group 2		-1.865(17)	.080
Pre-test	38.56(2.87)		
Post-test	39.56(4.05)		
Group 3		-1.542(17)	.141
Pre-test	38.42(3.08)		
Post-test	39.39(3.42)		
Subscale B			
Group 2		.242(17)	.812
Pre-test	40.44(3.42)		
Post-test	40.23(3.14)		
Group 3		1.150(17)	.266
Pre-test	40.22(4.39)		
Post-test	39.11(4.09)		
Subscale C			
Group 2		-0.608(17)	.551
Pre-test	38.83(5.86)		
Post-test	39.56(4.62)		
Group 3		2.264(17)	.037*
Pre-test	39.43(3.93)		
Post-test	37.88(4.55)		
Subscale D			
Group 2		-1.097(17)	.288
Pre-test	38.11(3.10)		
Post-test	38.67(3.48)		
Group 3		-.195(17)	.848
Pre-test	37.56(2.55)		
Post-test	37.67(2.74)		

Note. Subscales A, B, C, D are for the Clinical Decision-making in Nursing Scale (CDMNS). * Significance $p<.05$.

Both simulation groups received the prototype during simulation. Study results suggest that learning the prototypical model for MI of five essential symptoms develops pattern recognition for MI, but that pattern recognition can be improved with simulations presenting the prototype. Furthermore, contemporaneous presentation of a non-MI simulation with overlapping symptoms for MI does not interfere with development of pattern recognition for symptoms of MI.

Hypothesis 1 predicted a significant increase in measures of pattern recognition for MI, CDM, and CT in MI for the pattern recognition intervention simulation group. Results showed a significant improvement in pattern recognition scores for both simulation groups. However, there were no significant differences among mean group scores for CDM and CT in MI. Therefore, Hypothesis 1 was partially supported.

Additional findings. Demographic variables were correlated with variables of interest (Table 4-8). Significant correlations were found with age and gender (the study sample was predominantly female with a mean age of 28.66 years) and age and having a previous college degree. In addition there was a significant weak linear relationship between WPRT and gender, and GPA and gender. A moderate though nonsignificant relationship was seen between WPRT mean scores and GPA ($r = .326$, $p = .052$).

Grade point average should associate with higher knowledge and understanding, as highest grades in an academic class are usually awarded to students who demonstrate achievement of at least knowledge and comprehension of subject matter. A moderate correlation between the GPA and WPRT may indicate that the task of pattern recognition in MI is knowledge dependent.

Table 4-8

Post-Test Scale Correlations (N = 36) with Demographics (N = 54)

	1	2	3	4	5	6	7	8
1. Age		-.421**	-.143	.458**	.141	-.015	.090	-.241
2. Gender	-.421**		.279*	-.165	-.149	-.361*	.163	.230
3. GPA	-.143	.279*		-.109	.020	-.162	.326	-.058
4. Prv Degree	.458**	-.165	-.109		.111	-.003	-.260	- 161
5. Experience	.141	-.149	.020	.111		.115	.090	.211
6. WPRT	-.015	-.361*	-.162	-.003	.115		.072	-.184
7. CDMNS	.090	.163	.026	-.260	.090	.072		.007
8. HESI™	-.241	.230	-.058	-.161	.211	-.184	.007	

Note. GPA = grade point average, Prv Degree = previous degree, Exp = experience, WPRT = Welk Pattern Recognition Tool, CDMNS = Clinical Decision-Making in Nursing Scale, HESI™ = HESI™ custom exam. Group 2 = control simulation, Group 3 = experimental simulation. Gender 1 = male, 0 = female. Pearson correlations coefficient r, * Significance p <.05 2-tailed. **Significance p < .01 2-tailed.

Other positive correlations, for example, between age and previous degree, would be expected findings as achieving an academic education takes time. Positive correlations between age and gender, and gender and GPA may be related to the sample skewed as female.

Hypothesis 2. Hypothesis 2 states that nursing students who participate in pattern recognition based HFPS will accurately identify MI diagnosis based on symptom cues significantly more often than students who participate in textbook based HFPS.

During SBAR reporting in simulation students indicated a scenario diagnosis. Diagnostic accuracy was indicated as a ratio (# correct/3) and converted to a 100 scale. For Group 3 the non-MI scenario was reverse coded. T-tests results showed no significant group mean differences on diagnostic accuracy. However, mean Group 2 scores for diagnostic accuracy were higher than Group 3 (M = 85.19 (SD = 24.22) vs. M = 62.97 (SD 26.08), respectively); the mean difference approached statistical significance (p =.079). However, when MI only scenarios were examined for Group 3 (patients 'Golden' and 'Weissmuller') and compared with the equivalent scenario counterparts in Group 2 (patients 'Oakes' and 'Dinkins'), there was no statistical difference in diagnostic accuracy between groups (t(16) =.343, p =.738) and group means were more equivalent (Group 2 M = .667 (SD = .433), Group 3 M = .6111(SD =.221). Findings suggest that the simulation pattern recognition intervention does not significantly improve time to diagnosis when compared to a control simulation group exposed to typical symptoms of MI alone. Hypothesis 2 was not supported.

Analysis. Difficulty and complexity of simulation scenarios was equivalent between groups; however, the use of a non-MI simulation may have increased diagnostic task difficulty, which may explain Group 2's higher diagnostic accuracy rate. However, when MI equivalent only scenarios were compared, diagnostic accuracy was similar between groups. These results suggest that the addition of a non-MI scenario negatively affected the development of diagnostic efficiency.

Additional findings. Simulation with prototypical MIs had a large effect on pattern recognition development for nursing students, with the largest effect seen for students exclusively exposed to pattern prototypes for MI (Table 4-9). The effect of presenting prototypical scenarios for MI for Group 2 had a moderate effect on nursing student CDM compared to the experimental Group 3 whose exposure to two MI scenarios and an over-lapping scenario with feedback-based debriefing produced a small to moderate effect. Simulations of either type, including feedback-based debriefing, had small effects on study variables.

Table 4-9

Calculated Effect Sizes (Cohen's d) for Major Study Variables

	Group 1/Group 2	Group 1/Group 3	Group 2/Group 3
PR	-.872	-.684	.137
CT in MI	.004	-.031	-.044
CDM	-.618	-.253	.314

Note. Group 1 = nonsimulation control group, Group 2 = simulation control group, Group 3 = simulation experimental group, PR = pattern recognition (using Welk Pattern Recognition Tool), CT = critical thinking, MI = myocardial infarction (using HESI™ Custom Exam), CDM = clinical decision-making (using the Clinical Decision-Making in Nursing Scale). Cohen's d effect sizes small = .20, moderate = .50, large = .80.

Hypothesis 3. Hypothesis 3 stated that nursing students who participate in pattern recognition based HFPS will significantly improve time to diagnosis compared to students who participate in textbook based HFPS.

Students who participated in simulation were timed from the last scenario imbedded symptom until diagnosis; however, some students did not receive all scheduled symptoms before rendering a diagnosis. Therefore, two time measurements were taken: Time to diagnosis from first symptom (TFS) and time to diagnosis from last symptom (TLS). TFS and TLS were calculated by averaging diagnosis time for three simulation scenarios and entering the pair simulation mean time as the statistic. Independent measures t-tests were performed on time to diagnosis. Findings are presented in Table 4-10. Independent t-tests results showed no significant mean group differences. Results show that Hypothesis 3 was not supported.

Additional findings. Premature diagnosis occurred in 7/54 total simulations (12.9%). Students who prematurely diagnosed called the physician with SBAR (situation, background, assessment, recommendation) reporting before all symptoms were delivered during scenarios. Group 2 received five symptoms (essential) of MI, Group 3 received up to 8 symptoms for each scenario (8 symptoms for MI (5 essential + 3 nonessential), 5 symptoms for non-MI). Symptoms for both groups were delivered over approximately five minutes. An independent pairs t-test showed no significant differences in mean premature diagnosis between groups ($t(16) = -1.209$, $p = .233$).

Five out of nine pairs (55.5%) in Group 3 prematurely diagnosed the 'patient' before all symptoms were presented (after 4-7 symptoms). However, in Group 3 premature diagnosis occurred once in a set of three pattern simulations (1/3), and always on the first scenario. Scenarios were randomly ordered, however in three cases premature diagnosis occurred in the same scenario: Patient 'Golden', who was an obese (body mass index (BMI) of 36.8) 54 year-old Caucasian male in a sedentary job with previous history of chest pain. During recorded morning report patient pictures were displayed. Mr. Golden had a worried expression and was seated indoors in a polo shirt. One Group 3 student pair who started with patient 'Golden' did not have premature diagnosis.

In Group 2, premature diagnosis occurred in one pair out of nine (11.1%). Premature diagnosis occurred during the second and third scenarios (2/3).

Table 4-10

Time to Diagnosis Simulation Groups (n = 18 each group)

Group	*M**(SD)	*t*(df)	p-value
TLS		1.009(16)	.328
Typical Group 2	4.02(1.78)		
Pattern Group 3	3.31(1.10)		
TFS		.066(16)	.948
Typical Group 2	7.36(2.29)		
Pattern Group 3	7.29(2.36)		

Note. *Time in minutes, TFS = time from first symptom to diagnosis, TLS = time from last symptom to diagnosis. Significance $p < .05$.

Patients 'Berger' and 'Dinkins' were presented. Neither of these scenarios were equivalent to scenario 'Golden'. Patient 'Oakes' was the equivalent body type to patient 'Golden'. The pair experiencing premature diagnosis started with patient 'Oakes', however, two other student pairs also started with patient 'Oakes' but did not experience premature diagnosis. Patient 'Oakes' was an obese (BMI 32.7) 57 year-old Caucasian male in a sedentary job with a previous history of chest pain. Mr. Oakes had a confident expression, wore a business suit, and was pictured standing in an outdoor city scene.

Premature diagnosis meant all symptoms were not presented during simulation before students made a diagnosis. Therefore, Group 3 did not receive the full experimental dose, as some students did not receive the complete prototype (N=3 pairs) or enough symptoms for complex categories to aid in pattern recognition. Since Group 3 students received the prototype in two of three scenarios only, it should be noted that 3 of 9 pairs received 50% of the experimental dose.

Analysis of Results. Incomplete delivery of pattern cues, especially incomplete delivery of the prototype, may affect pattern recognition ability for MI. Feedback after the first premature diagnosis may have prevented premature closure where clinicians end data collection before all available evidence is considered. Students may have used matching for the typical MI using similarity processing (Zeithamova & Maddox, 2006) but with immediate feedback learned not to equate the stereotype (obese middle-aged sedentary white man) with the disease. Perhaps discussion of premature closure prior to simulation may aid in complete delivery of pattern cues. Group 3 students appeared to learn from their mistakes and discussed avoiding bias by not repeating the premature diagnostic error.

Hypothesis 4. Hypothesis 4 stated that nursing students who participate in pattern recognition based HFPS will better articulate the process of CDM and CJ than students who participate in textbook HFPS or didactic class alone.

Data Analysis

Qualitative data were collected with 'Thinking Aloud' technique to understand students' decision-making in MI. Interviews were conducted with standard questions (Appendix J) using the 'Thinking Aloud' technique with subjects in each of the study groups: Control without simulation (Group 1) (N = 9 pairs), control with simulation (Group 2) (N = 9 pairs), and experimental with simulation (Group 3) (N = 9 pairs) to understand students' thinking when diagnosing a patient who may be having a myocardial infarction (MI). Member checking by one student and peer evaluation of three transcripts (one from each simulation group) by a qualitative nurse researcher was conducted to establish rigor. Data from pairs are reported, though individual quotes were used. Data were treated as qualitative data and analyzed separately for each group, followed by analysis between groups.

Qualitative data analysis group 1. Each transcript was coded by line and analyzed for patterns and themes. All except one transcript were interviews of student pairs. One group of four student pairs (8 students) participated in a single interview, yielding a total of six transcripts for coding Group1. Five themes emerged from the data (Appendix P).

Theme 1: Know the symptoms of MI. Group 1 participants stated that to recognize an MI one must first know the symptoms. All study participants were given didactic instruction on essential and non-essential symptoms of MI. Essential signs (Appendix A) are symptoms which are likely seen in MI (chest pain, diaphoresis, nausea and vomiting, anxiety, and restlessness). Students were taught that the likelihood of MI increased with every added symptom, with a probable diagnosis occurring when all five symptoms are present at once. Students were also taught 14 non-essential signs of MI (Appendix A) which may or may not be seen with MI, but if seen with any essential signs, increased the likelihood that symptoms are caused by MI. Non-essential symptoms included a subjective feeling of doom, dizziness, and weakness. The average number of days between the didactic class and interview was shortest for Group 1 (M = 29.6 (14.6) meaning that this group had received the information about symptoms of MI most recently.

Students stated that remembering signs and symptoms associated with MI was difficult. When asked how the decision of MI was made, Karina responded, "It's just trying to remember what we learned in class!" Students appeared to use the list of signs as a rule to determine if MI is present. Fernando said,

> ...so if you're telling me, "Look this is serious. Something's wrong here. Figure it out." If you're telling me that and I can, you know, remember the classic signs that I learned in class, then I can put those two together.

However, students did not expressly articulate the association between knowing the signs and their use as a mental model for comparison, instead focusing on the importance of remembering the signs. Some students referred to assessing for 'classic' signs or suggested a comparison by discussing an expected 'norm' for symptoms of MI. There was little conscious awareness that a mental comparison between symptoms in situation and a mental checklist was being made. Maricela's statement alludes to a mental comparison: "[If] they don't have the classic signs of a heart attacks...we might not associate those symptoms with a heart attack. So, that might hinder [recognizing if someone is having an MI].

Students also indicated that under pressure to diagnose MI they may be less likely to remember the signs and symptoms. Melisa stated that in order to treat MI, "[I need to] get my panic out of the way, list the stuff I need to do in my head, ...and go through the signs and symptoms ..."

Group 1 students said they needed to have knowledge of the symptoms of MI in order to recognize MI in a clinical situation. Knowledge appeared to mean more than having been exposed to the information, however, or knowing where to retrieve it, but rather holding the information in working memory for manipulation of observed data compared to a symptom list. Student discussion focused on the necessity of remembering a list of symptoms, usually the essential signs of MI. Students' comments hinted at a employing a mental process for decision-making which began with knowing clinical signs which could be found in people experiencing a heart attack. Without the signs of a heart attack as a mental measure by which to compare symptoms students indicated lack of confidence in the ability to recognize an MI.

Theme 2: Recognize the symptoms when I see them. When trying to decide if someone was having a heart attack students expressed concern that they would not able be recognize the MI symptoms learned in class as they appeared in living people. Though students could list some essential or nonessential signs for MI, students lacked confidence in their ability to recognize those symptoms in a clinical situation for lack of previous clinical experience. For example, the clinical meaning of 'diaphoresis' lacked clarity for them, though students understood the textbook definition:

> I think I would be able to, maybe not definitely say, this is a heart attack, but I would be able to recognize some of the symptoms that we've learned. I mean, from what I've heard and read, diaphoresis isn't just sweating. It's actually almost like you pour water on somebody. And if you see somebody going through that process, you're going to think, "What's wrong with this guy?"[Margery].

If a student expected to see 'pouring water' as a sign of 'diaphoresis' in MI situations, the sign may not be associated with MI if diaphoresis appeared differently than expected, causing the diagnosis to possibly be missed. Margery indicated some confidence in her ability to recognize a MI, unaware of the discrepancy between her expectation of 'pouring water' and the differing forms diaphoresis may take in living people Lakisha and Ericka's statement also suggests that a diagnosis of MI could be missed because clinical signs may not be recognized:

> You may not know that you're actually seeing this person as having a heart attack. ...I think in every class they teach you about it, but it's different when you actually get out there and see it. Because you're taught so much information that you kind of forget and you won't know until you actually get out there in a clinical field and can actually see it for yourself, can actually work with seeing it, "ahh, that's what that is."

When asked if students felt capable of recognizing a person's symptoms as MI with current knowledge and experience, answers ranged from 'No' (N = 2 pair, 22.2%), to enough is known to suspect an MI, but not sure of the diagnosis (N = 3, 33.3%), to "[It's a] hit or miss thing" [Liza] indicating a 50% chance of recognizing an MI with current skills (N = 2, 22.2%). In total, most of Group 1 (N = 7, 77.8%) indicated some lack of confidence in their ability to recognize an MI.

Two pairs of students (N = 2, 22.2%) indicated 70-75% confidence in recognizing someone having a MI, but also indicated lack of confidence in interpreting symptoms correctly. In one case, this level of confidence was reserved for symptoms which were unquestionable in their meaning ("I think 75 [% chance of recognition] if it's a massive heart attack" [Karina and Fernando]).

Reasoning for lack of confidence was insufficient hands-on experience to correlate the symptoms written in texts with actuality. Students were not sure that symptoms of MI would appear as imagined. Fernando said:

> In class they always tell us pink rosy color, or you know, pink...When you see someone's who's pink and rosy, it doesn't look like the color pencil pink. You just have to look at it and then you know the pink that

they're talking about...It's about actually recognizing, like seeing the sweats and looking at their face when they're having that chest pain..."

Students suggested that 'hands-on' patient care experience was the best way to learn to recognize symptoms, but also postulated that testimonials by people who had MIs, or videos of people acting out an MI, might help bridge the experiential gap. Some student pairs stated having a mentor to help validate their thinking while diagnosing a person having a MI would be helpful for making associations between textbook descriptions and physical signs. One student pair suggested that seeing a nurse make a diagnosis of MI in a video would be helpful: "A patient, or a person...showing signs of a heart attack and how the nurse or some medical person would come and assess the person and what their steps would be...[helpful]" [Lakisha].

One student, when asked how she would decide what to do for a person having an MI said, "You just experience it and [use] some common sense" [Julianne]. Julianne appeared to have a sense that if she were in the experience, she would be able to recognize the situation as a MI, and furthermore, could rely on what she knew to guide her actions. This statement hinted at recognition of a MI as a gestalt understanding, rather than the result of any kind of comparison or analysis.

Students said that reading or hearing about symptoms in class is different than seeing the symptoms in an actual situation. In order to recognize a MI, students said they would need clinical experience of some kind to be able to associate actual symptoms with what was learned. Once the student had sufficient experience to recognize the symptoms, and knew what symptoms to expect in a MI, students felt they would be able to recognize if someone was having a MI.

Theme 3: Collect all the information I can think of. Students' thinking processes showed intellectual understanding for knowing the symptoms of MI, but when faced with the problem of diagnosing a symptomatic patient, students indicated that the decision rested on a number of parameters for which data collection was needed. However, students responses to which patient information was needed to determine if a MI were occurring ranged from clinical signs to medical tests. Students suggested gathering data about essential signs of MI, and some nonessential signs, but also selected a range of data which could be considered diagnostic, cardiac related, or prudent. Only one pair (11.1%) suggested they would gather data on all five essential signs.

Most student pairs indicated pain assessment was the first step in recognizing a heart attack (N = 7 pair, 77.8%), stating they would ask a few questions about chest pain (location, duration, type, onset, intensity, radiation) or attach significance to descriptors such as 'an elephant on my chest' or 'crushing' pain. Students said they would especially look for the sign of a patient holding the chest area (demonstrated by students as the sternal region) as an important indicator for a MI (N = 5, 55.5%). As Noemi said, [I look for] "how they're holding their chest … they feel it behind their breastbone, or usually they will, if they're having a heart attack…", or as Melisa said, "I would look [to…] see if they clutch their heart." Two student pairs (22.2%) indicated that the primary observation for diagnosing a MI is the hand-over-heart sign. Though not all students indicated pain assessment as the initial assessment, all pairs stated that pain assessment was important to diagnosing a MI.

Looking for diaphoresis, or sweating, was noted by six pairs (66.7%) as a sign associated with MI. A few students said they would look for evidence of anxiety and restlessness in terms of changes in calmness (N = 2, 22.2%) or physical attitude (N = 3, 33.3%), noting that patients could not be calmed if a MI was present, or patients would assume positions of sitting, hunching, or slumping. Two pairs of students mentioned observation for nausea (22.2%). No students said there would be observation for vomiting. As Noemi said, "I guess [I look for] the characteristic of the pain as well as if it's crushing or [for] some of the basic signs like sweating and nausea."

Many students wanted initial lab and test data (12-lead electrocardiogram (EKG), cardiac enzyme tests, oxygen level measurements, computed tomography (CT) scan, and magnetic resonance imaging (MRI) as useful information for determining if symptoms are related to a MI. Students also stated they would collect further information such as vital signs, look for any shortness of breath (SOB) (also called "heavy breathing"), alterations in airway function or skin color, dizziness, and level of consciousness. Students said that when evaluating vital signs, observations consistent with a MI would be blood pressure changes (up or down), temperature which went up, and a pulse that became bounding or slowed down.

Interviewing patients appeared to be an important means to collect data. Students asked about a patient's general well being, any feelings of impending doom, and any associated medical history such as a previous heart attack. Students also said they would ask if the patient could diagnose their own problem, including asking if the problem had ever occurred before this event:

> First I look at what their physical capacity is, meaning, like Noemi said, the sweating, the nausea. I [would] talk to them to see what's going on. Then I look for breathing. Once I know that they're able to at least breathe, I know that they're not passing out, I'm gonna take vitals. At that point I look

at their oxygen, the pulse, um, the type of pulse, like where their pulse is going…" [Maricela and Noemi].

Group 1 students collected data about the patient to aid in CDM, but had difficulty with saliency among the range of data options available by collecting a large amount of information. Students especially wanted EKG results, but also focused on two clinical signs: pain and diaphoresis. Though data collection was generally appropriate for MI and cardiac alterations, few students either established a priority order or cohesive plan for data collection, or explained how each point of information could contribute to determining the meaning of the clinical situation

Theme 4: Differentiate MI from other conditions. Many student pairs in Group 1 (N = 6, 66.7%) acknowledged there are many symptoms which could be associated with a MI and that presentation could be highly individual, atypical, and vary by age and gender. Furthermore, students acknowledged that signs for a MI were not all exclusive to a MI, but may be found in other conditions, rendering accurate diagnosis difficult. As Neil said:

> Symptoms of a heart attack come in many different forms and you can mistake them for something else. If the patient is complaining of pain, sometimes they're not holding the chest, so you're thinking they're having a stomach pain. If it's a pain in the arm, then it could be that they're hurt [in] the arm. You might mistake it for something else, not thinking that it might be the chest pain, and the pain is really moving down the arm. So you can miss it by thinking it's something else that's going on and not a myocardial infarction.

According to students, a MI should be distinguished from non-MI conditions such as chronic obstructive pulmonary disease (COPD), indigestion or stomach pain, an injured arm, lung pain, angina, anxiety, and unknown conditions, by a 'rule out' process. Students indicated they would have difficulty ruling out non-MI conditions with overlapping symptomatology because of inexperience and little knowledge about other conditions.

> Well, they've got these symptoms and you say, "What did you have for lunch?" and they say, "Well I had a bunch of jalapeños." Well that happened the last time you ate jalapeños? "Well, yea, I had the same pain then." So, [it's] probably not a heart attack. But I'm sure they're other more complicated things that we don't know about yet, but we could rule out too. [Jerri]

Students suggested two methods to differentiate a MI from a non-MI: Comparison of patient symptoms with a benchmark (textbook symptoms or previous clinical experience), and/or tests (interventional or medical). Neil stated, "You use them [previous patients with MI] as an example. You wouldn't use them as a *total* example but it's at least a look of what will happen to somebody else in the same situation." Or, as Kelly said, "You would just go through, based on what you've been taught, just go through a list and kind of rule out everything else until you're actually at the right one [diagnosis]."

Students observed patient response to chest pain interventions as a guide to CDM, noting especially whether the pain responded to doses of nitroglycerin (NTG). Students concluded that if pain was alleviated the situation was unlikely to represent a MI, "If a patient gets medication and oxygen, and the pain leaves, then it's probably not a heart attack" [Neil]. Some student pairs stated that medical tests such as cardiac enzymes or 12-lead EKG would distinguish a MI from a non-MI, and furthermore, stated these tests could confirm (rule in) the presence of MI.

Theme 5: Making a diagnosis - Err on the side of caution. When asked about decision-making regarding a MI, students stated they did not feel experienced enough to make the determination. Students said they could not make the diagnosis, or do it well, so said they would rely on the physician or an experienced nurse to make or confirm the decision. Students stated, though, that if symptoms of MI were present they would "err on the side of caution" [Jerri], treating the situation as a MI (N= 4 pairs, 44%).

Some students appeared to believe diagnosis meant proof of a MI and therefore indicated the diagnosis of MI could not be made on the basis of a person's symptoms alone. Students indicated medical tests were needed, such as EKG or cardiac enzymes, which could rule in the diagnosis. However, since medical tests required a physician's order, the ability to diagnose a MI was outside the scope of nursing practice, students said. As Katherine and Edwina stated, "I'd bring over a more experienced colleague to confirm my findings. And the EKG would help. You [also] can do lab work." Or as Fernando said, "Call for help!" Some students said that location of chest pain or severity of symptoms, especially pain which was not relieved, could rule in a heart attack. When asked how they would decide if someone were having a heart attack Lakisha and Erika said:

> If they're holding their chest, saying that they feel like they're about to die, they're sweating a lot, they may be short of breath, may be kind of dizzy or weak. The first thing I probably would do [would be to] give nitroglycerin and see if it relieves it... If it doesn't work after 15 minutes it's a heart attack.

However, rather than deciding whether a person was having a MI or not, students often relied on 'if/then' prescriptive interventions based on symptoms. If a symptom of a MI was present, then the student would know what to do, without having to address diagnosing the condition before treating. Treatments selected indicated a de facto decision, though students were not consciously aware that the decision was made. For example, Karina indicates she would treat the symptom 'pain' as a MI, "The first thing is to ask you to describe the pain, if you can. Then, if it seems like you are having a heart attack, give you that aspirin, a.s.a.p. [as soon as possible]". And, according to Elinor and Neil, if symptoms of a MI were recognized the following response would occur:

> The first thing you want to do with somebody you believe is having a heart attack is to maintain their safety and to make sure that they're getting some form of oxygen to prevent any further harm, just in case that's happening.

Students surmised that family members who interfered with data collection, patients who were not able to communicate, or someone who deliberately faked symptoms could cause difficulty with diagnosing a MI. For some students context was important, when, for example, access to medical equipment and lab data was not available because the MI symptoms occurred outside a hospital setting, the diagnosis would be difficult to make.

The greatest barrier to decision-making, according to students, was lack of experience. Students said that if they had sufficient experience with people having MIs, which was defined as hands-on clinical patient care; proxy-experiences, such as nurse stories, patient stories, and videos; or pseudo-experiences with manikins, they could more likely diagnose a MI. Student sources of information for making decisions about a MI were almost exclusively from the didactic class, though some students had family members or friends who had an MI, and many mentioned television depiction of a MI showing the person clutching the chest. Students suggested that with one to six clinical MI exposures their diagnostic skill might be sufficient:

> Just being a registered nurse, with no experience thus far with heart attack patients, I think I'd have to see it, I'd say a couple times. I mean, five or six was a good number. But once you actually see one time, you're more aware of what to look for. And then if you see it a second and third time, then you're like "Okay I got it." So by the time you do get to six, you definitely know, I'm not, I can't say for certain, but this looks like cardio factors…[Elinor]

Some students said that lack of experience lead to "second guessing" which hindered the decision-making process, though students said that if unsure, they would treat symptoms of a MI as a MI. As Julianne said, "Better that than them dead in the future."

Summary. Group 1 students received a didactic class on symptoms of a MI and were asked about their thoughts when deciding whether a symptomatic person was having a MI or not. Students indicated first that an understanding of the symptoms of a MI was needed plus the ability to recognize those signs as they appeared in actual patients, especially chest pain and diaphoresis. Students indicated a mental process of comparison occurred using a list which consisted of some of the signs and symptoms of MI, but also cardiac assessment and medical test data, to attempt to rule in or rule out a MI.

Group 1 students stated they needed to collect situational data, but were not sure which data were most needed. Students were challenged in diagnosing MI by their lack of experience, anxiety, and lack of knowledge about other conditions with overlapping symptomatology. Students realized that in order to diagnose MI, other conditions may have to be ruled out.

Students were unsure of their ability to diagnose and stated they would like validation of their decision when possible, or have a more advanced clinician make the decision. In fact, the decision to make a CJ was only tangential to their thinking. The diagnosis was less the result of cue recognition but students' decisions to treat MI symptoms as MI.

Analysis. According to the conceptual framework for clinical judgment, students in Group 1 exhibited architecture for decision-making, but due to lack of knowledge, experience, and trusted situational data, had difficulty in reaching a CJ. Students had virtually no prior experience for pattern recognition, other than a few stories and what was learned from depictions of people having heart attacks on television. With insufficient exemplars, no prototypes for a MI could be extracted. One student showed awareness for an unconscious process of recognition which would occur in a clinical situation with experience, but most students resorted to use of working memory for rule-based recognition of a MI. Rule-based diagnostic reasoning is characterized by 'If/then' statements. "If the patient has chest pain, then give analgesia" is an example of an 'if/then' statement. In addition, though students indicated hypothetico-deductive analysis of a symptom set should occur when a MI was suspected, in actuality, their 'if/then' solutions to MI diagnosis suggested a rule-based decision-making model (Cioffi et al., 2005; Shortliffe & Buchanan, 1975). Final diagnosis for a MI was often suspended, with students stating they would call for assistance with the CJ from more experienced clinicians. Furthermore, students asked for validation of their CJ, consistent with dopamine-based reward theories of learning. Corrective feedback improves accuracy of decisions (Maddox et al., 2003).

If experience, knowledge, and situational data are necessary for category learning, Group 1 students are unable to recognize category a MI because of deficiencies in all three areas. Students, save one, did not indicate any awareness that the answer to the diagnostic problem could be unconsciously solved by their presence in the situation. Without a basis for pattern recognition, students lacked CT to recognize the nature of the problem.

Students were unable to form a complete prototype (one student pair could name all essential signs), but also appeared unable to use information-integration processing because saliency of cues could not be determined. The wide range of information students said they would collect and use indicated that few feature cues were important to recognizing a MI for them. While some weight was attached to pain and diaphoresis, it may be that lack of clinical experience to reliably recognize symptoms lead to an alternative category learning strategy, because students could not trust that they could 'read' the symptoms correctly. In addition, as no feedback had ever been provided regarding decision-making in a MI situation, information-integration category learning did not occur.

Rule-based category learning is an easily articulated form of categorization which uses working memory under conscious control (Ashby & Maddox, 2005; Maddox, Ashby, & Bohil, 2003). Students indicated that if they could remember the 'rules' (symptoms of MI) then, through simple rule application, they could determine if a MI condition existed. Therefore, students repeatedly indicated the importance of remembering signs and symptoms as crucial to recognition. However, an important feature of rule-based learning is ability to verbalize the optimum rule (Ashby & Maddox, 2005). Students did not verbalize an optimum rule, but indicated a mental comparison would be made between the 'rules' and symptom cues presented. Memorization is essential to classification (Estes, 1994), and students had not committed the 'rules' to memory. Students in Group 1 would most likely have difficulty in recognizing a MI. Analysis of student statements indicates that neither prototype nor information-integration processing pattern recognition developed after the didactic class, and furthermore, students indicated rule-based recognition would be used. However the 'rule' (list if MI symptoms) was often incomplete due to lack of memory for the symptoms of MI.

In the conceptual framework for CJ, if CT does not occur through pattern recognition, then analytic, non-analytic, or nonanalytic followed by analytic CDM should be used to diagnose the condition. Students discussed generating alternative hypotheses for the diagnosis, a form of analytic CDM, recognizing that other clinical conditions had some of the same symptoms from which a diagnosis would need to be differentiated. However, students did not discuss actually performing hypothesis testing, but referred to 'if/then' scenarios which suggested a de facto diagnosis for MI consistent with rule-based pattern recognition used by novices for making a clinical decision (Shortliffe & Buchannan, 1975). Furthermore, decision-making without adequate category formation could be considered non-analytic heuristic or 'snap judgment'. Heuristics short-cut CDM because only enough information for the decision-maker to be reasonably certain of a correct judgment is used rather than recalling all relevant information before the decision is made (Schwarz, 1998).

Though Group 1 students made 'snap judgments' they did not reach awareness for the decision that was made; seldom arriving at the CJ, but holding the decision in abeyance, or if required, made the decision that anyone with symptoms of MI should be diagnosed as having a MI in the interest of patient safety.

Qualitative Data Analysis Group 2. Nine transcripts of 'Thinking Aloud' data for student pairs who were given control simulations of only essential signs of MI were qualitatively analyzed for patterns and themes (N= 9 pairs). Nine transcripts were coded. Four themes emerged from the data (Appendix Q).

Theme 1: Obtain data but look for the five essential signs. Students in Group 2 focused on identification of essential signs of MI (chest pain, diaphoresis, nausea and vomiting, restlessness, and anxiety), indicating that diagnosis of a MI could likely be made if some, or all, of the signs were present. Though students said they would collect, and in some cases, evaluate other data, students focused on finding the symptoms. In addition to looking for symptoms, students said they would also assess vital signs and oxygenation, and obtain lab and test data. Though students said they would identify patient risk factors for MI, the risk factors were used as a guide for decision-making rather than an evaluation of the likelihood of MI as if a positive cardiac history added cue weight to symptoms of MI, increasing saliency. As Marylou and Tia stated when discussing diagnosis of MI:

> I think abnormal vital signs are the first thing that I would look for and then, from there, how many of the [essential] signs and symptoms. Is it just

> one, or is it three out of five or, four out of five?... Do they fit the criteria?...Are there risk factors [such as a] history of smoking, obesity?

Or as Stacie said, "If they're having severe chest pain and already have a family history of heart attack, you could tell from that."

All students looked for some essential signs of a MI, but students indicated that recognition of a MI was essentially prescriptive (N = 7 pairs, 78%) ("If symptoms keep increasing from chest pain to the nausea, vomiting, other classic signs, then we should think he's going into heart attack [Sandi]). However, other data could support the decision such as evidence of nonessential signs of MI (for example, gender, age, left arm pain) and changes in vital signs. Students said that they could review cardiac enzyme lab data troponins and CK-MB) and some students would evaluate vital signs or other data for changes (N = 4 pairs, 44%). However, Clare stated that understanding changes in vital signs could be a barrier to diagnosing MI:

> If their blood pressure doesn't go high, but, maybe just the pulse does, or, if their respirations increase but they're not sweating, and they're not uncomfortable in any way and they're not in pain...if they have one symptom, or maybe two, then it's kind of like, "Well, I don't know. Are they? Are they not?"

Student statements suggested that when essential signs of MI are present the diagnostic task does not pose a problem. But Clare's statement suggests that when symptoms do not present as expected, and other signs are observed, such as pulse changes, that diagnosis is difficult. Students collected prospective data other than essential signs, listing many appropriate points, but selection of data was discrete and unrelated as a whole. Stacie and Gwen discussing how they will diagnose a MI is an example:

> You order the EKG and [look] if the ST is elevated, and you would look at the labs; definite would be the troponin. You assess the situation if they have chest pain, which is radiating to the left arm or to the back. If they are diaphoretic, if they have nausea and vomiting, if they are anxious, you could pretty much tell it's a heart attack. Do vital signs… know the baseline to check when they came in and what they have [at] the moment. Maybe a little of fever; ask for the signs and symptoms.

In this example most data are appropriate for diagnosing a MI, but observations are related in a stream of consciousness and students do not relate parts to a whole or indicate how meaning would be made from the observations. However, if relationships were suggested, thinking appeared to be associative rather than complex:

> If you are complaining about the chest pain and you are feeling sweaty, I have to check your blood pressure, 'cause most times chest pain goes along with blood pressure. If your blood pressure is high, I have to check your temperature. I have to check your respiration if you're having shortness of breath. You cannot really say if someone was having shortness of breath if you're not checking the respiration, if you're not checking the SPO2 [oxygen saturation]. So, the vital signs are also very important, as long as [they are] coupled with what [the] patient is telling you [Sandi].

Sandi alludes to a more complex relationship between the data and patient interview information, but how the data would relate is unexplained.

One student pair (11.1%) indicated that when symptoms of a MI were present, they would continue to look for information to fill the void to create a whole picture "I would try to assess for the other symptoms that I could kind of pull together [the clinical picture]" [Karen and April]. This statement indicates that the students would begin to assess for missing information to aid in diagnosis.

Though students in Group 2 stated they would collect different types of data to diagnose a MI, students said they would focus on evidence of the five essential symptoms to diagnose a MI. Patient history confounded some students by adding complexity to the decision making process, but others used the information in an additive manner, as if the presence of history and risk factors added weight to the essential symptoms to trigger a diagnosis.

Theme 2: Differentiate from other conditions. Students in Group 2 stated that to diagnose a MI symptoms had to be differentiated from other conditions. Some students indicated that conditions such as angina and gastro-esophageal reflux disease could have symptoms similar to a MI which would need to be ruled out. Some students differentiated a MI from a non-MI by response to treatment with the medication nitroglycerin. Others student pairs stated a MI could be ruled in by diagnostic tests. For one pair of students (11%) lack of knowledge about other conditions made diagnosing a MI difficult.

Six pairs of students (N = 67%) said that MI needed to be differentiated from other possible disease processes which had overlapping or similar symptoms. Students did not always identify which conditions would need to be ruled out but suggested that presence of MI symptoms alone did not confirm the diagnosis. As Tanisha said:

> If it's just heartburn they experience chest pain, so that would get in the way [of diagnosing a MI]. If they are having that, along with symptoms of a heart attack, you would have to rule out either one to know which one it really is.

Students said that if chest pain were relieved by treatment, it was unlikely to be a heart attack, most often citing administration of nitroglycerin as the differentiating treatment. Serena indicated the belief below:

> It's enough [pain] for them to have to have medication... Especially if they've had their three nitroglycerin [tablets] and they still are feeling chest pain, it's best to go to the hospital 'cause it's more than likely pointing to a MI.

Students used theoretical knowledge to try to differentiate a MI from a non-MI, but were not always sure that this could be done by a nurse, citing scope of practice limits on ordering confirmatory tests. One student pair (11.1%) stated that they did not have enough knowledge to differentiate a MI from a non-MI. As Tia states:

> As to a possible heart attack instead of anything else… I don't feel like I have the knowledge-base to be able to exclude other possibilities right now. I hope to when I graduate, but I don't feel like I have the training or the knowledge-base to be able to determine [a MI].

Group 2 students said that MI would need to be ruled out from other conditions with overlapping symptomatology, or ruled in with confirmatory tests. Students felt that tests such as an EKG and troponin levels could not be performed without a physician's order so therefore students were limited by their scope of practice to diagnose a MI. Without confirmatory tests, students were not sure how to exclude competing diagnoses, most often citing response to nitroglycerin administration (N = 2 pair, 22%) as a determining factor.

Theme 3: Make a diagnosis – Reaching the tipping point. Group 2 students indicated anxiety about making a correct diagnosis, especially under time pressure, but expressed confidence in their ability to make a clinical judgment about MI (50-95% confidence). Students indicated that the essential signs of a MI were needed but the presence of certain symptoms would raise an index of suspicion for a MI. Varying clinical presentations for MI added difficulty to the diagnostic task. For some students certain data were more salient than others for making the diagnosis. Some students suggested validation or mentoring would aid in diagnosing a MI but other students assumed the role of novice nurse and deferred decision making to another clinical practitioner. A few students erred on the side of caution (N = 2 pairs, 22%) by diagnosing a MI if symptoms were present and some students treated symptoms without making the diagnosis. One pair of students stated that caring about the patient was motivation to make accurate CJs.

Diaphoresis and vomiting appeared to have attained saliency for some student pairs (N = 4, 44%) as an important diagnostic indicator for a MI. Students said that presence of these symptoms would raise an index of suspicion for a MI. As Aubrey said, "The sweating, vomiting: If I saw those two together, and the restlessness, if I saw all three of these I would be very suspicious." Or as Sharon and Zelma observed, "A big thing [is] listening and watching [for] sweating and throwing up." For one pair of students (11.1%), symptom presentation order may have affected determination of salience. In the study symptoms were randomly assigned, however, for this pair nausea and vomiting were either first or second symptoms. Diaphoresis was the first, fourth, and fifth symptom, however, the mannikin was sprayed with water to simulate diaphoresis during scenario preparation, so it was possible to observe this sign prior to its planned presentation.

> When we [were] doing all the scenarios, it seemed like the diaphoresis and the nausea started first, before the chest pain. I don't know if that's how it is in real life, or if it changes, but those seem like they came before the chest pain, then the restlessness and anxiety...So I probably would look at those [to] see what comes first [Vernell].

Students appeared to develop saliency for two symptoms, nausea and vomiting, and diaphoresis, though all stated that chest pain (N = 9 pairs, 100%) was important to diagnosing a MI ("Chest pain is the red flag" [Tania]). One student pair exhibited surprise for the symptom 'diaphoresis', "Did you know about the sweating [addressed to partner]? Sure, I know about the sweating for a test, but did I *really* know about the sweating? No" [Kimiko].

Students easily listed appropriate cardiac data they would collect including essential and many nonessential signs, however students had less clarity on which set of observations would trigger the diagnosis. At the same time, students did not discuss attempting to interpret the data other than in terms of change or magnitude, with worsening essential symptoms associating with a MI.

> Well, they're experiencing pain right now. What else? What are the other signs about a MI? Do I need to just treat pain or maybe the whole MI procedure? And then, if that doesn't [work to treat pain] you know, just one step after the next trying to figure out if it escalates to the point where they are having the MI, you know to call the doctor [Nita].

Nita's statement suggests a decision is not made by analysis, but by a crescendo of symptoms which will motivate her to face the physician with her diagnosis. Students stated they would call the physician for orders such as pain medication, lab tests, or an EKG, but some would wait for physician feedback regarding the seriousness of the patient condition without actually assigning a diagnostic label. Students were uncomfortable with the prospect of incorrectly diagnosing and asked for mentoring or validation of their decision with another clinician.

No student pairs discussed or appeared to use hypothesis testing when making a clinical decision. One student pair (11%) alluded to using a mental model for comparison, and evaluating the resonance between the case and the model:

> You just have this picture in your head. Like it's an older, usually you think male, but women also. We just like to think males, but you know women have increased chances too. But this older kind of male, maybe with a big belly or something [is more likely to have a heart attack]....But if the person is under forty years, it would be hard for you to think to heart attack [Vernell].

Vernell's statement suggests that data which most closely matches the model will be given the diagnosis of MI.

Most students appeared at least moderately confident in their ability to diagnose a MI, believing that they knew to look for and identify data important to diagnosis, especially the five essential symptoms. Students were less clear about what to do with the data once collected and how it could be used to reach a diagnosis, instead almost assuming that a data tipping point would somehow be reached, triggering the diagnosis.

Theme 4: What I learned on reflection. Students in Group 2 reflected upon their simulation experiences and stated their knowledge and experience had been augmented (N = 7 pairs, 78%). However, students found simulation insufficient for complete confidence in diagnosing a MI and suggested needing at least one experience caring for an actual patient. Students spoke of learning about their errors, but reflection appeared to cause little insight, especially in relation to bias in CDM. However, one student pair (11.1%) discussed awareness for consequences of actions when diagnosing a MI:

> We assessed the situation and he continued [to] have severe chest pain...When [we] gave the [nitroglycerin] patch you would have an idea [that if] the person still is having chest pain ...[it] probably is a heart attack. But, you wouldn't just go and patch everybody...If the patient already had low blood pressure it would go even lower...There would need to be some baseline to put the patch on [Stacie and Gwen].

Stacie and Gwen's statement suggests a diagnosis of a MI was made followed by a CJ to treat with medication. However, the students imagined the consequences of treatment with nitroglycerin, a vasodilator (McCance & Huether, 2005) which would lower blood pressure, and projected that if the blood pressure was to low start with, it could go lower after the medication.

Some students said that simulation was an experience upon which more knowledge and experience could be built. For example, Aubrey and Kimiko said:

> From the first scenario to the last scenario I was much calmer and...I thought, 'I can think this through better'. And every scenario I felt, even at the end, I felt like I was coming up with more solutions to solve the

> problem…All of a sudden little thoughts would pop into my head…Every time you do this you're going to glean a little bit more information.

Students focused on tasks and stated they learned prioritization (N = 2 pairs, 22%). However, students did not reflect on CDM or gain insight into how decisions were made. Some students made statements which suggested an awareness that bias could be present in decision-making, but did not reflect upon its relevance to their own situations. Karen and April give an example about trying not bias a physician's diagnosis:

> I don't want to stick my foot in my mouth and say, 'Look, this is what I think it is' and he [the physician] comes up and he [thinks], 'This is totally different'. The thing is, if you prepare someone for one thing, I feel like you kind of have that mindset going into it. And if they're presented with something totally different, then I think I hindered the healing process.

The students are aware that how they present information could bias the physician's decision making, even causing the physician to incorrectly diagnose and affect the patient's welfare. However, no indication was made which suggested that the students' anticipated that their own thinking could be biased. Serena made a statement indicating an awareness of bias, but did not indicate an understanding that bias should be consciously avoided, "Sometimes you're like, 'Oh, he's had a heart attack before". Maybe it's just kind of the same thing [another heart attack], but what if, in the end, it was actually something else?

Students' statements indicated they did not attain realizations and insights related to making decisions about diagnosing a MI, focusing instead on gains in knowledge and experience. Though students were aware that bias could enter into decision-making, students did not appear to internalize the lesson for future use.

Students verbalized that the MI could be viewed as a whole, but appeared to view the whole as consisting of a series of tasks to achieve an outcome. Nita and Clare said:

> [When] you actually get out there [in the hospital] and do it, that's when everything kind of starts to fall into place...and you see the big picture. It's like pulling muscle memory, except not muscle....Just being able to predict what is going to happen based on a set of signs and symptoms....I can evaluate the situation, like, okay, this is consistent with this; you connect the dots and fill in.

Nita and Clare's comment suggests a belief that repetition will improve diagnostic ability which includes predicting which symptoms should be present if the situation is a MI. There is no indication of CDM, but the statement suggests students believe they will be able to recognize a MI with repeated exposure. Kimiko's comment sums up students beliefs about diagnosing a MI:

> I'm just hoping that the basic things that we learned today would clue me in, like looking at that little list that you gave [essential and non essential symptoms of a MI] and looking for more symptoms to assess and put the big picture together.

Student statements suggest a belief that if the right combination of symptoms occurs they will be able to diagnose a MI. By having clinical experiences caring for patients with a MI students believed that the constellation of symptoms associated with a MI will become meaningful, making diagnosis possible.

Students in Group 2 said that knowledge and experience improved with simulation, but that actual clinical experiences would be needed to improve their ability to diagnose a MI. Students appeared to believe that 'practice makes perfect', especially practice looking for symptoms of a MI and prioritizing actions. They also said enough practice could result in diagnostic expertise. Some students were aware of bias, but did not reflect on the impact of bias on their own decision-making. However, some students were able to cognitively determine potential consequences for actions and use this insight to guide CDM.

Summary. Students in Group 2 were confident of their ability to diagnose a MI, but lacked experience and believed that actual clinical care was necessary to have complete confidence. Students said they would look primarily for some or all of the five essential signs, but also would collect supporting data such as nonessential signs, lab, and test data. Students did not discuss a decision-making process but indicated that the number and increasing severity of symptoms would result in a diagnosis of a MI. However, students asked for validation of their decisions and mentoring because diagnoses needed to be timely and accurate.

Students indicated salience for some symptoms, especially chest pain, nausea and vomiting, and diaphoresis, which would raise an index of suspicion for a diagnosis of a MI. MI was seen as a whole phenomenon which could be understood by its associated symptoms. Though students indicated decisions could be biased in a clinical setting, students did not say how knowledge of bias would be used.

***Analysis*.** Students in Group 2 collected situational information and used prior knowledge to determine if patient symptoms were caused by a MI. Students easily articulated which data should be collected, however the information appeared to be a list-wise task, though students said that the information was part of a relational whole.

Student statements about use of patient history and risk factors suggested that predecisional judgments were made based on cue weighting to assist the student in determining salience of a sign to making the diagnosis. For example, if there is chest pain and the patient is a smoker, then the cue chest pain has greater significance (weight) for a MI (Ashby & Maddox, 2005). The use of predecisional judgments is consistent with information-processing theory which suggests that a pattern recognition category for a MI was forming. However, since the theory states learning is feedback dependent (Ashby & Maddox, 2005), and the students received little or no feedback, the strength of the category for diagnosing a MI may questionable.

Group 2 students were given the prototype for a MI (five essential signs and symptoms) which did not require the brain to extract averaged features. Students were not given additional category cues (other symptoms) during the simulation, rendering the category less complex and more difficult to learn (Homa & Chambliss, 1975; Sandhofer & Doumas, 2008; Scott et al., 2008). Some students appeared to rely on a template to compare feature cues observed against a mental model of patients having a MI to render a diagnosis (similarity-based recognition). However, bias may have entered the decision-making process as representativeness bias occurs when judgments are made based on a mental model (Brannon & Carson, 2003).

Some students appeared to develop a heuristic for diagnosing a MI based on the presence of chest pain, the association of nausea and vomiting with diaphoresis, and the temporal relationship of all three. Though students said that a MI can present differently among individuals and should be differentiated from conditions with overlapping symptomatology, students appeared to use underdeveloped pattern recognition and the newly developed heuristic to reach a CJ.

Students recognized that bias could occur, but did not recognize when bias was occurring. Students were subject to order bias, which occurred when students searched for symptoms in a particular order, and furthermore, students were aware of potential priming effects bias on the physician. Some students were able to use rudimentary parts of analytic CDM by determining consequences of actions before selecting a course. During hypothetico-deductive reasoning potential consequences of decisions are predicted (Manias et al., 2003). However, Group 2 students did not indicate or state that alternatives were being evaluated, but simply an awareness that an action could have consequences, which were irrelevant.

Qualitative Data Analysis Group 3. Transcripts of 'Thinking Aloud' data for students who experienced pattern recognition based simulation scenarios were analyzed for patterns and themes (N = 9 pairs) . All transcripts were interviews of student pairs yielding nine transcripts for coding. Five themes emerged from the data (Appendix R).

Theme 1: Obtain, analyze, and evaluate patient data for salience and context.

Students in Group 3 stated that data needed to be obtained to make a decision about whether a person was having a MI. However, students not only collected data, but evaluated some data based on saliency and context for the situation at hand. Saliency of data was determined after analysis and evaluation, and furthermore, considered as part of a perceived whole.

Students said to make a diagnosis of a MI they would obtain data and look for patient problems in determining a MI, particularly the presence of some or all of the essential signs of a MI (chest pain, nausea and vomiting, diaphoresis, restlessness, and anxiety) (N = 9 pairs, 100%) and some nonessential signs (for example, SOB, palpitations, pallor) (N = 6 pairs, 67%). For some students data were collected all at once rather than linearly "[I look for chest pain], check their O2 sat [oxygen saturation], check for sweating. I look for all those things, just at the same time" [Brian]. Furthermore, assessments were repeated and comparisons made between old and new data (N = 7 pairs, 78%). Students not only had some clarity about what to look for when determining the presence of a MI, but were able to articulate somewhat rapidly and fluently which parameters should be observed.

Students assigned significance to data by comparisons with previous measurements or other data, such as health history to establish a patient's risk for a MI, before determining that the symptom present was attributable to a MI. Students did not often state what cognitive operations occurred, but instead said that they were done. Kathryn and Jasmin stated that after initial data collection they would "evaluate the signs and symptoms" and Amy stated she would "first check vital signs, then do it again, monitoring changes". Evangeline hinted at analysis by stating that she would "review any previous conditions and ask 'why are they [the symptoms] here?' or 'what happened?"

More often students indicated they made decisions about data being more or less important than other data (N=5 pairs, 56%) but did not or could not explain the decision. Brian stated, "I think for some reason that checking the O2 sat is pretty important", or, as Fannie stated,

> I mean, there may be signs and symptoms that may not be relevant to the person's real diagnosis. So, I mean, you just have to know when to throw

those things out and not let it get in the way of coming up with what's really going on.

Most students (N = 7 pairs, 78%) indicated that the patient history should be evaluated for the presence of risk factors, such as smoking or a previous MI. In addition students indicated the patient could be interviewed for subjective symptoms such as location and intensity of pain and an impending sense of doom. Some students suggested assessing cardiac enzymes or EKG results.

Students indicated that data needed to be perceived as part of a whole to be understood. Students said a diagnosis is not made by presence or absence of symptoms, but in how the signs relate. Barbara said what was needed was:

> …a good assessment, the vital signs, [see] how the patient's feeling, what the patient is stating, how the patient's acting, and then look at that as a whole. Because, if the chest pain did not go away, and the restlessness, I would have probably thought, "Okay, he's probably just anxious or it's just the pain." But it wasn't any one symptom. It was the fact that he had this, this, this, this, and this together that was like, "Okay, I think he's having a heart attack."

Or as Frank said, "You should also look at the age of the patient, history, hypertension, [is the patient a] diabetic, [is the patient] a smoker, look at other things like race and lifestyle, too. Then add everything together and decide if this person is actually [having a heart attack].'

Students in Group 3 said that to make a diagnosis of MI assessment, test, and lab data were needed but students did not rely on the presence of specific signs or symptoms to make the diagnosis. Data were not considered equally as some data were considered more salient to the diagnosis than others. Students in Group 3 analyzed the data in comparison to other findings, and evaluated the significance of the data in relation to the diagnosis, seeming to attempt to visualize data in some contextual scheme or whole before reaching a conclusion.

Theme 2: Differentiate MI from other conditions. Students in Group 3 stated diagnosing a MI is difficult because symptoms may be indicative of another diagnosis with symptoms which overlap a MI. Therefore a process of rule out/rule in was used to aid in distinguishing a MI from a non-MI and often focused on alleviation of the symptom 'chest pain'. If chest pain could be eliminated with intervention, particularly with the medication nitroglycerin, students said a MI could be ruled out. Students said the magnitude of MI symptoms, especially a crescendo of symptoms, was a diagnostic indicator for a MI. However, students indicated differentiating symptoms of a MI from a non-MI was difficult as many signs and symptoms might be present during a clinical event.

Most student pairs indicated that to diagnose a MI, symptoms must be differentiated from other conditions which have similar symptoms (N = 8, 89%). Kathryn said, "I mean most people can have just a cough, heave, nausea or vomiting. That can be a normal thing. He [the patient] hadn't eaten since he's been here so it could have been something else [besides a MI]".

Students indicated the response to treatment for chest pain as helpful in differentiating a MI from a non-MI. Frank and Ruben said, "If he's having chest pain you can give him nitroglycerin. Try to get the patient comfortable. Sit him up. See how he does with that. Try to reposition the patient. See maybe [if it] might be a gas bubble." However, students stated that to diagnose a MI, other conditions may need to be ruled out. Bianca and Crystal said, "I think we try to rule everything out first, instead of going to the worst possible thing… I'd rather think that maybe it's just gas or something". While students stated they would rule out other diagnoses, they also took steps to rule in the diagnosis, such as by examining cardiac enzymes.

Students said differing presentations for the symptoms of a MI was a barrier to diagnosis (N = 7 pairs, 78%) because a MI presented differently in different people.

> I mean, I don't think you ever have a typical case and not everybody has A, B, & C. You know, you can have A & C or just A or B. So I think you can never have a typical case [Kathryn].

Students said that more experience with patients with MI, and patients with overlapping symptoms with a MI would aid in diagnosing a MI.

Group 3 students indicated that diagnosing a MI was more than identifying the presence of symptoms, but that symptoms needed to be discriminated from other possible causes. Though students were aware that differentiation was needed, their ability to do so was compromised by lack of experience with a MI and other conditions. However, students said that ruling out competing diagnoses, and possibly ruling in a MI, was part of the process for identifying the presence of a MI.

Theme 3: Making a diagnosis - I can do it with support. Students in Group 3 said they were uncomfortable making the diagnosis of MI unsupervised as novices, but said with mentoring or validation they believed they could. Students had an underlying concern with mis-diagnosis and were concerned with assigning the correct diagnosis to the problem. Without support, some students said they would err on the side of caution and diagnose patients having symptoms of a MI as a MI (N = 3 pairs, 33%). Students had concerns about the limits of their scope of practice as a nurse or student and felt under time pressure to make the diagnosis. A few students discussed deeper thinking, hypothesis testing, and hinted at pattern recognition.

Theresa's and Frank's sentiments about not feeling comfortable making the diagnosis 'in public', yet feeling capable of making the diagnosis 'in private' was common among students (N = 5 pairs, 56 %).

> I mean, I feel like if I were like out and about, like in a store, and I saw something I'd make a judgment call then, but like, when you're in a hospital as a student, you're like, "I don't know. I'm not gonna say that." Someone will jump down your throat and tell you that you're wrong just because you're a student (laughs) [Theresa].
>
> I feel pretty confident [in diagnosing a MI]. It's just I can't imagine being in the hospital and you know, like three or four nurses around me and then I just say, "Oh, he's having a heart attack," and they just look at me" [Frank].

Students appeared to fear embarrassment, chastisement, and/or an incorrect diagnosis if their clinical diagnosis were disclosed. Therefore students said they would like corroboration and validation of their judgments. Students stated that with mentoring, collaboration, and/or validation they would be more confident to make the decision within a hospital setting. Students said they would call upon experienced nurses, physicians, and colleagues for support in diagnosing a MI. Alondra said, "I can go to my coworkers and be like, "Hey, can you come double check behind me to make sure I'm not crazy?" Most student pairs (N = 8, 89%) stated that they felt more confident in diagnosing a MI than before simulation experiences.

Two pairs of students (22%) stated they would hypothesize several diagnoses before determining MI and furthermore, gather data after hypothesizing to confirm or disconfirm diagnoses:

> I think you will come up with a lot of ideas per diagnosis, but then you eliminate it one by one. You know we might think its angina, we might think it's a heart attack, it could be something else. But then when we see there's one symptom that doesn't corroborate that story, you know, it's like, okay well angina's out of the idea cause we know he wasn't exerting; he has the nitropaste, so we didn't think it was that; so the only thing that was left [was] the heart attack. Then we just got more evidence to back that up and then we just made our conclusion based on that, but we also kept in our minds that it could have been something that we didn't think of [Jasmin and Kathryn].

One pair of students (11%) stated that thinking needed to be "out of the box" [Jasmin] and another pair (11%) considered consequences of an imagined intervention (nitropaste): "First you want to get blood pressure before you do any medical intervention because it makes people's blood pressure drop" [Debra]. Three pairs of students (33%) showed evidence of some pattern recognition for a MI:

> When we first got here I was absolutely terrified that I was gonna miss it [the diagnosis], but now I feel confident that if I had anything anywhere close to what these patients had I could do it. I mean they don't even have to have the

same thing, but I feel confident now in myself that, hey I really did know this. I could pick up on this [Barbara].

Barbara's statement hints at development of a cognitive category for MI which allows her to recognize symptoms of a MI when they occur. She does not state how MI will be recognized, but has confidence that when faced with clinical symptoms of the MI she would correctly diagnose.

One student pair (11.1%) in Group 3 indicated that when confronted with a possible a MI situation they would examine the situation for missing information, "We thought about first the angina and a heart attack, but then we ruled out angina because it wasn't upon exertion. I guess you can rule out just by signs and symptoms not being there." [Kathryn and Jasmin]. The students' statement suggests deeper thinking to look for symptoms to determine which symptoms are not present which might be expected if the hypothesized diagnosis was true.

Students in Group 3 were personally more confident about diagnosing a MI but did not feel ready to make independent decisions. Some students employed strategies of hypothesis testing, deeper thinking in diagnosing a MI, and showed evidence of development of pattern recognition for a MI. Students had concerns about making errors in judgment, especially because judgments were made under time pressure. Though aware of their novice status and unsure of their scope of practice, students felt that mentoring, corroboration, and validation of decision making during clinical situations of a presenting MI would improve their diagnostic ability.

Theme 4: What I realize on reflection. During thinking aloud discussions, Group 3 students reflected upon their simulated clinical situations and became aware of missed interpretations and diagnoses, mistakes and/or biases. Students did not consciously state that their new awarenesses would improve future knowledge and experience with patients experiencing symptoms of MI, however, their statements suggested that learning was occurring.

Brian and Evangeline said "We made a mistake on the first one [simulation scenario]. I think I was biased in my thinking because I was thinking every scenario was going to be either MI, angina, or something related to cardiac." While the statement does not predict a change in behavior, awareness that bias leads to an incorrect diagnosis may aid the students to avoid future biases in thinking. Delaney's statement does suggest a planned change in practice from her experience, " I feel more confident to, maybe, if they do cough [note: a symptom related to pulmonary edema in the scenario] to check their lungs right afterwards, to make sure what it sounds like, instead of just being like oh, that's just them coughing or something."

Jasmin said that she would suspect a MI even if a patient was not admitted for a cardiac problem after her simulation experience:

> Like the first study, the scenario, we were completely left field with that one 'cause we were thinking pneumonia, we're just thinking respiratory, we're not thinking, well it could be something heart related, it could be something, you know, according to that. So yeah, I definitely think that makes it more difficult when you're not thinking you know, whole box or just thinking about the patients that have more than one disease or medical condition.

Jasmin realizes that her expectation that the admitting diagnosis accounts for patient symptoms is an error in thinking which needs correcting. As she says, she needs to avoid bias by considering all data ('whole box') when reaching a CJ. Rylee and Mikayla discussed their realization that they did not analyze the situation but made a premature CJ instead.

> I think even with the few symptoms we had, we prematurely jumped to conclusions in the first one [scenario] and I think that helps me to recognize that I do need to make sure that I have all my ducks in a row before contacting the doctor. So I would say definitely [I would get] the assessment and background information on my patient and then after doing all that, if it was like the first patient, I think the next step after that probably would have been calling the doctor, ordering the EKG, or whatever he decided to do.

In addition to the realization of premature CJ, the students suggested that given a similar situation, they would reprioritize their actions to avoid repeating the error in judgment.

During reflection Debra and Alondra recognized symptom saliency as important to making a CJ about MI, suggesting the symptom 'cough' would warrant greater attention when considering the diagnosis of MI again:

> I guess with the first patient we saw him sweat a lot; he was complaining. I guess [the symptoms were] more noticeable opposed to [this] patient. We did not catch a cough, obviously, and we didn't think ahead enough to be like, oh, that could be pulmonary edema…or anything like that. The only thing I really caught was complaining …anxiety [and] complaining about chest pain.

Students were saying that by looking for typical symptoms of MI only errors in CJ could occur. However, during reflection students noted that ignoring the symptom 'cough' lead to errors in thinking leading to incorrect CJ.

Students reflected upon their simulation scenarios and realized mistakes and errors. Students did not state that such realizations improved their knowledge and experience, but learning was occurring which would affect future knowledge and experiences with patients with symptoms of MI. Students' reflections indicated they learned or were learning to avoid biases and premature CJ, and to prioritize actions leading to the desired outcome.

Theme 5: Simulation is experience, but not the real thing. Group 3 students said they needed more clinical experience to diagnose a MI, but counted the simulation experience as a form of clinical experience. Students said that the simulations allowed application of theoretical knowledge and lessened anxiety so that thinking could occur. With simulation experiences students said they understood that patient presentation of symptoms was not linear, but symptoms and information 'intertwined' [Brianna]. In addition, some students said the simulation assisted in determining salience of data.

Jasmin said of simulation experiences, "in my mind, I've seen it [MI] twice", and in addition:

> I feel a lot more comfortable [diagnosing a MI]. Definitely seeing it, definitely experiencing it is always going to be better than just what you read in a textbook or what you think should happen. You follow the steps, because, you know there's MONA [acronym for morphine, oxygen, nitroglycerin, and oxygen], but you don't know if that really is going to be the best first start in the patient, like after experience, you might realize, 'I'd rather give aspirin first'.

However, students also said actual clinical experiences were still needed to diagnose a MI. Ruben said, "Simulation is so you find out how - what you want to look for" but that simulation alone does not provide enough experience to diagnose a MI:

> When you experience something you get more than you learn in the school because you don't know what's going to be happening in the patient, I mean each patient is - each person is - different so their reaction is going to be different too. You're going not going to learn everything from the school. You need to go to the patient and see. When you see it, it's going to be really happening, so you can find out, is it [MI] really happening?

Therefore, though students felt that simulation was a form of hands-on experience where skills could be practiced, further experiences were needed. Bianca and Crystal said, "Give me two more [simulated] patients…and one real patient" and they felt they would be able to confidently diagnose MI.

One student pair indicated that simulation improved learning saliency in MI:

> I think [I'm] just really anxious, too, when we go into a patient's room, I mean, they could be perfectly fine and have a cut on their finger and we're so nervous about talking to them. So I think, it's just being like in that simulation room, like this [simulation] was very helpful, so that you get all of the jitters out. I get in my mind to where it's like 'this is what we have to focus on' [Rylee and Mikayla].

Group 3 students were aware of their inexperience, and none felt they could confidently diagnose a MI 100% of the time after simulation (Note: Students stated they felt 60 - 95% confident to accurately diagnose a MI, which was improved from a stated low of 20% confident prior to simulation). Students all agreed (100%) that further experience caring for patients with MI was needed to diagnose MI. However, students noted that hands-on application of skill increased awareness for saliency and decreased anxiety.

Summary. Students who were given the pattern recognition-based simulation based scenarios (Group 3) indicated that to make a diagnostic decision about a MI assessment, interview, lab, and/or EKG information was needed. Students did not express concerns about which data was needed or how much to collect. Students appeared to have some knowledge of the prototype (five essential symptoms) when looking for symptoms of MI. Development of salience for signs and symptoms may suggest development of information-integration processing. However data were often treated by comparison, analysis, and evaluation and sometimes viewed as parts of a whole before CDM occurred. Students said they were aware that MI symptoms may be caused by other conditions and were challenged when symptoms overlapped with another diagnosis. Students examined the patient history for risk factors and looked for contextual explanations for the patient condition, such as sweating because "the room is too hot".

Students ruled-in a MI or ruled-out competing diagnoses, often using symptom severity or response to pain treatments to make determinations. Students felt confident to make the decision, but not competent, needing further experience and support from colleagues and mentors. Students felt pressures of accuracy and of time to make a diagnosis quickly. Students feared embarrassment and making errors in CJ and therefore preferred not to disclose the CJ unless they were in a non-clinical setting.

Simulation experiences increased confidence in diagnostic ability, but were insufficient for self-perceived competence. However, students reflected upon their experiences, making note of errors and ways to improve, which suggested learning had occurred. Furthermore, some students showed some evidence of category formation for MI. Though pattern recognition simulation lead to improvements in self-perceived diagnostic ability, students said care of at least one actual patient experiencing a MI was needed to attain diagnostic competence.

Analysis. Students in Group 3 collected situational data and used prior theoretical knowledge to compare, analyze, and evaluate the data, indicating critical thinking was occurring. Students lacked prior experience but demonstrated prototype category formation and information-integration processing pattern recognition. In addition, students further showed use of CDM with evidence of Bayesian decision-making, by attempting to evaluate patient history for risk (likelihood of MI), and hypothetico-deductive decision making, by hypothesis testing. Group 3 students reflected that an incorrect diagnosis was reached when heuristic CDM was used.

In Bayesian decision-making, data are collected and evaluated based on likelihood of the event. Students spoke of evaluating the history to determine the risk for a MI, in a sense evaluating the likelihood of a MI in the patient in the individual scenario. Some students used hypothetico-deductive reasoning by postulating a number of potential diagnoses and then regathering data to confirm or disconfirm diagnoses until a decision was reached. Students were aware that biases had interfered with accurate decision making when priming effects (Kahneman, 2003) led them to anticipate that all scenarios would be a MI. Awareness of the bias may assist in avoiding priming effects in the future. Some students had evidence of using heuristics to 'jump to conclusions'.

Table 4-11

Qualitative Analysis CDM in MI

Control – Group 1	Typical – Group 2	Pattern – Group 3
Simple rule –based category formation for MI (pattern recognition)	Rule-based category formation Prototype formation pattern recognition Information integration processing pattern recognition	Rule-based category formation Prototype formation pattern recognition Information-integration processing pattern recognition Hypothetico-deductive CDM Bayesian CDM
No heuristic formation	Heuristic formation	Avoided heuristics
Data collection – no salience	Data collection naïve Data salience	Data collection more complex Data salience
Cannot recognize symptoms	Recognizes symptoms Recognizes consequences	Recognizes symptoms Recognizes consequences
No confidence in CJ	Makes CJ with support	Makes CJ with support
No reflection	Reflection – lack insight, use bias Improved prioritization	Reflection – insight, avoid bias Improved prioritization
No observed change in knowledge and experience	Increased knowledge and experience –self report	Increased knowledge and experience- self report

Note. CDM = clinical decision-making, CJ = clinical judgment, MI = myocardial infarction

Which heuristic was employed could not be evaluated, but students noted that the decision-making technique led to an incorrect CJ.

Students' thinking aloud data suggest that learning occurs in simulation which adds to knowledge and experience. However, students noted that though realistic, simulation was not real, and only actual experience would assure competence in diagnosing a MI. Experience is the organization of memory to use knowledge, experience, and application of CDM skills to attain an accurate CJ. Experience may assist students in future situations with patients experiencing symptoms of MI.

Conclusion. Qualitative analysis of 24 transcripts from 54 students who were randomized to one of three study groups was conducted. Students in Group 1 served as a non-simulation control group, students in Group 2 served as a simulation control group, receiving standard simulation scenarios of patients experiencing typical symptoms of a MI, and students in Group 3 received experimental simulations with a pattern recognition intervention.

There were similarities in patterns and themes among groups: Obtaining data, differentiating a MI from a non-MI, and making a diagnosis. However, differences in CDM emerged (Table 4 -11).

Group 1 students did not appear to understand their decision-making process, but indicated a rule-based form of CDM would be employed to make a CJ. Students had concerns about remembering signs and symptom related to a MI. Students appeared to use the list of essential symptoms found in a typical MI as a rule for categorization. Rule-based categorization is a form of pattern recognition (Ashby & Maddox, 2005), therefore Group 1 indicated that category formation for the diagnosis of a MI had begun. Students did not easily discuss features of a typical MI, indicating a lack of prototype formation. No salience for any symptom cue was indicated or evidence of weighting symptoms cues was reported, suggesting that no information-integration processing was occurring, though students most often remembered the cue 'chest pain'. Students did not believe that they had sufficient ability to diagnose a MI. Students in Group 1 did not indicate that their level of knowledge or experience had changed since the didactic class.

No Group 2 students expressed concerns about knowing or recognizing the symptoms of a MI. Group 2 students demonstrated use of rule-based pattern recognition, prototype formation, and information processing indicating some pattern recognition formation for the category MI. Evidence that students appeared to learn the prototype for a MI was provided by students easily identifying essential symptoms.

Students in Group 2 attributed salience to some symptoms with cue weights assigned by history and risk factors before making a CJ. Students reflected on their clinical reasoning, but did not appear to gain insight or knowledge, including remaining unaware of bias. Group 2 students said they were confident in making a CJ but would prefer mentorship or validation of CJ. However, students also said that knowledge and experience had improved since the didactic class.

Group 3 students expressed no concerns about knowing or recognizing symptoms of a MI. Using data was more complex as students collected appropriate data but also related the data in a way to find meaning as a whole. Students' transcripts indicated that prototype, and to a greater extent, information-integration processing was operating for CDM. Students could not easily articulate the prototype, but more often appeared to be weighting cues for saliency prior to making a decision.

Furthermore, students in Group 3 used the rudiments of analytic processes, both Bayesian and hypothetico-deductive models, which was not found in either Group 1 or Group 2 transcripts. In addition, students indicated awareness for some of the pitfalls of heuristic decision-making and bias upon reflection. Group 3 students felt confident to make a CJ but questioned their competence and therefore asked for mentorship or validation of decisions. Group 3 students said knowledge and experience had improved since the didactic class.

Based on qualitative analysis of 'thinking aloud' data, Hypothesis 4 was supported. Group 3 articulated more about the process of CDM and CJ in a MI scenario than Groups 1 or 2.

Summary

Data were collected from 54 junior nursing baccalaureate students to answer research questions and hypotheses about CT, CDM, and CJ in nursing. Hypotheses that pattern recognition-based simulations scenarios would significantly improve CT, CDM, CJ, and speed of diagnosis and diagnostic accuracy for a MI in nursing students were not supported (Hypotheses 1, 2, and 3). However, qualitative data analysis supported greater articulation of CDM (Hypothesis 4) for students having the pattern recognition-based intervention.

Analysis of variance demonstrated significant improvement in pattern recognition after participation in two simulations which delivered the prototype for a MI, indicating that two exposures to the prototype can improve pattern recognition ability. However, pattern recognition ability does not associate with diagnostic accuracy or improved speed to diagnosis. Exposure to non-MI scenarios with overlapping symptomatology and use of reward-based feedback may develop analytic decision making. Furthermore, exposure to non-MI scenarios and the use of reward-based feedback may assist nursing students to identify and avoid biases, avoid the use of heuristics, and learn through reflection.

Study results suggest that cue salience can be learned, and furthermore, that biases and heuristics can be inadvertently developed, particularly by order sequencing of pattern cues. Bias may be potentially introduced by photos used to represent patients for scenarios. Results also show that a number of cognitive strategies are employed when diagnosing a MI which included hypothetico-deductive reasoning, Bayesian decision-making, and a number of pattern recognition processes: rule-based, prototype, information-integration processing, and similarity processing.

CHAPTER V

Discussion and Conclusions

In the following chapter study findings and conclusions in relation to the literature will be discussed. The conclusions address the study strengths and limitations and application of study findings to the conceptual framework. Recommendations for future study are proposed.

Discussion and Conclusions

Study results indicated differences among groups after the study on ability to recognize the pattern of MI and in clinical reasoning ability. Students who had no simulation experiences and few prior clinical experiences indicated diagnostic decisions about symptoms of MI would be rule-based, using a list of symptoms associated with MI as the 'rule'. Rule-based pattern recognition can occur in as little one exposure to the 'rule' (Smith & DeCoster, 2000), which may explain the high mean pattern recognition score which was initially achieved by the non-simulation control group (71.64 points/100 (SD 13.77) (on the Welk Pattern Recognition Tool (WPRT) though this may measure short term memory recall of symptom cues as well as pattern recognition). Memory storage of rules depends on how frequently the rules are encountered and over what length of time (Smith & DeCoster) which further explains the difficulty nonsimulation control group students had in articulating the symptoms of MI after one exposure in the didactic class. Furthermore, classification of symptoms by rules assumes a set of critical features which identifies members of the category (taxonomic classification), that is, a commonality which binds them to the category (Estes, 1994). However, clinical diagnoses are more likely made on probabilities based on the relationship among the symptoms (Estes, 1994) rather than similarities between symptoms, which would preclude students who had only exposure to a list of symptoms and little experience to understand relationships between symptoms from making an accurate diagnosis when faced with a clinical situation presenting symptoms of MI.

While rule-based processing is a form of pattern recognition (Ashby & Maddox, 2005); rule-based processing alone is unlikely to lead to accurate clinical recognition of MI because complex categorization rules are difficult to hold in working memory. For example, the rule 'chest pain' could be used to categorize a symptom as MI. Adding one or several conjunctions to the rule, however (for example 'chest pain' with 'X location' or 'chest pain' with 'X intensity') increases memory demands beyond the capacity for short term memory, rendering rule-based processing a suboptimal method for decision-making about complex categories. Furthermore, conjunctive rules which are integrated predecisionally changes the task from rule-based to information-integration processing, another pattern recognition mode (Maddox, Bohil, & Ashby, 2003).

Availability of working memory is a critical limitation for making a clinical diagnosis (Wong & Chung, 2002). Clinical diagnostic decisions are rationally bounded by what can be held in memory, what can be known about the situation, and by time (Gigerenzer & Selten, 2002; Simon, 1990). While the ability to remember information for cognitive processing is essential, clinicians are unable to bring all they know to bear on situation given the limits of working memory and clinical constraints of timely decision-making (Wong & Chung). In addition, intellectual ability and application of cognitive effort such as motivation to solve the problem or the effects of fatigue and mood on performance (Gigerenzer & Selten; Schmidt & Bork, 1992; Smith & DeCoster, 2000). Rule-based processing is more likely to be used when the decision-maker's mood is evaluated as negative (Smith & DeCoster).

The brain perpetually seeks patterns and compares what is known in stored memory to what is unknown for decision-making, freeing working memory and cognitive resources to make other associations (Markman & Gentner, 2005). Group 1 students were ill-equipped to recognize MI despite scoring well on the pattern recognition tool because the type of recognition was rule-based rather than prototype extraction based on exemplars of MI or information-integration processing based on knowledge and experience. Without experience Group 1 students had no memories for comparison which could decrease cognitive load, therefore they used working memory to solve the problem of clinical diagnosis. With short term memory resources encumbered by needing to remember symptoms of MI, other processes were not available for problem-solving. Furthermore, actual experience was needed to understand relationships between symptoms, as symptoms alone were not as useful as symptoms in relation to other symptoms for categorization as MI. Lastly, if students had other pattern recognition abilities aside from rule-based they were less likely to use them based on reported high anxiety surrounding the decision making process.

Study findings suggest that expecting students who have had didactic class alone to recognize symptoms of evolving MI in a clinical situation is unrealistic. Study findings suggest that experiential learning, which includes high fidelity simulated patient experiences, and decreasing high anxiety when learning, may be essential for nursing students to recognize a MI. Specific educational clinical experiences can rarely be planned by clinical nursing faculty. High fidelity patient simulation offers advantages in providing specific and replicable patient situations for experiential learning, such as for MI, and the opportunity to decrease high levels of student anxiety by providing practice in a safe environment.

Some Group 1 students indicated that hypothetico-deductive clinical reasoning should be used for decision-making which suggests that how students thought decisions ought to be made and how decisions are actually made differs. Group 1 students thought that deductive reasoning could be used to derive the diagnosis, but gave no indication as to how hypothetic-deductive reasoning could be applied to the process. Rather, students in Group 1 stated they would use what was known about symptoms of MI as a declarative rule for decision-making, which contrasted with Group 2 (simulation control) and 3 students (simulation experimental) who used prototype and information-integration processing pattern recognition, and Group 3 students who used, in addition to pattern recognition, hypothetico-deductive and Bayesian clinical decision-making.

The greatest gains in clinical decision making (CDM) were made by Group 3 students who had learned to avoid bias and heuristics, while Group 2 students were generally unaware of biases. Furthermore, some students in Group 2 developed a potentially deleterious heuristic for MI during simulation.

Group 2 and 3 students indicated use of prototype and information-integration processing, and to a lesser extent, similarity processing which was indicated when students said they would compare a mental model for a MI of an overweight middle-aged white man to an exemplar. In similarity processing, overall similarity to the category is used for decisional judgments (Zeithamova & Maddox, 2006). Rule-based categorization has high working memory requirements as opposed to the low requirements of similarity processing (Zeithamova & Maddox). However, results from the WPRT indicated pattern recognition occurred. This finding is supported by the work of Homa & Chambliss (1975) and Medin, Altom, & Murphy (1984) that states that prototype category learning can occur when there is exposure to the prototype only, without feature extraction to form the prototype.

Dual processing theory states that more than one cognitive strategy can operate to solve a problem (Ashby & Maddox, 2005; Smith & DeCoster, 2000; Zeithamova & Maddox, 2006). The Zeithamova & Maddox study supported the notion that dual processing occurs during category learning. Learning is initiated by hypothesis testing to determine the optimum rule in rule-based learning, which occurs in parallel with another categorization system. The second categorization system has low working memory requirements and competes to accomplish the same categorization task. Dual processing theory is partially supported by this study as all three groups developed rule-based and prototype pattern recognition to some extent. In addition, Groups 2 and 3 also developed evidence of using information-integration processing pattern recognition.

Study findings by Blair & Homa (2001) may assist in explaining less evidence of secondary processes in Group 1. Blair & Homa found that prototype formation occurs when new exemplars are judged by similarity to the prototype. However, when asked about CDM, Group 1 students as part of the study were not given an exemplar containing cues, precluding augmenting prototype development. Furthermore, Blair & Homa found that linearly separable categories were more easily learned than categories which were not. While students indicated a diagnosis of a MI was rule-based (and therefore linearly separable), awareness that a MI had overlapping symptomatology for other conditions which must be differentiated suggests awareness that the diagnostic task was actually not linearly separable. As a starting point for categorization, Group 1 appeared to rely on rule-based pattern recognition. Though WPRT results indicate prototype learning, Group 1 students did not appear confident enough about the prototype for its use.

Though both Groups 2 and 3 had evidence of development of rule-based pattern recognition (if/then statements), prototype formation (predominant in Group 2), and information-integration processing (predominant in Group 3) were more widely used. Students in simulation groups may have learned that the diagnostic categorization of MI was not a simple verbalizable rule-based task and, though they initiated category learning with rule-based processes, they used other processes as well.

Group 2 primarily used prototype formation pattern recognition, which is an expected finding as Group 2 did not receive reward-based feedback during debriefing on which information-integration processing is dependent (Ashby & Maddox, 2005; Maddox et al., 2008). It should be noted that during debriefing, some students in Group 2 made observations and provided reward-based self-feedback. However, both groups were able to form and augment prototypical categories for MI as shown by gains on the WPRT.

Welk (2002) stated 6-9 exposures to the prototype were necessary before pattern recognition could occur. In her study, Welk (2002) provided six case studies to sophomore nursing students as category exemplars. Findings showed that students were able to develop the prototypical pattern for MI after reading the case studies. Welk's 1994 pilot study presenting typical symptoms of pulmonary edema also supported development of pattern recognition after exposure to 10 written exemplars of the prototype. This study's results differed from Welk's 1994 and 2002 studies because evidence supported development of pattern recognition in one exposure to an exemplar containing the prototype (the didactic class). In addition this study results showed that pattern recognition can be improved by at least two more exposures to the prototype.

When categorical rules cannot be identified in rule-based categorization, accurate categorization is a matter of chance (Zeithamova & Maddox, 2006). For Groups 2 and 3 diagnostic accuracy was nonequivalent (85% Group 2, 63%, Group 3; adjusted for MI only - Group 2, 67%, Group 3, 61%) but greater than diagnosis by chance (50%). Results suggest that pattern recognition ability alone is insufficient to accurately diagnose a MI, as rates for pattern recognition for a MI were higher (72%, 84%, and 82% respectively for Groups 1-3).

Welk (2002) examined two groups of sophomore nursing students who were given essential (prototypical) and nonessential cues for a MI for diagnostic accuracy with 10 case scenarios and found no significant differences. In this study, Group 2 had a higher diagnostic success rate when all scenarios were MI. Welk (2002) suggested a priming effect for MI may occur when participants are aware of the purpose of the measurement activity. Students in this study also noted a priming effect, which affected some Group 2 and 3 participants who expected all scenarios to present a MI. Priming effects may favor diagnostic accuracy in the typical symptoms of a MI which would explain higher mean Group 2 scores for pattern recognition of MI.

Group 2 students received MI only simulation scenarios, but Group 3 students had one non-MI scenario. In Welk's 2002 study, the 'typical' group had a higher success rate in recognizing a non-MI than a MI. In this study Group 2 students did not have an opportunity to diagnose a non-MI, however, Group 3 was 44% accurate in recognizing a non-MI situation as a non-MI (4/9 pairs). Welk (2002) suggested that absence of essential symptoms for MI simplified the diagnostic task for non-MI; however, that notion was not supported by this study. Students in Group 3 were not assessed or given information on an anaphylactic reaction or pneumonia, though students had content on both pneumonia and anaphylaxis two semesters prior to the study. Findings suggested that Group 3 students were not using rule-based pattern recognition, as the absence of essential symptoms of MI would have indicated a non-MI diagnosis. Inability to recognize a non-MI may indicate incomplete prototype formation or underdeveloped information-integration processing for the category MI.

A research study by Manias et al. (2004) reported hierarchical use of hypothetico-deductive CDM, followed by pattern recognition, and intuition in decision-making in new graduate nurses. Pattern recognition was defined as a conscious process of "making a judgement based on a few critical pieces of information" (Manias et al., 2004, p. 271). Intuition was defined as the unconscious complement of pattern recognition. Examining Manias et al. (2004) in relation to definition of terms, this study supports the notion that students and novice nurses may use analytic (hypothetico-deductive) and non-analytic (intuitive or heuristic) decision making processes when making clinical decisions.

Both simulation groups received the prototypical cues during simulation; however Group 3 students were given additional category cues which should have strengthened category formation (Homa & Chambliss, 1975). When categories are more complex with greater membership, learning is more accurate and rapid for the category (Sandhofer & Doumas, 2008). Students in Group 2 received 5 different cues, however, Group 3 students received up to 14 different MI cues during the simulations. It would be expected that Group 3 would have a more developed category for a MI, having been exposed to a great range of cues. However, the diagnostic task appeared to be more complex for Group 3 students vis-à-vis their overall lower scores for diagnostic accuracy and lack of significantly faster time to diagnosis. Welk (2002) suggested that exposure to typical (essential) signs of MI alone facilitated ruling in the diagnosis, which may explain study findings.

The WPRT purports to measure prototypical pattern recognition, but it is possible it also captures rule-based pattern recognition as well. Understanding whether rules or prototypes were given to the learners aids in discriminating the type of pattern recognition measured. However, when pattern recognition types are mixed, it is unclear which type, or if both, are being measured. The difference is important because development of rule-based pattern recognition is less effective for diagnostic decisions than prototype based. The WPRT showed reliability within the sample and as reported in the literature, and appears valid in measuring pattern recognition.

An unexpected finding was development of a MI heuristic for nausea and vomiting with diaphoresis in the presence of chest pain for diagnosing MI in Group 2. The use of such a heuristic could be detrimental to accurate decision-making. When highly similar examples are given, attention is focused on shared category features. Furthermore, when cues are presented in order, learned salience for the cue order occurs (Sandhofer & Doumas, 2008). Repetition of the cue order for one pair may have inadvertently caused an order-effect on learning resulting in cue weighting by the order in which they appeared, attributing added salience to the cues for determining a MI.

Welk (2002) found that deliberate symptom pairing of male gender and over age 40 in six case studies led to students stating that the two symptoms were essential for a MI. Deliberate or inadvertent linking of symptoms can foster heuristic development, as found with symptoms 'nausea and vomiting' and 'diaphoresis' in this study. Research by West et al. (2008) found that the ability to avoid bias was a measure of critical thinking ability. Group 3 students were generally able to avoid bias, perhaps indicating increased CT ability.

Novice learners in the study erred on the side of caution by diagnosing any suspected MI as a MI which may be indicative of a value-induced bias (Croskerry, 2002). Value-induced bias is the inclination to over-diagnose to decrease the likelihood of missing a diagnosis which, if missed, could cause harm (Croskerry, 2002). While there is safety in over-diagnosing, unnecessary treatments and tests based on an inaccurate diagnosis can be detrimental.

In a decision-making study Dekay, Patino-Echeverri, & Fischbeck (2009) found that decision-makers exhibited bias toward protective actions in risky decisions. Consequences of decisions were cognitively evaluated by decision-makers with selection of the decision causing the least harm, rather than the best outcome, which was attributed to a 'better safe than sorry' value (Dekay et al., p. 338). Dekay et al. also noted that decisions are context dependent, meaning that antecedent facts and events affect the decision, for example, the emotional context of a situation. Students in this study repeatedly cited anxiety as a factor in making a decision about a MI, which is an emotional antecedent to CDM. Though students in simulation stated that practicing in a safe setting lowered anxiety about caring for a patient with a MI, the effect of anxiety on CJ during the study is not known because there were no baseline measures.

Bowles (2000) in a study of nursing students' CT and CJ used the California Critical Thinking Skills Test (CCTST) and CDMNS to measure constructs. Bowles found positive correlations between GPA and CDMNS subscales (N = 65) though no significant relationships between age or GPA and the total CDMNS scale were found. There were no significant correlations between GPA and CDMNS scores in this study.

Bowles (2000) also found that inductive reasoning ability is predictive of CDM ability ($r = 0.29$, $p < .05$). Though the relationship was weak, the study results suggest that reasoning ability affects CDM. Qualitative analysis in this study indicated that Group 3 students stated they would use inductive reasoning (Bayesian decision-making), however, quantitative study results did not support that notion. In Bowles' study (2000) the CCTST was used to measure students inferential ability, which is not measured in the CDMNS scale. None of the instruments used in this study measured inferential thinking.

Girot (2000) examined CDM using the CDMNS, and inferential thinking with a subscale of the Watson-Glaser Critical Thinking Appraisal (WGTCA) in a study of 82 nursing students and nurses. The sample was stratified on four levels of experience: the American equivalent of junior, senior, experienced nurses, and experienced nurses who were returning to academia. Junior nurses scores served as the control. Girot's study found no significant differences among groups on inferential critical thinking. However, Girot found that significant differences among group scores with highest scores in academic education: senior nursing students and nurses returning to academia ($F(2) = 17.709$, $p < .0000001$). Girot suggests that those in academic education are better clinical decision makers. In this study, having a previous degree, which could represent time in academia, did not associate with CDM. However, obtaining a degree in a domain outside of nursing does not add to nursing specific knowledge for CT (Facione, 1990) which may explain the study findings.

In addition, Girot (2000) stated that results suggest that a combination of experience and education improves evaluation and reevaluation of consequences and search for information based on significant differences between groups on subscales

C and D (CDMNS subscales C ($p < .025$) and D ($p < .01$). Therefore, teaching and experience may improve evaluation of consequences and search for information (Girot, 2000). These findings were not supported in this study, as the complexity of the diagnostic task may have decreased ability to make clinical decisions.

Analysis of qualitative data suggests that Group 3 students found the presentation of MI cues as complex, using adjectives such as 'intertwined' and 'muddled'. Group 3 students were given up to 13 different cues among three scenarios, while Group 2 students had the same five symptoms. For students in Group 2 who received the prototype alone, the task of CDM and CJ may have been less complex than for students in Group 3 who were aware of greater variability in presentation and actual difficulties in distinguishing a MI from a non-MI. Therefore, their self perception of CDM ability may have suffered as students questioned their ability to make a decision in relation to the perceived difficulty of the task. Group 2 students may have lacked this awareness because categorizing MI symptoms may have seemed simpler.

Qualitative analysis of data from students in Group 3 indicated greater use of analytic CDM and reflection to improve practice. In addition to a non-MI scenario, Group 3 students received more pattern cues and reward-based feedback during debriefing. Full feedback enhances development of Bayesian decision-making (Maddox et al., 2008), a finding supported by the study. Inclusion of the non-MI scenario was planned to foster improved pattern recognition. However, it is possible that students in Group 3 became aware of the complexity of the diagnostic task when presented with a patient experiencing a non-MI with overlapping MI symptomatology, which included symptoms such as chest pain, restlessness, anxiety, and shortness of breath. Though scenarios between groups were of equivalent difficulty and complexity, presentation of a non-MI scenario introduced the student to the complexity of the diagnostic task, possibly necessitating development of CDM to reach a diagnosis. Lee et al. (2006) noted in a review article that complexity of the diagnostic task, the number of cues, and information of low relevance increased diagnostic difficulty. Furthermore, Lee et al. noted that diagnostic accuracy decreases and decision-making difficulty increases with greater case complexity. This may have influenced Group 3's diagnostic accuracy as they had up to 14 relevant symptoms compared to 5 for Group 2.

The structure of debriefing is important to developing CDM skills as well as guiding the student to reflect upon performance (Dreifuerst, 2009). Though Groups 2 and 3 had similar opportunities to reflect on CDM during debriefing, it appeared that Group 3, having need of analysis for a diagnostically difficult task, used deeper reflection to develop analytic CDM. Furthermore, through reflection heuristic decision-making was recognized, as well as the possible poor outcomes from its use by novices. Dreifuerst (2009) states reflection augments knowledge and develops insight. Reflection develops skills to search for alternatives and evaluation consequences of actions (Mamede, Schmidt, & Penaforte, 2008). Seropian (2003) stated that debriefing is as important to clinical learning as the simulation. Results from this study support the significance of the structure of debriefing in affecting learning.

Group 3 also indicated a greater awareness for cue salience in diagnosing a MI, which may have been an outcome of task complexity and structured debriefing. However, improved recognition of salience does associate with improved CJ (Groves et al., 2003) which is consistent with findings in this study.

Working memory is the conscious awareness and retention of information which is not present in the immediate environment but is critical for thinking and guiding behavior (Postle, 2006). Similarity processing has low working memory requirements as it may be constantly functioning as a decisional gateway for allocating cognitive resources (Markman & Gentner, 2005). Similarity processing allows metacognitive judgments which short-cut the decision-making process by generalizing known solutions to similar situations (Markman & Gentner, 2005). Memory requirements in similarity processing are used for searching the environment and base memories for likenesses. Furthermore, if the situation rouses an association with a previous experience, recall of the name, content, and context of the aroused experience can be used in working memory to understand the present situation (Postle, 2006).

The significance of feedback-based debriefing to development of higher thinking processes such as information-integration processing pattern recognition and CDM was demonstrated in this study. Debriefing enhanced reflection which added to knowledge and experience, but also affected the reasoning process by which diagnostic decisions were made. In addition, not only was effective diagnostic reasoning enhanced, but learners avoided ineffective reasoning. Simulation educators should carefully structure debriefings to enhance feedback regarding cue salience and decision making which includes rewarding effective and noting ineffective behaviors.

Students in the research study who did not have simulated clinical experiences were unable to make clinical decisions as well as students exposed to simulation, indicating the value of pseudo-experiences created in high-fidelity simulation for MI category learning. Clinical experiences have been the cornerstone of nursing education. The findings of this study describes how clinical experiences support development of nursing expertise and why accumulation of domain-specific clinical experiences are essential do development of nursing expertise. Nurse educators should focus on providing replicate and specific MI experiences, which may be best provided in a high-fidelity simulated laboratory setting.

Qualitative and quantitative analysis of nursing students' critical thinking (CT), clinical decision making (CDM), and clinical judgment (CJ) abilities suggests that students' learning in relation to pattern recognition of myocardial infarction (MI), development of analytic and non-analytic decision-making, and clinical judgments can be augmented with simulation. Furthermore study results show how nursing student learning can be affected by structure and design of debriefing in simulation.

Relationship to Conceptual Framework

The conceptual framework for clinical reasoning is generally supported by the findings of this study. Quantitative and qualitative data analyses suggest that knowledge, experience, pattern recognition, and CDM, including heuristics and analytic decision-making, are separate constructs of clinical reasoning supported by operations of analysis and evaluation. Bias and affective attributes such as anxiety and caring were said to affect CJ by students. While students made CJs, there was less support that CJs were distinct from CDM. Furthermore, students' self-perceptions indicated that knowledge and experience are increased by simulation similarly to actual clinical experiences.

Dowding & Thompson (2003) distinguished the diagnostic from the judgment phase in CDM and CJ, but noted that an accurate clinical diagnosis does not ensure a good CJ, or that an inaccurate diagnosis causes a poor CJ. Dowding & Thompson do not view CJ as a reduction of cues to a CJ, but a function of how the cues are used to make a decision based on cue saliency and probability. When cue weights are accurately assigned (salience for situational cues accurate) then the CJ is more likely to be accurate (Dowding & Thompson, 2003). Dowding & Thompson suggest social judgment theory

(SJT) as a framework for evaluating diagnostic accuracy. Statistical regression can be applied to establish the amount of weight assigned to a cue to understand relative cue salience in making a CJ. Understanding how cue weights are assigned may aid in teaching CJ through development of strategies focusing on cue salience.

SJT (Dowding & Thompson, 2003) has overlapping assumptions with hypothetico-deductive and Bayesian decision-making which suggests that the use of CDM and CJ are closely related in this model. However, the suggestion that CJ is more complex than distillation of cues may be supported by this study. Though heuristic or analytic CDM was used by student pairs, the CJ still did not come easily, suggesting the possible existence of a subprocess which was not described.

In the conceptual framework for clinical reasoning the attribute of salience for situational cues during clinical reasoning is discussed, specifically in determining which data are most relevant to the situation at hand. However, information integration processing pattern recognition also assigns predecisional weights to cues which determine salience for decision making, and cue salience is a factor in Bayesian decision making. Benner's (1984) theory of novice-to-expert development also supports the importance of development of cue salience, and in addition, to assessing for information voids when examining a clinical situation, as signs of development towards clinical expertise.

In a literature review Lee et al. (2006) found that some sources recognize pattern recognition as an aspect of intuition. Rew (2000) defined intuition as nonanalytic understanding of the 'whole' necessary for complex judgment. Furthermore, as pattern recognition is a memory classification system and experience is memory (Estes, 1994) one might consider pattern recognition and intuition as application of experiential learning. In this study, however, pattern recognition is considered separately from intuition and experience. It could be argued that while memories are classified and categorized in pattern recognition, and that in addition to classification of disease, the prototypical treatments may be contained within the category, pattern recognition does not have a contextual basis. Experiential memory may place pattern recognition in contexts, which may be recalled in total when problem solving, rather than categorizing memory alone. For example, recognizing a MI is a pattern recognition function, but memories stored with their associated contexts (e.g., age race, gender, comorbidities) create experience against which future exemplars can be examined.

In the literature CDM is broadly defined as clinical reasoning, problem solving, diagnostic reasoning, and CT (Banning, 2008; Turner, 2005). A recent concept analysis of clinical reasoning associated proxy terms such as decision-making, diagnostic reasoning, and problem solving with the clinical reasoning concept (Simmons, 2010). However, Simmons' analysis found clinical reasoning has antecedents of knowledge, cues, experience, and memory which is congruent with the conceptual framework for clinical reasoning used in this study.

However, Simmons' (2010) concept analysis describes analysis, intuition, inference, and information processing as attributes of clinical reasoning, and inference as both an antecedent and consequence. In the conceptual framework for clinical reasoning used for this study the process of reaching a CJ can be recursive to diagnose a patient condition and determine a course of action for a given diagnosis in part by using cognitive operations such as 'inference' in both CT and CDM. Lack of significant correlations among study variables of pattern recognition, CDM, and CT in this study may support the notion that CT and CDM are separate constructs and not a single construct of clinical reasoning. If CJ is a separate construct from CDM then further study is needed to understand what barriers prevent finalizing the decision-making process with a judgment, including which factors stimulate CJ as output of the clinical reasoning process.

Simmons (2010) states that evaluating clinical information for significance [salience] is part of a cognitive process for weighing relevant alternative actions. Students in Groups 2 and 3 in this study indicated recognizing cue salience was significant to decision-making. Benner's work (1984) also supports development of salience as the advanced beginner recognizes meaningful information while the competent nurse is able to recognize the most important clinical attributes when making a decision.

Study evidence supported student self-perception of increased clinical knowledge by the mode of reflection, but there was no support that reflection increased experiential learning. Rather, upon reflection students stated experience was increased.

Limitations

Study participants were a small convenience sample from a single institution which could limit generalizability of the results. In addition, the study was limited by the small sample size as fewer students participated than was indicated by power analysis for the effect size. While there was sufficient power to detect significant mean differences on some measures, the sample size was insufficient to provide power for scales such as the HESI™ and CDMNS subscales.

Limitations to this study also included variability inherent in simulation scenarios which decreases control, low reliability of the customized HESI™ exam, limited use of WPRT in research studies, and time elapsed between didactic class and data collection (maturation). The intervention may not have been sufficiently different between groups to cause an effect, and systematic error may have been caused by most motivated and successful students selecting to participate in a simulation research study (Burns & Grove, 2005). Lastly, as pattern recognition is both conscious and unconscious, any exposure to exemplars could establish the pattern.

The study design could have been strengthened by providing for repeated measures for Group 1, which was assessed at a single time point. A second assessment near the end of the study would have been helpful to understand the effect of clinical experiences on study variables of interest. Furthermore, the experimental pattern recognition treatment was under-dosed when students did not receive all scheduled symptoms during simulation because of students prematurely diagnosed the 'patient' condition before all symptom cues were given. In addition, an awareness of the study's purpose created a priming effect which may have affected the results.

Selected scales measured variables of interest, but the presence of unmeasured variables may have affected study results such as emotional engagement in simulation and the presence of participant anxiety. In addition, baseline measures for CT operations such as analytic and evaluative ability and affective disposition for CT, were not measured, which may have affected CDM and CJ results. Furthermore, the effectiveness of using grade point average (GPA) as a surrogate for nursing knowledge may not be justified.

The contribution of discussion between peers in development of CT, CDM, and CJ was not assessed. Though responses to scales between pairs showed no correlations, the effect on learning is unmeasured and may contribute to study results. Finally, study findings about recognizing symptoms of a MI may not be generalizable to other patient conditions.

Implications for Nursing

Study results suggest that teaching nursing students to improve recognition of symptoms of a MI using pattern recognition based simulation is effective. Furthermore, prototype development can begin before simulation by providing the prototype in a didactic class followed by at least two simulation exemplars containing the prototype. Although the study did not show that including a non-MI scenario with overlapping symptomatology improved prototype pattern recognition, further study is warranted to understand the contribution, if any, non-MI scenarios with structured reward-based debriefing to CT and CDM.

Results from the study indicate that saliency for diagnostic cues can be taught which has implications for information-integration processing pattern recognition and Bayesian decision-making. Improving saliency in clinical settings develops expertise (Benner, 1984).

Educators who use simulation should be aware that biases and heuristics can be inadvertently taught during simulation and, therefore, design of simulations should be controlled. Study results emphasize the importance of reflection during debriefing to gain new insights and enhance knowledge and experience.

Recommendations for Future Research

The study should be replicated with a larger sample size from several institutions, and include graduate and experienced nurses, and redesigned to prevent under-dosing of the intervention. The Clinical Decision-Making in Nursing Scale had adequate reliability; however, self-perception of CDM may not equal actual CDM ability.

Development of an objective CDM tool is needed. Furthermore, CDMNS subscales A, B, and D should be reexamined due to low reliabilities. The HESI™ Custom Exam had low Kuder-Richardson-20 (KR-20) reliabilities for this study, though mean scores showed improvement in CT. According to the conceptual framework for clinical reasoning, CT is a multifaceted construct composed of multiple pattern recognition processes and having several cognitive operations. A tool of 25 items measuring a number of facets may be expected to have lower reliabilities. Redesigning the HESI™ Custom Exam with more items and subscale development congruent with the study definition would strengthen the research.

Further research is needed to determine if CJ is a separate construct from CDM, and, in addition, whether pattern recognition is intuitive and heuristic or a separate cognitive process. Furthermore, research studies should examine which heuristics are accurate and efficient when making a CJ. Finally, understanding the effects of non-MI simulation scenarios on brain-based learning is important to knowing how much of the gains in CT and CDM were attributed to feedback-based debriefing or the effects on category learning.

Study Summary

A quasi-experimental pre/post test three group design with triangulation on variables of interest was conducted. Fifty-four junior baccalaureate in nursing students participated in pairs in a research study designed to examine the effectiveness of a pattern recognition based simulation intervention on CT, CDM, CJ, and diagnostic accuracy and efficiency for symptoms of a MI.

Research indicates there is no 'best' decision-making strategy, only the optimum strategy for the situation at hand (Ashby & Maddox, 2005). Student nurses can and should be guided to make analytic clinical decisions while their knowledge and experience base are developing. While heuristic decision-making can be employed by novices, educators should encourage secondary self-validation of decision making by analytic processes. However, for analytic processes to be effective, they must be developed, which this research study suggests, can be affected by simulation teaching strategies.

Study results suggest an educational intervention which includes presentation of complex and overlapping categories for a MI with prototypical exemplars and feedback-based debriefing may improve pattern recognition for a MI and develop both hypothetico-deductive and Bayesian decision-making in nursing students.

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Appendix A

Distinctive and Common Symptoms of Myocardial Infarction

Appendix A

Distinctive and Common Symptoms of Myocardial Infarction*

Distinctive	Common
Chest pain	Pain radiating down left arm
Restlessness	Pallor
Diaphoresis	Male gender > female gender
Nausea and vomiting	Weakness
Anxiety	Shortness of breath
	Pain radiating back, neck, jaw
	Age older than 40 > age younger than 40
	Dizziness
	Sense of impending doom
	Racial background
	Crackling lung sounds
	Palpitations

**Note*: From Welk, D. S. (2002). Designing clinical examples to promote pattern recognition: nursing education-based research and practical applications. *Journal of Nursing Education, 41*(2), 53-60.

Appendix B

APA Delphi Study List of Cognitive Skills and Subskills.

Appendix B

APA* Delphi Study List of Cognitive Skills and Subskills.

Skill	Sub-skill
1. Interpretation	Categorization
	Decoding significance
	Clarifying meaning
2. Analysis	Examining ideas
	Identifying arguments
	Analyzing arguments
3. Evaluation	Assessing claims
	Assessing arguments
4. Inference	Querying evidence
	Conjecturing alternatives
	Drawing conclusions
5. Explanation	Stating Results
	Justifying Procedures
	Presenting Arguments
6. Self-regulation	Self-examination
	Self-correction

**Note:* APA = American Philosophical Association. From: Facione (1990). Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. The California Academic Press: Millbrae, CA.

Appendix C

APA Delphi Study List of Dispositional Skills

Appendix C

APA* Delphi Study List of Dispositional Skills

Affective Dispositional Traits

1. Inquisitiveness with regard to a wide range of issues.
2. Concern to become and remain generally well-informed.
3. Alertness to opportunities to use CT.
4. Trust in the processes of reasoned inquiry.
5. Self-confidence in one's own ability to reason.
6. Open-mindedness regarding divergent world views.
7. Flexibility in considering alternatives and opinions.
8. Understanding of the opinions of other people.
9. Fair-mindedness in appraising reasoning.
10. Honesty in facing one's own biases, prejudices, stereotypes, egocentric or sociocentric tendencies.
11. Prudence in suspending, making, or altering judgments.
12. Willingness to reconsider and revise views where honest reflection suggests that change is warranted.
13. Clarity in stating the question or concern.
14. Orderliness in working with complexity.
15. Diligence in seeking relevant information.
16. Reasonableness in selecting and applying criteria.
17. Care in focusing attention on the concern at hand.

18. Persistence though difficulties are encountered.

19. Precision to the degree permitted by the subject and the circumstance.

**Note:* APA = American Philosophical Association. From: Facione (1990). Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. The California Academic Press: Millbrae, CA.

Appendix D

Nursing Delphi Study of Cognitive and Affective Skills

Appendix D

Nursing Delphi Study* Cognitive and Affective Skills

Cognitive Skills	Affective Skills
Seeks information	Intellectual integrity
Analyzes	Intuition
Applies standards	Open mindedness
Predicts	Creativity
Reasons logically	Confidence
	Flexibility
Discriminates	Contextual perspective
Transforms knowledge	Perseverance
	Reflection
	Inquisitiveness

**Note:* Scheffer, B. K., & Rubenfeld, M. G. (2000). A consensus statement on critical thinking in nursing. *Journal of Nursing Education, 39*(8), 352-359.

Appendix E

Informed Consent

Appendix E

Georgia State University
School of Nursing

Informed Consent

Title: Teaching Nursing Students Symptoms of Myocardial Infarction Using Pattern Recognition and High Fidelity Simulation

Principal Investigator: Susan A. Walsh
Co-Principal Investigator: Dr. Cecelia Gatson Grindel

I. Purpose:

You are invited to participate in a research study. The purpose of the study is to investigate whether using high fidelity simulation scenarios, with a mannikin in a nursing laboratory, can be used to teach nursing students to recognize symptoms of a patient heart attack/myocardial infarction (MI), and also improve critical thinking, clinical decision making, and clinical judgment. You are invited to participate because you are a junior level nursing student. A total of 74 participants will be recruited for this study. Participation will require up to 4.5 hours of your time over 1 or 2 days.

II. Procedures:

After giving your 3X5 card to the researcher, all cards from possible participants will be gathered together in a box. Three by five cards with student names will be randomly selected from the box one at a time. If you are one of the first 74 students whose name is drawn, you will be contacted by the researcher.

If you decide to participate, you will be asked to meet the researcher in a Georgia State Univeristy nursing classroom at an agreed upon date and time. The researcher will describe the study, and if you agree to participate, you will be asked to sign this consent form. If you participate, you will be assigned to one of three groups. All participating students will be given a short class (about 20-30 minutes) on symptoms of a heart attack. After the class you will be asked to fill out several questionnaires and some background information about yourself. One of the questionnaires will be administered on a computer in a computer lab. You will also be asked to provide information about your age, gender, race, grade point average, any previous college degrees, experience with patient care, and whether you have taken a critical care course elective. There also will be three questionnaires asking about how you recognize symptoms of a heart attack, how you make decisions when caring for patients, general critical thinking in nursing, and critical thinking when a person has acute symptoms which may be a heart attack. It will take about 40-60 minutes to complete the consent form, the questionnaires, and background information about yourself.

After the questionnaires are completed, you will be assigned to a group. If you are in Group 1, you and your partner will be asked to discuss a fictional situation about a patient who is having symptoms of MI and how you would decide if the patient is having an MI or not. You will be video recorded during this discussion. Your participation in the study will end at this point. If you are in Group 2 or Group 3, you will also be asked to complete information about yourself and answer questionnaires about how you recognize symptoms of a heart attack, make decisions when caring for patients, general critical thinking in nursing, and critical thinking when a person has acute symptoms of a heart attack. In addition, you will be asked to participate in patient simulation at a nursing simulation lab at Clayton State University, in Morrow, Georgia, at an agreed upon date and time to participate in simulation with a partner. You and your partner will have a simulated hospital clinical experience in the nursing simulation lab using a high fidelity patient simulator mannikin, which has features similar to a real person such as heart beat and blood pressure. You and your partner will be given a chance to see how the mannikin works. Next, you and your partner will be given a recorded nursing report, and then you and your partner will be asked to care for the simulated patient. You will either be the primary nurse or medication nurse during the simulation. Three different simulation scenarios, each lasting 20-30 minutes, will be conducted. You will be in the role of primary nurse or medication nurse at least once during the simulations.

You will be asked to wear a white nursing type uniform when participating in the simulation. During the simulation, you will be video-recorded, and after each simulation, the recording will be played back so you can see what you did during care for the 'patient'. The researcher will discuss the actions you took during the simulation as you watch the video of you and your partner caring for the patient.

When all three simulations are complete, you will be asked to reflect on the simulation experience and discuss the decisions you made. You will be also be videotaped during this discussion about your actions and decisions during simulation. After reflecting about the simulated experience, you will be asked to fill out questionnaires again. The expected time will be 3.5 to 4 hours for the simulation scenarios, including filling out questionnaires.

The researcher and at least one research assistant to help prepare and run the simulator will be conducting the study. The study will be conducted in the nursing simulation laboratory at Clayton State University. You will receive credit for participation in simulation as clinical hours during your senior practicum course.

If you are selected for Group 1 but would like to have a simulation experience you may select to have the same experience as Groups 2 or 3, alone or with your partner, after your study data are collected. This experience is not part of the study and no data will be collected during optional simulation. Optional simulation will be conducted at a mutually agreed date and time.

At the end of your participation, you will be given a small gift card of $20 from Target Store if you are in Group 1, and a $40 gift card if you are in Groups 2 or 3. The difference in the amount of the gift card reflects the amount of time needed for participants in Group 1 (about 90 minutes) and those in Groups 2 and 3 (about 5.5 hours) to complete the study.

III. Risks:

In this study, you will not have any more risks than you would in a normal day of life. There is a possibility that participation in this study will cause feelings that are distressing for you. You may find it distressing to simulate care for a sick person. After each scenario you will be able to discuss your feelings. If you continue to feel distress, you will be referred to the Georgia State University Counseling Center. If such counseling is needed, the student will be responsible for the cost. Members of the research team nor Georgia State University will be liable for any risks.

IV. Benefits:

Participation in this study may or may not benefit you personally. You may find it helpful to practice care of patients with heart attack or other symptoms. Overall, we hope to gain information about how nursing students learn to recognize patient symptoms of heart attack and how critical thinking, clinical decision-making, and clinical judgment are affected so that nurse educators can better teach students how to be critical thinkers in preparation for their new role as registered nurses. This critical thinking preparation will possibly benefit all patients in the care of nurses.

V. Voluntary Participation and Withdrawal:

Participation in research is voluntary. You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions on questionnaires or stop participating at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled. You will not be treated any differently by your nursing professors at Georgia State University.

VI. Confidentiality:

We will keep your records private to the extent allowed by law. We will use a number code rather than your name on study records. You will be given a non-identifying code to take the computer based exam. Results will be reported only by code. The code key will be stored separately from the data and destroyed at the same time as the video recorded data, one year after analysis of the results. Video and questionnaire data will be stored on a password- and firewall-protected computer. Videotapes and printed questionnaire data will be kept in a locked filing cabinet in the researcher's office (or wherever you indicate). Members of the research team will have access to the information you provide.

Information may also be shared with those who make sure the study is done correctly (GSU Institutional Review Board, the Office for Human Research Protection (OHRP) and/or the Food and Drug Administration (FDA), and the sponsor). Your name and other facts that might point to you will not appear when we present this study or publish its results. The findings will be summarized and reported in group form. You will not be identified personally.

Because you are working with a partner, you will be asked to keep information about your partner's participation in the study confidential also, including actions and discussion during and after simulation.

Your professors will not be aware of who is participating and who is not participating in this study unless clinical credit for participation in simulation in this research study is given by your professor. In that case, your name as a participant will be given to the professor so that clinical credit can be applied near the end of the semester.

VII. Contact Persons:

Contact Susan A. Walsh [redacted]) or Dr. Grindel [redacted]) if you have questions about this study. If you have questions or concerns about your rights as a participant in this research study, you may contact Dr. Tom Eaves, Institutional Officer at Clayton State University; [redacted]0, and, you may contact Susan Vogtner in the Office of Research Integrity at Georgia State University, a[redacted]

VIII. Copy of Consent Form to Subject:

We will give you a copy of this consent form to keep.

If you are willing to volunteer for this research and be video-recorded, please sign below.

____ ________________
Participant Date

____ ________________
Principal Investigator or Researcher Obtaining Consent Date

Appendix F

Welk Pattern Recognition Tool

Appendix F

Welk Pattern Recognition Tool
Recognition of Essential and Nonessential Signs and Symptoms of a Heart Attack

For the purposes of this instrument, the following definitions apply:

An "essential" sign or symptom refers to one that you consider must be present for you to recognize that a heart attack may be occurring.

A "nonessential" sign or symptom refers to one that you consider may be present for you to recognize that a heart attack may be occurring but you would not wait to see it in order to recognize that a heart attack may be occurring.

Directions: For each of the following signs and symptoms, place a check mark in the box (essential or nonessential) as it pertains to whether or not you think it "must be" or "may be" present for you to recognize that a heart attack may be occurring.

Sign or Symptom	Essential to Recognition of a Heart Attack	Nonessential to Recognition of a Heart Attack
Shortness of breath		
Palpitations		
Restlessness		
Age younger than 40		
Racial background		
Weakness		
Nausea or vomiting		
Male gender		
Age older than 40		
Diaphoresis (sweating)		
Sense of impending doom		
Dizziness		
Female gender		
Pallor		
Chest pain		
Crackling lung sounds		
Anxiety		
Pain radiating to the back, neck, or jaw		
Pain radiating down the left arm		

Appendix G

Consent to Use Welk Pattern Recognition Tool

Appendix G

From: Dorette Welk [mailto:[redacted]]
Sent: Wednesday, March 11, 2009 1:43 PM
To: Susan Walsh
Subject: Re:

Greetings, Susan! Glad to know things are moving along. Yes, you may use the tool with attribution to me (Dorette E. Welk), used with permission. As you know from my study, I developed just word scenarios (exemplar or typical examples) so it will be very interesting to see how the tool does with simulations (like SimMan?)...or what is a high-fidelity simulation? Best wishes and let me know how it works out! Dee Welk

On Wed, Mar 11, 2009 at 10:28 AM, Susan Walsh <[redacted]> wrote:

Dear Dr. Welk,

I am a graduate student at Georgia State University who was in contact with you last year about your Pattern Recognition Tool for MI symptoms.

I would like to ask permission to use the tool for a feasibility study this semester, and most likely, my dissertation, which should start Summer 2009.

My study is titled tentatively "Teaching Nursing Student Symptoms of Myocardial Infarction Using Pattern Recognition and High Fidelity Simulation". I am trying to use theories of category learning to construct scenarios to increase not only recognition of symptoms, but improve critical thinking, clinical judgment, and clinical decision making.

Your tool will help me measure whether students were able to identify the pattern of MI as a result of specially constructed simulations.

I spent last semester doing a directed reading on pattern recognition and found it fascinating!

I hope all is well with you and yours.

Thanks!

Susan

Appendix H

Clinical Decision Making In Nursing Scale

Appendix H

Clinical Decision Making In Nursing Scale

ID # ________________

Please note: Circle the letter to indicate the answer that comes closes to the way you ordinarily behave. Be sure to respond in terms of what you are doing in the clinical setting.

	Always	Frequently	Occ.	Seldom	Never
1. If the clinical decision is vital and there is time, I conduct a thorough search for alternatives.	A	F	O	S	N
2. When a person is ill, his or her cultural values and beliefs are secondary to the implementation of health service.	A	F	O	S	N
3. The situational factors at the time determine the number of options that I explore before making a decision.	A	F	O	S	N
4. Looking for new information is making a decision is more trouble than it's worth.	A	F	O	S	N
5. I use books or professional literature to look up things I don't understand.	A	F	O	S	N
6. A random approach for looking at options works best for me.	A	F	O	S	N
7. Brainstorming is a method I use when thinking of ideas for options.	A	F	O	S	N
8. I go out of my way to get as much information as possible to make decisions.	A	F	O	S	N
9. I assist clients in exercising their rights to make decisions about their own care.	A	F	O	S	N
10. When my values conflict with those of the client, I am objective enough to handle the decision making required for the situation.	A	F	O	S	N

Please note: Circle the letter to indicate the answer that comes closes to the way you ordinarily behave. Be sure to respond in terms of what you are doing in the clinical setting.

	Always	Frequently	Occ.	Seldom	Never
11. I listen to or consider expert advice or judgment, even though it may not be the choice I would make.	A	F	O	S	N
12. I solve a problem or make a decision without consulting anyone, using information available to me at the time.	A	F	O	S	N
13. I don't always take time to examine all the possible consequences of a decision I must make.	A	F	O	S	N
14. I consider the future welfare of the family when I make a clinical decision which involves and individual.	A	F	O	S	N
15. I have little time or energy available to search for information.	A	F	O	S	N
16. I mentally list options before making a decision.	A	F	O	S	N
17. When examining consequences of options I might choose, I generally think through "If I did this…"	A	F	O	S	N
18. I consider even the remotest consequence before making a choice.	A	F	O	S	N
19. Consensus among my peer group is important to me in making a decision.	A	F	O	S	N
20. I include clients as resources of information.	A	F	O	S	N
21. I consider what my peers will say when I Think of possible choices I could make.	A	F	O	S	N
22. If an instructor recommends an option to a clinical decision making situation, I adopt it rather than searching for other options.	A	F	O	S	N

Please note: Circle the letter to indicate the answer that comes closes to the way you ordinarily behave. Be sure to respond in terms of what you are doing in the clinical

	Always	Frequently	Occ.	Seldom	Never
23. If a benefit is really great, I will favor without looking at all the risks.	A	F	O	S	N
24. I search for new information randomly.	A	F	O	S	N
25. My past experiences have little to do with how actively I look at risks and benefits for decisions about clients.	A	F	O	S	N
26. When examining consequences of options I might choose, I am aware of the positive outcomes for my client.	A	F	O	S	N
27. I select options that I have used successfully in similar circumstances in the past.	A	F	O	S	N
28. If the risks are serious enough to cause a problem, I reject the option.	A	F	O	S	N
29. I write out a list of positive and negative consequences when I am evaluating an important clinical decision.	A	F	O	S	N
30. I do not ask my peers to suggest options for my clinical decisions.	A	F	O	S	N
31. My professional values are inconsistent with my personal values.	A	F	O	S	N
32. My findings of alternatives seems to be largely a matter of luck.	A	F	O	S	N
33. In the clinical setting I keep in mind the course objectives for the day's experience.	A	F	O	S	N
34. The risks and benefits are the farthest thing from my mind when I make a decision.	A	F	O	S	N
35. When I have a clinical decision top make, I consider the institutional priorities and standards.	A	F	O	S	N

Please note: Circle the letter to indicate the answer that comes closes to the way you ordinarily behave. Be sure to respond in terms of what you are doing in the clinical setting.

	Always	Frequently	Occ.	Seldom	Never
36. I involve others in my decision making only if the situation calls for it.	A	F	O	S	N
37. In my search for options, I include even those that might be thought as “far out’ or non-feasible.	A	F	O	S	N
38. Finding out about the client’s objectives is a regular part of my clinical decision making.	A	F	O	S	N
39. I examine the risks and benefits only for consequences that have serious implications.	A	F	O	S	N
40. The client’s values have to be consistent with my own, in order for me to make a good decision	A	F	O	S	N

Thank you for being a participant in this study. Do you have any ideas about decision making in nursing that were not covered by the scale that you would like to share? You can speak to specific items or give any general comments you would like.

Additional comments:
(Feel free to use the addition space back page for comments).

Appendix I

Permission to Use Clinical Decision Making in Nursing Scale Tool

Appendix I

From: [redacted]
Sent: Wednesday, March 11, 2009 10:56 AM
To: Susan Walsh
Cc: [redacted]
Subject: Re: Jenkins Clinical Decision Making in Nursing Scale

Dear Ms. Walsh:
The family of Helen Jenkins has given us permission to grant you permission for use of this tool. If I hear of anything regarding scoring information, I will pass it on.
Margaret Ream

Susan Walsh wrote:

Dear Dr. Ream,
Thank you so much for assisting me with my request to use Dr.Jenkin's Clinical Decision Making in Nursing Scale. I am asking for a return email granting permission for its use for a feasibility study this semester, and, possibly, a dissertation study in the fall.
I am still searching for scoring information, so if you find anything I would appreciate it!
Thanks so much for your time.
Susan
PS I am not only a student at Georgia State University, but a faculty at Clayton State University in Georgia.

Susan A. Walsh RN MN CCRN
Assistant Professor
School of Nursing
Clayton State University
Morrow, GA 30260
[redacted]

Appendix J

Thinking Aloud Questions

Appendix J

Thinking Aloud Questions

1. When faced with a clinical situation where a patient may be having a heart attack, how do you go about deciding whether it is a myocardial infarction or not?
2. What steps do you take in the decision process? What do you think about first, second, and third, when trying to make the decision?
3. What kinds of things do you think about when you make an important clinical decision about whether a person is having a heart attack or not? What kinds of things help you make the decision? What kinds of things hinder your decision making?
4. How do you decide what to do if you believe your patient is having a heart attack?
5. Do you feel you learned what you need to know in school to differentiate a patient having a heart attack from one who is not?
6. Is their some other way you learned to tell if someone is having a heart attack outside of what you learned in school?
7. Tell me how confident you are about recognizing when a patient is having a heart attack?
8. What would assist you in becoming more confident in your ability to recognize when a patient is having a heart attack?

Appendix K

Demographic Data Collection Tool

Appendix K

Georgia State University
Institutional Review Board Application

DEMOGRAPHIC DATA SHEET

CODE: ☐☐☐☐☐☐☐

1. Age (in years): ______________ years

2. Gender:

   - ☐ Male
   - ☐ Female

3. RACE or ETHNIC IDENTITY:

   - ☐ American Indian/Alaskan Native
   - ☐ Asian
   - ☐ African American
   - ☐ Hispanic/Latino (non-European)
   - ☐ Native African
   - ☐ Native Hawaiian/Pacific Islander
   - ☐ Two or more races/ethnic identity
   - ☐ White/Caucasian
   - ☐ Other. Please indicate: ____________________

4. Number of nursing courses you have had in which <u>clinical experiences occurred</u> (*including* current course).

- ☐ One
- ☐ Two
- ☐ Three
- ☐ Four

5. Do you have experience outside of your nursing courses in direct patient care of adults with heart conditions?

Yes ________

No ________

6. Have you, or are you participating, in a critical care course?

Yes__________

No___________

7. Current college Grade Point Average

(GPA) ____________

8. Do you have another college degree?

☐ No

☐ Yes (circle one):
- o Associate
- o Bachelor
- o Master
- o Doctorate

Please state your major:

____

9. Are you a licensed practical or vocational nurse?

- ☐ No
- ☐ Yes

Appendix L

Control Simulations with Typical Symptoms of Myocardial Infarction

Appendix L

Control Simulations with Typical Symptoms of Myocardial Infarction

1. Typical MI Berger.

Teaching Modality: Simulation
Objective: Typical presentation of symptoms of evolving MI
Myron Berger 72 year old Caucasian male. 5'11, 141# , 64.09 Kg Dx: Chest Pain r/o MI PMH: MI 5/2008 with angioplasty and stent. HTN (on Norvasc and Lasix). Smokes ½ pack filtered cigarettes per day. ID: MR900157890 Birth date: April 22, 1937 Allergies: Sulfa. Fall precautions: No. Skin precautions: Standard.
Physician: Dr. Kimes, Attending/Dr. Morales Cardiologist
Scenario: Typical MI symptoms (includes gender male, age over 40 years, non African American). Mr. Berger is a 72 year old retired white male admitted through the Emergency Department (ED) with complaints of acute chest pain. He has had a previous angioplasty with stent two years ago left anterior descending (LAD) coronary artery. Smokes ½ pack filtered cigarettes per day (PPD). Mr. Berger is under the care of a primary care physician and cardiologist. Home meds are: Norvasc (amlodipine) 5 mg PO QAM Lasix 20 mg PO Q AM ASA 81 mg PO daily Admitted ED night before, about 5am, to telemetry unit about 0730 am. EKG and cardiac enzymes have been drawn. Initial EKG normal and enzymes negative. Second set of enzymes to be drawn in several hours. Has NTG paste on STAT dose for chest pain. ASA 325 mg in given ED. Admitted and placed on telemetry.

<table>
<tr><th colspan="2">Simulation time: 0900 Transfer from ED</th></tr>
<tr><td>Physical: 5'11" Male,141 #,64.09 Kg
BP: 118/62, P 80, RR 16, T 98.6 (o)
O2 Sat on assessment 98%</td><td rowspan="4">Supplies:
Bed 101.
Standard man in bed with patient gown.
Correct genitalia.
Name Band: See above.
Allergy Band: Sulfa.

INT 20 gauge R hand.
NS @ 100 ml/hr.
NTG patch anterior chest.
Telemetry leads (attached).
O2 nasal cannula hanging off bed.
Bandage where blood was drawn R AC.

Set up:
Scenario clock 0900
Telephone for call to MD.
Pulse oximeter at bedside (off patient).
Drug book.
Chart.

<u>Medications:</u>
NTG paste on anterior L chest.
NTG papers
Lasix (furosemide) 20 mg PO
Norvasc (amlodipine) 5 mg PO
Tenormin 50 mg PO
ASA 325 mg PO
Heparin 5000 units
Colace 100mg
Phenergan 12.5 mg IV PRN
Flush.
Syringes.
Bag of saline.

<u>Moulage:</u>
None</td></tr>
<tr><td><u>Medications:</u>
Lasix (furosemide) 20 mg PO QAM
Norvasc (amlodipine) 5 mg PO QAM
NTG paste 1in Q 6 hours.
ASA 325 mg PO Q Day.
Phenergan 12.5 mg IV PRN nausea
Order: STAT EKG for chest pain.
Telemetry
Cardiac Diet (1500 mg NA, Low cholesterol, low fiber)
OOB as tolerated.
VS Q4 hours and PRN</td></tr>
<tr><td>Social: Married drinks 1 beer daily.
Wife in good health.
Wife is with husband, but off unit, nurse does not know where.
Occupation: Retired.</td></tr>
<tr><td>History: Previous MI 2007 with angioplasty with stent and cardiac rehab.</td></tr>
<tr><td colspan="2">Simulation:
Introduce students to simulator.
Assign roles: [coin toss first and 3rd scenario]. Primary and medication.
Explain roles. Primary supervises care and communicates with the physician, secondary nurse gives meds, supports primary.
Encourage students to speak out loud and interact.</td></tr>
</table>

GIVE STUDENTS CHART Listen to report. Go over SBAR. Primary interacts with the physician. State will be told when scenario ends, to treat situation as real, don't talk to researchers. Set Scenario time. ***Start: Stable. V/S set at BP 122/62, 70, RR 20, T 98.6 (o), O2 Sat 98%.*** Personality: Upbeat, jokes, mock flirting with females, conspiratorial with males. Wife is out of the room. Asks for a cigarette because his wife is gone. Asks for the urinal if given the dose of Lasix medication. If asked about chest pain it was 7/10 in the ED, but now there is none. Patient sounds anxious; concerned about another MI. Nursing shift report patient has no chest pain during the previous shift. When primary nurse assesses, patient starts complaints. Primary Nurse: General assessment. Secondary nurse: medication due: Norvasc, Lasix, Tenormin, ASA. After assessment patient asks if he can call his wife to cancel the breakfast she is getting for him, he feels a little nauseous. ***Stage II: Vital signs BP 142/70, HR 80, RR 22, T 98.8(o) O2 Sat 93%.*** Increasing pain. Medication nurse should respond. As she gets this primary nurse should reassess. Patient complains of increasing chest pain, behind sternum. Patient becomes restless, calls for wife, increased anxiousness and restlessness. States, 'Look, I'm just sweating." Chest pain 7/10 in general MI area. *Begin timing after 5 typical symptoms given:* **Cardiac Event:** Continue with escalating symptoms until physician is called. Chest pain 10/10. ***Stage III: VS 152/84, HR 88, RR 24 T 98.8 (o), SpO2 when assessed 93%*** When student uses SBAR to report the problem **END TIME at the point student states a diagnosis. Physician will prompt with "what do you think is wrong?" if no diagnosis given.**

End scenario. Debrief with debriefing questions. Change roles, Start next scenario.	Ask students if would they like to take a break between scenarios (allow no more than about 15 minutes if needed).

2. Typical MI Dinkins.

<table>
<tr><th colspan="2">Teaching Modality: Simulation</th></tr>
<tr><td colspan="2">Objective: Typical presentation of symptoms of evolving MI</td></tr>
<tr><td colspan="2">Bert Dinkins, 64 year old Caucasian Male. Height 5'7", 132 #, 60 Kg
Dx: R/O MI
ID: MR900157006
Birth date: June 14, 1945
Allergies: NKA
Fall precautions: No.
Skin precautions: Standard.

Physician: Dr. Carp, Attending</td></tr>
<tr><td colspan="2">Scenario: Typical MI (includes gender male, age over 40 years, non African American).
Mr. Dinkins is a 64 year old White male janitor admitted today for CP and nausea. He has spent the afternoon cleaning out the garage and has had chest pain for the last two hours.
No previous medical history, no home meds.

EKG and cardiac enzymes have been drawn. Initial EKG normal and cardiac enzymes are negative and due in several hours again. EKG ordered for chest pain. Has a NTG patch on which was placed in the ED. ASA 325 mg in ED.
Admitted to hospital R/O MI, on telemetry.</td></tr>
<tr><td colspan="2">Simulation time: 1600</td></tr>
<tr><td>Physical: 5' 11" Male, 141#Kg
BP: 108/66, HR 62, RR 18
T(o) 98.6</td><td rowspan="2">Supplies:
Bed 101
Standard man in bed with patient gown.
Correct genitalia.
Name Band: See above.
Allergy: NKA.
Make ID stickers.

INT 20 gauge R hand
NO telemetry cables.
NTG patch 1 inch (dated same day).

Scenario clock start at 1600.</td></tr>
<tr><td>Medications:
Colace 100mg PO daily
ASA 325 mg PO Q Day.
Phenergan 12.5 mg IV PRN nausea

Order: STAT EKG for chest pain.
VS Q4 hours and PRN</td></tr>
</table>

<table>
<tr><td></td><td rowspan="3">Telephone for call to MD.
Pulse oximeter.
Drug book.
Chart.

Medications:
Colace 100mg PO daily
ASA 325 mg PO Q Day.
Phenergan 12.5 mg IV PRN nausea
Flush.
Syringes.
Bag of saline.

Moulage:
None.</td></tr>
<tr><td>Social: Divorced. Drinks beer on weekends, two six packs.
Occupation: Janitor.</td></tr>
<tr><td>History: Tonsils as a child. Admitted for complaint of chest pain after cleaning the garage for several hours.
R/O MI</td></tr>
<tr><td colspan="2">Simulation:
Introduce students to simulator.
Assign roles: [coin toss first and 3rd scenario]. Primary and medication.
Explain roles. Primary supervises care and communicates with the physician, secondary gives meds, supports primary.
Encourage students to speak out loud and interact.
Listen to report. Go over SBAR. Primary interacts with the physician.
State will be told when scenario ends, to treat situation as real, don’t talk to researchers.

Start: Stable. Current BP 118/62, HR 66, RR 16, T 98.6 (o) O2 Sat 98%
<u>Personality: Dour, grumpy, pessimistic</u>.
Examples of patient statements: Complaints, such as “I’ve hardly seen my doctor.” “I sorry I came because I didn’t think they would make me stay in the hospital”. “I don’t really want any visitors”. States he feels ‘fine’ but is quiet and tense.
No tenderness or musculoskeletal pain from moving boxes in garage prior to admission. States the pain started 30 minutes after he sat down for a glass of cold tea after cleaning the garage. If nausea an assigned symptom states, I need a bucket, I’m going to throw up!”

Primary Nurse: Focused assessment.
Medication nurse: Medication administration and assist primary nurse</td></tr>
</table>

Stage II: Vital signs: BP 122/70, HR 82, RR 20, T 98.6(o). O2 Sat 97% Phase II begins with first symptom. Chest pain 7/10 in general MI area. Presentation of scenario symptoms over about 5minutes. Medication nurse should respond; primary nurse should reassess. ***Stage III: VS 152/84, HR 88, RR 24 T 98.8 (o). O2 Sat 94%*** Increasing frequency of symptoms. Chest pain progresses to 10/10. **START TIME** Continue with escalating symptoms until physician is called. When student uses SBAR to report the problem **END TIME at the point student states a diagnosis. Physician will prompt with "what do you think is wrong?" if no diagnosis given.**	
End scenario. Debrief with debriefing questions. Change roles, Start next scenario.	Ask students if would they like to take a break between scenarios (allow no more than about 15 minutes if needed).

3. Typical MI Oakes.

Teaching Modality: Simulation	
Objective: Typical presentation of symptoms of evolving MI	
Joshua Oakes, Caucasian male, 57 years old. HT 5' 8" 210#, 95.45 Kg DX: New onset atrial fibrillation. Procedure: S/P coronary angiography. PMH: Hypertension (HTN). Father died of 'heart attack' at age 65. ID: MR900173809 Birth date: February 22, 1952 NKA (no known allergies). Fall precautions: None Skin precautions: Standard. Physician: Dr. Ray Morales, cardiologist	
Scenario: Typical MI (includes gender male, age over 40 years, non African American). Mr. Joshua Oakes is a 57 year old white male admitted after an episode of chest pain which caused him to seek medical care. His physician referred him to a cardiologist who performed a stress test followed by cardiac catheterization. Results of the catheterization show moderate single vessel disease and 75% occlusion of the right coronary artery (RCA). He developed atrial fibrillation, a cardiac dysrhthymia, post-catheterization with symptomatic hypotension. He is admitted stable for regulation of the cardiac rhythm. Current rhythm is sinus.	
Scenario Time: 1800	
Physical: 5' 8" Male, 210 #, 95.45Kg Beginning vital signs BP: 138/72, HR 74, RR 18 T98.6(o) O2 Sat 98% (when assessed). <u>Medications:</u> *Home:* Metoprolol 25 mg daily for HTN. Daily aspirin, 81mg. *Hospital:* Started on diltiazem (Cardizem) gtt for sudden a fib, change to PO	**Supplies:** Bed 101. Standard man in bed with patient gown. Correct genitalia. Name Band: See above. Allergy band: NKA Make ID stickers. **INT 20 gauge R hand** **NS @ 100 ml/hr** **R groin pressure dressing with serosanguinous drainage.**

30 mg for well controlled NSR. Zofran 4mg IV for Nausea Q4-6 h. Chart orders admission and post-cardiac catheterization: V/S 1hX4, thenQ4h. Neurovascular checks Q1X4 then Q4h. Telemetry Cardiac diet. OOB as tolerated 6 hours post cath. HOB no more than 15°.	(Positive pedal pulses). **Sheet immobilizer over R knee** **Oxygen nasal cannula hanging off bed.** **Telemetry leads on patient** **Lab sample dressing R AC** **Pulse oximetry available** **Telephone for call to MD.** **Extra dressings for groin** **Pulse oximeter.** **Drug book.** **Chart.** **Medications Drawer:** **Metoprolol 25 mg PO** **ASA 81 mg PO** **Zofran 4 mg IV** **Flush** **Syringes** **NS 500 ml** **Moulage:** Pressure dressing Right groin showing 2X4 cm area of serosanguinous drainage.
Social: Married 30 years, 1 child living at home, drinks socially. Mother lives independently but patient has care responsibilities for her. Occupation: Transportation routing for major trucking company. Sedentary	

Simulation:
Introduce students to simulator.
Assign roles: [coin toss first and 3rd scenario]. Primary and medication.
Explain roles. Primary supervises care and communicates with the physician, secondary gives meds, supports primary.
Encourage students to speak out loud and interact.
Listen to report. Go over SBAR. Primary interacts with the physician.
State will be told when scenario ends, to treat situation as real, do not talk to researchers.

Start Scenario:
Start: BP 118/62, HR 80, RR 16, T 98.6 (o), Sat 98% when assessed.
Personality: Steady, down-to-earth.
Examples of patient statements: "My thigh [angioplasty catheterization site] is throbbing. It's about a 2-3 [pain rating]. States his daughter will be visiting as soon as she is finished with her job for the day at 6 p.m. Wife is off the unit for a meal. Talks about the experience after the cardiac catheterization as feeling 'bad', 'weak', or 'light headed' when he tried to

assist transferring off the exam table. Primary Nurse: General assessment and for post heart cath. Secondary nurse: medication due: Metoprolol.   **Stage II: Vital signs: BP 122/70, HR 82, RR 20, T 98.6(o). Sat 96%** Phase II begins with first symptom. Presentation of scenario symptoms over about 5minutes. Medication nurse should respond; primary nurse should reassess. Examples of patient statements: Patient complains of chest pain rated 7/10, which progresses to 10/10. behind sternum. Examples of statements: "I can't get comfortable, put a pillow, raise my head, lower my head". Patient shows anxiety "My chest is hurting. Where is my wife? Is everything all right?" *Begin timing after 5 typical symptoms given. Go to Stage III.* **Cardiac event:** **Stage III: VS 152/84, HR 88, RR 24 T 98.8 (o). Sat 96%** **Continue with escalating symptoms until physician is called.** **When student uses SBAR to report the problem** **END TIME at the point student states a diagnosis. Physician will prompt with "what do you think is wrong?" if no diagnosis given.**

End scenario. Debrief with debriefing questions. Change roles, Start next scenario.	Ask students if would they like to take a break between scenarios (allow no more than about 15 minutes if needed).

Appendix M

Pattern Recognition Simulations (Intervention)

Appendix M

Pattern Recognition Simulations (Intervention)

1. Experimental MI Golden.

Teaching Modality: Simulation	
Objective: Present symptoms of evolving MI	
Alex Golden, 54 year old male. 5'8, 242 #, 110 Kg ID: PCS71900 Dx: R/O MI Birth date:7/19/1954 Allergies: NKA Fall precautions: No. Skin precautions: Standard. **Physician: Dr. O'Neill, cardiologist; Dr. Barnes, attending.**	
Scenario: Pattern MI (includes typical and non-typical symptoms. Admitted via the ED with CP rated 8. Visit to ED for same reason one month ago. Home meds are: "Water pill" EKG and cardiac enzymes have been drawn. Initial EKG and enzymes are negative and due in several hours again. Has a NTG patch on. ASA 325 mg in ED. On telemetry.	
Simulation Time: 1000	
Physical: 5' 8" Male, 242 #, 110Kg BP: 138, 88, HR 82, RR 18 T(o) 98.6 NSR without ectopy.	Supplies: Bed 101 Standard man in bed with patient gown. Male genitalia. Name Band: See above. Allergies: NKA. Make ID stickers. **20 gauge R hand.** **NS @ 100 ml/hr** **NTG patch 1 inch** on anterior chest (see MD orders). **Telemetry** **O2 nasal cannula** hanging at bedside, not on patient.
Medications: Order: STAT EKG for chest pain. NTG paste NS 100 ml/hr Colace 100 mg PO daily Heparin 5000 units SQ Q6 hours	

<table>
<tr><td>ASA 325mg PO daily

VS Q4 hours and PRN</td><td rowspan="3">Scenario clock start at 1000.
Telephone for call to MD.
Pulse oximeter.
Drug book.
Chart.

Medications:
NTG patch
NS 100 ml/hr
Colace 100 mg PO
Heparin 5000 units SQ
ASA 325mg PO
Flush.
Syringes.
Bag of saline.

Moulage:
None</td></tr>
<tr><td>Social: Married drinks 2 drinks/day, smokes ½ pk pd
Occupation: Truck driver</td></tr>
<tr><td>History: ED visit X 1 month ago for CP, diaphoresis, and SOB.</td></tr>
<tr><td colspan="2">Simulation:
Introduce students to simulator.
Assign roles: [coin toss first and 3rd scenario]. Primary and medication.
Explain roles. Primary supervises care and communicates with the physician, secondary gives meds, supports primary.
Encourage students to speak out loud and interact.
GIVE STUDENTS CHART
Listen to report. Go over SBAR. Primary interacts with the physician.
State will be told when scenario ends, to treat situation as real, don't talk to researchers.
Start: Stable. Current BP 140/90, P82, RR 18, T 98.6 (o). O2 Sat 98%.
All telemetry NSR.
<u>Personality: Steady, down-to-earth.</u>
Examples of patient statements during scenario:
Patient says, " Can I have a cigarette?" "Hey that pain is coming back. Nurse, I need help". Restless, anxious, complains of nausea, states, "I'm about to throw up!" Calls out for wife, "Honey, help!" "Oh, man, let me sit up a minute, Oh, man!" Patient sounds anxious, concerned about MI.</td></tr>
</table>

Other statements depend upon symptoms: "Honey, this feels bad", "Nurse, help me, me left arm is really hurting. Can you fix it?" "I feel so weak". "I think I feel my heart skipping beats. Should I be feeling that?" Pulmonary edema: Short soft expiratory cough, with nearly each breath. "There's a funny feeling in my chest." All chest pain is described as 'smothering'. Primary Nurse: Focused assessment. Secondary nurse: medication as needed (antiemetic, pain). After assessment patient asks if he can call his wife to cancel the dinner she is getting for him, he feels a little nauseous, depending on symptoms necessary for scenario. ***Stage II: Vital signs: BP 122/70, HR 82, RR 20, T 98.6(o). O2 Sat 97%.*** ***All telemetry NSR.*** Phase II begins with first symptom. Chest pain 7/10. Presentation of scenario symptoms over about 5minutes. Medication nurse should respond; primary nurse should reassess. When last symptom given, timing begun. **<u>START TIMING</u>** **Stage III: VS 100/54, HR 90, RR 24 T 98.8 (o). O2 Sat 94%.** **All telemetry NSR.** Phase III vital signs after last symptom is given. Chest pain 10/10. **Continue with escalating symptoms until physician is called.** When student uses SBAR to report the problem **<u>END TIME at the point student states a diagnosis. Physician will prompt with "what do you think is wrong?" if no diagnosis given.</u>**	
End scenario. Debrief with debriefing questions. Change roles, Start next scenario.	Ask students if would they like to take a break between scenarios (allow no more than about 15 minutes if needed).

2. Experimental **Non-MI** Johnson.

<table>
<tr><th colspan="2">Teaching Modality: Simulation</th></tr>
<tr><td colspan="2">Objective: Present symptoms of evolving MI</td></tr>
<tr><td colspan="2">Daniel Johnson, 27 year old male. 6’ 0”, 180#, 81.82 Kg
Dx: Pneumonia
PMH: Viral influenza two weeks ago. Tonsillectomy
age 8 years. Family history for early MI age 42 (father).
ID: PCS71900
Birth date:11/19/1982
Allergies: PCN
Fall precautions: No.
Skin precautions: Standard.

Physician: Dr. Kimes, Internist</td></tr>
<tr><td colspan="2">Scenario: Overlapping symptomatology: Computer software programmer. Admitting for severe cough, diagnosed with bacterial pneumonia secondary to viral influenza.
Admitted via the ED from physician’s office with pleuritic chest pain on coughing [frequent cough during scenario].
Home meds are:
None.
EKG and cardiac enzymes have been drawn. Results for EKG are normal and cardiac enzymes negative.</td></tr>
<tr><td colspan="2">Simulation time: 1000</td></tr>
<tr><td>Physical: 6’ 2” Male, 180 #
BP: 108/66, HR 62, RR 18
T(o) 98.6</td><td rowspan="2">Supplies:
Bed 101
Standard man in bed with patient gown.
Correct genitalia.
Name Band: See above.
Allergy Band: PCN.
Make ID stickers.

20 gauge R hand.
NS @ 125 ml/hour
O2 nasal cannula hanging at bedside, not on patient.

Scenario clock start at 1000.
Telephone for call to MD.
Pulse oximeter.</td></tr>
<tr><td>Medications:
Order: STAT EKG for chest pain.

Percocet tabs 1 PO q 4 h prn pain.
Tylenol 650 mg PO q4h prn fever.
Rocephin 1 gm IVPB q 6 hours.
NS @ 125 ml/hour
Diet Regular
OOB as tolerated

VS Q4 hours and PRN</td></tr>
</table>

Social: Bachelor. Lives alone in an apartment. Mother close to son, lives 3 hours away. Occupation: Computer software sales for a large company.	**Drug book.** **Chart.** **Medications:** Percocet tabs Tylenol 650 mg PO Rocephin 1 gm IVPB Levaquin 500 mg IVPB X 60 minutes (100 ml bag) on top of medication cart. NS @ 125 ml/hour Flush. Syringes. Bag of saline. **Moulage:** **None**
History. Unremarkable. Tonsillectomy age 8 years.	

Simulation:
Introduce students to simulator.
Assign roles: [coin toss first and 3rd scenario]. Primary and medication.
Explain roles. Primary supervises care and communicates with the physician, secondary gives meds, supports primary.
Encourage students to speak out loud and interact.
Listen to report. Go over SBAR. Primary interacts with the physician.
State will be told when scenario ends, to treat situation as real, don't talk to researchers.

Start: Stable. Current BP 122/62, HR 70, RR 22, T 99.0 (o). O2 Sat 98%
Personality: Upbeat, jokes, mock flirting with females, conspiratorial with males.
Patient coughing, mildly complaining of chest pain with cough [rates 2-3 with cough only]. If asked, cough is occasionally productive. "My mom is coming to visit today, she'll be here in about 3 hours. She's bringing my favorite cookies, chocolate chip and macadamia nut". "I need to get out of the hospital. My buddies and I have a great deal, $300 for four nights for hotel and 2 meals in Cancun. I can't wait to go." "If I get the antibiotic, can I go home?" "Can you believe I got this sick from the flu?". "I had trouble breathing during the night so I came to the hospital".
Primary Nurse: General assessment.
Secondary nurse has medication due: Rocephin.

If medication nurse gives medication: Anaphylactic reaction due to PCN allergy. If student recognizes allergy to Rocephin, Levaquin is ordered. As soon as either given intravenously Stage II begins [anaphylactic reaction]. ***Stage II: Vital signs: BP 142/70, HR 80, RR 24, T 99.6(o). O2sat 93%*** Repeatedly asks for mother to be called [mother is in route and will be there in 2 hours]. "My chest hurts all the time". Vaguely indicates mitral area." "I don't feel good about this, something awful is going to happen". "I can't catch my breath". Breathing audible. Asks to sit up, have an extra pillow, be turned to the side. Chest pain 7/10, same general area as MI. After last symptom **START TIME** Begin Stage III. ***Stage III: VS 152/84, HR 88, RR 24 T 99.8 (o). O2 Sat 93%*** Increasing symptomatology. Medication nurse should respond. As she gives any medication this primary nurse should reassess. Chest pain 10/10, same general area as MI. **Continue with escalating symptoms until physician is called.** Continue with escalating symptoms until physician is called. When student uses SBAR to report the problem **END TIME at the point student states a diagnosis. Physician will prompt with "what do you think is wrong?" if no diagnosis given.**	
End scenario. Debrief with debriefing questions. Change roles, Start next scenario.	Ask students if would they like to take a break between scenarios (allow no more than about 15 minutes if needed).

3. Experimental MI Weissmuller.

Teaching Modality: Simulation	
Objective: Present symptoms of evolving MI.	
Donald Weissmuller, 44 year old African American male. 6' 1" 148 #, 67.3 kg ID: PCS10337 Birth date:12/9/1964 Allergies: IVP dye (iodine) Fall precautions: Yes. Skin precautions: Standard.	
Physician: Dr. Foster, attending.	
Scenario: Pattern MI (includes typical and non-typical symptoms. Admitted via the doctor's office for diabetic ulcer Right foot. Complaining of throbbing foot pain 2-3/10. R foot dressed at the doctor's office with small amount serosanguinous drainage. Admitted four days ago. Stable. Has diabetes related MI during scenario.	
Simulation Time: 0900	
Physical: 6' 1" Male, 148 #, 67.3 kg BP: 138, 88, HR 82, RR 18 T(o) 98.6	Supplies: Bed 101 [label] Standard man in bed with patient gown. Male genitalia. Name Band: See above. Allergy: Iodine Fall Precautions Band. Make ID stickers. **INT 20 gauge R hand** (NO IV) **Telephone for call to MD.** **Pulse oximeter.** **<u>Glucometer and supplies.</u>** **Drug book.** **Chart.** **Moulage:** **Diabetic foot Right with** pink drainage (small) and Kerlix bandage. Saline and dressings Waterproof pad
Medications: Order: Rocephin 1 Gm IVBP q 12 h SSI AC & HS if BG > 150 mg/dl BG-30/100 = # units Regular insulin. Change dressing BID wet to dry. Tylenol 1000 mg po Q4 hours PRN T> 101 Percocet tabs ii PO PRN pain. PO q 6h 1800 cal ADA diet. OOB as tolerated. VS Q4 hours and PRN	

Social: Married. Abstains. Tried marijuana as a teenager. Occupation: Computer software programmer.	**Medications:** Rocephin 1 Gm IVPB (not scheduled to give during scenario). Regular Insulin (not scheduled to give during scenario). Tylenol Percocet tabs Flush syringes. Syringes. Bag of saline.
History: Diabetic X 9 years, insulin dependent last two years. Frequent respiratory infections.	

Simulation:
Introduce students to simulator.
Assign roles: [coin toss first and 3rd scenario]. Primary and medication.
Explain roles. Primary supervises care and communicates with the physician, secondary gives meds, supports primary.
Encourage students to speak out loud and interact.
GIVE CHART TO STUDENTS.
Listen to report. Go over SBAR. Primary interacts with the physician.
State will be told when scenario ends, to treat situation as real, don't talk to researchers.
Start: Stable. Current BP 118/62, P80, RR 16, T 98.6 (o). O2 Sat 98%.
BG 138 if taken.
<u>Personality: Dour, grumpy, pessimistic</u>.
Examples of patient statements: "I can't believe after all this time and how careful I have been this has happened to me [discussing foot ulcer]". "Have you seen it? Do you think I am going to lose my foot?" "How am I going to keep my job?" "I think my wife is seeing her old boyfriend [no evidence]." "Would you want a husband [wife] without a foot?" "I won't be able to dance; I'll be in a wheelchair." "My foot aches, it throbs]" "The [foot] pain is rated 2-3".
Primary Nurse: Focused assessment.
Medication nurse: Medication administration and assist primary nurse.

Stage II: Vital signs: BP 122/70, HR 82, RR 20, T 98.8(o). O2 Sat 96%.
BG 138 if taken.
Phase II begins with first symptom. Chest pain rated 7/10.
Presentation of scenario symptoms over about 5minutes. Medication nurse should respond; primary nurse should reassess.

<table>
<tr><td colspan="2"><u>START TIME</u>
Continue with escalating symptoms until physician is called.
Stage III: VS 152/84, HR 88, RR 24 T 98.7 (o). O2 Sat 96%.
BG 142 if taken.
Phase III vital signs after last symptom is given. Chest pain 10/10.
Continue with escalating symptoms until physician is called.
When student uses SBAR to report the problem

<u>END TIME at the point student states a diagnosis. Physician will prompt with “what do you think is wrong?” if no diagnosis given.</u></td></tr>
<tr><td>End scenario.
Debrief with debriefing questions.
Change roles,
Start next scenario.</td><td>Ask students if would they like to take a break between scenarios (allow no more than about 15 minutes if needed).</td></tr>
</table>

Appendix N

Debriefing Template

Appendix N

Debriefing Template

1. What did you think was wrong (diagnosis) with the patient during the simulation?
2. Were you able to gather all the assessment information needed to understand the patient's problem?

   Experimental (pattern) only:

   a. Positive reinforcement for accurate data collection.
   b. Point out missed data collection opportunities, if any.
3. Could you draw on your experience to understand the patient's problem?
4. What signs and symptoms did you notice?

   Experimental (pattern) only:

   a. Were you able to pick out the important signs and symptoms?
   b. Positive reinforcement for accurate identification of salient signs and symptoms.
   c. Point out missed salient signs and symptoms, if any.
5. Do you think you noticed all the signs and symptoms available?
6. Were you able to decide what was wrong with the patient based on your assessment?
7. Did you consider more than one reason for this set of symptoms?
   a. Positive reinforcement for considering more than one reason for this set of symptoms.
8. Did you need to gather more information after hypothesizing about what might be wrong to prove or disprove your idea?

9. When you decided to call the physician, was it a 'quick judgment' or did you analyze the situation first and decide you needed to call?

    Experimental (pattern) only:

    a. Positive feedback for analytic decision making.

    b. Negative feedback for 'snap judgment'

10. Based on what you learned after this debriefing, would you change your patient diagnosis now? If so, based on what?

    Experimental (pattern) only:

    a. Correct diagnosis for the scenario disclosed to students.

Appendix O

Simulated Symptoms

Appendix O

Simulated Symptoms

1. Nausea and vomiting – "I don't think I can [eat, take that medication] I feel sick!" "I'm sick to my stomach". Preprogrammed simulator sound for vomiting.
2. Chest pain – "Oh, my chest", "My chest hurts". End expiratory grunt or "Oh!" at onset of chest pain followed by verbalization. Rates 2-3/10 initially if asked, then 7-10/10 if asked. Pain is described as "smothering" and "in the middle of my chest". If asked to identify location, the general sternal region, vaguely left, is indicated.
3. Diaphoresis – "I'm just sweating!", "Why am I sweating?" Sprayed with fine mist plant mister over face, neck, and visible anterior bilateral arms.
4. Anxiety – "Where's my [wife, mother, daughter, doctor]", "I wish s/he'd get here, where is s/he?", "I need my [wife, mother, daughter, doctor].
5. Restlessness – "I can't get comfortable", "Sit me up", "Sit me up higher", "Turn me over", "Can I sit on the edge of the bed?"
6. Sense of impending doom – "I have a bad feeling about this", "Something bad is going to happen, I just know it".
7. Pulmonary edema – "I feel like there's something in my chest". Frequent short soft end-expiratory cough. Lung crackles programmed on mannikin with volume up to maximum. Crackles faintly audible in room without using stethoscope.
8. Palpitations – "My heart feels like it's up in my throat", "I have a funny feeling in my chest". Premature ventricular contractions programmed at a 75% rate from maximum on mannikin. Result is irregular pulse and heart tones.

9. Pallor – "I feel like I'm pale". Thin layer of petroleum jelly covered with thin layer of cornstarch, patted flat, on face neck and visible bilateral anterior arms.
10. Weakness – "I feel so weak", "Why am I so weak?" , "Help me, I feel so weak."
11. Shortness of breath – "I can't catch my breath", "I'm having trouble breathing". Louder respirations made by 'patient' in cadence with the simulated breaths.
12. Pain radiating down left arm – "What did you do to my arm? It hurts", "My arm is hurting", "My arm hurts from my shoulders to my fingers".
13. Pain radiating back, neck, jaw – Complaints of pain in back, neck, and jaw. Rates 2-3/10 initially, if asked, then 7-10/ if asked.
14. Dizziness – " I feel so dizzy", "Why am I so dizzy?". "Lay me down a little, I feel dizzy."
15. Diabetic foot ulcer – Changeable mannikin diabetic foot with plastic colored ulcers on great toe and heel, right foot. Kerlix dressing over gauze on foot and blue waterproof pad under heel. Use of pomegranate-blueberry juice for wound drainage on dressing and pad, 1 inch.
16. Angiography dressing – Two inch silk tape applied in groin pressure dressing configuration (flank to groin to posterior thigh) over 4 X 4 inch gauze and one abdominal 8 X 4 inch dressing with 2 inch area of pomegranate-blueberry juice to represent wound drainage. If student tried to remove dressing, 'patient' stated, "My doctor said that was not to be taken off, I might bleed!".
17. Knee immobilizer – Twin size top sheet folded longitudinally about 24 inches wide. One end placed under mattress, then draped over right knee and under left knee, then tucked under mattress on opposite side.

APPENDIX P

Group 1 (Control Non-Simulation) Themes and Patterns from Thinking Aloud Data

APPENDIX P

Group 1 (Control Non-Simulation) Themes and Patterns from Thinking Aloud Data

Group Theme	Pattern
1. Know the symptoms of MI	There are atypical symptoms we may not know
2. Recognize the symptoms when I see them	Compare what I see to what I know I need to see it in real life Anxiety makes recognizing MI difficult Severity of the symptoms matters Can the patient tell me about the symptoms? I need hands on experience Videos and testimonials might help
3. Collect all the information I can think of	But I'm not sure which But for sure I need to know about the pain Severity of symptoms matters Patient history can point me in the right direction What does the patient say? What if I'm not in a hospital? I look for MI symptoms
4. Differentiate MI from other conditions.	Rule out/rule in Response to treatment can help me decide MI is different in different people EKG can differentiate Compare what I see to what I know
5. Make a diagnosis- err on the side of caution	Though not sure anyone but the MD can do it I can't do it or I can't do it well Context makes a difference

Note: MI = myocardial infarction, EKG = electrocardiogram, MD = medical doctor.

APPENDIX Q

Control Group 2 (Control Simulation) Themes and Patterns from 'Thinking Aloud' Data

APPENDIX Q

Control Group 2 (Control Simulation) Themes and Patterns from 'Thinking Aloud' Data

Group Theme		Pattern
1	Obtain data but look for the five essential signs.	Support decision by looking for nonessential and atypical signs Evaluate data Risk factors guide me
2	Make a diagnosis: Reaching the tipping point.	I need the five essential signs to know Index of suspicion I want to be right Analysis Scope of practice Anxiety is a barrier but simulation made me less anxious. Mentor/validate Time pressure Err on the side of caution Salience Magnitude of symptoms. Not all MIs are the same
3	Differentiate from other conditions.	Pain differentiates. I don't know enough to differentiate Rule out/rule in (Hypothesis testing absent)
4	What I learned on reflection.	The steps (No realization) (Unaware of biases) I need more experience Simulation is experience Think about potential consequences for actions

APPENDIX R

Experimental Simulation Group 3 Themes and Patterns from 'Thinking Aloud' Data

APPENDIX R

Experimental Simulation Group 3 Themes and Patterns from 'Thinking Aloud' Data

	Group Theme	Pattern
1	Obtain, analyze, and evaluate patient data for salience and context.	Evaluate data Evaluate risk factors Analyze data as a whole
2	Differentiate from other conditions.	Pain differentiates. I don't know enough to differentiate Rule out/rule in
3	Making a diagnosis - I can do it with support.	The five essential signs help me to know Index of suspicion I want to be right Analysis Scope of practice Anxiety is a barrier but simulation made me less anxious Mentor/validate Time pressure Err on the side of caution Magnitude of symptoms Not all MIs are the same.
4	What I realize on reflection.	See the whole. I can be biased I need more experience Think about potential consequences for actions
5	Simulation is experience, but not the real thing.	I need hands on experience