Southern California CSU DNP Consortium

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COGNITIVE STRATEGIES FOR SAFE MEDICATION ADMINISTRATION

A DOCTORAL PROJECT
Submitted in Partial Fulfillment of the Requirements
For the degree of
DOCTOR OF NURSING PRACTICE

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ABSTRACT

Driven by increasing incidences of medication errors made by nurses and the accompanying adverse patient outcomes and complex etiologies of the errors, there has been a plethora of research generated. Medication errors and their sequelae are well documented. However, there remains a paucity of studies that examine nurses’ clinical judgment and reasoning abilities especially those that facilitate safe medication administration. In this doctor of nursing practice project, cognitive strategies for nurses and nurse leaders are proposed to mitigate this problem. Based upon an integrative literature review, 98 cognitive strategies for safe medication administration were identified. Benner’s Framework of Nursing Competence and the Johns Hopkins Nursing Evidence-based (JHNEBP) Practice Rating Scales guided the integrated literature review and synthesis of findings. The Tang Model of Cognitive Strategies for Safe Medication Administration was formulated using Lasater’s Clinical Judgment Rubric as a guide. The model is to be used during medication administration. Ideally, the nurse would visualize the Model and then activate the cognitive strategies from the model. This should remind the nurse to employ: 1) patient-centered and pattern-recollected Mindfulness; 2) Clinical Reasoning while prioritizing; 3) protective, protocol-driven, and proactive Decision-making; 4) perceptive reassessment with Validation in patient care. The Model has not been tested.
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BACKGROUND

Medication preparation and administration by nurses require complex physical and intellectual activities to ensure safe patient outcomes (Fero, Witsberger, Wesmiller, Zullo, & Hoffman, 2009). Three competencies (cognitive, psycho-motor, and affective clinical judgment) are required as nurses observe patients, communicate with stakeholders, and interpret relevant data, prior to administering medication to patients (Maynard, 1996). Consequently, medication administration is neither an isolated skill nor a purely knowledge-based decision. Unfortunately, medication errors most often occur due to deficiency in one or more of these basic competencies. Therefore, errors in medication administration are multifaceted and require multiple strategies to prevent.

Nursing medication errors have continued to increase over the years and have been the cause of mild, moderate, or fatal patient outcomes (Brady, Malone, & Fleming, 2009). Causes of medication errors are numerous but many common etiological factors have been described through observation and research. Common etiologies found to increase medication errors are: 1) higher levels of patients' acuity; 2) complex patient health problems; 3) poly-pharmacy; 4) increased complexity of medication routes; 5) numerous times and procedures; 6) measurable fatigue and stress on nursing personnel; 7) time constraints of overworked nurses; 8) poor medication math skills; 9) lack of knowledge of new medications; and, 10) the unprepared nurse who lacks clinical judgment and reasoning (Cleary-Holdforth et al. 2013; Leufer, et al. 2013). Because medication administration is not only skilled-based but requires cognitive reasoning ability, effective cognitive strategies need to be investigated and ultimately recommended for safe clinical administration.
The average nurse in a hospital spends about 40% of her/his time administering medications. Because the bulk of the nurse's time is focused on medication administration, there is a significant higher probability of medication error (Popescu, Currey, & Botti, 2011). Research has demonstrated that “medication errors have been identified as the most common type of error affecting the safety of patients and the most common single preventable cause of adverse events” (National Medicines Information Center, 2001, p. 1). Brady et al. (2009) found that nurses lacked “adequate pharmacological skills for practice” (p. 692) and this lack of knowledge and experience with medications or equipment caused 79% of all errors.

A 2008 study reported that “adverse drug events kill 7,000 Americans annually and that medication errors that result in harm are the number-one cause of inpatient fatalities” (Hicks, Becker, & Cousins, 2008, p. 8). Medication errors lead to adverse patient outcomes such as increased mortality rates, increased length of stay in the hospital, and increased medical expenses. Thousands of patients incur lethal events due to medication errors every year. The financial costs associated with these medical complications have been estimated as $77 million annually. In addition, studies have suggested medication errors prolong hospital stay by 2 days and increase costs by $2000-2500 per patient (Tang, Sheu, Yu, Wei, & Chen, 2007).

The Institute of Medicine (IOM) reports that medication errors are the single most common type of error in health care, representing 19% of all adverse events and over 7,000 deaths annually. At least one medication error occurs every day for every hospitalized patient (Barker et al. 2002). Leape, Bates, & Cullen, (1995) studied adverse drug effects (ADE) and found that 56% of these drug errors were attributed to prescribing
errors by providers and 44% of adverse drug events (ADEs) involved drug administration errors. Barker et al (2002) additionally reports that medication errors were common (nearly 1 out of every 5 doses in the typical hospital) and of these errors 7% were rated potentially harmful.

In the last ten years, extensive research has been done describing the types and causes of nursing medication errors (Brady et al. 2009). Brady et al reported a systematic review of ninety-three articles studying the complex factors that contribute to medication errors. These articles covered multiple disciplines such as medicine, pharmacy, and nursing. However, studies have not focused on nursing medication errors in relation to the nurse's lack of clinical judgment and reasoning, particularly in the area of understanding the medications to be administered. Correct medication administration requires correct and critical cognitive clinical reasoning and is a basic competency taught in pre-licensure nursing curricula programs (Leufer et al. 2013).

Although medication knowledge and medication administration are routinely tested during nursing school and are included on standardized exams for licensure, research supports that the lack of critical knowledge needed for safe and accurate medication administration is a contributing factor in medication error (Brady et al. 2009). Nursing curricula as well as State Boards of nursing recognize the importance of cognitive ability (Chang & Mark, 2009). Registered nurses must be prepared to practice proven evidence-based strategies and clinical reasoning when safely administering medications. Nurses need cognitive strategies to improve clinical reasoning and to decrease adverse patient outcomes.
Problem Statement

There is a paucity of research literature available that examines the nurse’s clinical judgment and reasoning abilities that facilitate safe medication administration. Evidence-based literature investigating the association of these two factors needs to be developed. Together clinical judgment and reasoning abilities refer to areas in the cognitive domain of thought. Substantial scholarly work has described medication administration error and cognition in nursing, but there has been few studies examining cognitive strategies during medication administration (Sitterding, Ebright, Broome, Paterson, & Wuchner, 2014).

Purpose

The purpose of this project was fourfold: first, cognitive strategies were identified in an integrative literature review (ILR) by collating and evaluating research studies that identify clinical judgment and reasoning abilities. Second, the Tang conceptual model of cognitive strategies was formulated from the literature. Third, this model was recommended to nursing stakeholders who directly insure safe cognitive skills during medication administration. And, fourth, a manuscript describing the Tang model of cognitive strategies for safe medication administration was developed. The manuscript was submitted to a peer-reviewed journal for publication and dissemination to nursing administrators and educators.

Project

The project begun as an integrated literature review (ILR) to identify cognitive strategies for safe nursing medication administration, but changed direction at the completion of the ILR. This was due to an unexpected development: at the culmination
of the ILR, synthesis of the findings facilitated the formulation of a conceptual model for cognitive strategies. This conceptual model was a combination of all the cognitive strategies aggregated and condensed from the ILR.

The Tang model was developed in seven phases: phase I- the investigator performed an ILR using key variables and phrases; phase II- the investigator utilized research tools to identify and extract cognitive strategies for safe medication administration from the ILR. The tools used were two conceptual frameworks, one rubric, two scales and a table of evidence; phase III- the investigator mined and identified ninety eight cognitive strategies from the ILR; phase IV- the investigator condensed the ninety eight cognitive strategies into four common cognitive themes; phase V- a conceptual model was developed; phase VI- the new conceptual model describing the four cognitive strategies and recommendations to nurse administrators and nursing educators was exhibited in a manuscript submitted to a peer-reviewed journal; and phase VII- the new conceptual model was disseminated to nursing educators and nursing administrators at a local hospital and nursing college for review.

The goal of the project was to propose evidenced-based cognitive strategies to nurse educators (novice as well as experienced) and nurse leaders. When integrated into practice, these strategies would develop and deepen clinical reasoning, judgment, and decision-making. Clinical reasoning, judgment, and decision-making are subsets of cognitive competency, and are one of three basic abilities in the development of nursing professional competences. Two other related areas of competency, although not discussed are in the psychomotor and affective domains (Maynard, 1996). Ultimately, the long-term goal of nursing was to deepen nursing professional competency acquired in
all domains using the educational process and developmental maturation acquired through professional experiences (Booth, 1985).

Proactively, the implementation of the Tang model by nurses would not only improve medication safety but also would decrease the frequency of medication errors; improve mortality rates; decrease length of stay; and, reduce medical center costs. Because medication administration is a primary function of all nurses, the nurse’s clinical judgment, reasoning, and decision making directly impacts patient safety.

**Supporting Framework**

Two conceptual frameworks were used to guide this project. The first one was Benner's work in professional nursing competence. Benner's theory (2001) provided a conceptual model to help organize cognitive themes used in medication administration. Lasater's Clinical Judgment Rubric (LCJR) was the second framework utilized to identify cognitive strategies for clinical judgment or “how the nurse thinks” (Lasater, 2007). This rubric was applied when collating and categorizing the extracted cognitive strategies from the literature.

In the first conceptual framework, Benner's original work (1984) described the development of professional nursing competence in stages of clinical reasoning acquisition. Because this project examined clinical practice and knowledge of nurses, Benner's model was ideal. Benner states that nurses progress in knowledge by utilizing contextual cases with applying personal acquired knowledge (Maynard, 1996). Benner defines nursing competence as stages in clinical and practical knowledge acquisition (novice, advanced beginner, competent, proficient, and expert). The five central concepts of Benner's theory (competence, clinical knowledge, practical knowledge, skill
acquisition, and experience) were applied. Benner's work focuses on the nurse's clinical expertise in practice settings. From the five central concepts of Benner's theory, the conceptual model focused on two areas for medication administration:

1. Competence (clinical reasoning and decision making)
2. Clinical and practical knowledge (medication, math, time management)

(Benner's Model in Nursing, McEwen, 2002).

Benner's Model was also utilized to organize and guide the literature review and assisted in providing the application of concepts, terms, and definitions (Bonnel & Smith, 2014). The model provided structure, direction, and clarification for the project's key variables, which are: competence, clinical knowledge, practical knowledge, skill acquisition, and experience.

The model also served to develop the recommended cognitive strategies needed for the project by: addressing and delineating the progression of clinical and practical knowledge and competency acquisition (Benner, 2001). According to Benner (2001), learning takes place when nursing competencies are activated in set case scenarios focused primarily on five central concepts. The central concepts are: competence, clinical knowledge, practical knowledge, skill acquisition, and experience. These concepts described nursing performance. These concepts also provided direction when cognitive strategies were developed for Tang’s conceptual model. For example, Benner's model uses the concept of continuum to denote the nurse's professional growth as the “evolution of the beginner to expert nurse” (Maynard, 1996, p.12). This concept provided direction to identify the nurse's competency level in medication administration.
Clinical reasoning and critical thinking are often used interchangeably but they are not the same. For example, clinical reasoning is the ability of the nurse to use critical thinking skills in the clinical environment. Critical thinking is defined in the context of a point in time; whereas clinical reasoning includes the entire changing clinical milieu (Billings and Halstead, 2012).

Lasater Rubric was utilized for the second conceptual framework. The Lasater Clinical Judgment Rubric (LCJR) was utilized (Appendix C) to define and differentiate multiple cognitive strategies needed for safe medication administration. The LCJR is a tool to enhance the clinical judgment skills of novice to experience nurses to practice in the clinical setting (Asselin & Miraglia, 2015). The LCJR was developed from Tanner’s Clinical Judgment Model (Tanner, 2006). Tanner's Clinical Judgment Model (CJM) describes the process of nursing judgment used by beginning to experienced nurses.

Tanner's CJM breaks down the process of clinical judgment into four aspects: (noticing, interpreting, responding, and reflecting) and describes the relationship among them. According to Tanner, the concept of “noticing” is defined by the ability of the nurse to understand the clinical situation at hand (Tanner, 2006). Positive noticing is shaped by theoretical knowledge, experiential knowledge, and knowledge of a particular patient (Tanner, 2006). When the nurse practices the strategy of “noticing”, the nurse understands clinical reasoning patterns to assist in data interpretation to plan nursing actions. Tanner, (2006), clearly defined the following concepts: “interpreting” which includes analytical reasoning, narrative thinking, intuition, and pattern recognition; “responding” is defined as deciding on a clinical course of action; and the aspect of
“reflecting” describes the process of evaluating how the patient is responding and exploring the clinical experience to gain clinical knowledge.

Lasater (2007) expands upon Tanner’s four aspects of clinical judgment by adding more dimensions within each concept. The concept of “Noticing” had three dimensions added: focused observation, recognizing deviations from expected patterns, and information seeking. “Interpreting” had two dimensions added: prioritizing data and making sense of the data. “Responding”, had four dimensions added: calm confident manner, clear communication, well planned intervention, and being skillful; “Reflecting” had two dimensions added: evaluation/self-analysis and commitment to improvement. The conceptual figure of Lasater's Rubric is included to depict these four concepts: noticing, interpretation, responding, and reflection; and, the corresponding nineteen cognitive strategies gleaned and deduced from the literature (Figure 2).

**Project Goal and Objectives**

To achieve the goal of formulating a new conceptual model for cognitive strategies for safe medication administration, specific objectives were outlined.

Specific Investigator Objectives were:

1. Examined factors that facilitate cognitive reasoning in the nursing, medicine, pharmacy, nursing administration, psychology, and education literature. An integrative literature review was conducted using the following electronic databases: Academic Search Premier, MEDLINE/PubMed, CINAHL, Web of Science, Science Digest, ProQuest, and Mednar (Google Scholar and National Institute of Health).

2. Collected, evaluated, synthesized, and tabulated research findings on a table of evidence (TOE) utilizing an evaluative scale (Johns Hopkins Nursing Evidence-based
Practice Rating Scales (JHNEBP)(Appendix D). The TOE assisted to develop salient points regarding nursing clinical reasoning in medication administration (Holly, 2014).

3. Identified cognitive strategies from the TOE and categorized them on the rubric (LCJR).

4. Developed a conceptual nursing model for cognitive strategies used in medication administration.

5. Wrote a manuscript about the model for a peer reviewed nursing journal for nursing administrators and nursing educators.

6. Recommended the new conceptual model to nursing educators and nursing leaders.
REVIEW OF LITERATURE

In Phase I of the project, an integrative literature review (ILR) was performed to identify cognitive strategies for safe medication administration. The aim of the integrative literature review was to explore available evidence using the key terms related to nursing clinical judgment and reasoning abilities for improved medication administration. The ILR was conducted by collating and evaluating relevant research to synthesize, compare, contrast and analyze the studies. Throughout the literature search, it was important to keep in mind that there is “no one strategy considered most effective in developing clinical reasoning and judgment” when looking for cognitive strategies for safe medication administration (Cappelletti et al., p.12, 2014).

During the ILR, key terms, phrases, or concepts were flagged to locate the studies. The terms were: (1) medication administration and errors, (2) nursing practice, (3) clinical reasoning/knowledge, (4) decision making, (5) critical thinking classifications, (6) nursing pharmacology courses, (7) NCLEX-RN (National Council Licensure Examination for Registered Nurses) preparation and test content, (8) nursing pharmacology, (9) medication skill acquisition and experience, and 10) cognitive processing and competencies. Holly (2014, p.126) described four questions that assisted in identifying pertinent literature for the integrative literature review. These four questions were:

1. What is known about cognitive strategies that would facilitate clinical judgment and reasoning abilities for improved medication administration?

2. What should be known about this topic?

3. What is the quality of what is known about this topic?
4. What is the next step for nursing practice?

A flow diagram of the literature review is included (Figure 1). The parameters of the search included primary, secondary, and tertiary literature from 2000-2015 in only the English language, and included quantitative, evidence-based, peer-reviewed studies; experimental and quasi-experimental studies; qualitative studies; and descriptive research. The inclusion criteria were studies that discussed cognitive abilities in nursing medication administration directly relevant to nursing practice only. The exclusion criteria included gray literature, editorials, blogs, commentaries, and opinion articles. The table of evidence (TOE) did not include the excluded studies or the studies, which did not meet the inclusion criteria.

In Phase II of the project, the Johns Hopkins Nursing Evidence-based Practice (JHNEBP) Rating Scales (Newhouse, Dearholt, Poe, Pugh, & White, 2005) for rating the quality and strength of the evidence in research was utilized to evaluate each study (Dearholt et al, 2007)(Appendix D). This scale assisted with adding inclusion and exclusion criteria for the TOE. Each of the selected studies was critically appraised. One investigator completed the critical appraisal for this integrative review. The timeline for the above activities took place in the spring and summer of 2015. The investigator performed the above activities when searching data bases, extracting studies online, reading studies, performing critical appraisals, completing the TOE, and analyzing and evaluating the integrative literature review findings in fall 2015.

The JHNEBP Rating Scale was a tool used to designate levels one through five as describing the strength of the evidence. Level one was the strongest or highest level of evidence (experimental study, randomized controlled trial (RCT), or meta- analysis of a
RCT. And level five was the least strong level of evidence (opinion of an individual expert on non-research evidence). The quality of the evidence was identified on this tool with letters. With the letter “A” signifying a high quality study; “B” for a good quality study; and “C” for a low quality study with major flaws (Newhouse et al. 2005). The JHNEBP tool assessed the type of study and its research; summative reviews; organizational lay out; and the use of expert opinions in describing the analysis of the study according to its accuracy and congruency with other primary sources (Whittemore and Knafl, 2005) (Appendix D).

The critical appraisal focused on the strength and quality of each study chosen in the integrative literature review. To do this, the investigator specifically determined the TOE's key identifiers and topics. These elements were placed in a table of evidence chart (Holly et al. 2012). An analysis of the findings of the critical appraisal of each study was documented and described. The analysis included similarity, differences, and relevancy of the pertinent studies in relation to the project. Common themes and patterns were investigated and developed. Specifically, the investigator studied if there existed new or supporting current knowledge about cognitive strategies that would facilitate clinical judgment and reasoning abilities for improved medication administration. For example, Ulanimo et al. (2006) stated, “there is a gap between nurses' perceived knowledge and their actual knowledge of medication errors” (p. 33).

The final assessment using the JHNEBP rating scale in the integrative review was to draw conclusions and summarize the findings. Similarities and differences in the findings were determined and reported. Additionally, the general findings and themes from the integrative review as a whole were reported. Any knowledge gaps concerning
cognitive strategies found were documented. This was because few empirical studies existed and the search was to obtain any available evidence remaining. Lastly, the strength of the research was evaluated.

When searching for the term “cognitive strategies” in the literature, it was important to define the phrase. Cognitive strategies had six main themes: hypotheticodeductive (inference and idea modification-based); algorithmic (preset pathways); pattern recognition (using salient features); rule out worse case scenario (consider “cannot miss” diagnoses); exhaustive (accumulated facts); and event-driven (evaluate responses to therapy) (Sandu & Carpenter, 2006). These six features were evident in cognitive science and considered during the ILR. Few studies were found that examined cognitive strategies during nursing medication administration.

Another consideration kept in mind was the definition of the term “cognitive”. Cognitive was described as relating to perception, memory, judgment, and reasoning (Billings & Halstead, 2012). Cognitive development is “the way in which individuals reason, view knowledge, manage diversity of opinion and conflicting points of view, and relate to authorities or experts” (McGovern & Valiga, 199, p.29). Cognitive strategies, then, are plans or methods the nurse would employ to increase the ability to clinically reason. Other related terms for the cognitive process were: remembering, understanding, applying, analyzing, evaluating, and creating (Anderson & Krathwohl, 2001).

Phase II also included documenting the ILR findings on the TOE. The results from the ILR are systematized on the TOE. Appendix C includes the tables that summarize the evidence found on cognitive strategies. The findings from the TOE
contain evidence that nursing medication errors are of supreme importance to the safety of the patient. These studies were synthesized to reveal common themes and similarities, inconsistencies and differences, strengths, and weaknesses.

Specifically, the initial search found 324 articles based on the key terms identified. After reviewing the articles and applying the inclusion criteria, 239 articles remained. Next, in the abstract review, studies were excluded if they did not meet the JHNEBP Evidence Rating Scale levels one to five. Thus, 189 articles remained to be read in their entirety. After reading the 189 studies, these studies were then screened using the same JHNEBP Rating Scale levels one to five. Of the 189 studies, twenty remained for integrative literature review. Of these twenty studies, six were literature reviews, ten were descriptive studies, and four used quasi-experimental designs. Hence, twenty studies were selected from 324 articles identified in the initial search (Figure 1).

<table>
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<tr>
<th>Total articles reviewed for key terms: N= 324</th>
<th>Excluded (did not meet inclusion criteria): N=85</th>
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<tr>
<td>Total abstracts reviewed for JHNEBP for levels I-V: N= 239</td>
<td>Excluded at abstract review: N= 50</td>
</tr>
<tr>
<td>Total full articles read for JHNEBP for levels I-V: N=189</td>
<td>Excluded at full article review: N = 169</td>
</tr>
<tr>
<td>Total articles included: N= 20</td>
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Figure 1. Flow Diagram of Integrative Review of Literature using the JHNEBP Rating Scale.
Twenty articles have been utilized for this study since they have met the inclusion criteria as described previously. In these articles, the research contained large amounts of nursing and medication administration literature due to the inclusion of large systematic and integrative literature reviews. Inclusion was determined by salient descriptors of nursing clinical and cognitive behaviors that help safe medication administration. These studies were appraised for relevance to cognitive strategies in nursing for medication administration. 89.4% of the retrieved articles were excluded due to the methodological limitations of the studies, lack of relevance to the project, and lack of alignment with the purpose of the project.

It is important to point out that after all the studies were measured and analyzed using the JHNEBP Scale the investigator did not locate any high level (Level IA) research investigating cognitive strategies for medication administration. According to the JHNEBP Evidence Rating Scale, Level IA studies are classified on the highest level of evidence and quality of research. However, the investigator did not find any explicit quantitative studies directly related to cognitive strategies for safe medication administration by nurses (Appendix D).

**Table of Evidence**

Phase II of the project continued by further populating the TOE. The TOE contained mainly studies researching nurses administering medications to patients and the cognitive competencies needed. Preliminary findings from the TOE elucidated many studies conducted on medication errors and their sources. However, fewer studies were found on nursing cognitive processes (competence and clinical knowledge) contributing to those errors; such as the nurse's knowledge of medications. In addition, from this
initial literature search there appeared to be even fewer studies on cognitive ways to improve medication administration outcomes.

Individual research articles within the TOE were each evaluated for key topics and identifiers. These evaluative criteria used for each study were: the study's design and question, methodology, source, key variables, purpose, sample size and setting, data collection methods, measurements, data analysis, key findings, author, year of publication, title, limitations, the author's conclusions, study limitations and nursing clinical implications. The TOE included several broad topics: nursing behavior and nursing knowledge (Benner, 2001). The research articles were categorized into reverse chronological order with the most recent at the top. The TOE is included in Appendix C. Systematic and integrative reviews both quantitative and qualitative were included on the TOE.
METHODS

During Phase III of the project, the twenty studies that met inclusion criteria were synthesized and appraised for identifiable cognitive strategies. Each cognitive strategy was identified and placed in the LCJR rubric for cataloging under topics and descriptors. These cognitive strategies were further organized into two columns of competence and knowledge (Appendix C). Since the project began as an integrative literature review, it was at this point of the investigation that the project's goal shifted. It was no longer a goal just to identify cognitive strategies for medication administration. Since there was such a large amount of cognitive strategies emerging from the literature, conceptual threads and themes were developing into a few broader concepts. The new goal was to capture these conceptual threads and to diagram them into a model for nurses to use for medication administration. Ninety-eight cognitive strategies emerged through the collation and documentation of the cognitive strategies from the ILR and into the LCJR. Each cognitive strategy was placed in one of two columns: competence-based (clinical reasoning and decision making) (Benner, 2002) or knowledge-based (clinical or practical)(Benner, 2002). These two concepts are based on Benner's framework of clinical expertise (Appendix C).

The LCJR was used to document effective cognitive strategies in medication administration found in the ILR. These strategies were first categorized and then applied to Lasater's eleven dimensions (Lasater, 2007)(Appendix C). The LCJR rubric assisted in organizing reoccurring cognitive strategies into conceptual themes. From these strategies, a concept map was developed to illustrate the relationship and interconnections among cognitive themes. The cognitive strategies synthesized from the literature review
were sorted and categorized according to the LCJR conceptual framework guidelines. From this, patterns developed in each category. From these conceptual patterns, differing levels of strategies emerged.

Themes from the strategies were determined. These themes were then incorporated into a concept map to illustrate their interrelationship (Figure 2). Themes were determined by reoccurring concepts in each category in the LCJR rubric. These themes summarized the cognitive strategies in each corresponding box. Ninety-eight cognitive strategies were gleaned from the synthesis of the ILR. From these ninety-eight cognitive strategies, nineteen cognitive themes emerged reflecting a summary of the compilation of the cognitive strategies for those terms used in Lasater's clinical judgment framework. A summary of the cognitive strategies for safe medication administration found in the studies is compiled in Appendix C.

In Phase IV, the ninety-eight cognitive strategies were further condensed and grouped according to like concepts. This distilling activity produced nineteen cognitive strategies (Figure 2). Again, these nineteen were reduced to similar themes. This reduction produced four main cognitive strategies with minor descriptors (Figure 3).
Figure 2  Lasater's Model of 19 Cognitive Strategies from the ILR.

In Phase V, a conceptual model was developed from these four cognitive strategies and their minor descriptors. This nursing concept map or model was formulated as a visual cue for safe medication administration. It was labeled as the “Tang Model of Cognitive Strategies for Safe Medication Administration” (Figure 3). The model's concepts were reductions of the ninety-eight strategies originating from the review (ILR) of the 189 studies and from applying the JHNEBP Scales and LCJR rubric tools to formulate a schema.
Phase VI consisted of developing a manuscript describing The Tang Model and its intended application for nurses. The manuscript was submitted to a peer-reviewed publication, the *Journal of Nursing Education and Practice*, in the spring of 2016 for review and possible acceptance for publication.

Lastly, in Phase VII the Tang Model of Cognitive Strategies for Safe Medication Administration was disseminated to nursing educators and nursing administrators for review and possible use on the nursing unit at Kaiser Hospital in Baldwin Park, California and at Rio Hondo College's nursing department during medication training in simulation.

*Figure 3.* The Tang Model of Cognitive Strategies for Safe Medication Administration.
OUTCOMES

In Phase II of the project, cognitive strategies were identified utilizing the ILR tools (two conceptual frameworks, the JHNEBP Scales, the LCJR Rubric, and the TOE). The following is a compilation of the findings of the cognitive strategies in the ILR by themes. These cognitive strategies were extracted from the studies and embedded into the LCJR rubric (Appendix C). The discussion traces the themes of the cognitive strategies emerging from the literature by topic and the themes that developed into the Tang Model. The reoccurring cognitive themes became the four concepts in The Tang Model: mindfulness, clinical reasoning, decision-making, and validation. In the literature synthesis, many cognitive themes overlapped and therefore the corrective action or cognitive strategies overlapped (Figure 2). Identification and implementation of different levels of cognitive strategies could assist nurses to become safer in medication administration since a nurse's clinical reasoning processes extends beyond rules and procedures (Benner, 2004). Identification of cognitive reasoning strategies can help nurses move beyond the technical application of medication administration to deeper clinical judgment and avoidance clinical error (Croskerry, 2000).

Before citing strategies to alleviate medication errors, the documented causes of medication errors found in the studies must be highlighted. The problems must be detailed, before the corrective interventions are addressed. The following are cited causes of medication errors. Benner's theory of nursing competence assisted in categorizing the etiologies of nursing medication errors into two domains: competency and knowledge.

The causes of medication errors related to the nurse's competency domain (Benner, 2002) were: many work interruptions and distractions; poor patient assessment
abilities; lack of focus and observational skills; did not recognize high alert drugs; cannot
differentiate look alike and sound alike medications; cannot differentiate medication
routes and potential problems; does not see abnormal pattern recognition or pertinent
patient problems; fear of reporting errors; inadequate staffing patterns; inefficient work
flow with medication delivery; decreased in-service training; unable to extract relevant
medication data; poor prioritization ability; overworked nurses; difficulty differentiating
urgent and emergent situations; difficulty assessing important clinical concerns;
incorrectly interprets pertinent data; poor anticipatory problem solving; unsafe and
negative working culture; lack of management support; has little or no say in patient care
assignments; does not utilize SBAR (Situation, Background, Assessment, and
Recommendation); untimely communication of pertinent data; incorrect communication;
lack of team work; lack of communication with nursing leaders; late or no reporting of
essential clinical data; unfinished documentation; incorrect use of hand off guidelines;
does not intervene to abort drug incompatibilities; ten rights of medication administration
not followed; poor medication administration techniques; underutilized patient data;
underutilized Rapid Response and Code Blue teams; does not follow standards of
care; forgets to label different ports for different routes with corresponding infusion
pumps; lacks informed decision making; does not perform medication reconciliation per
protocol; does not initiate independent nursing interventions; lack of anticipation of
relevant medical orders.; none or few standardized checklists for medication prep; did not
use visual and auditory alerts on IV pumps; turns off alarms on medication machinery;
does not educate the patient regarding medications; does not advocate for the patient's
needs; does not know or follow procedures/protocols; increased fatigue, stress, and
decreased concentration; increased nursing overtime; lacks clinical judgment/reasoning and reflection; and ineffective communication skills and conflict-resolution (Cappelletti, Engel, & Prentice, 2014; Keers, Williams, Cooke, & Ashcroft, 2013; Sulosaari, Suhonen, & Leino-Kilpi, 2010; Hewitt, 2010; Brady, Malone, & Fleming, 2009; Flynn, Liang, Dickson, Xie, & Suh, 2012; Popescu, Currey, & Botti, 2011; Chang & Mark, 2009; Eisenhauer, Hurley, & Dolan, 2007; & Ulanimo, O'Leary-Kelley, and & Connolly, 2006).

The causes of medication errors related to the nurse's knowledge domain (Benner, 2002) were: not knowing the patient and typical pattern of responses; poor understanding of the patient's situational and cultural contexts; not knowing profiles of high-risk and vulnerable patients; unaware of specific error-prone areas; poor knowledge of medications (purpose, side and adverse effects, labs, and nursing implications); unfamiliar with abnormal assessment findings; unfamiliar with current policies and procedures; lack of training and experience; unaware of patient's concerns; decreased medication math knowledge; unaware of resources; incompetency in computerized software and telemedicine monitors; not current with medication updates; less knowledge in theory-based approaches but more skill-based and task-based approaches; unaware of standardized procedures; does not follow medication order correctly; non-therapeutic relationship with patient; does not know or follow safety measures; unaware or under utilizes workplace training opportunities; less knowledge of medications; cannot operate medication IV pumps and medication equipment and computerized medication dispensing machines; does not know (IT) systems in medication delivery and computer charting; lack of understanding of algorithms and decision trees for medication
management; lack of knowledge of high-fidelity patient simulations to analyze errors; does not develop own clinical knowledge; and does not use critical thinking in clinical scenarios (Cappelletti, Engel, & Prentice, 2014; Keers, Williams, Cooke, & Ashcroft, 2013; Sulosaari, Suhonen, & Leino-Kilpi, 2010; Hewitt, 2010; Brady, Malone, & Fleming, 2009; Flynn, Liang, Dickson, Xie, & Suh, 2012; Popescu, Currey, & Botti, 2011; Chang & Mark, 2009; Eisenhauer, Hurley, & Dolan, 2007; & Ulanimo, O'Leary-Kelley, and & Connolly, 2006).

To remediate these medication errors multiple studies offered solutions that could assist the nurse to practice medication administration safely. Although the investigator gleaned a total of ninety-eight strategies from the ILR, many cognitive strategies found in the literature were repeated and overlapped each other within multiple studies. The following four main cognitive strategies (CS) were found throughout the majority of the studies and therefore comprised the four main concepts (#1, #2, #3, and #4) for The Tang Model. The four main CS concepts found are: Mindfulness, Clinical Reasoning, Decision-making, and Validation.

**Cognitive Strategy #1: Mindfulness**

Mindfulness is the cognitive ability of the nurse to pay attention to and make sense of the external and internal changes in the patient's status. These two activities assist to increase core measures of safe, quality patient care (Ebright, 2003). The following studies exhibit nursing mindfulness by descriptors such as vigilance, observation, focus, and “pay attention to”.

Three types of “mindfulness” cognitive strategies found to decrease medication errors by nurses were: recognizing nurse call cards on patient areas or medication
preparation areas to remind nurses to give medications; acting on colored flagged areas on the medication administration record (MAR) indicating unfinished documentation; and, used designated restricted areas and access for medication preparation to reduce distractions and interruptions (Johnson, 2010).

Popescu et al. (2011) found similar results with mindful activity in an exploratory descriptive study examining the multiple factors contributing to deviations from safe medication practices by nurses in the hospital. The nurses' mindful ability to develop a therapeutic relationship with the patient and awareness of the contextual situation actually enhanced medication safety outcomes dramatically.

In a qualitative study focusing on the nurses’ ten areas of reported thinking during medication administration, Eisenhauer et al (2007) found that effective cognitive strategies were based on being mindful of patient data and interdisciplinary professional knowledge. The investigators' conclusions were that safe medication administration is more than a technical mechanical process. Clinical judgment regarding choosing correct dosage, timing, and selection of specific medication revealed the most explicit data about high levels of clinical reasoning (Eisenhauer et al, 2007). The determinants for high clinical reasoning would be: keen patient observational skills, correct interpretation of pertinent data, anticipatory problem solving, consultation with other health professionals, and timely communication. Of the ten areas of thinking measured, a common cognitive strategy was the nurse's constant vigilance assuring the patient received the correct medication. Professional vigilance is “a state of scientifically, intellectually, and experientially grounded attention to and identification of clinically significant observations/signals/cues; calculation of risk inherent in nursing practice situations; and
readiness to act appropriately and efficiently to minimize risks and to respond to them” (Meyer & Levin, 2005, p. 2). A key finding was nurses must practice constant vigilance for safe medication administration to occur. The results of the study stressed that clinical vigilance protects and advocates for the patient.

Another literature review by Hewitt (2010) gathered data about nurses' perceptions of the causes of medication errors. The central themes gleaned from the ILR were that nurses experienced a decrease in medication accuracy because of external and internal factors. External factors included: distractions and higher priority events. On the other hand, internal factors included failure to follow the ten rights, failure to follow protocol, fatigue and confusion, medication miscalculations, and not knowing how to work medication devices. From these findings, cognitive strategies that assist the nurse to be safe were: hyper-vigilance during stressful events; increased training and experience with medications, the ten medication rights, protocols and procedures, medication math, and inservice devices; and improved staffing.

Paparella (2008) cited that key practical cognitive strategies are already in place to reduce medication errors. Three common strategies were used in hospitals: high-alert medications, high-risk patients, and error-prone processes. Nurses are to be hyper-vigilant with medications with a low margin of error (high-alert medications); with highly vulnerable patients (pediatrics, geriatrics, etc.); and with processes that have a high probability for error (conscious sedation medications). Mayo and Duncan (2004) emphasized the need for critical thinking to be taught and strongly promoted to increase nursing judgment abilities to increase medication error reporting.
Kruer, Jarrell, and Latif (2014) addressed a multi-modal approach to reduce medication errors by utilizing reviews from pharmacy and medicine research. They described eight areas that the nurse can focus on to alleviate medication errors: pay attention to “look alike and sound alike” drugs (medication labeling); differentiate medication routes and their potential problems (enteral, subcutaneous, intramuscular, intravenous, transdermal, and epidural routes); label different ports for different routes with their corresponding infusion pumps; increase competency in using all computerized software and telemedicine monitors; support and use of simulation training; and embrace a culture of safety.

**Cognitive Strategy #2: Clinical Reasoning**

Eisenhaur, Hurley, & Dolan (2007) found that nurses needed to possess professional judgment and clinical reasoning specifically in the areas of medication knowledge. The cognitive ability to know, administer, and calculate medications in a fast-paced health care environment demands clinical reasoning ability. If medication knowledge, administration, and calculation deficiencies were corrected, it would decrease medical and medication errors, increase medication administration accuracy and efficiency, and therefore improve patient outcomes.

In numerous hospital studies, researchers observed nurses on multiple units during medication preparations. Findings demonstrated that the nurses could improve clinical reasoning by knowing how to operate the medication equipment (Barker et al. 2002). Clinical reasoning strategies were effective when applied to multiple areas: the purpose and the adverse effects of medications; confusing look alike and sound alike medications; and IV pumps and computerized medication dispensing machines. Clinical
reasoning was ranked high when a nurse could correctly perform medication math calculations (Keers et al. 2013).

Clinical reasoning strategies were effective when utilized in solving drug compatibilities when mixing drugs, documentation, in navigating nursing stress, and managing ongoing interruptions and distractions in the nursing work place (Barker et al. 2002; Keers et al. 2013).

A few studies defined what clinical reasoning abilities were needed by nurses to safely give medications. Nursing competency studies indicated that two mental abilities were necessary in order to perform accurate drug calculations: basic math calculation ability and the ability to conceptualize the clinical information presented and extract the relevant information in order to formulate a math calculation (Keers, et al. 2013). Cognitive strategies needed to accomplish these skills would be medication math review and practice, knowledge of pertinent patient assessment skills, and familiarity and practice with medication pumps, computers, and machinery (Keers et al. 2013). The research suggested that this particular competency is cognitively very complex. Basic math skills are a prerequisite for nursing drug calculations. Specifically, one of the most frequent mathematical errors identified in the literature is the misplacement of decimal points in medication calculations (Keers, 2013).

In their qualitative study, Dickson and Flynn (2011) found that nurses used two medication safety cognitive processes within a clinical reasoning context. The two processes were: maintaining medication safety (six patient-focused categories) and managing the environment (four external categories). Using the narrative of fifty medical-surgical nurses, descriptive themes emerged. The nurses reported that they
maintained medication safety by: educating the patient, assessing all pertinent data, advocating for patients, coordinating care with providers, practicing independent medication reconciliation, and verifying practice with colleagues. The nurses managed their work environment by: dealing with interruptions and distractions, correctly interpreting provider orders, documenting potential medication errors, and encouraging open dialogue between the healthcare team.

The need for more clinical reasoning strategies is evident throughout many studies though. From the literature appraisal, it was seen that two key cognitive competencies have not been clearly developed for nursing medication procedures. They were the development and use of clinical reasoning algorithms and decision-making competencies. Both included critical thinking classifications and effective sequencing of clinical behaviors (Maynard, 1996). Maynard illustrated that the rationale for these strategies was to progress the nurse from novice to expert (Benner, 2001). Using critical thinking competencies gleaned from years of experience and practice did this. These findings supported Benner's (2001) theory that nurses gain knowledge primarily through stages based on experience. The experiential factor was shown to have a large influence on the development of clinical reasoning ability (Maynard, 1996).

Fero et al. (2009) detailed cognitive determinants of nurses’ clinical reasoning abilities in their post hoc retrospective study. The goal was to identify the clinical reasoning learning needs of new and experienced nurses. Fero et al. found that nurses exhibited six categories of learning needs: initiating independent nursing interventions; differentiating urgency; reporting essential clinical data; anticipating relevant medical orders; providing relevant rationale to support decisions; and recognizing patient
problems. According to Fero et al., the evaluation of clinical competence is difficult but the study elucidated the need to focus on the cognitive domain to improve patient safety. These highlighted clinical reasoning abilities contribute toward the development of cognitive strategies because clinical reasoning is required for competent nursing care (Benner, 1984).

Other cognitive strategies for nurses were illustrated in a study about clinical reasoning in experience nurses. This qualitative, descriptive peer-reviewed study explored the cognitive strategies used in patient assessment. Conceptual cognitive abilities used by these nurses were: plan, rationale, status, test, treatment, and value. The nurses would employ pattern recognition and link and chunk similar data to make sound clinical decisions (Simmons, Lanuza, Fonteyn, Hicks, & Holm, 2003).

Promising evidence was found in a systematic literature review on the use of High Fidelity Simulation (HFS) as a tool to increase clinical judgment and reasoning in medication administration (Cappelletti, Engel, & Prentice, 2014). In another study, on improving clinical decision-making, through patient simulation scenarios, Guhde (2010) described that nursing students gained insight into both their sound and faulty clinical reasoning by receiving direct and immediate feedback from expert observers after the simulation. Guhde concluded that a cognitive strategy would include using high-fidelity patient simulations to assist nurses in analyzing their thinking processes for errors. Though HFS has demonstrated positive correlation for applying theory to nursing practice, Cappelletti et al. (2014) reiterated that there is “no one strategy considered most effective in developing clinical reasoning and judgment” (p.12). The correct utilization
of information technology (IT) systems in medication delivery by the nurse is “perceived” to assist in the decrease of medication errors (Ulanimo et al. 2006).

The study of medical science and cognitive science (Croskerry, 2003), highlighted the important role that cognition plays in clinical decision making. Croskerry argues that medical and nursing clinicians should be educated on cognitive strategies to reduce errors in clinical decision-making. To minimize and/or prevent error, cognitive strategies can work at the knowledge-based level. This is the highest level that cognitive error or correction can occur. Error on this level would lead to more serious outcomes. But inversely, correction on this level would give evidence to long-lasting safer patient outcomes. Clinical reasoning would improve if nurses adopt a knowledge-based problem-solving mental activity over the skill/task-based and rule-based decision-making activity (Mattox, 2012)(Croskerry, 2003).

A qualitative, descriptive study concurred with Mattox and Croskerry’s findings that clinical reasoning extends far beyond rule-based and procedural-based thinking. Eisenhaur, Hurley, and Dolan’s (2007) findings categorized the way nurses exhibit clinical reasoning. Key features discovered about the nurses reported thinking during medication administration were their clinical judgment related to dosage, timing, or selection of the specific medications and their constant vigilance of their patients. These findings revealed the most explicit data about the nurses’ clinical reasoning abilities: nurses use highly complex thinking and application methods to avert patient harm and error.
Cognitive Strategy #3: Decision Making

Five studies found that the nurse working in a fast-paced health care environment impacted two areas. The external stress decreased the decisiveness of the decision-making capacity of the nurse. And it also decreased the safe handling of medications since the nurse was navigating distractions and interruptions constantly. Results from many studies indicated that nurses lacked adequate pharmacological knowledge for practice (AHRQ, 2003; Barker et al. 2002; Fero et al. 2009; Keers et al. 2013). Examples of sound cognitive strategies for decision-making were for the nurse to follow protocols and procedure are proactive in patient care, and to be protective or advocate for the patients. The authors emphasized the need for increased environmental controls in the medication room to prepare medications and increased medication training programs for nurses so the nurse can be decisive in clinical judgment.

A cross-sectional descriptive study investigated nurses’ cognitive abilities during medication administration. Sitterding et al., (2014) found that when managing interruptions, the nurse exhibited specific cognitive abilities of situation awareness, cognitive resourcing, and time-sharing. Cognitive behaviors observed were high levels of efficient, responses; sound decision making, and effective workload prioritization. These cognitive strategies were very effective in decreasing errors and adverse events. The findings contributed to an increase in understanding of the cognitive work needed by nurses to correctly give medications.

Ebright outlined two cognitive strategies to enable nurses to decrease medication errors. The first one is “RN Stacking”. This is a cognitive strategy employed by the nurse to aid in decision-making. This invisible mind work helps the nurse to decide on
what, how, and when to deliver care to patients (Ebright, et al., 2003). This cognitive process specifically helps the nurse to decide on levels of care as the nurse continuously reorders the needs of the patient.

Further research into “RN Stacking” by Patterson, Ebright, and Saleem (2009) developed a normative framework used for making decisions about nursing activities. A seven-level prioritization hierarchy was created to assist nurses to give high-level quality patient care. This framework would assist in the development of cognitive strategies for safe medication administration since the nursing medication process requires constant vigilant RN Stacking activity. The hierarchical concepts, with the first being the most important to the nurse, includes: 1) addressing imminent clinical concerns, 2) high uncertainty activities, 3A) significant, core clinical caregiving, 3B) managing pain, 4) relationship management, 5A) documenting, 5B) helping others, 5C) patient support, 6A) system improvement, 6B) cleaning, preparing supplies, 7) personal breaks and social interactions. Concepts #1, #2, #3, #5C, and #6B directly impact cognitive activities of the nurse and are included in the cognitive strategy list for the LCJR.

Two studies outlined ways nurses can manage decisions regarding medication errors. Mattox (2012) identified strategies for improving patient safety in her nursing study in the intensive care unit. The investigator cited that a knowledge-based task type contributes to nursing error and how error management can reduce and contain unsafe situations. Her findings identify underlying cognitive processes that affect medical errors. She states that “aggressive standardization of healthcare processes reduce error risk at all cognitive levels” (p. 59). Examples of nursing standardization would be medications (high alert drugs), communication (Situation, Background, Assessment, and
Recommendation or SBAR), and Rapid Response teams. Another cognitive strategy to reduce or contain error would be the use of checklists for even “routine” processes. For error containment, the use and development of algorithms for the management of clinical scenarios can help detect the presence of unforeseen errors.

Cappelletti et al. (2014) in their systematic review on clinical judgment and reasoning in nurses found numerous characteristics of how nurses make decisions. Their findings revealed that: “1) clinical judgments are more influenced by what the nurse brings to the situation than the objective data about the situation at hand; 2) sound clinical judgment rests to some degree on knowing the patient and his or her typical pattern of responses, as well as engagement with the patient and his or her concerns; 3) clinical judgments are influenced by the context in which the situation occurs and the culture of the nursing unit; 4) nurses use a variety of reasoning patterns alone or in combination; and 5) reflection on practice is often triggered by breakdown in clinical judgment and is critical for the development of clinical knowledge and improvement in clinical reasoning” (p. 5-9). Their research elucidated the complex cognitive processes that nurses must follow to make safe clinical decisions and also emphasized that the cognitive domain is the focal point for improving clinical skills, safe patient outcomes, and strengthening patient to nurse relationships. The authors concluded that the beginner nurse needs to overcome the gap of application of theory to practice and the experienced nurse must avoid routine thinking.

Sound decision making for safe medication administration is cognitive strategy that must be utilized to alleviate medication errors (Sulosaari et al., 2010). Regarding medication safety, in her study on educational strategies to improve medication
administration, Stolic (2014) found that a combination of cognitive strategies was used: teacher-centered training, interactive technologies, simulations, and blended learning encapsulating all three. This reaffirmed the findings of many studies that state no one cognitive strategy was found most effective for safe medication administration.

Other studies that researched decision-making strategies compiled findings useful to decrease medication errors. Practical decision-making strategies to employ for safe medication administration are: use checklists, protocols, and computerized decision trees; improve information access; implement error-proof pathways as in visual and auditory alerts on IV pumps; standardize repetitive procedures; and reduce the number of hand-offs (Leape et al. 1995). Armutlu, Foley, Surette, Belzile, & McCusker (2008) emphasize the need for nurses to practice other practical decision-making strategies such as: consistent referencing of established policy and procedures related to medication safety and the reduction of any handwritten communication such as medication orders and therapies.

**Cognitive Strategy #4: Validation**

Validation refers to making sound, logical evaluations on nursing care by the nurse. Validation includes appraising nursing care, patient’s wellbeing, and the healthcare environment and improving all areas of the nurses' competencies and surroundings. The Agency for Healthcare Research and Quality's (AHRQ) (2003) report on patient safety outlined eight ways health professionals can improve on medication errors: correct communication problems; investigate sub-optimal information pathways; follow standards of care; focus on patient-related issues; decrease deficiencies in organizational transfer of knowledge (orientation and training); look into inadequate
staffing patterns and work flow; alleviate technical failures (equipment); and upgrade dated policies and procedures.

Two studies demonstrate that improving the culture of the nursing climate correlates to improved medication safety. Kruer et al. (2014) noted that the safety climate of a nursing unit is predictive of medication error incidence: a more “positive culture” is correlated to fewer errors. Moody, Pesut, and Harrington (2006) reported that creating a culture of safety on the nursing units has direct, measurable correlation with decreased medication errors. Nurses who operated from an innovative improvement cognitive style fared more favorably in emergency situations and thus created a safer culture.

Flynn et al. (2012) also explored the relationship of medication errors and nurse practice environments. They found that improved supportive practice environment enhances nurses’ error interception. This inversely associated with medication error rates. Validation strategies that create support to nurses are: positive inter-collaborative team work; participation in unit-wide decision; input in patient care assignments; having continuing education; and having accessible nursing leaders who listened to nurses and held high standards of care (Flynn et al., 2012).

Validation of the impact of nursing education was found to improve patient safety. Improving the nurses' educational levels was found to decrease medication errors. The findings of Chang and Mark's longitudinal study (2009) on antecedents of severe and non-severe medication errors by nurses aligned with the strategy that nurses commit less medication errors when they possess greater educational experience and medication competency. Their research found that “as the percentage of unit BSN-
prepared nurses increased, severe medication errors decreased” (p. 70). Cleary-Holdforth and Leufer (2013) offered pragmatic proposals to increase clinical medication competencies such as: required online and face-to-face tutorials with specific medication math testing to decrease medication errors.

A qualitative study was done to find effective medication administration education strategies. The team of Krautscheld et al. (2011) outlined these strategies. Their research revealed themes for safe medication education that would assist nurses in cognitive strategies for positive patient outcomes. Strategies needed to learn safe medication administration are: visualizing teacher demonstrations; performing peer-learning activities; demonstrating repetitive practice with feedback; learning communication and conflict-resolution; and implementing decision-support technologies.

Cognitive strategies are developed from established nursing competencies found in nursing education and curricula design. A comprehensive ILR described and defined the registered nurses' medication competencies in phases of this process. Sulosaari, Suakonen, and Leino-Kilpi (2010) identified eleven competency areas that nurses employ to give medications. These competency areas were: 1) anatomy and physiology, 2) pharmacology, 3) communication, 4) interdisciplinary collaboration, 5) information seeking, 6) mathematical and medication calculation, 7) medication administration, 8) medication education, 9) assessment and evaluation, 10) documentation, 11) medication safety. Their conclusions identified three major themes that were threaded throughout all eleven competency areas.
DISCUSSION

The Tang Model of Cognitive Strategies for Safe Medication Administration (Figure 3) was developed from the ILR. After the selected studies were synthesized using the Benner and Lasater frameworks, the investigator viewed the cognitive strategies from a greater holistic perspective. The initial model was established by extracting ninety-eight cognitive strategies found in the ILR. These ninety-eight cognitive strategies were then grouped into two columns according to the concepts of “competence” and “knowledge” (Benner, 2001). Each cognitive strategy was then stratified according to Lasater's concepts of either: Noticing, Interpreting, Responding, or Reflecting. Each cognitive strategy was then sorted into a Lasater category (Appendix C).

Once the ninety-eight cognitive strategies were categorized into each column and row type, then they were further synthesized and condensed based on similarities, into 19 common cognitive strategies. These 19 were further distilled down to four major cognitive strategies with sub-descriptors. The four major cognitive strategies were: Mindfulness, Clinical Reasoning, Decision-Making, and Validation. These cognitive strategies were the main content of The Tang Model. Each of the four cognitive strategies incorporated Lasater's concepts from the rubric: Mindfulness incorporated Noticing including minor descriptors of Patient-centered and Patterns. Clinical Reasoning incorporated Interpreting with a minor concept of prioritizing. Decision-making incorporated Responding with the sub concepts of protective, protocol, and proactive. Validation incorporated Lasater's concept of Reflecting with the minor descriptor of perceptive reassessment (Appendix C).
Recommendations

A proposed recommendation is to pilot test the newly developed Tang Model before it is implemented into the medication administration procedure on nursing units. The model would be tested on a nursing unit where common and documented medication errors have occurred. Testing of the model would include defining and measuring the conceptual terms of the model; defining its operationalized terms; and performing randomized controlled tests (RCT) on its function in nursing. Evaluation of the pilot study would include staff nurses, nursing educators and nurse leaders who would give feedback regarding the Model’s efficacy and applicability for nursing practice. If the model demonstrates a measurable decrease in medication errors, training would be offered for the model’s implementation.

An additional method to test the Tang Model is a controlled lab environment such as High Fidelity Simulation (HFS). HFS has been proven as a tool to increase clinical judgment and reasoning in medication administration (Cappelletti, Engel, & Prentice, 2014). In another study using patient simulation scenarios, Guhde (2010) found that nursing students gained insight into their cognitive clinical reasoning. The students were able to identify both their sound and faulty clinical reasoning by receiving direct and immediate feedback from expert observation. Guhde concluded that a cognitive strategy would include high-fidelity patient simulations to assist nurses in analyzing their thinking processes for medication errors. It is at this point the Tang Model could be inserted into the teaching and training of medication administration during HFS. The students would use the Tang Model during the HFS exercises on medication preparation.
After the Tang model has been pilot tested for effectiveness, and training for the nurses have been provided, the model would be incorporated into medication administration procedures on the nursing unit. When giving patient medications, nurses should continue to employ the “10 Rights of Medication Administration” (Kee, Hayes, & McCuistion, 2015). The ten rights are: The Right Medication, The Right Dose, The Right Time, The Right Route, The Right Patient, The Right Patient Education, The Right Documentation, The Right to Refuse, The Right Assessment, and The Right Evaluation. This project proposes that the nurse will use The Tang Model of Cognitive Strategies whenever the nurse activates the “10 Rights of Medication Administration” before medication administration. According to the Tang Model, the ultimate nursing goal is for the nurse to practice: mindfulness; clinical reasoning; decision making; and validation when employing the “10 Rights” (Kee et al., 2015).

During the medication administration procedure, the nurse's goal would be to visualize the Tang Model and then activate the cognitive strategies on the model, which will serve as a visual cue. According to the model, the concepts will remind the nurse to employ: 1) patient-centered and pattern-recollected Mindfulness; 2) Clinical Reasoning while prioritizing; 3) protective, protocol-driven, and proactive Decision-making; 4) perceptive reassessment with Validation in patient care. The nurse must activate many other antecedent cognitive strategies when using the model (Table1). For example, to activate “Mindfulness”, the nurse will know about the first sub-topic: patient-centered care. To understand patient-centered care, the nurse will have thought about: pertinent data, clinical vigilance, and situation awareness. Another sub-descriptor of
“Mindfulness” is patterns. To understand patterns, the nurse will think about linking and chunking patient data, creating information baselines, and picking up deviations. Four main concepts of the Tang Model and all the antecedent concepts are found on Table 1.

**Future Research**

Future research is needed to investigate if using the Tang Model will improve medication safety, decrease medication errors, and prevent adverse drug reactions. The Tang Model exhibits the circular nature of a nurse's cognitive processes that indicates the fluidity in safe medication administration. The mental activity of giving medications activates continuous cognitive strategies that reflect ongoing assessment and evaluation. Moreover, the ability to give medications safely is a cyclical, not a linear cognitive process (Croskerry, 2003).
CONCLUSION

The conclusion of the current study supports the initial premise that there is a gap of knowledge in evidenced-based cognitive strategies needed for medication administration. In the final analysis of the ILR for cognitive strategies for safe medication administration, there still remains a paucity of research literature available that examines the nurse’s clinical judgment and reasoning abilities that facilitate safe medication administration. Because there exists very few evidenced based studies investigating cognitive strategies for nursing medication administration, focused research is needed to provide a specific study on this crucial safety issue. Literature studying cognitive strategies can be examined in qualitative, retrospective descriptive, longitudinal cross-sectional, and large literature reviews. Previously, studies mainly contained research describing medication error prevention and safe medication administration training for curriculum development and safe nursing practice.

Because nurses have the longest patient access time and maintain the place of primary caregiving at the bedside, nurses are key players in medication error reduction and safe medication administration. Nurses are the main healthcare providers to monitor and manage the quality of medication administration. Nurses' responsibilities include safe, high quality medication management, immediate detection and intervention of medication error, and the reduction of adverse events for their patients. Cognitive strategies when employed by the nurse are definitive ways to achieve these goals (Benner et al., 2002).
Limitations

As the ILR progressed, four limitations to this review were noted. The assessments and appraisals of the articles reviewed were limited to English language publications only. This may pose a possibility that other non-English studies might have changed the results of the integrative literature review. Another limitation in the ILR was that the cultural context of the nursing settings in the studies varied. This posed a high heterogeneity index in the type of studies reviewed. The implications were that different operational variables with the same name had different meanings to them in each study.

An additional limitation was that the entire literature search and review did not reveal any quantitative studies or randomized controlled studies for cognitive strategies. The primary purpose of the ILR was to search for and find evidenced based quantitative studies on cognitive strategies for safe medication administration. The lack of quantitative studies supports the initial proposition that a paucity of literature exists for the study of cognitive strategies for medication administration for nurses. A final limitation was that the findings were not generalizable due to the different cultural contexts where the studies were conducted in many different countries. This would also limit applicability of the findings.

Nursing Implications

The ILR revealed the multi-faceted cognitive factors needed to safely administer medications. Cognitive requirements needed for clinical reasoning for a nurse to administer just one medication are complex and layered (Brady et al. 2009). Safe administration requires safe thinking. Sound cognitive processing will enhance sound medication skills. Because of this, it is imperative that nursing administrators and
educators implement specific cognitive strategies for safe medication administration. The Tang Model for Cognitive Strategies is helpful to meet the demand of developing concept-based nursing education curricula and nursing clinical training programs. This model contributes a cognitive perspective on the nursing process of medication administration.

It is the ethical responsibility of each nurse to develop and maintain knowledge-based competencies in medication administration. The nurse will need to maintain competency levels and a current clinical practice. High-level evidence-based research on the study of cognitive strategies for safe medication administration is needed to fill a knowledge gap in nursing science and practice. The nurse's clinical judgment may be enhanced by the use of the Tang Model for Cognitive Strategies for Safe Medication Administration and thereby improve patient outcomes.

**Manuscript Information**

In Phase VI of this project, a manuscript describing and recommending the cognitive strategies for safe medication administration to nurse administrators and nursing educators was submitted to a peer-reviewed journal. Examples of selected journals would be: International Journal of Nursing Education Scholarship; Journal of Clinical Nursing; Journal of Nursing Education; Journal of Nursing Education and Practice; Nurse Educator; Nurse Education in Practice; Nurse Education Today; and The Journal of Nursing Education. The manuscript was submitted to the Journal of Nursing Education and Practice in the spring of 2016 for possible acceptance and publication.
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Abstract

Driven by increasing incidences of medication errors made by nurses and the accompanying adverse patient outcomes and complex etiologies of the errors, there has been a plethora of research generated. Medication error problems and the subsequent negative effects are well documented and described in the literature. But there still remains a paucity of research literature available that examines the nurse’s clinical judgment and reasoning abilities that specifically facilitate safe medication administration. This project proposes cognitive strategies to nurses and nurse leaders to mitigate this problem. The project is the formulation of a conceptual model of cognitive strategies for safe medication administration. This project conducted an integrative literature review and identified 98 cognitive strategies for safe medication administration; formulated a condensed comprehensive conceptual model of these cognitive strategies; recommended the Tang model to nursing leaders; and developed a manuscript for submission to a nursing journal. Benner’s Framework of Nursing Competence and the Johns Hopkins Nursing Evidence-based (JHNEBP) Practice Rating Scales and a Table of Evidence (TOE) guided the integrated literature review and synthesis. Lasater’s Clinical Judgment Rubric (LCJR) was used to guide the development of the Tang Model.

Keywords: medication administration, errors, nursing, clinical reasoning/knowledge critical thinking, cognitive strategies, competencies, decision-making, pharmacology.
Introduction

Medication preparation and administration by nurses require complex physical and intellectual activities to ensure safe patient outcomes (Fero, Witsberger, Wesmiller, Zullo, & Hoffman, 2009). Three competencies (cognitive, psycho-motor, and affective clinical judgment) are required as nurses observe patients, communicate with stakeholders, and interpret relevant data, prior to administering medication to patients (Maynard, 1996). Consequently, medication administration is neither an isolated skill nor a purely knowledge-based decision. Unfortunately, medication errors most often occur due to deficiency in one or more of these basic competencies. Therefore, errors in medication administration are multifaceted and require multiple strategies to prevent.

Nursing medication errors have continued to increase over the years and have been the cause of mild, moderate, or fatal patient outcomes (Brady, Malone, & Fleming, 2009). Causes of medication errors are numerous but many common etiological factors have been described through observation and research. Common etiologies found to increase medication errors are: 1) higher levels of patients' acuity; 2) complex patient health problems; 3) poly-pharmacy; 4) increased complexity of medication routes; 5) numerous times and procedures; 6) measurable fatigue and stress on nursing personnel; 7) time constraints of overworked nurses; 8) poor medication math skills; 9) lack of knowledge of new medications; and, 10) the unprepared nurse who lacks clinical judgment and reasoning (Cleary-Holdforth et al. 2013; Leufer, et al. 2013). Because medication administration is not only skilled-based but requires cognitive reasoning ability, effective cognitive strategies need to be investigated and ultimately recommended for safe clinical administration.

Importance of the Problem
The average nurse in a hospital spends about 40% of her/his time administering medications. Because the bulk of the nurse's time is focused on medication administration, there is a significant higher probability of medication error (Popescu, Currey, & Botti, 2011). Research has demonstrated that “medication errors have been identified as the most common type of error affecting the safety of patients and the most common single preventable cause of adverse events” (National Medicines Information Center, 2001, p. 1). Brady et al. (2009) found that nurses lacked “adequate pharmacological skills for practice” (p. 692) and this lack of knowledge and experience with medications or equipment caused 79% of all errors.

A 2008 study reported that “adverse drug events kill 7,000 Americans annually and that medication errors that result in harm are the number-one cause of inpatient fatalities” (Hicks, Becker, & Cousins, 2008, p. 8). Medication errors lead to adverse patient outcomes such as increased mortality rates, increased length of stay in the hospital, and increased medical expenses. Thousands of patients incur lethal events due to medication errors every year. The financial costs associated with these medical complications have been estimated as $77 million annually. In addition, studies have suggested medication errors prolong hospital stay by 2 days and increase costs by $2000-2500 per patient (Tang, Sheu, Yu, Wei, & Chen, 2007).

Describe Relevant Scholarship

The Institute of Medicine (IOM) reports that medication errors are the single most common type of error in health care, representing 19% of all adverse events and over 7,000 deaths annually. At least one medication error occurs every day for every hospitalized patient (Barker et al. 2002). Leape, Bates, & Cullen, (1995) studied adverse
drug effects (ADE) and found that 56% of these drug errors were attributed to prescribing errors by providers and 44% of adverse drug events (ADEs) involved drug administration errors. Barker et al (2002) additionally reports that medication errors were common (nearly 1 out of every 5 doses in the typical hospital) and of these errors 7% were rated potentially harmful.

In the last ten years, extensive research has been done describing the types and causes of nursing medication errors (Brady et al. 2009). Brady et al reported a systematic review of ninety-three articles studying the complex factors that contribute to medication errors. These articles covered multiple disciplines such as medicine, pharmacy, and nursing. However, studies have not focused on nursing medication errors in relation to the nurse’s lack of clinical judgment and reasoning, particularly in the area of understanding the medications to be administered. Correct medication administration requires correct and critical cognitive clinical reasoning and is a basic competency taught in pre-licensure nursing curricula programs (Leufer et al. 2013).

Although medication knowledge and medication administration are routinely tested during nursing school and are included on standardized exams for licensure, research supports that the lack of critical knowledge needed for safe and accurate medication administration is a contributing factor in medication error (Brady et al. 2009). Nursing curricula as well as State Boards of nursing recognize the importance of cognitive ability (Chang & Mark, 2009). Registered nurses must be prepared to practice proven evidence-based strategies and clinical reasoning when safely administering medications. Nurses need cognitive strategies to improve clinical reasoning and to decrease adverse patient outcomes.
Describe the Problem

There is a paucity of research literature available that examines the nurse’s clinical judgment and reasoning abilities that facilitate safe medication administration. Evidence-based literature investigating the association of these two factors needs to be developed. Together clinical judgment and reasoning abilities refer to areas in the cognitive domain of thought. Substantial scholarly work has described medication administration error and cognition in nursing, but there has been few studies examining cognitive strategies during medication administration (Sitterding, Ebright, Broome, Paterson, & Wuchner, 2014).

Purpose of the Project

The purpose of this project was fourfold: first, cognitive strategies were identified in an integrative literature review (ILR) by collating and evaluating research studies that identify clinical judgment and reasoning abilities. Second, the Tang conceptual model of cognitive strategies was formulated from the literature. Third, this model was recommended to nursing stakeholders who directly insure safe cognitive skills during medication administration. And, fourth, a manuscript describing the Tang model of cognitive strategies for safe medication administration was developed. The manuscript was submitted to a peer-reviewed journal for publication and dissemination to nursing administrators and educators.

State Hypotheses

The goal of the project was to propose evidenced-based cognitive strategies to nurse educators (novice as well as experienced) and nurse leaders. When integrated into practice, these strategies would develop and deepen clinical reasoning, judgment, and
decision-making. Clinical reasoning, judgment, and decision-making are subsets of cognitive competency, and is one of three basic abilities in the development of nursing professional competences. Two other related areas of competency, although not discussed are in the psychomotor and affective domains (Maynard, 1996). Ultimately, the long-term goal of nursing was to deepen nursing professional competency acquired in all domains using the educational process and developmental maturation acquired through professional experiences (Booth, 1985).

Proactively, the implementation of the Tang model by nurses would not only improve medication safety but would decrease the frequency of medication errors; improve mortality rates; decrease length of stay; and, reduce medical center costs. Because medication administration is a primary function of all nurses, the nurse’s clinical judgment, reasoning, and decision making directly impacts patient safety.

Method

The project begun as an integrated literature review (ILR) to identify cognitive strategies for safe nursing medication administration, but changed direction at the completion of the ILR. This was due to an unexpected development: at the culmination of the ILR, synthesis of the findings facilitated the formulation of a conceptual model for cognitive strategies. This conceptual model was a combination of all the cognitive strategies aggregated and condensed from the ILR.

The Tang model was developed in seven phases: phase I- the investigator performed an ILR using key variables and phrases; phase II- the investigator utilized research tools to identify and extract cognitive strategies for safe medication administration from the ILR. The tools used were two conceptual frameworks, one
rubric, two scales and a table of evidence; phase III- the investigator mined and identified ninety eight cognitive strategies from the ILR; phase IV- the investigator condensed the ninety eight cognitive strategies into four common cognitive themes; phase V- a conceptual model was developed; phase VI- the new conceptual model describing the four cognitive strategies and recommendations to nurse administrators and nursing educators was exhibited in a manuscript submitted to a peer-reviewed journal; and phase VII- the new conceptual model was disseminated to nursing educators, nursing administrators, and staff nurses at a local hospital and nursing college.

Identify Subsections

In Phase I of the project, an integrative literature review (ILR) was performed to identify cognitive strategies for safe medication administration. The aim of the integrative literature review was to explore available evidence studying the key terms related to nursing clinical judgment and reasoning abilities for improved medication administration. The ILR was conducted by collating and evaluating relevant research to synthesize, compare, contrast and analyze the studies. Throughout the literature search, it was important to keep in mind that there is “no one strategy considered most effective in developing clinical reasoning and judgment” when looking for cognitive strategies for safe medication administration (Cappelletti et al., p.12, 2014).

A flow diagram of the literature review is included (Figure 1). The parameters of the search included primary, secondary, and tertiary literature from 2000-2015 in only the English language, and included quantitative, evidence-based, peer-reviewed studies; experimental and quasi-experimental studies; qualitative studies; and descriptive research. The inclusion criteria were studies that discussed cognitive abilities in nursing
medication administration directly relevant to nursing practice only. The exclusion criteria included gray literature, editorials, blogs, commentaries, and opinion articles. The table of evidence (TOE) did not include the excluded studies or the studies, which did not meet the inclusion criteria.

In Phase II of the project, the Johns Hopkins Nursing Evidence-based Practice (JHNEBP) Rating Scales (Newhouse, Dearholt, Poe, Pugh, & White, 2005) for rating the quality and strength of the evidence in research was utilized to evaluate each study (Dearholt et al, 2007)(Appendix D). This scale assisted with adding inclusion and exclusion criteria for the TOE. Each of the selected studies was critically appraised. One investigator completed the critical appraisal for this integrative review. The timeline for the above activities took place in the spring and summer of 2015. The investigator performed the above activities when searching data bases, extracting studies online, reading studies, performing critical appraisals, completing the TOE, and analyzing and evaluating the integrative literature review findings in fall 2015 (Appendix D).

The critical appraisal focused on the strength and quality of each study chosen in the integrative literature review. To do this, the investigator specifically determined the TOE's key identifiers and topics. These elements were placed in a table of evidence chart (Holly et al. 2012). An analysis of the findings of the critical appraisal of each study was documented and described. The analysis included similarity, differences, and relevancy of the pertinent studies in relation to the project. Common themes and patterns were investigated and developed. Specifically, the investigator studied if there existed new or supporting current knowledge about cognitive strategies that would facilitate clinical judgment and reasoning abilities for improved medication administration. For example,
Ulanimo et al. (2006), stated that “there is a gap between nurses' perceived knowledge and their actual knowledge of medication errors” (p. 33).

Phase II also included documenting the ILR findings on the TOE. The results from the ILR are systematized on the TOE. Appendix C includes the tables that summarize the evidence found on cognitive strategies. The findings from the TOE contain evidence that nursing medication errors are of supreme importance to the safety of the patient. These studies were synthesized to reveal common themes and similarities, inconsistencies and differences, strengths, and weaknesses.

Specifically, the initial search found 324 articles based on the key terms identified. After reviewing the articles and applying the inclusion criteria, 239 articles remained. Next, in the abstract review, studies were excluded if they did not meet the JHNEBP Evidence Rating Scale levels one to five. Thus, 189 articles remained to be read in their entirety. After reading the 189 studies, these studies were then screened using the same JHNEBP Rating Scale levels one to five. Of the 189 studies, twenty remained for integrative literature review. Of these twenty studies, six were literature reviews, ten were descriptive studies, and four used quasi-experimental designs. Hence, twenty studies were selected from 324 articles identified in the initial search (Figure 1).

Twenty articles have been utilized for this study since they have met the inclusion criteria as described previously. In these articles, the research contained large amounts of nursing and medication administration literature due to the inclusion of large systematic and integrative literature reviews. Inclusion was determined by salient descriptors of nursing clinical and cognitive behaviors that help safe medication administration. These studies were appraised for relevance to cognitive strategies in
nursing for medication administration. 89.4% of the retrieved articles were excluded due to the methodological limitations of the studies, lack of relevance to the project, and lack of alignment with the purpose of the project.

Figure 1  Flow Diagram of Integrative Review of Literature using the JHNEBP Rating Scale

| Total articles reviewed for key terms:  
N= 324 | Excluded (did not meet inclusion criteria):  
N=85 |
|---|---|
| Total abstracts reviewed for JHNEBP for levels I-V: N= 239 | Excluded at abstract review:  
N= 50 |
| Total full articles read for JHNEBP for levels I-V: N=189 | Excluded at full article review:  
N = 169 |
| Total articles included: N= 20 | --- |

It is important to point out that after all the studies were measured and analyzed using the JHNEBP Scale the investigator did not locate any high level (Level IA) research investigating cognitive strategies for medication administration. According to the JHNEBP Evidence Rating Scale, Level IA studies are classified on the highest level of evidence and quality of research. However, the investigator did not find any explicit quantitative studies directly related to cognitive strategies for safe medication administration by nurses (Appendix D).
Phase II of the project continued by further populating the TOE. The TOE contained mainly studies researching nurses administering medications to patients and the cognitive competencies needed. Preliminary findings from the TOE elucidated many studies conducted on medication errors and their sources. However, fewer studies were found on nursing cognitive processes (competence and clinical knowledge) contributing to those errors; such as the nurse's knowledge of medications. In addition, from this initial literature search there appeared to be even fewer studies on cognitive ways to improve medication administration outcomes.

The TOE included several broad topics: nursing behavior and nursing knowledge (Benner, 2001). The research articles were categorized into reverse chronological order with the most recent at the top. The TOE is included in Appendix C. Systematic and integrative reviews both quantitative and qualitative were included on the TOE.

During Phase III of the project, the twenty studies that met inclusion criteria were synthesized and appraised for identifiable cognitive strategies. Each cognitive strategy was identified and placed in the LCJR rubric for cataloging under topics and descriptors. These cognitive strategies were further organized into two columns of competence and knowledge (Appendix C). Since the project began as an integrative literature review, it was at this point of the investigation that the project's goal shifted. It was no longer a goal just to identify cognitive strategies for medication administration. Since there was such a large amount of cognitive strategies emerging from the literature, conceptual threads and themes were developing into a few broader concepts. The new goal was to capture these conceptual threads and to diagram them into a model for nurses to use for medication administration.
Ninety-eight cognitive strategies emerged through the collation and documentation of the cognitive strategies from the ILR and into the LCJR. Each cognitive strategy was placed in one of two columns: competence-based (clinical reasoning and decision making) (Benner, 2002) or knowledge-based (clinical or practical) (Benner, 2002). These two concepts are based on Benner's framework of clinical expertise (Appendix C).

The LCJR was used to document effective cognitive strategies in medication administration found in the ILR. These strategies were first categorized and then applied to Lasater's eleven dimensions (Lasater, 2007) (Appendix C). The LCJR rubric assisted in organizing reoccurring cognitive strategies into conceptual themes. From these strategies, a concept map was developed to illustrate the relationship and interconnections among cognitive themes. The cognitive strategies synthesized from the literature review were sorted and categorized according to the LCJR conceptual framework guidelines. From this, patterns developed in each category. From these conceptual patterns, differing levels of strategies emerged.

Themes from the strategies were determined. These themes were then incorporated into a concept map to illustrate their interrelationship (Figure 2). Themes were determined by reoccurring concepts in each category in the LCJR rubric. These themes summarized the cognitive strategies in each corresponding box. Ninety-eight cognitive strategies were gleaned from the synthesis of the ILR. From these ninety-eight cognitive strategies, nineteen cognitive themes emerged reflecting a summary of the compilation of the cognitive strategies for those terms used in Lasater's clinical judgment.
framework. A summary of the cognitive strategies for safe medication administration found in the studies is compiled in Appendix C.

In Phase IV, the ninety-eight cognitive strategies were further condensed and grouped according to like concepts. This distilling activity produced nineteen cognitive strategies (Figure 2). Again, these nineteen were reduced to similar themes. This reduction produced four main cognitive strategies with minor descriptors (Figure 3).

*Figure 2*  Lasater’s Model with Nineteen Cognitive Strategies from the ILR

In Phase V, a conceptual model was developed from these four cognitive strategies and their minor descriptors. This nursing concept map or model was formulated as a visual cue for safe medication administration. It was labeled as the “Tang Model of Cognitive Strategies for Safe Medication Administration” (Figure 3). The model's concepts were reductions of the ninety-eight strategies originating from the review (ILR) of the 189
studies and from applying the JHNEBP Scales and LCJR rubric tools to formulate a schema.

*Figure 3* The Tang Model of Cognitive Strategies

Phase VI consisted of developing a manuscript describing The Tang Model and its intended application for nurses. The manuscript was submitted to a peer-reviewed publication, the *Journal of Nursing Education and Practice* in the spring of 2016 for review and possible acceptance for publication.

Lastly, in Phase VII the Tang Model of Cognitive Strategies for Safe Medication Administration was disseminated to nursing educators and nursing administrators for possible use on the nursing unit at Kaiser Hospital in Baldwin Park, California and at Rio Hondo College's nursing department during medication training in simulation.

Results
The Tang Model of Cognitive Strategies for Safe Medication Administration (Figure 3) was developed from the ILR. After the selected studies were synthesized using the Benner and Lasater frameworks, the investigator viewed the cognitive strategies from a greater holistic perspective. The initial model was established by extracting ninety-eight cognitive strategies found in the ILR. These ninety-eight cognitive strategies were then grouped into two columns according to the concepts of “competence” and “knowledge” (Benner, 2001). Each cognitive strategy was then stratified according to Lasater's concepts of either: Noticing, Interpreting, Responding, or Reflecting. Each cognitive strategy was then sorted into a Lasater category (Appendix C). Once the ninety-eight cognitive strategies were categorized into each column and row type, then they were further synthesized and condensed based on similarities, into 19 common cognitive strategies. These 19 were further distilled down to four major cognitive strategies with sub-descriptors. The four major cognitive strategies were: Mindfulness, Clinical Reasoning, Decision-Making, and Validation. These cognitive strategies were the main content of The Tang Model. Each of the four cognitive strategies incorporated Lasater's concepts from the rubric: Mindfulness incorporated Noticing including minor descriptors of Patient-centered and Patterns. Clinical Reasoning incorporated Interpreting with a minor concept of prioritizing. Decision-making incorporated Responding with the sub concepts of protective, protocol, and proactive. Validation incorporated Lasater's concept of Reflecting with the minor descriptor of perceptive reassessment (Appendix C).

Discussion

A proposed recommendation is to pilot test the newly developed Tang Model before it is implemented into the medication administration procedure on nursing
units. The model would be tested on a nursing unit where common and documented medication errors have occurred. Testing of the model would include defining and measuring the conceptual terms of the model; defining its operationalized terms; and performing randomized controlled tests (RCT) on its function in nursing. Evaluation of the pilot study would include staff nurses, nursing educators and nurse leaders who would give feedback regarding the Model’s efficacy and applicability for nursing practice. If the model demonstrates a measurable decrease in medication errors, training would be offered for the model’s implementation.

An additional method to test the Tang Model is a controlled lab environment such as High Fidelity Simulation (HFS). HFS has been proven as a tool to increase clinical judgment and reasoning in medication administration (Cappelletti, Engel, & Prentice, 2014). In another study using patient simulation scenarios, Guhde (2010) found that nursing students gained insight into their cognitive clinical reasoning. The students were able to identify both their sound and faulty clinical reasoning by receiving direct and immediate feedback from expert observation. Guhde concluded that a cognitive strategy would include high-fidelity patient simulations to assist nurses in analyzing their thinking processes for medication errors. It is at this point the Tang Model could be inserted into the teaching and training of medication administration during HFS. The students would use the Tang Model during the HFS exercises on medication preparation.

After the Tang model has been pilot tested for effectiveness, and training for the nurses have been provided, the model would be incorporated into medication administration procedures on the nursing unit. When giving patient medications, nurses should continue to employ the “10 Rights of Medication
The ten rights are: The Right Medication, The Right Dose, The Right Time, The Right Route, The Right Patient, The Right Patient Education, The Right Documentation, The Right to Refuse, The Right Assessment, and The Right Evaluation. This project proposes that the nurse will use the Tang Model of Cognitive Strategies whenever the nurse activates the “10 Rights of Medication Administration” before medication administration. According to the Tang Model, the ultimate nursing goal is for the nurse to practice: mindfulness; clinical reasoning; decision making; and validation when employing the “10 Rights” (Kee et al., 2015).

During the medication administration procedure, the nurse's goal would be to visualize the Tang Model and then activate the cognitive strategies on the model, which will serve as a visual cue. According to the model, the concepts will remind the nurse to employ: 1) patient-centered and pattern-recollected Mindfulness; 2) Clinical Reasoning while prioritizing; 3) protective, protocol-driven, and proactive Decision-making; 4) perceptive reassessment with Validation in patient care. The nurse must activate many other antecedent cognitive strategies when using the model (Table1). For example, to activate “Mindfulness”, the nurse will know about the first sub-topic: patient-centered care. To understand patient-centered care, the nurse will have thought about: pertinent data, clinical vigilance, and situation awareness. Another sub-descriptor of “Mindfulness” is patterns. To understand patterns, the nurse will think about linking and chunking patient data, creating information baselines, and picking up deviations. Four main concepts of the Tang Model and all the antecedent concepts are found on Table 1.
Future research is needed to investigate if using the Tang Model will improve medication safety, decrease medication errors, and prevent adverse drug reactions. The Tang Model exhibits the circular nature of a nurse's cognitive processes that indicates the fluidity in safe medication administration. The mental activity of giving medications activates continuous cognitive strategies that reflect ongoing assessment and evaluation. Moreover, the ability to give medications safely is a cyclical, not a linear cognitive process (Croskerry, 2003).

Conclusion

The conclusion of the current study supports the initial premise that there is a gap of knowledge in evidenced-based cognitive strategies needed for medication administration. In the final analysis of the ILR for cognitive strategies for safe medication administration, there still remains a paucity of research literature available that examines the nurse’s clinical judgment and reasoning abilities that facilitate safe medication administration. Because there exists very few evidenced based studies investigating cognitive strategies for nursing medication administration, focused research is needed to provide a specific study on this crucial safety issue. Literature studying cognitive strategies can be examined in qualitative, retrospective descriptive, longitudinal cross-sectional, and large literature reviews. Previously, studies mainly contained research describing medication error prevention and safe medication administration training for curriculum development and safe nursing practice.

Because nurses have the longest patient access time and maintain the place of primary caregiving at the bedside, nurses are key players in medication error reduction and safe medication administration. Nurses are the main healthcare providers to monitor
and manage the quality of medication administration. Nurses' responsibilities include safe, high quality medication management, immediate detection and intervention of medication error, and the reduction of adverse events for their patients. Cognitive strategies when employed by the nurse are definitive ways to achieve these goals (Benner et al., 2002).

Nursing Implications

The ILR revealed the multi-faceted cognitive factors needed to safely administer medications. Cognitive requirements needed for clinical reasoning for a nurse to administer just one medication are complex and layered (Brady et al. 2009). Safe administration requires safe thinking. Sound cognitive processing will enhance sound medication skills. Because of this, it is imperative that nursing administrators and educators implement specific cognitive strategies for safe medication administration. The Tang Model for Cognitive Strategies is helpful to meet the demand of developing concept-based nursing education curricula and nursing clinical training programs. This model contributes a cognitive perspective on the nursing process of medication administration.

It is the ethical responsibility of each nurse to develop and maintain knowledge-based competencies in medication administration. The nurse will need to maintain competency levels and a current clinical practice. High-level evidence-based research on the study of cognitive strategies for safe medication administration is needed to fill a knowledge gap in nursing science and practice. The nurse's clinical judgment may be enhanced by the use of the Tang Model for Cognitive Strategies for Safe Medication Administration and thereby improve patient outcomes.
Acknowledgements:

The investigator would like to thank Dr. Gail Washington and Dr. Lorie H. Judson for their invaluable guidance and coaching in the writing of the project. The author would also like to thank Rio Hondo College and Kaiser Baldwin Park Hospital for hearing a demonstration of the project's findings and for their feedback on the Tang Model of Cognitive Strategies.
APPENDIX B

JNEP AUTHOR GUIDELINES FOR MANUSCRIPT SUBMISSION

Journal of Nursing Education and Practice
Paper Submission Guide

1. General Requirements

1.1 Language and Numbers
Please write your text in proper English; American or British usage is accepted, but not a mixture of both. When writing numbers, use a period, not a comma, to represent the decimal point and a space to separate numbers of more than five digits into groups of three, whether on the left or the right of the decimal point (i.e., 10 000.471 85, but 1000.4718). We only accept manuscripts written in English.

1.2 Length of Paper
Papers between 3,000 and 8,000 words are preferred.

2. Title Page
To ensure the integrity of the peer review process, every effort should be made to prevent the identities of the authors and reviewers from being known to each other.
When you upload a submission file, author identities should be removed from it. You should upload the title page as a supplementary file for the editor to review.

2.1 Title
Be concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible. If you choose to have a subtitle, it should be italicized and centered directly below the main title.

2.2 Authors’ Names and Affiliations
The preferred form of an author's name is first name, middle initial(s), and last name; this form reduces the likelihood of mistaken identity. To assist researchers as well as librarians, use the same form for publication throughout your career; that is, do not use initials on one manuscript and your full name on a later one. Determining whether Juanita A. Smith is the same person as J. A. Smith, J. Smith, or A. Smith can be difficult, particularly when citations span several years and institutional affiliations. Omit all titles (e.g., Dr., Professor) and degrees (e.g., PhD, PsyD, EdD).

The authors’ affiliation identifies the location of the author(s) at the time the research was conducted, which is usually an institution. Include a dual affiliation only if two institutions contributed substantial support to the study. Include no more than two affiliations per author.
Example:

Anne Smith\textsuperscript{1}, Mary Meade\textsuperscript{1,2}, David Wolf\textsuperscript{1} & Jerry Song\textsuperscript{2}

\textsuperscript{1} School of Management, Northern Canada University, Toronto, Canada
\textsuperscript{2} School of Economics, Peking University, Beijing, China

Correspondence: David Wolf, School of Management, Northern Canada University, Toronto, Ontario, M3A 2K7, Canada. Tel: 1-613-947-3592. E-mail: davidwolf@gc.ca

3. Preparation of Text

Manuscripts should be organized in the following order:
keywords (indexing terms, normally three-to-six items); introduction; material studied, area descriptions, methods, and/or techniques; results; discussion; conclusion; acknowledgements; references.
### APPENDIX C

#### TABLE OF EVIDENCE

Evidence Appendix C. *Summary of Literature Reviews on Cognitive Strategies for Safe Medication Administration (reverse chronological order)*

<table>
<thead>
<tr>
<th>Purpose, Study Questions (Author(s), Year)</th>
<th>Study Design &amp; Key Variables</th>
<th>JHNEBP Rating</th>
<th>Sample &amp; Setting</th>
<th>Measurements, Operational Definitions of Variables</th>
<th>Results or Findings</th>
<th>Authors’ Conclusions; Study Limitations and Notes (clinical implications)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aim: Examine clinical judgment and reasoning in nursing Obj: Locate primary research studies about clinical judgment and reasoning in nursing (Cappelletti, Engel, &amp; Prentice, 2014)</td>
<td>Systematic literature review: quantitative and qualitative studies Used: Pubmed, MEDLINE, ERIC, CINAHL from 1980-2012 KV: clinical judgment nursing clinical reasoning</td>
<td>IV B</td>
<td>N = 15 studies met the selection criteria</td>
<td>Operationalized terms: clinical judgment nursing clinical reasoning</td>
<td>Clinical judgment consists of six educational strategies</td>
<td>Beginning nurses must overcome the theory-practice gap Experienced nurses must avoid routine thinking Clinical judgment develops over time in the nurse who consistently reflects overtime and responds accordingly</td>
</tr>
</tbody>
</table>
### 2. Aim:
Examine effective education strategies on medication dosage calculations.

**Obj:**
Methodological analysis and presentation of past empirical and theoretical literature related to interventions to improve medication calculations (Stolic, 2014)

<table>
<thead>
<tr>
<th>Integrative literature review:</th>
<th>VB</th>
<th>N= 20 studies met the selection criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>quantitative and qualitative studies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used: Sciencedirect, CINAHL, PubMed, Proquest, Medline from 1990-2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KV: education strategies and medication dosage calculation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Operationalized terms:**
- nurse
- student
- medication drug
- calculation dosage
- education numeracy

**Four types of educational strategies found in the ILR:**
- traditional pedagogy
- technology
- psychomotor skills
- blended learning

**L:** small sample sizes within studies in one or two sites, assessment tools with poor reliability

**C:** very few well-designed and adequate powered studies on educational strategies.

### 3. Aim:
Causes of medication administration errors (MAE) in hospitals

**Obj:**
Review and appraise empirical

<table>
<thead>
<tr>
<th>Systematic literature review:</th>
<th>IV A</th>
<th>N= 54 studies met selection criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>quantitative and qualitative studies/ evidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used: MEDLINE, EMBASE, International</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Used Reason's Model of accident causation for MAE categorization.**

**Terms operationalized and measured:**
- Most common MAEs were: non-compliance in following the 5-10 Rights of Medication administration; knowledge-based mistakes; nursing lacked needed
<table>
<thead>
<tr>
<th>Evidence relating to causes of MAEs (Keers, Williams, Cooke, &amp; Ashcroft, 2013)</th>
<th>Pharmaceutical Abstracts, ASSIA, PsycINFO, British Nursing Index, CINAHL, Health Management Information Consortium and Social Science Citation Index from 1985-2013 KV: medication administration error</th>
<th>MAE, route of administration, nurse.</th>
<th>high demanding workload; problems with equipment, nurse fatigue/stress; &amp; interruptions/distractions during medication administration.</th>
</tr>
</thead>
</table>

4. **Aim:** Describe RNs’ medication competencies  
**Obj:** Use results for instrument development (Sulosaari, Suhonen, & Leino-Kilpi, 2010)  
**Integrative literature review:** descriptive and correlational studies  
**Used:** CINAHL, Medline, ERIC, Cochrane Systematic, evidence-based, peer-reviewed studies from 1999-2009 KV:  
**N= 21 studies met selection criteria**  
**Critical Analysis, Synthesis, and Summary of each study**  
Each done in five stages:  
- problem identification, literature search, data evaluation, data analysis, and presentation  
**Identified and coded 11 nurse competency categories in medication administration:**  
1) anatomy and physiology  
2) pharmacology,  
3) communication,  
4) interdisciplinary  
**C: Medication competence requires:** solid knowledge base, application of knowledge, work in complex patient medication processes  
**Decision making competence:** most important and integral part of nursing competency  
**CI:** Nursing curriculum/education
medication competence

5) information seeking
6) mathematical and medication calculation
7) medication administration
8) medication education
9) assessment and evaluation
10) documentation
11) promoting medication safety with patient safety

Analysis:
3 major competence categories
integrate the 11:
1) decision making
2) theoretical competence
3) practical competence

Migration of the nursing workforce
L:
older studies from 2003-2009
no sentinel study noted transferability or generalizability bias in sampling
no correlational tests for terms
<table>
<thead>
<tr>
<th>5. Aim: Identify evidence related to nurses' perceptions that contribute to medication errors (Hewitt, 2010)</th>
<th>Integrative literature review: qualitative and quantitative (mixed studies) CINAHL, IOM, and Medline Studies from 2002 to 2008</th>
<th>N= 9 studies met the selection criteria</th>
<th>ILR followed themes and operationalized terms (distractions, failure to follow 5 rights, failure to follow protocol, fatigue, confusion, miscalculations, high priority events, incompetence of devices) Etiology of medication errors: health care system environmental distractions poor protocol adherence human fatigue miscalculations</th>
<th>C: Small sample size in ILR points to specific nursing behaviors to improve safe medication administration L: No theoretical framework or quantitative approach CI: Transferability and generalizability bias due incongruent mixture of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Aim: Review of empirical literature investigating individual and systems factors that relate to nursing medication errors (Brady, Malone, &amp; Fleming, 2009)</td>
<td>Integrative literature review: qualitative and quantitative (mixed studies) CINAHL, PubMed, Science Direct and Synergy from 1988 to 2007</td>
<td>N= 26 studies met the selection criteria</td>
<td>Operationalized terms: medication reconciliation drug distribution systems deviation from procedures quality of prescriptions medication knowledge medication</td>
<td>Nursing medication errors related to: medication reconciliation drug distribution system deviation from procedures quality of prescriptions medication knowledge medication</td>
</tr>
<tr>
<td>deviation from procedures</td>
<td>errors in reporting medication errors</td>
<td>workloads errors in nurse's lack of medication knowledge error</td>
<td>Streamline reporting errors</td>
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<tr>
<td>deviation from procedures</td>
<td>errors in reporting medication errors</td>
<td>workloads errors in nurse's lack of medication knowledge error</td>
<td>Streamline reporting errors</td>
<td></td>
</tr>
<tr>
<td>medication</td>
<td>errors in reporting medication errors</td>
<td>workloads errors in nurse's lack of medication knowledge error</td>
<td>Streamline reporting errors</td>
<td></td>
</tr>
<tr>
<td>knowledge/skills workloads reconciliation barriers to reporting</td>
<td>Streamline reporting errors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>workloads</td>
<td>errors in nurse's lack of medication knowledge error</td>
<td>Streamline reporting errors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nurse's lack of knowledge error</td>
<td>Streamline reporting errors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>error</td>
<td>Streamline reporting errors</td>
<td></td>
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</tr>
<tr>
<td>Acquisition and maintenance of mathematical competency for nurses systems errors</td>
<td>Streamline reporting errors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L: term operationalization not clearly identified</td>
<td>Streamline reporting errors</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Evidence Table 2. Summary of Descriptive Studies on Cognitive Strategies for Safe Medication Administration (reverse chronological order)

<table>
<thead>
<tr>
<th>Purpose, Study Questions (Author(s), Year)</th>
<th>Study Design &amp; Key Variables</th>
<th>JHNEBP Rating</th>
<th>Sample &amp; Setting</th>
<th>Measurements, Operational Definitions of Variables</th>
<th>Results or Findings</th>
<th>Authors’ Conclusions; Study Limitations and Notes (clinical implications)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aim: To examine differences in clinical reasoning between novice, experienced, and expert pediatric nurses (Anderson, Klang, &amp; Peterson, 2012)</td>
<td>Qualitative content analysis</td>
<td>III B</td>
<td>N = 21 from one hospital&lt;br&gt;Nurses: Novice: 0.5 – 2 years&lt;br&gt;Experienced: 4-7 years&lt;br&gt;Expert: 7-25 years</td>
<td>Case studies</td>
<td>Clinical reasoning of nurses related to high correlation experience and training&lt;br&gt;Novice demonstrated superficial analysis of situations&lt;br&gt;Novice and Experienced used skill-based approaches&lt;br&gt;Experts used theory-based and holistic approaches</td>
<td>Poor transferability and moderate generalizability to other nursing populations</td>
</tr>
</tbody>
</table>
2. **Aim**: Identify the characteristics and relationships of the nursing practice environment, nurse staffing levels, nurses' error interception practices, and rates of non-intercepted medication errors in acute care hospitals (Flynn, Liang, Dickson, Xie, & Suh, 2012)

<table>
<thead>
<tr>
<th>Non-experimental</th>
<th>III A</th>
<th>N = 82 medical-surgical units recruited from 14 U.S. acute care hospitals (convenient samples) N = 686 staff RNs surveyed Over 8 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice Environment Scale of the Nursing Work Index (validity and reliability established)</td>
<td>measures environmental characteristics</td>
<td>Hierarchical linear modeling Nursing Organization and Outcomes Model Correlation coefficients computed between study variables (+) “Supportive” practice environment: &gt; quality care (+) collaborative relationships &gt; RN participation (+) nurse manager &gt; adequate staffing/ resources &gt; Error interception practices by nurses &lt; Medication error rates</td>
</tr>
<tr>
<td>KV: non-intercepted medication errors</td>
<td></td>
<td>C: Nurses want/need &gt; support by administration, other colleagues, and other departments to &gt; interception of medication errors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L: no randomization of sample &lt; reporting of medication errors (+) Large, diverse RN selected sample</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CI: study quantifies important role nurses have in &gt; patient safety (+) supportive environment &gt; safer patient outcomes Healthcare administrators to &gt; strategies to &gt;</td>
</tr>
</tbody>
</table>
3. Aim: Explore the many influences on medication quality and safe medication administration in acute care (Popescu, Currey, & Botti, 2011)

| Exploratory Descriptive Qualitative | N = 30 non-randomized Non-participant observation Follow-up interview | (+) Influences: nurses developed therapeutic relationships with patients > assessing patients before administering medications > educating patients about drugs during medication administration
(-) Influences: nurses > frequent distractions
nurses deviated from best-practice guidelines during medication administration |
|---|---|---|
| KV: medication administration safety | Written observations: - nurses’ interactions with patients during medication administration - characteristics of the environment Short semi-structured interviews with participant nurses | (+) increased medication administration quality and safety by > nursing behavior
(-) violations of practice standards CI: (+) therapeutic relationships with patients > medication quality and safety > protecting patients from potential adverse events - good ward design and medication storage areas < potential errors (-) deviations from best-practice medication administration |
4. Aim: To explore the nursing experience and how it effects clinical judgment (Yang & Thompson, 2011)

Comparative study

N = 97 of nursing students and experienced nurses from acute and critical care units in one hospital

Risk assessments made on physical and paper-simulated patients; correct judgment and clinical experience measured

Experienced nurses demonstrated more consistent correct clinical judgment ($p = 0.04$) but this clinical experience did not significantly improve clinical experience for experienced nurses. Therefore, HFS impairs judgment in high-fidelity simulation (HFS)

Experienced nurses are older in age and possibly less exposed to HFS than the younger student nurses; therefore HFS impairs versus measures true clinical judgment for experienced nurses

Less rigor due to nonrandom sampling

N = 21 nurses in Grounded Theory

N = 97 of nursing students and experienced nurses from acute and critical care units in one hospital

Risk assessments made on physical and paper-simulated patients; more consistent correct clinical judgment

Experienced nurses demonstrated more consistent correct clinical judgment ($p = 0.04$) but this clinical experience did not significantly improve clinical experience for experienced nurses. Therefore, HFS impairs judgment in high-fidelity simulation (HFS)

Experienced nurses are older in age and possibly less exposed to HFS than the younger student nurses; therefore HFS impairs versus measures true clinical judgment for experienced nurses

Less rigor due to nonrandom sampling
<table>
<thead>
<tr>
<th>Examine responses of nurses in clinical decision making (Elliot, 2010)</th>
<th>Utilization in methodology</th>
<th>Outpatient healthcare institutions</th>
<th>Variables: negotiation and compromise during clinical decision making</th>
<th>Patient responses when these two strategies used and calculation of patient responses. Nurses were advance practice could decrease transferability of findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Aim: Are there differences in preceding events/factors of severe and nonsevere medication errors? (Chang &amp; Mark, 2009)</td>
<td>Longitudinal Descriptive DV: medication error IV: work dynamics, RN hours, communication with physicians, nursing expertise, educational level, experience, medication-related support services, patients' age, health status, and previous hospitalization</td>
<td>III A</td>
<td>N= 279 nursing units in 146 randomly selected hospitals in U.S. over 6 months</td>
<td>Antecedents (preceding events/factors) defined and operationalized): work environment, team, persons, patients, and medication-related support services GEE with (-) binomial distribution (nursing units= unit of analysis)</td>
</tr>
</tbody>
</table>
7. Aim: To examine clinical reasoning strategies with preset criteria for clinical decision making (Ramezani-Badr, Nasrabadi, Yekta & Taleghani, 2009)

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Sample Size</th>
<th>Data Collection</th>
<th>Data Analysis</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative descriptive</td>
<td>N = 14 critical care nurses from four teaching hospitals</td>
<td>Use of content analysis of nurses' responses</td>
<td>Clinical reasoning strategies identified: intuition, recognizing similar situations, and hypothesis testing</td>
<td>Nurses felt that their job descriptions did include all their activities in clinical decision making</td>
</tr>
</tbody>
</table>

reported thinking processes during medication administration (Eisenhauer, Hurley, & Dolan, 2007)

<table>
<thead>
<tr>
<th>Qualitative Content Analysis</th>
<th>Inpatient care units Large tertiary care teaching hospital Northeastern US Semi-structured interviews Real-time tape recordings to document the nurses' thinking processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>KV: critical thinking medication administration professional vigilance</td>
<td>descriptive categories of nurses' thinking: communication, dose-time, checking, assessment, evaluation, teaching, side effects, work arrounds, anticipating problem solving, and drug administration</td>
</tr>
<tr>
<td></td>
<td>High frequency occurrence: judgment decisions utilizing critical thinking and clinical judgment</td>
</tr>
<tr>
<td></td>
<td>Reoccurring thread: vigilance with appropriate medications</td>
</tr>
<tr>
<td></td>
<td>assessment interdisciplinary professional knowledge provides safe and effective care processes helps explain the medication administration expertise inherent in patient safety beyond the technical skills</td>
</tr>
<tr>
<td></td>
<td>L: Selection bias &gt; RNs hand selected for expertise and many years of experience No randomization of any variables</td>
</tr>
<tr>
<td></td>
<td>CI: more quantitative studies are needed to identify nursing variables of clinical reasoning in medication administration</td>
</tr>
</tbody>
</table>

nurses perceptions of frequent causes of medication errors; what constitutes a medication error; and barriers and avenues to report medication errors (Ulanimo, O'Leary-Kelley, and & Connolly, 2006)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Failure to check the Five Rights</th>
<th>findings due to: physician order entry bar coding of medications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurses from inpatient veterans administration hospital in California 27 questionnaires 44% response rate</td>
<td>Tire and exhausted MD incorrect order Nurse miscalculations on dosing Confusion of drugs with similar names Illegible writing Distractions Confusion with infusion devices and medication labeling/packaging</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>10. Aim: Compare two delivery methods: integrated pharmacology content versus a separate pharmacology course in a 4-year nursing curriculum (Zellner, Boerst, &amp; Semling, 2003)</th>
<th>Non-experimental Descriptive Retrospective Exploratory Theory applied: Item Response Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenient sample: N= 299 Senior nursing students using computerized adaptive pharmacology test IV: national norm of senior nursing students' scores DV: 2 senior nursing groups in study</td>
<td>Instrument: Computerized adaptive pharmacology testing (NLN CAT Pharm) (r= .93 for calculations) (r = .91 for principles) (r= .89 for effects) No significant difference between the entire groups combined when compared to</td>
</tr>
<tr>
<td>Teaching a separate pharmacology course did not result in an increased NLN CAT-Pharm scores</td>
<td>C: Teach pharmacology theory throughout entire nursing curriculum and not as a separate course</td>
</tr>
<tr>
<td>L: Convenient sample Older study Research on BSN programs and not ADN or diploma RN programs</td>
<td></td>
</tr>
<tr>
<td>national norm (p= .452)</td>
<td>Significant difference between the 2 groups' scores compared to each other (p = .001)</td>
</tr>
<tr>
<td>Purpose, Study Questions (Author(s), Year)</td>
<td>Study Design &amp; Key Variables</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>1. Aim: To describe situation awareness (SA) during medication administration and to describe interruption handling strategies (Sitterding et al, 2014)</td>
<td>Cross-sectional and Descriptive: Cognitive task analysis methods used Cognitive time-sharing</td>
</tr>
<tr>
<td>2. Aim: To study and identify critical thinking learning needs of new and experienced nurses (Fero et al., 2009)</td>
<td>Quantitative Retrospective analysis Tool used: Performance Based Development system Assessment (PBDS) to measure critical thinking</td>
</tr>
<tr>
<td>3. Aim: Measure nursing workload during medication administration (Pape et al., 2005)</td>
<td>Using standardized protocol, clinical educators observe nurses during medication administration</td>
</tr>
<tr>
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<td>---</td>
</tr>
<tr>
<td>4. Aim: Testing theory and knowledge of medication calculation skills (Grandell-Niemi et al., 2003)</td>
<td>Quantitative-evaluative KV: medication calculation skills test (MCQ test) questionnaire to determine level of medication math skills</td>
</tr>
</tbody>
</table>

**Note:** ILR= Integrative literature review; NLN = National League for Nursing; NLN CAT- Pharm: National League for Nursing Computerized Adaptive Test for Pharmacology; IV= Independent variable; DV= Depend Variable; U.S. = United States; GEE= Generalized estimating equations; CI: = clinical implications; KV= key variables; CINAHL= Cumulative Index for Nursing & Allied Health Literature; ERIC = Education Resources Information Center; C= conclusions; L = limitations; IOM = Institute of Medicine; RQ= research question. JHNEBP Rating = Johns Hopkins Nursing Evidence-Based Practice Rating.
## APPENDIX C

### TABLE: COGNITIVE STRATEGIES FOR SAFE MEDICATION ADMINISTRATION USING THE LASATER CLINICAL JUDGMENT RUBRIC (LCJR)*

|------------------------|--------------------------------------------------------------------------------|-------------------------------------------------|------------------------|------------------------|
| **1. Effective Noticing involves:** | Mindfulness when giving medications  
Focused on pertinent patient assessment  
Practices continuous clinical vigilance  
Possesses keen patient observational skills  
Focuses on pertinent patient-related issues  
Practice focused situation awareness (SA) | Knowing the patient and his/her typical pattern of responses  
Understanding patient's situational and cultural contexts  
Visualizing teacher demonstrations in training | Mindfulness  
Pertinence  
Clinical Vigilance  
Situation Awareness  
Patient-centered | Mindfulness  
Pertinent  
Patient-centered |
| Focused observation | Recognizes deviations from expected patterns  
Assesses adverse effects of medications  
Recognize high alert drugs  
Differentiates look alike and sound alike medications  
Differentiates medication routes and their potential problems (enteral, subcutaneous, intramuscular, intravenous, transdermal, and epidural routes) | Knows profile of a high-risk patient and highly vulnerable patients (pediatrics and geriatrics)  
Knows specific error-prone processes (low margin of error) | Deviation and Pattern recognition  
Link and chunk data | Patterns |
Employs pattern recognition and links and chunks similar data
Recognizes pertinent patient problems
Consults with other health professionals
Appraises staffing patterns and work flow with medication delivery
Performs peer-learning activities

Retains knowledge about the medications (purpose, side and adverse effects, labs, and nursing implications)
Obtaining accurate patient assessment data
Knowing current policies and procedures
Retaining training and experience
Engagement with the patient and his/her concerns
Uses online and face-to-face tutorials with specific medication math testing
Takes part in medication training programs
Investigates sub-optimal information pathways
Increases competency in using all

Creates baselines for comparisons
Finds and leverages resources
<table>
<thead>
<tr>
<th>2. Effective <strong>Interpreting</strong> involves:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prioritizing data</td>
<td>computerized software and telemedicine monitors</td>
<td>Seeks continuing education and competency training</td>
<td>Adopts a knowledge-based problem-solving activity over a skill-based</td>
</tr>
<tr>
<td></td>
<td>Uses standardized procedures</td>
<td></td>
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<tr>
<td>Extracts relevant information to give medications</td>
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<tr>
<td>Detects higher priority situations</td>
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<tr>
<td>Hyper-vigilant during stressful events</td>
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<td></td>
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<tr>
<td>Practiced efficient patient workload prioritization</td>
<td></td>
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<tr>
<td>Differentiates urgent and emergent situations</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Employs RN Stacking techniques: addresses imminent clinical concerns, high uncertainty activities, patient support, and managing pain</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Clinical Reasoning**

**Prioritizing relevant data**

**Prioritize**

**RN Stacking**
<table>
<thead>
<tr>
<th>Making sense of data</th>
<th>Correctly interprets pertinent data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Anticipatory problem solving</td>
</tr>
<tr>
<td></td>
<td>Uses clinical reasoning patterns</td>
</tr>
<tr>
<td>3. Effective <strong>Responding</strong> involves:</td>
<td>Follows medication order correctly</td>
</tr>
<tr>
<td></td>
<td>Sound clinical reasoning</td>
</tr>
<tr>
<td>Calm, confident manner</td>
<td>Embraces a culture of safety and positivity</td>
</tr>
<tr>
<td></td>
<td>Supports unit-wide decisions</td>
</tr>
<tr>
<td></td>
<td>Gives input in patient care assignments</td>
</tr>
<tr>
<td></td>
<td>Develops a therapeutic relationship with their patient</td>
</tr>
<tr>
<td></td>
<td>Complying to safety measures</td>
</tr>
<tr>
<td>Clear communication</td>
<td>Uses SBAR (Situation, Background, Assessment, and Recommendation)</td>
</tr>
<tr>
<td></td>
<td>Timely communication of pertinent data</td>
</tr>
<tr>
<td></td>
<td>Corrects communication problems</td>
</tr>
<tr>
<td></td>
<td>Participates in positive inter-collaborative team work</td>
</tr>
<tr>
<td></td>
<td>Communicates with nursing leaders</td>
</tr>
<tr>
<td></td>
<td>Reports essential clinical data</td>
</tr>
<tr>
<td></td>
<td>Uses nurse call cards on patient areas or medication preparation areas</td>
</tr>
<tr>
<td></td>
<td>Acts on flagged areas on the medication administration record (MAR) indicating unfinished documentation</td>
</tr>
<tr>
<td></td>
<td>Understands organization's transfer of knowledge</td>
</tr>
<tr>
<td></td>
<td>Improves information access to medications</td>
</tr>
<tr>
<td></td>
<td>Inter-collaborative, interpersonal, and intra-personal communication</td>
</tr>
<tr>
<td></td>
<td>Decision-making</td>
</tr>
</tbody>
</table>
| Well-planned intervene/flexibility | Uses correct hand off guidelines  
Reduces handwritten communication | Intervenes to abort drug compatibilities  
Follows the ten rights of medication administration | Performs correct medication math  
Ability to work medication IV pumps and medication equipment |
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Correct medication administration techniques</td>
<td>Utilizes patient data and professional resources</td>
<td>Ability to work computerized medication dispensing machines</td>
<td>Informed decision making</td>
</tr>
</tbody>
</table>
| Utilizes Rapid Response and Code Blue teams  
Follows standards of care  
Labels different ports for different routes with their corresponding infusion pumps | Uses informed decision making  
Performs medication reconciliation per protocol | Participates in increased environmental controls in the medication room to prepare medications | Proactive |
| Uses informed decision making  
Performs medication reconciliation per protocol | High levels of efficient, effective interventions  
Initiates independent nursing interventions  
Anticipates relevant medical orders  
Uses standardized checklists for medication prep | Uses all forms of information technology (IT) systems in medication delivery |  |
| Uses visual and auditory alerts on IV pumps  
| Does not turn off alarms on medication machinery  
| Educates the patient regarding medications  
| Advocates for the patient's needs  
| Functions with ongoing interruptions and distractions  
| Follows correct medication procedures/protocols  
| Uses checklists for even “routine” processes  
| Uses designated restricted areas and access for medication preparation to reduce distractions and interruptions  
| Correctly documents medication in computer  
| Uses and develops algorithms and decision trees for medication management  
| Focused adherence  
| Protocol  

| Validation  

| Can diagnose own fatigue, stress, and decreased concentration  
| Provides relevant rationale to support decisions  
| Able to say no to overtime  
| Reflects on clinical practice and clinical judgment  
| Uses high-fidelity patient simulations to analyze their errors  
| Develops own clinical knowledge  
| Autonomous self evaluation  
| Appraise  

| Reflecting  

| Effective Reflecting involves:  

| 4. Effective Reflecting involves:  

<table>
<thead>
<tr>
<th>Commitment to improvement</th>
<th>Improves in clinical reasoning</th>
<th>Trained in critical thinking in clinical scenarios</th>
<th>Ongoing improvement</th>
<th>Perceptive reassessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Learns effective communication skills and conflict-resolution</td>
<td></td>
<td>Improve</td>
<td></td>
</tr>
</tbody>
</table>

*From Lasater and Nielsen, 2009.*
APPENDIX D

JHNEBP EVIDENCE RATING SCALES

Strength of the Evidence

Level 1
Experimental study/randomized control trial (RCT) or meta analysis of RCT

Level 2
Quasi-experimental study

Level 3
Non-experimental study, qualitative study, or meta-synthesis

Level 4
Opinion of nationally recognized experts based on research evidence or expert consensus panel (systematic review, clinical practice guidelines)

Level 5
Opinion of individual expert based on non-research evidence. (Includes case studies; literature review; organizational experience e.g., quality improvement and financial data; clinical expertise, or personal experience)

Quality of the Evidence

A High
Research
Consistent results with sufficient sample size, adequate control, and definitive conclusions; consistent recommendations based on extensive literature review that includes thoughtful reference to scientific evidence.
Summative reviews
Well-defined, reproducible search strategies; consistent results with sufficient number of studies; criteria-based evaluation of overall scientific strength and quality of included studies; definitive conclusions.
Organizational
Well-defined methods using a rigorous approach; consistent results with sufficient sample size; use of reliable and valid measures well-defined methods using a rigorous approach; consistent results with sufficient sample size
Expert Opinion
Expertise is clearly evident

B Good
Research
Reasonably consistent results, sufficient sample size, some control, fairly definitive conclusions; reasonably consistent recommendations based on comprehensive literature review that includes some reference to scientific evidence
Summative reviews
Reasonably thorough and appropriate search; reasonably consistent results with sufficient numbers of defined studies; evaluation of strengths and limitations of included studies; fairly definitive conclusions

Organizational
Well-defined methods; reasonably consistent results; use of reliable and valid measures; consistent recommendations

Expert Opinion
Expertise appears to be credible

C Low quality or major flaws

Research
Little evidence with inconsistent results, insufficient sample size, conclusions cannot be drawn

Summative reviews
Undefined, poorly defined, or limited search strategies; insufficient evidence with inconsistent results; conclusions cannot be drawn.

Organizational
Undefined, or poorly defined methods; insufficient sample size; inconsistent results; undefined, poorly defined or measures that lack adequate reliability or validity

Expert Opinion
Expertise is not discernible or is dubious

(Johns Hopkins Nursing Evidence-Based Practice Model and Guidelines, JHN EBP - Resources and Consultations. http://www.hopkinsmedicine.org/institute_nursing/continuing_education/ebp/ebp_books_consultations.html.)