Nursing Clinical Decision-Making: A Literature Review

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Abstract—**Clinical judgment and decision-making is a required component of professional nursing. Expert nurses are known for their efficient and intuitive decision-making processes, while novice nurses are known for more effortful and deliberate decision-making processes. Despite taking longer to make decisions, novices still have trouble with effective decision-making. The aim of this paper is to review the factors that contribute to clinical judgment and decision-making of novice nurses. This was achieved by reviewing over two hundred articles produced by searches through PsycINFO. These articles used various methods of data collection, ranging from observation to well-controlled experimentation, although the majority of the studies were exploratory in nature. Factors that influenced decision-making were categorized as either individual or environmental factors. Individual factors captured elements unique to the decision-maker and included factors such as experience, cue recognition, and hypothesis updating. By contrast, environmental factors captured elements surrounding the decision-task. Among these factors were task complexity, time pressure, and interruptions. The reliability and robustness of these factors are discussed.**

Keywords: **novice nurses, clinical decision-making, clinical reasoning, clinical judgment**

I. INTRODUCTION

Sound clinical reasoning and clinical decision-making is largely considered a "hallmark" of expert nursing (Simmons, Lanuza, Fonteyn, Hicks, & Holm, 2003). The ability to carry out competent decision-making is a critical and fundamental aspect of professional nursing. Decision-making abilities distinguish professional nurses from ancillary health care workers (Hughes & Young, 1990). In professional health care, it is often the case that decision consequences approach high risks, leaving little room for errors. Furthermore, the current health care environment has trended towards placing more accountability and responsibilities on nurses (Simmons et al., 2003; Saintsing, Gibson, & Pennington, 2011; Ebright, Urden, Patterson, & Chalko, 2004; Casey, Fink, Krugman, & Propst, 2004; Hickey, 2009).

Nurses are at the forefront of patient care, usually the first link in the causal chain between identifying complications and eventual rescue (Thompson et al., 2008). This, coupled with the increasing responsibilities, underscores the importance of sound clinical reasoning and decision-making. Choosing appropriate interventions accurately and timely is crucial (Clarke & Aiken, 2003).

Brennan and colleagues estimate that up to 65% of adverse events that hospital inpatients endure may be preventable—a result of poor clinical decision-making (Brennan et al., 2004; Leape, 2000). Hodgetts et al. (2002) report that 60% of cardiac arrests suffered by inpatients during hospitalization could have been prevented, with nearly half of those cases showing clinical signs of deterioration recorded in the preceding 24 hours, but not acted on (as cited in Thompson et al., 2008). Shockingly, the values recorded—but not acted upon—are the part of the basic knowledge of nursing practice, and are essential cues used to make clinical decisions (e.g., hear rate, respiratory rate, and oxygenation; see Goldhill, 2001). Surely, nurses must be aware that the decisions they make have significant impact on the healthcare outcome of their patients, yet these reports raise major concern (Long, Young, & Shields, 2007; Dowding & Thompson, 2003). What factors contributed to such lapses in clinical judgments?

Given the nature of the profession, nurses must perform at high levels—but can this be expected of novice nurses who just enter the field? A descriptive survey of employers of new nurses found that, in general, newly licensed nurses tend to be inadequately prepared to enter practice (Smith & Crawford 2002), with half the novice nurses being involved in errors of nursing care (Saintsing et al., 2011; Smith & Crawford 2003; Kenward & Zhong 2006). In addition, Saintsing et al. (2011) reported that only 20% of employers were satisfied with decision-making abilities of new nurses. Given the high involvement in errors and the assumption that decision-making is an integral part of nursing, it would prudent to carefully inspect the factors contributing to clinical decision-making in novice nurses. In what follows, I present a review of the emerging themes that have been explored in nursing clinical decision-making and highlight the known and suspected influencers on clinical decision-making.

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II. Literature Review Process

An evaluation of the peer-reviewed literature generated from PsycINFO with various combinations of the terms "decision-making", "judgment", "clinical", "novice", and "nursing" was carried out. The following limits were placed on the search: (1) articles must come from peer-reviewed journals; (2) only English language publications were reviewed; and (3) full text of the article must be available. Using these criteria, the search produced an overwhelming set of articles—over 1500 studies. Of these articles, roughly 800 were loosely related to nursing clinical decision-making and were reviewed. This subset of articles produced about 200 articles that had strong relevance to clinical decision-making and were subjected to a more detailed and thorough review.

The following paper summarizes research from the final subset of articles. In addition to a database search, citations to and from articles were also used. This led to the review of several book chapters, but to foreshadow a general theme found in the literature, most chapters are not reported because of the highly subjective nature of the content. Overall, this process uncovered three research themes on clinical decision-making—research on factors that influence nurse participation in clinical decision-making, research comparing decision-making processes between novice and expert nurses, and research on factors known (or suspected) to influence decision-making in nursing.

The single primary objective of this literature review was to uncover factors that influence clinical decision-making (either positively or negatively) in first-year novice nurses. However, there is a dearth of studies conducted with such a specific research goal; studies either deviate on participants used or focus on other aspects of clinical decision-making. There are several likely reasons that research on clinical decision-making of novice nurses is limited. First, there is a lack of consistency as to what constitutes a novice nurse (Simmons et al., 2003). Several researchers qualify nursing students (perhaps inappropriately) as novices (Tanner, Padrick, Westfall, & Putzier, 1987; Thiele, Holloway, Murphy, & Pendarvis, 1991; Baxter & Rideout, 2006; Lofmark, Smide, & Wikblad, 2006; Shin, 1998), whereas others define it within a single year (Ebright et al., 2004; Wainwright, Shepard, Harman, & Stephens, 2011; Saintsing et al., 2011; Greenwood & King, 1995; Forneris & Peden-McAlpine, 2007) and still others define it as within two years (Hoffman, Aitken, & Duffield, 2009; Grobe, Drew, & Fonteyn, 1991).

Second, a substantial number of clinical decision-making researchers have seemingly focused on the development of decision-making abilities and therefore include novice nurses as a mere baseline comparison group (Chunta & Katrancha, 2010; Benner, Tanner, & Chesla, 1992). Lastly, researchers focusing on the core decision-making process are more interested in nurses whose decision-making abilities are purportedly fully developed (e.g., *expert nurses*), which makes the implicit assumption that all novice decision-making is inferior and unstable (Buckingham & Adams, 2000a, 2000b). Often times these studies are carried out on specialized nurses, requiring more expertise and experience than most novice nurses have (Kaasalainen et al., 2007; Marshall, West, & Aitken, 2011; Monterosso et al., 2005). Despite the dispersive focus of the field, studies that had strong implications for novice decision-making were included and described accordingly.

The three lines of research that emerged from the review are intimately related and need to be considered collectively. For instance, factors that influence the frequency of participation in decision-making may have differential effects on expert and novice nurses (Hoffman, Donoghue, & Duffield, 2004; Prescott, Dennis, & Jacox, 1987). Frequency of decision-making participation is assumed to play a critical developmental role in clinical competency (see, e.g., Thiele et al., 1991). Those who receive more opportunity in clinical decision-making are provided with more feedback on their decisions and interventions, ultimately leading to better quality decisions in the future (Thiele, Baldwin, Hyde, Sloan, & Strandquist, 1986). This is not to say that experience alone accounts for the development of decision-making skills (Benner, 1984), but instead it allows for more occurrences of factors that contribute to clinical decision-making skill development (Zinsmeister & Schafer, 2009).

Studies comparing novice and expert nurses are important for understanding clinical decision-making. This line of research focuses on the underlying decision-making process involved when nurses make clinical decisions. Various theoretical frameworks are put forth in the literature and each is useful for investigating decision-making factors because the frameworks break down the decision process into subcomponents—providing simpler methods of investigating influencers. For instance, expert nurses have been shown to use more forward reasoning in decision-making (e.g., data evaluation triggers a hypothesis), while novice nurses are shown to use more backward reasoning (e.g., hypothesis constrains data evaluation). Therefore, any manipulation affecting the collection of information (e.g., the quality of information, the ratio of confirming/disconfirming evidence to a particular action plan, etc.) will differentially impact expert and novice nurses in their ability to update their hypothesis. Hence, offering a method to differentiate between novice and expert nurses (Lamond, Crow, & Chase, 1996; Lauri & Salantera, 1995).

The final theme in the literature review is research that investigated factors contributing to clinical decision-making. These studies tend to be qualitative in nature (e.g., focus groups, think-aloud, observations) and use self-report questionnaires or survey methods for data collection (Funk, Tornquist, & Champagne, 1995), which might be problematic because conclusions are drawn on an ad hoc, exploratory basis (for a lengthier explanation, see Thompson, 1999a). That is, researchers explore transcriptions of interview or observation data and find general decision-making factors that are reported by participants. No further confirmatory research is conducted to determine whether the factors in question are discovered through chance or are actually found in the nursing population.

Few studies employ experimental techniques (e.g., manipulation of variables, proper controls, randomization, etc.). This speaks to the difficulty and complexity of conducting nursing research in applied environments

(Dowding & Thompson, 2003; Aitken, Marshall, Elliott, & Mckinley 2011). Although experimentation has the benefit of controlling for nuisance variables (e.g., confounds) and showing causality, it runs the risk of oversimplification. And while reducing nursing environments to vignettes for the sake of experimentation might show the basic processes of decision-making, doing so can lose sight of the overall picture of applicability. It is the classic argument of *in vitro* versus *in vivo*—applied versus laboratory research. Therefore, regardless of the exploratory nature of nursing clinical decision-making research, these studies lay the groundwork for future experiments to confirm the critical factors that impact clinical judgment and decision-making.

Collectively, these three themes highlight two categories of variables that impact nursing clinical decision-making, individual factors (e.g., cue recognition, knowledge structure, ability to update working hypothesis, communication, current state of emotion, etc.) and environmental factors (e.g., task complexity, time pressure, interruptions, professional autonomy, etc.). Individual factors focus on the decision-maker and various properties of information processing. By contrast, environmental factors relate to the to-be-processed information. For example, a nurse's cue recognition ability will directly impact the efficiency and accuracy of their decisions—an individual factor. However, task complexity— an environmental factor—affects the presentation of cues and has an indirect impact on the decision-maker. The agreement on these factors in the literature is mixed. Some factors, such as task complexity, have repeatedly been shown to impact clinical decision-making (Corcoran, 1986a; Hicks, Merritt, & Elstein, 2003; Hughes & Young, 1990; Lewis, 1997). However, there has been less agreement on other factors, such as education level or experience (Sanford, Genrich, & Nowotny, 1992; del Bueno, 1983; Shin, 1998; Bechtel, Smith, Printz, Gronseth, 1993). Where appropriate, reasons for disparate results are discussed.

III. Applied Decision-making Research: Methodological Difficulties

As mentioned above, the majority of studies reviewed implement qualitative methods, varying primarily between either observational designs or think aloud protocols, although there are a substantial amount of studies that collect data through surveys. There are several issues with these methods that are worth mentioning. First, for qualitative research, regardless of the means of collection, data must be coded either descriptively or thematically. This requires multiple trained coders to ensure reliability in coding. Furthermore, statistics should be provided as to the amount of agreement between coders, also known as inter-rater reliability. Given that the majority of nursing research is qualitative (Cullum, 1997; Thompson, McCaughan, Cullum, Sheldon, & Raynor, 2004; Thompson, 1999a), reliable coding is imperative so results and conclusions are not contingent on researcher bias or ambiguous constructs. However, nearly all articles reviewed either failed to include multiple raters or included multiple raters but provided no measure of inter-rater reliability. This issue is so prevalent in the nursing clinical decision-making literature that Thompson and colleagues published a paper calling on researchers to be more transparent in coding procedures (Thompson et al., 2004).

Employing questionnaires as a means of collecting data affords the luxury of obtaining a large sample, but information collected through this method is contingent on the decision maker's retrospective memory capabilities. These memories are particularly susceptible to a slew of memory biases (e.g., misattribution, suggestibility, hindsight bias, fluency effects, etc.). Caution should be given when interpreting results from studies that use questionnaires to investigate clinical decision-making (Aitken et al., 2011). To add to the problem, questionnaire response rates in some studies drop as low as 29%, raising the issue of selective sampling bias (Thompson, 1999a).

An additional method used to investigate nursing clinical decision-making is through constructed interviews or focus groups. These studies use an introspective approach to collect data: An interviewer guides nurses to explain the decision-making process and factors that affect it. The main concern with all introspective approaches is that it capitalizes on idiosyncrasies of the participant and the environment that surrounds them. Generalizability is very limited, unless the proper sampling techniques are used. For instance, factors that impact novice nurses in one hospital setting might be unique and not prevalent in other hospitals—a conclusion made by Bucknall and Thomas (1995). In complex areas of study, such as nursing, it is extremely challenging and very costly to implement appropriate sampling techniques and still control for nuisance variables.[1]

Setting aside the issue of sampling and generalizability, introspective methodology is not necessarily an improper tool for investigating nursing clinical decision-making factors. In fact, can be an exceptionally powerful technique for grasping a broad range of influential variables—it casts a wide net on seemingly important factors. However, with any broad research approach, additional studies (and to the extent possible, experimentation) should be carried out to provide corroborating evidence and rule out any idiosyncrasies.

Decision classification presents another difficulty in applied clinical decision-making. What constitutes as a *correct* decision? This issue is exacerbated by the fact that most applied nursing research lack the feedback to ascertain whether a nurse's action plan reached an appropriate outcome. For instance, most observational studies examine nurses for several hours over a sequence of several days and observers receive no feedback on the outcome of their nurse's decisions (Buckingham & Adams, 2000a; Long et al., 2007; Dowding & Thompson, 2003). Furthermore, not all decisions or action

[1] Stratified random sampling is not the be-all and end-all technique in nursing research. Many authors argue that it is more important to get subjects and data likely to generate robust, rich, and deep understanding (Thompson, 1999a).

plans can be classified as binary. Decisions are often considered on gradient scales. Take for example two decisions or action plans that reach the same conclusion. Despite no differences in outcome, the two decisions could differ in efficiency, resources needed, complexity required, and therefore ultimately differ in quality. One solution offered by Bucknall (2000) and King and Clark (2002) is to encourage researchers to conduct larger scale longitudinal studies. This is an admirable request, indeed, but also a rather costly and difficult paradigm to implement, hence only several studies use this technique (Casey et al., 2004; Standing, 2007; O'Neill & Dluhy, 1997).

Lastly, when comparing observational methods to think aloud protocols, systematic differences have been observed. Think aloud protocols have been shown to collect a greater frequency of decisions than that of observation (Aiken et al., 2011). Specifically, when investigating decision-making involving assessment, diagnosis, and evaluation, think aloud protocols should be used because it affords information that cannot otherwise be collected by observation. However, there are limitations with think aloud protocols. Nurses must be comfortable with a continuous verbalization and they must be given adequate practice sessions. In addition, the very nature of thinking aloud might itself change the decision process that occurs with covert thinking (e.g., Heisenberg effect and/or Hawthorne effect; see Thompson, 2011). Observational methods also have some limitations. They require the observer to become a participant in the environment and their interactions can influence the patient-nurse dynamics—the consequence is creating an artificial setting (Luker & Kenrick, 1992). Therefore, the literature reviewed includes a mix of both observational methods and think aloud protocols.

Before detailing each category of factors, I briefly describe several frameworks of nursing decision-making that have been endorsed throughout the literature. Although these frameworks have been put forth primarily to distinguish between novice and expert nurses, they are insightful and explain the core elements involved in decision-making. Additionally, these frameworks provide the context in which the contributing factors are described in nursing research and, to some degree, in the current review.

IV. Clinical Decision-making models and Frameworks

One source of complexity that surrounds nursing clinical decision-making is that different nurses use different decision strategies. Depending on the dynamics of the task a single nurse can even use multiple strategies (Corcoran, 1986a, 1986b; Jenks, 1993; Cader, Campbell, & Watson, 2005). Factors that influence one method of decision-making may not have the same effect on another decision strategy (Baker, 1997). A unifying approach to nursing clinical decision-making is exceptionally difficult for this reason. There are a few proponents of this approach, though. Buckingham & Adams (2000a, 2000b) suggest that the major clinical decision-making theories are so similar that they only differ in terminology and semantics. They argue that decision-making research would be much more efficient and communicable if the research community endorsed this approach rather than placing so much energy on distinguishing theories apart[2]. Despite the similarities (or differences) three popular theories are summarized below.

Skills acquisition and the humanistic-intuitive approach

Perhaps the most influential framework of nursing decision-making is Benner's (1984) modification of the skills acquisition theory (for a review, see Dreyfus & Dreyfus, 1986). Benner postulated that clinical decision-making expertise is developed through experience as one progresses through five stages of skill acquisition. The first stage is the *novice* stage, which describes a beginner in the nursing domain. They learn through instruction and learn domain-specific facts, features, and actions (Gobet & Chassy, 2008). Novice decision-making is context free, meaning that novices ignore idiosyncrasies of the situation. This results in decision-making that is primarily rule based. It is inflexible and resulting in very limited performance.

After acquiring a fair amount of experience, a novice progress to an *advance beginner*. Advance beginners account for more situational variables when making decisions. Decision-making attributes start to become context dependent. They also make use of limited past experience (given that they have had a similar past encounter). The *competence* stage involves organization structures such as hierarchical long-range plans. Decisions are reached with greater efficiency, albeit still relying on conscious, abstract, analytical, and deliberate planning.

The *proficiency* stage marks holistic thinking rather than fragmented subcomponents. Problem features are viewed as salient or irrelevant, allowing decision-makers to organize and analyze a situation intuitively, but analytical thinking is still required to choose the action plan. Lastly, *expertise* stage represents those who can understand a situation intuitively *and* make decisions intuitively as well. Accordingly, experts act naturally and often reach conclusions without explicit understanding. Experts can revert to previous stages of analytical thinking if a situation is novel or their initial intuition is incorrect.

A strength of the humanistic-intuitive model of decision-making is its simplicity. It describes the progression from novice to expert succinctly—from a slow and hesitant decision-maker to a fast and fluid problem solver. It captures the relationship between knowledge and experience. Another strength of the theory is that it captures the involvement of emotion, namely in the intuition process (Benner et al., 1992; Jenks, 1993). Perhaps this is the reason why the framework has been adopted as the standard in nursing clinical decision-making (Agan, 1987; Benner & Tanner, 1987;

[2] For an example of the lively ongoing debate on nursing clinical decision-making theories, see English, 1993; Darbyshire, 1994; Benner & Tanner, 1987; Cash, 1995; Benner, 1996.

Corcoran, 1986a, 1986b; Crandall & Getchell-Reiter, 1993; Pyles & Stern, 1983; Rew, 1988, 1990, 1991; Schraeder & Fisher, 1986, 1987; Young, 1987). Intuition is phenomenological in spirit and is often described as a feeling of knowing something without conscious use of reason (Banning, 2007) or an understanding without rationale (Benner & Tanner, 1987). For this reason, hypothesis testing is not necessarily used as a criterion for accurate or inaccurate propositions and reasoning, which raised much skepticism as to whether this approach is scientifically based (Banning, 2007; Cash, 1995; English, 1993).

Due to the phenomenological nature, researchers using this approach have a difficult time unifying the definition of intuition (Buckingham & Adams, 2000b). As a consequence, nursing decision-making literature is filled with this loose construct. For example, over 25% of the articles reviewed used the term 'gut feeling' as a proxy for intuition when surveying nurses on factors that led to their decisions (see, e.g., Burman, Stepans, Jansa, & Steiner, 2002; Pretz & Folse, 2011; Ericsson, Whyte, & Ward, 2007). This raises the question, how can this body of research differential between 'gut feelings' and guesses? If surveys included a *guess* option, how would the endorsement of this choice be interpreted—especially when a guess resulted in the correct decision? Would that constitute as intuition, being a *gut feeling guess*? Hence, therein lies the biggest criticism of this framework, construct specificity (Rew, 2000).

Recent studies have made attempts to better define intuition as it is used in nursing clinical decision-making (e.g., domain specific intuition; Rew, 2000; Smith et al., 2004; Smith, 2006, 2007; Miller, 1995; Pretz & Folse, 2011). Rew (2000) conducted a three-phase study on validating an intuition assessment scale, hoping that it would provide a way to measure a nurse's propensity of utilizing intuition. The scale started out with a 50-item questionnaire that covered six conceptual categories relating to complex decision-making: uses sudden/immediate insight, creativity, risk taking, rigidity, cautiousness, and realistic approach (Rew, 1986; Masters & Masters, 1989). An expert nursing panel reviewed the assessment and reduced the number of questions to 28 items. Following the review, a Content Validity Index was carried out and revealed a high level of agreement (CVI = .96).

TABLE I
ACKNOWLEDGES USING INTUITION IN NURSING SCALE

QUESTION #	SCALE ITEM
1	There are times when I suddenly know what to do for a patient, but I don't know why.
2	I am inclined to make decisions based on a sudden flash of insight.
3	There are times when I immediately understand what to do for a patient, but I can't explain it to other people.
4	There are times when I feel that I know what will happen to a patient, but I don't know why.
5	There are times when a decision about my patient's care just comes to me.
6	There are some things I suddenly know to be true about some of my patients, but I am unable to support this with concrete data.
7	Sometimes I act on a sudden knowledge about a patient to prevent a crisis from developing even when I can't explain it.

Note—Reproduced from Rew (2000)

TABLE 2
INTUITION FACTORS

FACTOR	SCALE ITEM
Physical sensations	I get a shiver down my spine when I think something is wrong with my patient.
	The hair on my arms and neck stand up when something is wrong with my patient.
	I get a lump in my throat when something is wrong with my patient.
	I feel cold when something is wrong with my patient.
	I feel nauseous when something is wrong.
Premonitions	I experience a gut reaction when something is wrong with my patient.
	I get a bad feeling about a patient's condition.
	I get a persistent feeling about a patient's condition.
	I get a sinking feeling in my stomach when something is about to go wrong.
Spiritual connections	I connect with my patients at the soul level.
	I sense a spiritual connection with my patients.
	I experience a deep connection with my patients.
	I do not need verbal communication to sense a spiritual connection with my patient.
Reading cues	I read the non-verbal body language of my patient.
	I read non-verbal cues of my patient.
	I can read my patient's expressions.
Sensing energy	I sense positive energy coming from my patient.
	I sense negative energy coming from my patient.
	I sense an energy field around my patient
Apprehension	I experience a feeling of dread when caring for my patient.
	I get a nagging feeling about a patient's condition.
	I feel anxious when I think something will go wrong.
	I get an odd feeling about a patient's condition.
Reassuring feelings	I get a calm feeling when I know things will be okay.
	I get a peaceful feeling when I know my patient is stable.

Note—Reproduced from Smith, Thurkettle, & dela Cruz (2004)

In the next phase, the assessment was sent out to 106 nurses and responses were subjected to a principal component factor analysis. This analysis led to a six-factor model. However, seven questions had very low factor loadings and thus the scale was reduced to 21-items. For the final phase of the study, the reduced scale was administered to an additional set of nurses. As before, a factor analysis was conducted on these responses. This time three factors were retained, and only a single factor clearly came from the original domain. The author then further reduced scale to a unidimensional measure of seven questions and labeled it as the Acknowledges Using Intuition in Nursing Scale (AUINS) (see Table 1). Interestingly, this measure has yet to be explicitly tested in the decision-making literature. How does this measure correlate with the quality and efficacy of decisions that nurses make?

Smith and colleagues have also made attempts at better defining intuition (Smith, Thurkettle, & dela Cruz, 2004; Smith, 2006). Using similar exploratory factor analyses that Rew (2000) used, Smith et al. (2004) developed their own intuition measurement scale. This resulted in a 25-item scale with seven factors: physical sensations, premonitions, spiritual connections, reading cues, sensing energy, apprehension, and reassuring feelings (see Table 2). The most striking issue with this study (and the follow-up study, Smith, 2006) was that nursing students were used as participants. This is seemingly problematic because according to Benner's theory, novice nurses lack the intuition abilities that expert nurses have (Benner et al., 1992). Collectively, these studies take on the

challenge of establishing a valid construct of intuition, but there are too many remaining issues surrounding the measurement scales that prevent their adoption in the literature (but see Pretz & Folse, 2011).

Despite the aforementioned challenges with conducting research on domain specific intuition, there is plenty of evidence that suggest the role of intuition in nursing clinical decision-making. Pretz & Folse (2011) administered several domain specific measures of intuition, as well as domain general (e.g., Myers–Briggs Type Indicator, Myers, McCaulley, Quenk, & Hammer, 1998; Rational-Experiential Inventory, Pacini & Epstein, 1999), to nurses of various experience (from nursing students through nurses with over 25 years of experience). The researchers sought to test the hypothesis that preference and the use of intuition increased with experience. Their battery of tests and surveys showed an overwhelming use of intuition and more experienced nurses placed a greater reliance on intuition when making clinical decisions, confirming their hypothesis. Additionally, King and Clark (2002) conducted an observational study on nurses ranging from advance beginner to expert nurses (according to Benner's classification; Benner & Tanner, 1987) and found traces of intuition in both expert and non-expert nurses, but intuition was better utilized by expert nurses. These studies, along with others (King & Appleton, 1997; Manias, Aitken, & Dunning, 2004; McCormack, 1993; Traynor, Boland, & Buus, 2010) suggest that experience and expertise are key factors in the use of intuition.

Information-processing Model and Hypothetico-deductive Reasoning

An alternative framework for nursing clinical decision-making is the information-processing model. The decision-maker is viewed as a capacity-limited information-processing system that interacts with the problem task (Joseph & Patel, 1990; Hamers, Abu Saad, & Halfens, 1994). It assumes the system (i.e., the decision-maker) has a memory component comprising two parts, short-term and long-term memory. In simple terms, short-term memory holds information for online processing. It is limited in capacity, usually no more than seven chunks (e.g., recognizable patterns; Newell & Simon, 1972). Long-term memory is limitless and stores knowledge structures of both factual (semantic) and experiential (episodic) memories. The interaction of short-term and long-term memory provides the mechanism of information processing used in decision-making. This model attributes decision-making to four components: (a) cue acquisition, (b) hypothesis generation, (c) cue interpretation, and (4) hypothesis evaluation (Elstein, 1976).

Initially, a decision-maker searches for cues relating to the problem task. Data collection occurs through various methods, sometimes even implicitly. For instance, a nurse might read a patient's medical chart—an explicit method of data collection—and then supplement that information with salient cues gained from their interaction with the patient—implicit cues. Afterwards, or in some cases even before finishing data collection, a hypothesis is generated from long-term memory. This is followed by the generation of an action plan.

The framework places a constraint on the number of working hypotheses a decision-maker can hold active in short-term memory, usually four or five. Hypotheses and action plans are loosely tested through cue evaluations, where cues are considered as either supporting, refuting, or noncontributing to the hypothesis. Finally, the hypothesis is evaluated and either entertained or replaced by another generated hypothesis, thereby repeating the evaluation process. This framework is assumed to be analytical, arriving to a conclusion in a logical and linear manner that can be repeated and readily communicated (Panniers & Walker, 1994).

The information-processing model uses a scientific or hypothetico-deductive approach to assist metacognitive reasoning (Banning, 2007). It makes the assumption that decision-makers follow rational logical when arriving to a decision. Much like the humanistic-intuitive approach, the analytical model also accounts for different levels of experience and knowledge. During the cue recognition stage, past experience facilitates the recognition of meaningful cues and patterns; greater experience results in faster processing and finer recognition acuity of relevant cues. Hence, less experienced nurses will find it more difficult to initially understand a problem-task than a nurse with more experience (O'Neill, Dluhy, & Chin, 2005).

In addition, a novice nurse's lack of experience will hinder the hypothesis generation phase—they will have greater difficulty producing an appropriate hypothesis. This, coupled with the lack of cue recognition, produces a synergistic effect of inaccurate decision-making. Not only can the information-processing model account for differences in experience, it has an advantage over the humanistic-intuitive approach by providing a template to facilitate communication on how one arrived to a conclusion. This is a key strength of the analytical model and an element that distinguishes itself from the intuitive approach of decision-making: Intuition is an intangible process, whereas hypothetico-deductive reasoning follows well-defined stages. Moreover, the model breaks down complex decision-making into simpler parts that can be carefully examined in isolation.

Support for the information-processing model comes from the large body of studies comparing novice and expert nurses (see, e.g., Boblin, Baxter, Alvarado, Baumann, & Akhtar-Danesh, 2008; Botti & Reeve, 2003; Lamond et al., 1996). In one study, Offredy (1998) conducted structured interviews, taped interviews, and finally observations of practitioner consultations. Interview transcriptions and observation notes were subjected to a content analysis and categorized according to which type of decision process was used. Offredy noticed that for anything more than simple low-consequence routine issues, nurses began using hypothetico-deductive reasoning. This was true for all levels of expertise, though Offredy pointed out that experienced

nurses did report the involvement of intuition. Interestingly, when task-problems became complex and unfamiliar, expert nurses abandoned the use of intuition and reverted back to analytical models of decision-making. This study, like others (e.g., Hicks et al., 2003; Hughes & Young, 1990), shows the involvement of both analytical reasoning and intuition in nursing clinical decision-making.

Cognitive Continuum Theory

Analytical decision-making and intuition are not mutually exclusive, per se. While analytical reasoning follows procedural rules to reach a decision, intuition is not occluded from the involvement in this process. Besides, both strategies involve pattern/cue recognition. According to the hypothetico-deductive model, cue recognition primarily involves conscious recognition, whereas intuition is exclusively a subconscious recognition (Manias et al., 2004). Similarly, hypothesis generation under the hypothetico-deductive model is explicitly formulated from the reviewed data, whereas intuition assumes hypotheses are generated implicitly with a degree of automaticity (Buckingham & Adams, 2000b). Several theories describe the decision-maker's transition from analytical decision-making to more abstract intuitive strategies (see, e.g., Cader et al., 2005; Standing, 2008; Harbison, 2001).

The cognitive continuum theory serves to reconcile the opposing views that decision-making is purely analytical or purely intuitive (Hammond, 1981; Harbison, 2001). It assumes that decision-making strategies are located along a continuum that is determined by the task structure (Hamm, 1988; Thompson, 1999b). In other words, the situational context of a problem determines which strategy is the most ideal approach to decision-making. In nursing clinical decision-making research, evidence for this postulation comes from studies that show nurses varying decision strategies for different tasks and problems (Corcoran, 1986a, 1986b; Hicks et al., 2003; Lauri et al., 2001; Cader et al., 2005; Hughes & Young, 1990). In addition, many nursing decision-making theorists proclaim the importance of contextual elements, also commonly known as domain-specific knowledge structures (Crow, Chase, and Lamond, 1995).

In a study conducted by Crow et al. (1995), nurses reported that experience in a particular nursing domain brought about a contextual familiarity. In familiar situations, elements surrounding the task problem are more concrete and easily understood. By contrast, unfamiliar situations bring about ambiguous task elements and are more challenging to discern.

In the cognitive continuum, familiarity is subsumed by how ill- or well-structured a task is perceived by the decision-maker. The amount and type of information cues associated with the judgment task is critical to the theory. A problem increases in structure as more cues are recognized, provoking the use of analytical decision-making. As a problem becomes more ill-structured the theory suggests the decision-maker should increase their preference towards intuitive decision-making. On the one hand, well-structured tasks can be compartmentalized, have a high degree of certainty, and are not marked by time constraints. On the other hand, ill-structured tasks have a low-level of decomposition, have a high degree of uncertainty, and have to be resolved quickly (see Figure 1).

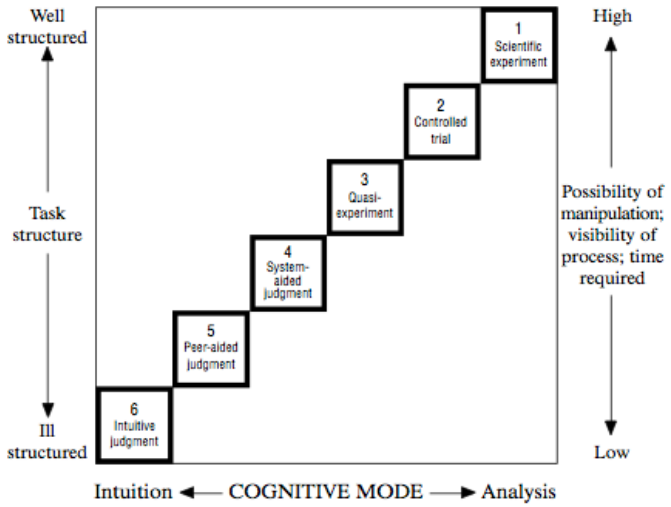

Fig. 1. The cognitive continuum. Reproduced from Lamond & Thompson (2000)

Additional factors help determine where along the cognitive continuum a task problem lies. According to the theory, task complexity—which can involve the number of information cues, redundancy of cues, or the principle of combining cues—has a major impact on decision-making strategies; which is empirically supported in several studies (Corcoran, 1986a, 1986b; Lewis, 1997; Hughes & Young, 1990).

The environmental presentation of material related to the problem has a similar effect; it can either reduce or increase the structure of the decision-task. If the environment allows for an adequate time to reach a decision then the perceived structure of the task is increased. The opposite is true as well: Greater time pressure results in less structured tasks and requires a greater reliance on intuition. In contrast to holistic representations of the decision task, the environment can present decision information in smaller subcomponents—allowing the decision maker to analyze the information linearly and independently. As mentioned above, this results in well-structured tasks.

In summary, the cognitive continuum theory brings resolution to the opposing views that decisions are either all analytical or all intuitive. It balances the criticism that (a) analytical thinking is a unitary generic process that is insensitive to idiosyncrasies of the decision task context and (b) that intuition is almost entirely tied to context-specific elements that are unique to each decision. This solution acknowledges the diversity of individual cognitive strategy thereby mitigating some complexity in nursing decision-making. It provides a valid framework for theoretical and empirical testing, some of which will be discussed below.

V. Factors Impacting Nursing Clinical Decision-making

The literature review revealed studies mentioning a number of factors that contribute to clinical decision-making. A variety of methods were used in these studies; controlled experimental settings, robust observations, focus group interviews, and/or questionnaires. As such, the scientific rigor varies between studies, resulting in several inconsistent findings. However, despite the lack of scientific merit of some studies, there are "clusters of recurring findings" (Thompson, 1999a pg. 816) that suggest these factors be given some a priori theoretical consideration. The following factors are categorized as either individual factors or environmental factors.

Individual Factors

Age and Education Level

Bakalis, Bowman, and Porock (2003) conducted an experiment comparing Greek and English nurses on their clinical decision-making abilities. Within each country, eight hospitals were randomly selected to sample nurse volunteers. Nurses from coronary care units with a minimum of 6-months experience participated. Eight clinical decision-making-cards were presented to the nurses; half on acute phases and the other half on recovery phases. Each card required at least five decisions to be made, which were scored on a 5-point scale ranging from helpful to inappropriate. Furthermore, the nurses had a "call the doctor" option to indicate where in the decision-making process the nurse handed the decision over to the medical staff. In addition to the clinical decision-making-cards, nurses had to rank order 10 factors (knowledge, clinical experience, job description, intuition, medical cover, clinical guidelines, authority, autonomy, stress, and post-registration education) on their importance in influencing their decision-making.

Collapsing across country, the authors separately regressed decision-making scores on four demographic variables—age of nurse, years of experience, academic attainment, and medical cover. All four factors had reliable effects on decision scores; nurses scored higher with increasing age, with more experience, with more academic attainment, and with more medical cover. It is important to point out that there were significant correlations among the demographic variables, so it is unclear from the analyses run whether the variables measure a similar underlying construct—knowledge. Nonetheless, this study underscores the importance that knowledge plays in decision-making.

The Bakalis et al. (2003) experiment supported the hypothesis that academic attainment positively impacts clinical decision-making, but the literature review revealed conflicting results. Some studies showed that education level promoted successful decision-making (Prescott et al., 1987; Verhonick, Nichols, Glor, & McCarthy, 1968; Davis, 1974; del Bueno, 1983; Shin, 1998; Girot, 2000), while other studies found no effect or even a negative effect (Pardue, 1987; Frederickson & Mayer, 1977; Mayer, 1975; Sanford et al., 1992; Sims & Fought, 1989; Bechtel et al., 1993; Hicks et al., 2003; Henry, 1991; Lauri & Salantera, 1995; Twycross & Powls, 2006). These disparate findings suggest that other factors related to experience and knowledge might play a larger role than merely education level alone.

Verhonick et al. (1968) showed nurses a filmed patient scenario and then had them fill out questions pertaining to observations and action plans. Nurses with higher levels of education were more observant to cues provided by the patients and in turn made better action plans. Although this study did not directly measure decision-making per se, it showed that nurses with higher levels of education were able to identify more cues and evaluate them properly. In addition, the authors reported nurses with less than 1-year experience were the worst in selecting action plans, owing to their poor observational and cue recognition skills.

Frederickson and Mayer (1977), Mayer (1975), and Davis (1974) made attempts to replicate the previous results using the same filmed scenarios. Frederickson and Mayer (1974) and Mayer (1975) found no differences in performance as a function of academic attainment or experience. One methodological difference was that they used think-aloud procedures. These researchers did report that baccalaureate nurses scored higher on the Watson-Glaser Critical Thinking Appraisal than did nurses who held only a high school diploma.

By contrast, Davis (1974) did replicate the major finding of Verhonick et al. (1968) but also reported a result that was troubling to explain. Nurses performed better as education levels increased, as predicted, but when analyzing responses as a function of clinical experience, nurses started to perform worse after six years of experience. Davis then evaluated nurses who took refresher courses and concluded that as long as nurses took refresher courses experience predicted performance scores.

Lauri and Salanterà (1995) also investigated time since last professional training or reorientation. They constructed a questionnaire to investigate the propensity for nurses to use intuitive decision-making strategies and information-processing strategies. The intuitive questions reflected nursing knowledge, practical experience, and nursing context, while the information-processing questions reflected data collection, data processing, plans of action, and monitoring and evaluation. Two hundred Finnish nurses responded to the questionnaire and these data were subjected to a factor analysis. A four-factor solution was retained: Factor 1 represented the use of questions during the data collection process; Factor 2 assessed creative decision-making; Factor 3 assessed whether nurses were patient-oriented or nursing-oriented; and Factor 4 represented the likelihood of using rule-based decisions.

Factor scores were calculated for each participant and then

analyzed as a function of experience, time since last professional training, and knowledge structure—which was determined by a content analysis from open-ended questions and classified as either abstract or concrete. Nurses with less than two years experience used a questioning approach to collect patient data and nurses with 3-5 years experience used an "unquestioning" approach. That is, they collected patient information more or less through observations. Nurses who had not received professional training or reorientation in ten or more years tended to be patient-oriented and were able to observe more patient related cues. Knowledge structure was significantly correlated with creative decision-making; nurses with more abstract knowledge structures had higher creative decision-making scores.

Sanford et al. (1992) reanalyzed data collected by a nursing education department during a hospital orientation of newly graduated nurses. Much like the previously mentioned studies, the authors were interested in the effects of education level on decision-making abilities. Of the 116 nurses analyzed, 112 graduated within a year and 74 graduated with a baccalaureate degree in nursing. Each nurse watched four video vignettes and had to (a) identify the specific patient problem, (b) specify the nursing interventions required in order of priority, (c) identify the rationale for each stated intervention and (d) identify preventive actions that could have eliminated or minimized patient risk. Responses were scored on a three-point scale ranging from a completely acceptable answer to a completely unacceptable answer. These data revealed no reliable difference between nurses with or without a baccalaureate degree.

The effect of education level on decision-making is, at best, inconclusive. One potential explanation is that studies were using a coarse measure of education and therefore were insensitive in detecting differences. For example, most studies contrasted high school diploma against all other levels of education. Perhaps other measures of education might provide some resolution on the conflicting results.

Experience, Knowledge, and Cue Recognition

Experience, knowledge, and cue recognition are all intimately related. Cue recognition depends on knowledge, which is gained through years of experience. On the surface, this causal chain seems plausible and convincing. In fact, it is a pillar of the skills acquisition theory (i.e., the humanistic-intuitive approach to decision-making) and is implicitly represented in the information-processing theory. Despite the theoretical merit, this causal chain has not yet been directly tested empirically. There is, however, evidence demonstrating the importance of each of these factors on decision-making.

Studies that have enough subjects often use years-of-experience as a covariate (see, e.g., Bakalis et al., 2003; Lauri & Salanterà, 1995) and typically find a small effect or no effect at all (Lauri & Salantera, 1998). When there are fewer subjects, years-of-experience is either neglected or coarsely clustered and analyzed in a descriptive manner (see, e.g., Twycross & Powls, 2006; Monterosso et al., 2005; Tanner et al., 1987; Henry, 1991). Nursing clinical decision-making research that is interested in experience place primary focus on decision strategies rather than efficacy of decisions. When nurses of different experience use the same strategies, research concluded that they are of the same expertise (Twycross & Powls, 2006). This makes it difficult to disentangle experience and expertise—especially since years-of-experience has been a measure of expertise (Benner & Tanner, 1987; Benner, 1984; Grobe et al., 1991; Benner et al., 1992; Hedberg & Larsson, 2004).

In one study, Scottish nurses were presented with patient scenarios and were instructed to provide decision-making information using a think-aloud protocol (Twycross & Powls, 2006). Transcriptions were coded and categorized according to data collection, data interpretation, action plans, and evaluation. Interestingly, no differences were found between nurses with more than five years experience (which is commonly used as a threshold to classify nurses as experts; see Benner, 1984) and nurses with less years of experience. Furthermore, regardless of experience, all nurses used very similar backward-reasoning decision strategies, which is an indication of novice decision-making. Twycross and Powls concluded that nurses in their study were all of equal expertise.

Years-of-experience has also been shown to have no bearing on clinical decision-making frequency. Hoffman, Donoghue, and Duffield (2004) surveyed roughly 100 Australian nurses to investigate factors that contributed to perceptive and normative decision-making. Perceptive decision-making was defined as decisions that nurses believed they made, whereas normative decision-making was defined as decisions that nurses wanted to make. Essentially, Hoffman and colleagues were interested in the factors that influenced decision-making propensity. They found that age had an impact on perceptive decision-making; increases in age were accompanied with increases in perceived clinical decision-making. Interestingly, they found no similar effect for years-of-experience or education level—which were both significantly correlated with age.

It is puzzling to find conflicting studies on the effects of nursing experience—at least measured by years. All major theories of clinical decision-making rest on the assumption that experience is a major determinant of competent decision-making. Past experience brings about a familiarity of the elements involved with the decision task at hand. Therefore, years-of-experience should result in more fluent decision-making. While several studies demonstrated this effect either statistically or descriptively (Benner & Tanner, 1987; Benner, 1984; Grobe et al., 1991; Benner et al., 1992; Hedberg & Larsson, 2004; Watson, 1994; Lauri & Salantera, 1995; Wainwright et al., 2011; Thompson et al., 2008; Monterosso et al., 2005; Westfall, Tanner, Putzier, & Padrick, 1986) it was not always obtained (Twycross & Powls, 2006; Tanner et al., 1987; Henry, 1991; Lauri & Salantera, 1998; Greenwood & King, 1995; Corcoran-Perry & Cochrane, 1999). Perhaps it is safe to conclude that not all experience is

equal.

One explanation offered for the discrepant results is that past experience can actually lead to systematic biases (Thompson, 1999a; Tanner & Hughes, 1984). Nurses are better able to generate and consider more hypotheses as they gain experience. However, as a byproduct, nurses can over sample recent experiences and neglect older, but still useful, experiences. Furthermore, nurses assess probabilities of the associations between cues and likely outcomes when interpreting cues—which is biased by past experience (Kahneman & Tversky, 1996). Dramatic and profound events come to mind more easily and cause additional interference in assessing accurate probabilities. Inaccurate probabilities lead nurses to make inadequate decisions; hence, inaccurate probabilities are a counteracting force to experience.

Although that might explain one potential drawback of nursing experience, there are still many benefits (see Thompson, 1999a). Experience is associated with greater pattern recognition in the hypothesis generation stage of the information-processing strategy (Draper, 1986). It allows for more complex combinations of chunks in short-term memory (Gobet & Chassy, 2008), making it easier to access related information in long-term memory. In addition, nurses with greater experience can activate more complex hypotheses—a major benefit in difficult decision-tasks (Westfall et al., 1986). Therefore, experience helps develop other decision-making facilitators, such as knowledge and cue recognition (Bakalis et al., 2003; Baumann & Bourbonnais, 1982; Benner & Tanner, 1987; Abu Saad & Hamers, 1997; Bucknall & Thomas, 1997; Caputo & Mior, 1998).

Casey et al. (2004) conducted a longitudinal study of newly graduated nurses in the Denver metropolitan area. The authors were interested in factors impacting the transition into a registered nurse. Surveys were distributed to nurses with approximately a year or less of experience and newly graduated nurses (nurses with less than 3 months experience) were surveyed once more. The questionnaire had a mixture of multiple-choice and open-ended questions from five categories: demographics, skills/procedure performance, comfort/confidence, job-satisfaction, and difficulties in role transition. One of the major themes that the newly graduated nurses expressed was their lack of knowledge, which affected their ability to make decisions while caring for their patients. Only nurses who approached a year of experience began to express that they finally started being comfortable with their level of knowledge—indicating, at least to some degree, that experience played a role in knowledge acquisition.

In a related study, Ebright et al. (2004) conducted semi-structured interviews with twelve novice nurses that had at least three months experience but no more than a year experience. The authors were investigating factors that contributed to near-miss/adverse-event situations. Nearly all cases of reported events were due to lack of knowledge base related to the decision-task. Novice nurses often found themselves in so-called *first-time situations*, where they lacked knowledge and experience. Lack of knowledge impeded competent decision-making and resulted in near-miss or adverse events.

Poor decision-making due to lack of knowledge is not just limited to novice nurses, however. Knowledge is a core attribute to decision-making and can impact nurses of all levels of expertise and experience. Bucknall and Thomas (1997) surveyed Australian critical care nurses on issues related to clinical decision-making. Unlike the nurses used in Ebright et al. (2004), these nurses had an average of nine years of clinical experience. The researchers asked nurses to indicate how often they experienced problems in making decisions because of their knowledge base. The responses were surprising: More than 1 out 3 nurses indicated that their knowledge base posed a problem in making decisions on a weekly basis. Therefore, regardless of clinical experience, knowledge is the fuel that makes decision-making effective.

Cue recognition also depends on knowledge base (Manias et al, 2004; Hedberg & Larsson, 2003). Nurses making decisions must distinguish important information from irrelevant cues (Corcoran, 1986a, 1986b; Thiele, Holloway, Murphy, & Pendarvis, 1991; Thiele et al., 1986). And as Tanner et al. (1987) indicated, the majority of novice nurses use an analytical hypothesis-driven decision-making approach that relies on cue recognition. Cue and pattern recognition are not just limited to novice nurses, though. It is implicitly embedded in intuition—which is a marker of expertise—and has been theorized to be unconscious cue recognition (Offredy, 1998). Under ambiguous and uncertain situations, like many found in clinical nursing, dismissing cues as irrelevant and relying on only partial cue information can lead to inappropriate decision-making (Girot, 2000; Corcoran, 1986a).

A specific kind of cue recognition is identifying diagnostic cues—ones that rule out opposing interventions and action plans. Students who were able to identify and make use of these cues made better clinical decisions (Elstein, 1978). However, students in general have a difficult time recognizing cues and distinguishing relevant from irrelevant information (Thiele et al., 1986, 1991). Novice nurses might not be that much better, though.

Itano (1989) used nurse-patient observations and discovered that expert nurses collected more cues than did novice nurses, which has been observed by other researchers (Tanner et al., 1987; Taylor, 1997; Hoffman et al., 2009). Hoffman and colleagues replicated this finding using Australian Intensive Care Unit novice and expert nurses; with novice nurses having fewer than two years of experience. Data was collected through a think-aloud protocol with actual patients. Compared to expert nurses, novices collected nearly half as many cues.

Additionally, novice nurses clustered cues in a linear manner, demonstrating simple organization structures. Expert nurses, by contrast, clustered cues in complex schemas, allowing them to consider more information in parallel. Novices also engaged in less proactive cue collection (i.e., planning ahead, anticipating what would happen, and collecting cues in anticipation of problems) and instead were more focused on retroactive tasks. That is, novices waited for a problem to occur and then collect cues in response to the

problem. Preventative cue collection seems to play a large role in decision-making, but more research is required on the topic (Hoffman et al., 2009).

In contrast to the previous studies, Greenwood and King (1995) found that novice nurses actually collected *more* cues than did expert nurses. However, they attributed this finding to an inability to discriminate between salient and non-salient cues. Novices simply collected more cues regardless of whether the cues would be helpful or not. Despite the importance of cue recognition in decision-making there is a lack of research using novice nurses; most studies rely on experts or students as participants.

In a study using senior baccalaureate nursing students, Thiele et al. (1986) demonstrated the impact of cue recognition on decision-making. The experiment used a pre-test/post-test design with each test presenting new clinical situations that required participants to identify and sort cues, as well as link them together to make decisions. In between tests, the students engaged in computer-assisted learning simulations. They were presented information on effective decision-making and cue recognition. Although the experiment was not conducted on registered nurses, several of the experiment's conclusions are relevant for novice nurses.

First, the pre-test showed that participants were identifying nearly as many irrelevant cues as relevant ones. It should be no surprise, then, that the students reached many inappropriate decisions. According to the study, students are not readily provided with decision-making training and are not taught the importance of cue recognition. Extrapolating this logic to novice nurses, if their ability to recognize cues is substandard—compared to nurses with more experience—then it will likely contribute to decision-making errors. Second, the post-test indicated that, after completing the computer simulations, senior students were significantly better able to differentiate between relevant and irrelevant cues. Moreover, their decision-making scores reflected this improvement; they made better and more appropriate decisions. And finally, the authors noted that once participants began improving their cue recognition they were able to chunk the cues together and link them in meaningful ways that assisted their decisions. Accordingly, chunking cues allows more information to be considered simultaneously, which facilitated the evaluation of decisions and hypotheses considered. These results show that novice nurses may require some training to promote successful decision-making through cue recognition.

While cue recognition is considered a necessary component of accurate decision-making, it does have some drawbacks. Radwin (1995) studied nurses' decision-making in a 30-bed cardiology unit. After analyzing field notes and post-observation interviews, Radwin described nurses as having several decision strategies. When time was not constrained many nurses engaged in what Radwin termed, *knowing the patient*. Essentially, it is a purposeful action to understand the patient's experiences, behaviors, feelings, and/or perceptions to select individualized interventions. Radwin reasoned that knowing the patient allows for more personalized care and decisions. Under certain circumstances, such as when time is constrained or under high pressure, nurses do not have the resources to implement this strategy. Instead, nurses switched to a pattern and cue recognition strategy where decisions and interventions were selected based on familiarity of previous patients.

Radwin argued that cue recognition and using familiarity of previous situations to determine interventions ultimately reduces patients to symbols and patterns—moving away from individualized care (Radwin, 1995; 1998). However, this heuristic is effective and efficient (Buckingham & Adams, 2000b; Woolley, 1990; O'Neill, 1995). Furthermore, pattern recognition and individualized care are not mutually exclusive. In fact, individualization can be facilitated when nurses are able to recognize a greater variety of patterns and cues (O'Neill, 1995; Smith, Higgs, & Ellis, 2008; May, 1996).

Hypothesis Updating

Cue recognition contributes to clinical decision-making mainly by allowing nurses to generate a working hypothesis and evaluate decisions or action plans (Greenwood, 2000; Rawdin, 1990; Lewis, 1997). In addition, they can be used to update hypotheses or generate entirely new ones (Thompson, 1999b). In fact, updating hypothesis is an essential component of the information-processing model of decision-making. Often times a nurse's initial hypothesis is not in the best form and must be modified when receiving new information. Failing to do so can result in errant decisions and contribute to poor decision-making (Manias et al., 2004).

Updating and revising hypotheses have been studied using various methods, but the most popular approach is comparing nursing decisions to probabilistic models. In this paradigm, nurses are required to make decisions (e.g., on the current state of a patient or to specify an appropriate action plan) in a sequential manner, typically after new patient information is revealed to the nurse. Additionally, the nurses accompany their decisions with likelihood estimations that their decisions are correct. At each step, the nurse's decisions are compared with a normative model and then assessed on their ability to update their hypothesis (Hughes & Young, 1990; Dowding & Thompson, 2003; Cioffi, 2011).

Hammond, Kelly, Schneider, and Vancini (1967) conducted one of the first experiments pertaining to hypothesis revaluation and updating. Six nurses were presented with four patient scenarios and instructed to select as many as 15 cues from the 128 cues available to them—stopping when the nurses felt that additional cues would not change their decisions. Following each selection, the nurses had to determine the state of the patient, which was then compared to a Bayesian normative model. The main finding in this study was that nurses were overly conservative when updating their hypothesis—they were cautious in changing their original hypothesis. On the average, nurses changed their likelihood estimations at a third of what the normative model predicted. The authors warned that such caution or reluctance to update the working hypothesis could contribute to decision errors.

The conclusions made by Hammond et al. (1967) are

corroborated by other studies (Corcoran, 1986a, 1986b; Ebright et al., 2004; Ramezani-Badr, Nasrabadi, Yekta, & Taleghani, 2009). When discussing factors that led to adverse events, Ebright et al. (2004) noted that novice nurses too often "loose the big picture" and ignore new aspects of a patient's condition. Essentially, nurses were not able to update their hypothesis when presented with additional information.

In complex decision tasks, novice nurses were described as taking too narrow of an approach, placing a limit on their abilities to update their hypothesis (Corcoran, 1986a). By contrast, expert nurses took a broader initial approach and then refined their hypothesis accordingly. Furthermore, Corcoran (1986a) reported that a source of erroneous decision-making was the inability to combine patient information with an alternative hypothesis (e.g., hypothesis updating). This issue is exacerbated in complex tasks: Corcoran noted that fewer alternative hypotheses were being evaluated, despite more being generated. Although this was attributed to a limited short-term memory capacity, it is important to mention that evaluation of hypotheses also plays a critical role in decision-making.

The quality and complexity of hypothesis generation has also been investigated (Westfall et al., 1986; Tanner et al., 1987). Westfall et al. showed nursing students and RN nurses several videotaped patient scenarios and analyzed the participants' verbal protocols. Each scenario had several accurately diagnostic hypotheses as well as several plausible but inaccurate hypotheses; hence, participants could produce and update multiple hypotheses. All hypotheses generated were scored and used to create several measures.

Complexity was judged by the link between cues and hypothesis. A direct link between a cue and a hypothesis was a relatively simple hypothesis because it naturally led to the hypothesis. By contrast, an indirect link required more information than a cue could provide. A participant must hold a working hypothesis in memory and update it accordingly when receiving additional information. Therefore, hypotheses generated from indirect links were judged as more complex. A complexity scored was the ratio of the number of indirect hypotheses generated to all hypothesis generated. In addition, hypotheses were judged on comprehensiveness (whether nurses were able to generated all potentially acceptable hypotheses), efficiency (a ratio of acceptable hypotheses to all hypotheses generated), proficiency (a ratio of acceptable and plausible but inaccurate hypotheses to all hypotheses generated), and earliness (the proportion of hypotheses generated during the first half of the verbal protocol transcript).

Oddly enough, nurses performed no better than students on the comprehensiveness measure—all groups produced around 20% of the acceptable hypotheses. The low proportion of accurate hypotheses brings to question whether the materials used (e.g., scenarios and cues provided) were sensitive enough to study the decision-making process. Regardless, students and nurses produced equal scores of efficiency, proficiency, and earliness, but differed in complexity. Nurses generated hypotheses that were more complex and required updating with additional information.

The same authors published a related study investigating hypothesis generation and decision-making (Tanner et al., 1987). Using what seems like the same set of subjects, the authors conducted a similar experiment but analyzed the verbal reports slightly differently, adding several new measures. One new measure bears mentioning. Participants were allowed to ask questions to receive additional information on the patient. These questions were scored on their relevancy to hypotheses generated. The authors described this as hypothesis-driven questions for the purpose of updating and modifying working hypotheses. Nurses asked more relevant questions than did students and this was taken as evidence that nurses were able to update their hypotheses. Despite the more relevant questions asked, all groups—nurses and students, alike—produced an equal amount of accurate hypotheses. Therefore, these results should be interpreted with caution.

Communication

Novice nurses encounter unfamiliar situations on a regular basis during their first year of nursing (Ebright et al., 2004; Smith et al., 2008; Casey et al., 2004). As discussed earlier, novices that lack domain-specific knowledge are more prone to make decision errors (Bucknall & Thompson, 1997; Watson, 1994; Baumann & Bourbonnais, 1982; Benner & Tanner, 1987; Abu Saad & Hamers, 1997; Corcoran, 1986a, 1986b). When novices are faced with these unfamiliar conditions they have the opportunity to receive assistance from more experienced colleagues. Whether or not novices exercise this option has been determined to influence decision-making (Jenks, 1993; Manias et al., 2004; Hedberg & Larsson, 2003).

One cannot help but wonder whether a novice's propensity to communicate with colleagues, for the purpose of receiving assistance or guidance, has been a reason for so many discrepant results in applied nursing decision-making research. In other words, communication willingness, and ability, is a significant covariate in nursing decision-making research—hence, a confound when not controlled for. This underscores the complexity that surrounds applied research on nursing clinical decision-making.

Hedberg and Larsson (2003) observed experienced nurses and described a central theme that was abundant in clinical decision-making—the corroboration of information with colleagues. Nurses approached and consulted each other on cues and information gathered from patients. They asked whether other nurses had any experience with their patients or had encountered patients with similar conditions. According to the study, nurses used corroboration for the purpose of minimizing the risk of making a wrong decision. Written communication was less effective than was face-to-face communication, especially under ambiguous situations where cue interpretation was difficult.

Using a focus group technique, Jenks (1993) discovered that clinical decision-making was facilitated through knowing the

patient, the peer nursing staff, and the physicians. Much like what Radwin (1995) termed *knowing the patient*, Jenks (1993) concluded that decision-making was aided when nurses better communicated with patients and understood the idiosyncrasies of their conditions better. Furthermore, knowing the peer nursing staff provides an avenue for consultation and support system when nurses needed assistance on complex decisions. Jenks (1993) made it clear that communication plays an important role in clinical decision-making.

To study factors contributing to clinical decision-making, Ramezani-Badr et al. (2009) interviewed critical care nurses from Iran. The authors reported several findings that are prevalent in the nursing decision-making literature. Nurses primarily used a hypothesis-driven approach and updated their hypotheses by either collecting more information or by explicitly testing them through interventions and patient reactions. Additionally, nurses used familiarity approaches by recognizing cues that matched previous patients and situations, corroborating extant research (Cioffi, 2000, 2001). However, Ramezani-Badr et al. (2009) reported a factor that has been relatively under researched in applied decision-making: consultation and communication among colleagues.

All nurses reported that consulting with colleagues was an essential criterion for making decisions that involved proper patient care. As cases increased in complexity, greater depth of consultation was required. This finding supports previous research that showed nurses prefer to turn to colleagues under complex decisions tasks (McCaughan, Thompson, Cullum, Sheldon, & Raynor, 2005). Although this study interviewed experienced nurses (all nurses had more than three years of critical care experience), novices might consider new and unfamiliar tasks as being relatively complex—a situation that would require consultation from colleagues. While Ramezani-Badr et al. (2009) concluded that experienced nurses did not lack hesitation when needing assistance in decision-making, novice nurses may not share this attribute.

Lack of communication was a key factor involved in adverse events reported by novice nurses in Ebright et al. (2004). Specifically, novice nurses were poor communicators during handoffs and shift changes; they failed to report key information on the patient. Furthermore, major issues occurred when novices received handoffs from other novices. The reports provided fewer cues to assist nurses in their tasks and left the receiving novices unaware of pressing issues. This lack of communication compromised their subsequent decision-making and consequently led to inappropriate care to patients. Indeed, Miller (2001) linked poor communication in ICU to a 1.8 increase in risk-adjusted mortality.

Novice nurses did seek assistance under certain situations, however. But Ebright et al. (2004) described this theme as hindering decision-making because novices were assisting novices. In fact, one nurse interviewed reported being worried about the lack of experience when being assisted. It seems as though this finding in Ebright et al. is a special case—it is not often that novice nurses seek assistance from other novices.

In a related study, Manias et al. (2004) observed twelve recently graduated Australian nurses with less than one year of experience and commended the willingness of those nurses to seek assistance. The study was particularly interested in the decision-making process of novice nurses and it was determined that novices primarily use hypothetico-deductive reasoning. Under this framework, novices were seeking assistance when evaluating hypotheses, and more specifically, the novices consulted experienced nurses when contemplating decisions on treatment options.

The result reported by Manias et al. (2004) might not be a general finding. Although nursing students acknowledge the importance of communication in clinical decision-making (Garrett, 2005; Hamers et al., 1994), they lack confidence in their ability to communicate once they begin practice (Casey et al., 2004). In the survey conducted by Casey et al., newly graduated nurses indicated they were not comfortable with communication among staff, residents, and other nurses. They had a difficult time conveying issues and problems with physicians and peer nurses. However, there was a significant increase in communication confidence as nurses increased their experience from six months to one year. Furthermore, after a year nurses were more comfortable delegating intervention methods to ancillary personnel.

Emotions and Perceptions

Nurses' current mental and emotional states have been shown to influence their decision-making, both positively and negatively (Hamers et al., 1994; Garrett, 2005; Casey et al., 2004; Hagbaghery, Salsali, & Ahmadi, 2004; Rhodes, 1985; Woolley, 1990). If nurses feel pressured, unconfident, or incompetent, it can result in poor quality decisions—at least measured by self-reports (Hagbaghery et al., 2004). Emotional characteristics are difficult to measure and manipulate experimentally. Therefore, studies investigating this aspect of decision-making primarily use questionnaires or introspective methods.

Confidence

Thiele and colleagues had nursing students take the Clinical Decision-Making in Nursing Scale (CDMNS) prior to a completing several clinical decision-making scenarios (Thiele et al., 1991). The CDMNS measures perceptions of decision-making under four categories: a) searching for alternatives or options; b) canvassing objectives and values; c) evaluating and reevaluating consequences; and d) searching for information and assimilating new information in an unbiased manner. The total potential score for CDMNS is 200, with higher scores indicating greater confidence in decision-making. According to Thiele et al., scores of 150 indicated an average level of confidence in decision-making.

Participants scored an average of roughly 111, indicating a lack of confidence in their decision-making abilities. The authors interpreted these low scores as evidence that students were hesitant about making clinical decisions. This comported with the responses from the decision-making scenarios—participants' decisions were characterized by

random choice, with over selection of cues. On the surface, the conclusions of this study seem plausible, but the authors failed to regress CDMNS scores with decision-making scores on the simulation. Such a test would provide better support for the strong form of their argument.

In the survey study conducted by Casey et al. (2004), newly graduated nurses answered a battery of questions pertaining to their confidence in making clinical decisions. The results revealed a U-shaped function such that nurses between zero and three months of experience started out confident, which then declined until roughly a year of experience, and finally increased thereafter. This pattern is interesting because it could be interpreted as a learning curve of applied nursing. That is, newly entering nurses are naïve and overly confident but once they receive some experience they understand the complexity and dynamics of nursing—they realize the difficulties of clinical decision-making. However, following an acquisition period of a year, they come to understand their roles better and are more comfortable making decisions. This interpretation is consistent with Radwin (1998), which showed nurses gain confidence with experience.

To investigate facilitators and inhibitors of clinical decision-making, Hagbaghery et al. (2004) interviewed thirty-eight participants comprising Iranian nurses, nursing managers, and physicians. A nurse's self-confidence was a critical theme that emerged from the interviews. On the one hand, nurses described that being self-confident allowed them to take control of situations and increased the potential to make independent decisions. On the other hand, nurses reported that when they lacked self-confidence they felt self-doubt, powerless, and hopeless; they even went so far as avoiding participation in decision-making.

Self-confidence also inspired nurses to become proactive decision-makers. Much like the nurses in Hoffman et al. (2009), confident nurses in Hagbaghery et al. (2004) were initiators and made preventative decisions rather than merely responders of problems. Nurses felt more efficient and reported that confidence accelerated their timeliness in making and implementing decisions—which supports previous findings (Young, 1987).

Although confidence is reported to have influential effects on decision-making, no studies provide direct links to the accuracy of decisions. How does confidence relate to the efficacy of decisions? Do nurses make high-confidence errors in their decision? If so, what are the contributing factors? High-confidence decision errors are particularly problematic because the nursing environment does not allow for automatic corrective feedback, perpetuating erroneous decision-making.

Professional Orientation

Closely related to confidence is a nurse's perception on their value roles and occupational orientation. Rhodes (1985) investigated the effects orientation ideology on clinical decision-making and categorized nurses as belonging to one of three categories. First, a paramedical occupation orientation is a nurse who considers themselves as a subordinate to doctors and believes their job involves carrying out medical orders. Second, a bureaucratic occupational orientation is a nurse who defers authority and responsibility for decision-making to those higher in the hospital hierarchy. And third, a professional occupational orientation is a nurse who believes in having control over his or her own work and decision-making.

Using British nurses, Rhodes concluded that a professional occupational orientation is linked with higher levels of clinical decision-making. Hoffman, Donoghue, and Duffield (2004) replicated this finding with Australian nurses. In their study, those who had a professional occupation had a greater propensity to make clinical decisions. In addition to these findings, Hagbaghery et al. (2004) indicated that nurses who lacked confidence in their decision-making had poor occupational orientations; nurses viewed themselves as agents to complete physician's orders.

Consequences

A nurse's perception of positive and negative consequences has been reported to affect clinical decision-making (Ramezani-Badr et al., 2009; Offredy, 1998; Smith et al., 2008; Morrow, 2009). Nurses assess the risk involved with decisions and outcomes of those decisions. When risks are perceived to be too high, nurse can become uncomfortable with decision-making and in turn make more errors (Smith et al., 2008). Furthermore, the assessment of risk has been a proxy for difficultly in decision-making, with easier decisions representing lower risks. Hence, there are fewer errors with low-risk decisions.

Ramezani-Badr et al. (2009) reported that nurses selected decision options as a function of the risk-benefit tradeoff. When the risks were increasingly high, nurses avoiding exercising that option, regardless of whether it was the correct option or not. Nurses in Morrow (2009) indicated that they received pressure to go beyond the scope of their practice, thereby potentially altering the risk-seeking threshold of decisions. If nurses become more pressured they lean towards making higher-risk decisions and as a result, make more errors.

Offredy (1998) described nurses as appreciating the inappropriate consequences of their decisions. That is to say, nurses made deliberate efforts to avoid erroneous decisions and the negative consequences associated with them. Nurses proceeded to make decisions in a conservative and cautious manner, demonstrating risk-aversion. Nursing students are similar in this regard (Garrett, 2005). They considered the patient outcome when making decisions and also considered how they would feel making the decision. Students reported feeling the anticipation of a positive reward when making a seemingly correct decision. Conversely, they had a feeling of internal conflict or stressor when believing they made an incorrect decision. Students stated that these feelings influenced their decision-making.

Personal Values

Nursing decision-making is not free of influence from

personal values and beliefs (Field, 1987; Woolley, 1990; Mahon & Fowler, 1979; Berggren, Bégat, & Severinsson, 2002; De Casterlé, Izumi, Godfrey, & Denhaerynck, 2008; Dreyer, Forde, & Nortvedt, 2011; Monterosso et al., 2005). Nurses have been shown to introduce their own personal beliefs and biases in their decision-making. Bucknall & Thompson (1997) reported that 22% of their surveyed nurses indicated that, at least once a week, their decision-making was conflicted with personal values. Despite this large proportion of responses, nurses stated that the majority of their peer nurses held the same personal values. The confliction with personal values arose from the separation in values and beliefs from doctors and physicians.

Woolley (1990) wrote a report on factors that influence clinical reasoning and termed one factor as subjective responses. She describes several studies that have reported biased treatment because of personal belief. Webb (1985) surveyed thirty nurses about beliefs of early termination of pregnancy and found that all expressed negative attitudes—one nurse expressed that those seeking termination should be punished for their mistake by putting them through pain and trauma! While these views are grossly extreme, and can be argued as less relevant today due to societal changes, it does speak to the issue that personal values are present in clinical decision-making (for more examples, see Stockwell, 1972; Jeffery, 1979).

Environmental Factors

In contrast to individual factors, which are a property of the decision-maker, environmental factors are a property of the task problem itself. These factors relate to the contextual features that surround decisions. They interact with individual factors and are the backdrop for every decision—whether they facilitate, hinder, or have a neutral effect on decision-making. For this reason, applied research on nursing clinical decision-making can be challenging. Furthermore, the nature of the interactions with individual factors are unknown and under-researched. Despite the dearth of research, several environmental variables have been well established; their effects on clinical decision-making are largely undisputed. These factors are discussed below.

Task Complexity

Of all the environmental factors examined in clinical decision-making, task complexity has produced consistent outcomes on decisions: Increasing the complexity of the decision-task results in greater difficulty and a greater propensity for making errors (see, e.g., Corcoran, 1986a, 1986b; Evangelisti, Whitman, & Johnston, 1986; Lewis, 1997; Gordon, 1980; Onken, Hastie, & Revelle, 1985; Paquette & Kida, 1988; Payne, 1976). Task-complexity can be a function of any characteristic within the decision-making task that increases the demands on the decision-maker's information processing (Lewis, 1997).

Frameworks and theories of nursing clinical decision-making are conflicted when describing the effects of task complexity. From the cognitive continuum perspective, as a problem becomes less structured, more ambiguous, and more difficult, decision-making outcomes are best when intuitive approaches are entertained (Lamond & Thompson, 2000). Oddly, according to the skills acquisition theory (e.g., the humanistic-intuitive approach), if a decision-maker encounters a task that is overwhelming difficult, they are theorized to revert back to analytical procedural strategies (e.g., Gobet & Chassy, 2008; O'Neill & Dluhy, 1997; Tanner, 1989, Schmidt et al., 1990; Benner et al., 1992; Cioffi, 1998). The information-processing model makes no assumption on the effects of task complexity—it prescribes a hypothetico-deductive reasoning strategy regardless of difficulty, familiarity, or other related factors (Greenwood, 2000; Radwin, 1990; Banning, 2007).

Support for each of these frameworks has been shown empirically, and thus it is difficult to endorse one framework over another. Although the general finding is that as decisions become more complex, nurses use less normative thinking, collect fewer data, and rely more on short-cut strategies (O'Neill, 1995; O'Neill, Dluhy, Fortier, & Michel, 2004; Cioffi & Markham, 1997; Rew, 1988). However, this is not always observed (e.g., Hicks et al., 2003).

One study examining complexity and decision-making strategies compared nurses' natural decision-making strategies with a baseline created from a decision aid (Hughes & Young, 1990). The decision aid was the Decision Analytic Questionnaire (DAQ) and can be loosely compared to a decision tree. It served as the "optimal" decision derived from a systematic and analytical decision-making approach. The authors provided scenarios of various complexities to nurses who then generated decisions, both naturally and with the DAQ. The authors found that nurses' decisions were consistent with the DAQ for low complex situations, demonstrating a tendency to naturally use a systematic decision strategy. However, nurses were inconsistent with the DAQ for complex scenarios, indicating that they were relying more on intuitive approaches to decision-making. Collectively, these results support the assumptions made by the cognitive continuum theory—well-structured tasks are better suited for systematic strategies and ill-structured tasks are better suited for intuitive strategies.

Hicks et al. (2003) replicated the findings of Hughes and Young (1990) using similar procedures. The DAQ was modified for the use of critical care nurses and instead of having three levels of complexity, as was done in Hughes and Young, only two scenarios were constructed—high and low complexity. The nurses also took a critical disposition inventory to measure the extent to which a person possesses the attitudes of a critical thinker. Education and experience levels were obtained to investigate their effects on both decision-making strategies and critical thinking.

Neither education nor experience was correlated with critical thinking dispositions. In addition, critical thinking dispositions were not correlated with decision-making

consistency (e.g., the correspondence between the DAQ and the nature strategy used by the nurse). One reason for this odd finding is that critical thinking dispositions might not be the most accurate measure of critical thinking abilities (Long et al., 2007; Girot, 2004).

Perhaps the most well known study examining task complexity in nursing clinical decision-making was conducted by Corcoran (1986a). There were two sets of nurses used for this study, novice nurses who had less than six months of experience and expert nurses who had more than eighteen months of experience. Each participant viewed three written scenarios that varied in complexity from least to greatest. Complexity was assessed by varying the number of pain-related problems presented by the patient, the interrelation of the pain-related problems, and the extent to which protocols for pain control could be applied to the case. Using a think aloud protocol, the subjects verbalized an action plan to control the patient's pain.

Novices and experts did not differ in their initial approaches as a function of complexity. However, novice and experts did differ from one another: Experts used a broad initial approach and novices used a narrow approach. A broad approach is one that gains an overview of situation and attends to several cues before making a general hypothesis, which is the refined and updated upon the collection of additional information. By contrast, a narrow approach focuses immediately on one aspect of the situation and immediately forms a hypothesis. Although novices and experts did use different initial approaches, complex tasks resulted in fewer hypotheses being evaluated despite more being generated.

There was no clear pattern on whether novice nurses were using an opportunistic approach or systematic approach to solving problems, regardless of task complexity. However, expert nurses used systematic approaches for the low complex scenario and opportunistic approaches for the complex scenarios. Corcoran (1986a) described the opportunistic approach as being one that is multidirectional and appears to be chaotic and disorderly because the nurse chooses to pursue what she or he believes to be opportune at the time (e.g., intuitively guided decision-making). This empirical result supports the cognitive continuum theory, which assumes complex tasks require intuitive strategies to reach optimal decision-making.

Complexity characteristics have been defined by the literature in a variety of forms, but the majority of studies describe complexity as the number of attributes or dimensions of the task (Gordon, 1980; Lewis, 1997; Corcoran, 1986a, 1986b; Hicks et al., 2003). Lewis (1997) wanted to get a better understanding of the primary features responsible for task-complexity. She created a scenario describing a patient on a mechanical ventilator and had nurses decide whether to wean the client off the ventilator or not.

Complexity was assessed through four types of cues: irrelevant cues, ambiguous cues, conflicting cues, and change cues. Irrelevant cues were pieces of information that had no bearing on the decision task. Ambiguous cues were pieces of information that could affect the decision to wean but the relationship was unclear. Conflicting cues were pieces of information that would lead to a different decision than other information. And change cues were pieces of information that described a change in behavior, such as symptoms that improved or worsened.

The presence or absence of the four cues was factorially manipulated creating sixteen different versions of the script, but the two "end anchors" were omitted from experimentation. A repeated measure design was used such that each nurse saw every version of the scenario, rating each scenario on the complexity of decision-making task using a 7-point likert scale. The results revealed that the presence of conflicting cues led to greatest increase in complexity ratings, followed by ambiguous cues and change cues, which did not differ from one another. Irrelevant cues were shown to have the least impact on the nurses' ratings.

Other researchers have ascribed decision-making complexity to additional environmental elements (Thompson, 1999a; Tanner et al., 1987). First, the number of cues a nurse has to process is directly related with the complexity of the decision task. Increasing the number of cues places an increasing demand on the processing ability of the nurse. Second, dependability of the cues is inversely related with decision complexity. If cues are highly dependable then nurses require fewer cues to make decisions, thereby reducing the complexity of the task. Third, as the degree of overlap between the cues increases—that is, more than one problem is associated with the overall clinical challenge—then the complexity of the task increases. And forth, if the decision task has a limited amount of irreducible uncertainty then the task is deemed to be challenging and complex.

As described above, a wide range of variables determine the complexity of clinical decision-making. While the research shows complexity increases difficulty, increases error making, and reduces certainty—for both expert and novice nurses—little research has been conducted on factors that mitigate these effects. Perhaps such a task it is too great of a challenge, seeing as the nursing environment is so dynamic and so difficult to control for idiosyncrasies. Given that task-complexity produces such a robust effect on clinical decision-making, it seems that this is a viable pursuit for future studies.

Time Pressure

In addition to the challenges brought about by task-complexity, the nursing environment is replete with decision-making under time constraints (Saintsing et al., 2011; Ebright et al., 2004; Casey et al., 2004; Hickey, 2009). Regardless of whether the decision tasks are routine or not, the reduction of time required to make decisions introduces the potential for erroneous decisions and increases the likelihood of making mistakes (Ebright et al., 2004; Bucknall & Thompson, 1997; Bourbonnais & Baumann, 1985; Thompson et al., 2008). Bucknall & Thompson (1997) showed an overwhelming proportion of surveyed nurses indicating that on a weekly basis they either did not have enough time to

make decisions (40%) or enough time to implement decisions (56%). Still, nurses are trained to perform under such in-the-moment conditions and make immediate life-saving decisions. However, time pressure does not always come in the form of critical emergency, and often it is even unbeknownst to the nurses themselves.

At first blush, the number of patients a nurse is responsible for is a seemingly innocuous decision-making factor, presumably because this number should never be excessive. However, that is only under idealistic conditions, which are not always possible. Notwithstanding the reasons for a greater patient-to-nurse ratio, increasing the ratio is an effective way to place a time limit on clinical decision-making. The empirical result is simple and straightforward: In Ebright et al. (2004), novice nurses who made decision errors were assigned an average of 5.6 clients whereas those who did not make errors were assigned an average of 4 clients.

Roughly 80% of novice nurses who made decision errors indicated that time pressure played a large role (Ebright et al., 2004). Nurses complained that they did not have time to carefully assess the condition of their patients (Saintsing et al., 2011; Casey et al, 2004; Hickey, 2009). Under these conditions, nurses place a larger emphasis on familiarity strategies, such as heuristics or intuition (Paley, Cheyne, Dalgleish, Duncan, & Niven, 2007; Buckingham & Adams, 2000b; O'Neill, 1995). As discussed earlier, these strategies are less effective for novices than experts, and therefore a potential underlying cause for novice errors under these situations (Hamm, 1988).

Novice nurses reported peer-pressure as an indirect source of time constraint (Ebright et al., 2004; Hagbaghery et al., 2004). Specifically, nurses are pressured to complete their rounds and assigned tasks so that incoming nurses are presented with a *clean sheet*, rather than having to complete a previous nurse's unfinished tasks. This self-imposed time constraint is described as potent, especially for novice nurses who want to avoid the reputation of being unable to complete their work. These circumstances force nurses to forgo the "should-do" work in order to complete the "must-do" work (Bowers, Lauring, & Jacobson, 2001), thereby defaulting nurses to perform retroactive decision-making rather than using a more effective proactive decision-making procedure (Hoffman et al., 2009).

Criticizing studies for not investigating real decisions under real decision-making contexts, Bucknall (2003) used a naturalistic observation paradigm to study environmental influencers. Eighteen Australian nurses from various hospitals were observed for two hours during routine practice and then subsequently interviewed within the following 24-hours. Content analyses on field notes and interview transcriptions revealed that time constraints were carefully considered before making decisions.

Nurses intentionally slowed their decision-making process when there was enough time or if there was a lack of challenge in the decision task. When this happened, they used familiarity based decision strategies (e.g., mentally comparing patient situations to previous encounters) and were described as being more confident in their decisions. Conversely, nurses under time pressure indicated rushing into decision-making, and their decision-making was unintentionally slowed when they lacked familiarity or when uncertainty surrounded the decision task, though no mention was made on their confidence in those decisions.

Although Bucknall (2003) advocated the use of real environments when studying clinical decision-making, one laboratory-conducted experiment shows methodological promise for future research. Thompson et al. (2008) was interested the efficacy of decisions under time pressures. Registered nurses in acute care environments were sampled from the United Kingdom (n = 95), Netherlands (n = 50), Australia (n = 50), and Canada (n = 50) and varied in years of experience. They were provided with 50 vignettes of patients who had a perioperative myocardial infarction while undergoing an elective surgical procedure. As can be seen from Table 3, the vignettes contained simple chart information that varied in symptoms.

According to the Modified Early Warning Score (MEWS; Subbe, Kruger, Rutherford, & Gemmel, 2001), a standardized assessment of the likelihood a patient is at-risk of a critical event, eighteen of the vignettes had scores that require a nurse to intervene by contacting a senior nurse or doctor. After viewing each vignette, the nurse participants had to decide whether an intervention was appropriate. Time pressure was introduced on some trials by the presence of a clock symbol, which informed nurses that decisions must be made within ten seconds.

This study led to several methodological benefits over observational studies. First, the designed allowed for a large number of observations from each nurse. Second, normative decision outcomes were known and thus nursing scores could be compared to an objective measure of a *correct* decision. Third, because of the previously mentioned points, signal-detection analyses could be carried out to establish the sensitivity (accuracy) and response bias of the nurses.

In the context of the experiment, signal-detection theory assumes that the vignettes form two normal distributions underlying the strength of evidence in favor of an intervention (see Figure 2). The two distributions represent vignettes that require and do not require an intervention (i.e., signal distribution and noise distribution, respectively). Sensitivity (i.e., accuracy) is a measure of overlap between the

TABLE 3
VARIABLE INFORMATION CUES USED IN VIGNETTES

CUE	RANGE
Heart rate	50 - 155 bpm
Systolic blood pressure	72 - 221 mm Hg
Respiratory rate	9 – 48 bpm
Urine output (last 4 hours)	0 – 960 ml
Oxygen saturation	67% - 100%
Conscious level	Fully conscious to unconsious
Oxygenation support	Breathing room air to CPAP
Time pressure	Present or absent

Note—CPAP = continuous positive airway pressure. Reproduced from Thompson et al. (2008).

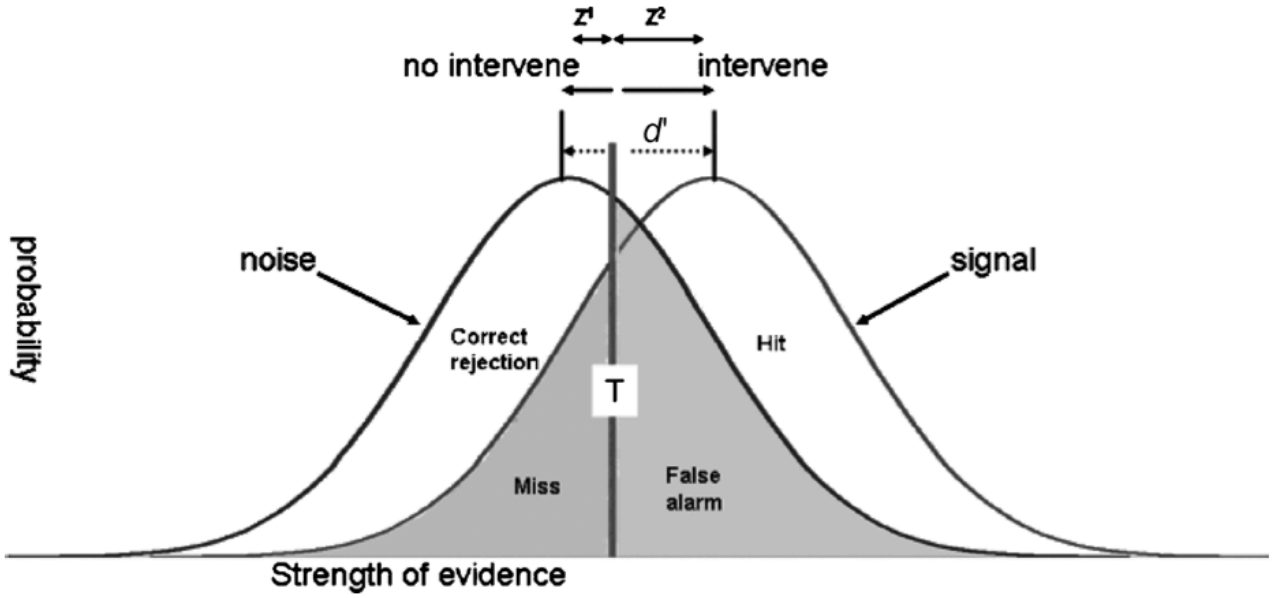

Fig. 2. An illustration of the signal and noise distributions of the vignettes.

distributions; accuracy increases as the distance between the distribution means increase. Signal-detection has the added benefit of measuring the criterion for endorsement. That is, any vignette with a strength-of-evidence greater than the criterion will result in an intervention—regardless of which distribution the vignette belongs to. A liberal criterion will result in a greater proportion of vignettes classified as needing an intervention, whereas a conservative criterion has the opposite effects—a lower proportion of cases are identified as needing interventions.

Thompson et al. reported that the countries differed on bias, such that Australian nurses had less of a tendency to take action than did the other countries. Apart from that effect, country did not interact with any other variable and was omitted from further analyses. Time pressure resulted in both less accurate decisions and a lower tendency to intervene. Perhaps the accuracy data can be seen as unsurprising, but this study is the first of its kind to demonstrate such effects empirically, rather than through interviews or the like. Furthermore, this study revealed that time pressure biases nurses away from making interventions, which explains a source of errant decision-making.

For accuracy, years-of-experience interacted with time pressure. When there was no time restriction, greater experience led to more accurate decisions. However, novice nurses were just as accurate as expert nurses when time was limited. This pattern is somewhat surprising because intuitive reasoning, which is purportedly more predominant in experienced nurses, is a quick process that can immunize decision-making from the negative effects of time pressure. If experienced nurses relied more on intuitive reasoning then that would suggest no interaction. However, an interaction was obtained, which is theoretically puzzling.

There was no interaction of experience and time pressure for threshold placement, but there was a main effect of experience. Novice nurses were less cautious under time pressure than more experienced nurses, thereby failing to take action on cases that required interventions. This finding is somewhat counterintuitive. One would predict the opposite pattern; nurses with less experience would lean on the side of intervening because of the lower cost of error, whereas failing to intervene might lead to severe consequences. However, according to Thompson et al., novice nurses have yet to learn these associations and instead are too focused on irritating doctors and critical care outreach nurses by contacting them with false alarms.

Collectively, these studies show the dramatic effects of time pressure on decision-making. Nurses are more prone to errors when rushing their orders and decision-making process. The source of time constraints can come in many environmental forms and may even be self-imposed. Regardless of the source, limiting the time needed to make decisions will result in less efficient decision-making for novice as well as expert nurses.

Interruptions

Increasing the workload of nurses not only places time constraints on nurses, but also increases the propensity to become interrupted while performing their duties and tasks (Hedberg & Larsson, 2004). For general decision-making, disruptions have been shown the produce both positive and negative consequences, depending on the complexity of the task (Speier, Valacich, & Vessey, 1999). Simple decision-making tasks require relatively fewer cues to be processed than complex tasks and therefore place a lower cognitive demand on the decision-maker. Under simple conditions, disruptions have been shown to narrow attention,

increase arousal, and reduce the number irrelevant cues processed by the decision-maker. As a result, decisions are made quicker and with little or no loss of task-relevant cues; accuracy is not sacrificed.

By contrast, complex decision tasks place a much higher cognitive load on the decision-maker. They must attend to more cues and process them relationally to reach an appropriate decision. Narrowing attention—as a byproduct of disruption—will result in the loss of information processing, some of which will be relevant cues. There will be a greater deterioration in performance as the number of disruptions increase. Furthermore, to save cognitive resources a decision-maker will rely more on heuristic approaches, which have systematic shortcomings and produce less accurate decisions (Baron, 1986; Kahneman & Tversky, 1996).

Disruptions happen quite often in nursing environment. Hedberg & Larsson (2004) observed six Swedish nurses for thirty hours to discover environmental factors that affect decision-making. Two general themes emerged from their field notes, interruptions and work procedures. Because the researchers used observational methods they were not able to verify the efficacy of nursing decisions, but nurses were reported to be frustrated at times when disrupted or interrupted. Hedberg and Larrson took this as evidence that interruptions negatively impacted clinical decision-making. While this implicit argument might be weak, it does lay the groundwork for future experimentation and corroborates other decision-making findings (see, Speier et al., 1999).

Interruptions occurred through various forms, but the most predominant type was interruptions through assistant nurses and patients, which accounted for over half of the observed distractions. These interruptions happened regardless of location and task; they occurred in all daily routine tasks. While attending to patients, nurses were most often interrupted by client questions, although staff members (especially assistant nurses) also contributed to the distractions—either by asking procedural questions or requesting assistance with other patients.

Hedberg and Larrson (2004) characterized these interruptions as impeding decision-making. This might be an overgeneralization, though, at least in the case of patient questions. On the one hand, increasing nurse-patient interactions could lead to the discovery of more information cues, facilitating the decision-making process. On the other hand, patients might ask questions that lead to processing of unrelated information, increasing the cognitive load of the nurse and displacing relevant cues. The authors were not able to make a clear connection one way or the other. They defaulted to the assumption that interrupting nurses by asking questions hinders decision-making, but more research is needed to establish a direct causal link.

Technical interruptions accounted for a much lower proportion of the distractions that nurses faced in Hedberg and Larrson (2004), roughly 13%, with the main source coming from phone calls or emergency alarms of various sorts. Nurses in this study needed to be on hand at all times and when they heard a phone ring they interrupted their work to answer. Patient rooms also had phones, which rang on a regular basis causing further disruptions when nurses were giving care. During interruptions, two thirds of the nurses were performing direct patient care (e.g., personal care, administering medication, preparing patients for activities such as meals or resting), while the rest were performing indirect patient care (e.g., sorting and documenting laboratory tests or preparing patients records). Regardless of what type of the task nurses were performing, interruptions were prevalent and disrupted nursing duties and decision-making.

Area of Specialty and Professional Autonomy

A nurse's area of specialty and the department that he or she works for has some influence on clinical decision-making. In particular, departments differ in the average risks associated with decisions. For example, a poor decision made by a surgical nurse might lead to greater consequences than a poor decision made by a nurse who is prepping a patient's dinner. Decision-making under high risks is associated with more complex tasks and has been linked to more erroneous decisions (Smith et al., 2008).

Setting aside the associated risk, the average complexity of a decision task also differs as a function of a nurse's department, and can result in dissimilar quality of decision-making (Thompson, 1999a). This adds to the difficulty in assessing decision-making in applied settings, especially because nurses from different areas of specialties will inherently have unequal base rates for decision errors. Furthermore, area of specialty can affect the propensity to make decisions, allowing more opportunity to make errors (Hoffman, Donoghue, & Duffield, 2004; but see, Rhodes, 1985).

Professional autonomy, the freedom to make unsupervised decisions, also varies as a function of environment. Empowering nurses to make independent decisions, or at the very least increasing their independence, has been shown to have positive effects on clinical decision-making (Bakalis et al., 2003; Schutzenhofer & Musser, 1994; Hooft, 1990; Hagbaghery et al., 2004; Ramezani-Badr et al., 2009). Bakalis et al. (2003) compared decision-making of Greek and English nurses using clinical decision-making cards. As described earlier, nurses in this study saw eight scenarios that contained a set of sequential decisions—each made by selecting the appropriate option among several alternatives. In addition to the presented alternatives, nurses were allowed to select a "call the doctor" option to indicate when they would hand off decision responsibilities over to other medical staff. The researchers used this as a proxy to gauge professional autonomy.

The scenarios covered acute and recovery phases of post-myocardial infraction and English nurses were discovered to make better quality decisions during recovery phases. This was attributed to greater professional autonomy that English nurses held; they chose to hand off responsibility later in the decision set. Borrowing from Hooft (1990), Bakalis et al. (2003) theorized that professional autonomy

involves the nurse's freedom to act in the best interest of the patient, and therefore more emphasis is placed on the patient care. This assumption may be premature because autonomy could be viewed as a social phenomenon, which is influenced by different perceptions of nursing held by Greek and English nurses.

Several factors have been correlated with autonomous practitioners. Schutzenhofer & Musser (1994) surveyed over 500 registered nurses using a Nursing Activity Scale (NAS), which requires nurses to answer questions where they must exercise some degree of professional autonomy. For autonomous practice, there was no main effect of education, but simple pairwise comparisons showed that those holding a MSN were more autonomous than either nurses with a diploma, ADN, or BSN. There was a difference in NAS scores for different areas of specialty: psychiatric/mental health nurses were more autonomous than medical-surgical, maternal-newborn, and critical care nurses. These data lend further support to the assumption that decision-making is dependent on environmental context, although to be fair, novice nurses are not likely to be placed in advance areas.

On a similar note, novice nurses are not autonomous to begin with. They are required to report to senior nurses when encountering any issues of concern. According to Hagbaghery et al. (2004), this could reduce a novice's confidence in their ability to make effective decisions. Increasing a novice nurse's autonomy might not be the solution, however. Nurses with more professional autonomy place a greater reliance on risk-benefit criteria rather than organizational necessities when making decisions (Ramezani-Badr et al., 2009). While this is not a concern for nurses who understand risk-benefit tradeoffs well, novices have yet to learn these associations—at least in real world situations. Despite the handful of studies researching professional autonomy on clinical decision-making, more research is needed to clearly understand the effects on novice nurses.

VI. Conclusions

When entering professional nursing, novices are accompanied with a large set of responsibilities involving their decision-making. The literature reviewed made it clear that nursing students are inadequately trained in critical thinking and decision-making—at least decision-making found in real life settings (see, e.g., Saintsting et al., 2011; Smith & Crawford, 2002). Submerging novices in clinical decision-making seems to provide a solution but only for those who can handle it, as indicated by confidence in decision-making of nurses who pass the one-year mark of practice (Casey et al., 2004). This is a potential costly solution and puts both patients and nurses at risk, especially for novices who are dramatically inclined at decision-making. Furthermore, many variables have been identified to impede effective decision-making, slowing down the process of gaining competency.

Factors identified in this literature review either affect the decision-maker or the decision-task—perhaps even an interaction of both. A mix of the individual factors can be taught and tested (e.g., cue recognition and hypothesis updating). Cue recognition is the foundation of all decision-making and is built through knowledge that is gained in nursing school. While this can be supplemented with clinical experience, novice nurses must enter the profession with an acceptable level knowledge. This can be easily tested to ensure that novices do not lack the fundamentals. However, Lewis (1997) showed that cue recognition is multidimensional and not all types of cue recognition are equal. Will novice nurses be able to make effective decisions when facing decision-tasks that contain conflicting cues?

But not all the individual factors discovered through the review can be tested (e.g., education, clinical experience, or propensity to communicate). These factors are a byproduct of exploratory studies—ones that rely on observational and survey studies. These studies are insightful and provide the motive for future confirmatory studies, but the method of data collection places a limit on the type of factors that can be researched (Aitken et al., 2011). Methodological innovations are underway and recent studies show promise that more testable factors will be discovered (Thompson et al., 2008).

Much the same can be said about environmental factors—some can be explicitly test (e.g., time pressure and task complexity), but others cannot (e.g., professional autonomy). Increasing task complexity is a reliable way to introduce decision-making errors (Corcoran, 1986a), and luckily, it differs individually. Essentially, task complexity is relative. For instance, novice nurses who have stronger mental representations and nursing schemas can chunk greater amount of information compared to those with poorer representations. Nurses who process more information simultaneously will have less cognitive load when filtering through cues and will perceive decision-tasks as less complex.

Overall, nursing research on clinical decision-making is very challenging because of the dynamic environment in the applied setting. The research reviewed in this paper clearly demonstrates this. While no single experiment or study can account for all the variables affecting clinical decision-making, researchers have made good attempts to isolate individual factors and explore them to the extent possible.

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