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THE EFFECT OF LEVEL OF PATIENT ACUITY ON CLINICAL DECISION MAKING BY CRITICAL CARE NURSES WITH VARYING LEVELS OF KNOWLEDGE AND EXPERIENCE

by

Suzanne Bakken Henry

DISSERTATION

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DOCTOR OF NURSING SCIENCE

in the

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of the

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San Francisco

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THE EFFECT OF LEVEL OF PATIENT ACUITY ON CLINICAL DECISION MAKING BY CRITICAL CARE NURSES WITH VARYING LEVELS OF KNOWLEDGE AND EXPERIENCE

by

Suzanne Bakken Henry

University of California, San Francisco

October 1989

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by

Suzanne Bakken Henry

DEDICATION

This dissertation is dedicated to my family:

To my parents, Raymond and Kathleen Bakken, who, by their example, taught me the value of hard work;

and

To my husband, James W. Henry; my children, Tanya and Bill; and my father-in-law, James O. Henry; who have supported me in the pursuit of this goal.

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THE EFFECT OF LEVEL OF PATIENT ACUITY
ON CLINICAL DECISION MAKING BY CRITICAL CARE NURSES
WITH VARYING LEVELS OF KNOWLEDGE AND EXPERIENCE

Suzanne Bakken Henry
University of California, San Francisco

The purpose of this investigation was to examine the effect of patient acuity on clinical decision making processes and outcomes of critical care nurses with varying levels of knowledge and experience. Secondary purposes were: (a) to examine the relationship between the process and the outcome of clinical decision making and (b) to explore the relationship between clinical decision making on computerized clinical simulations and self-evaluation of clinical expertise.

The sample of critical care nurses (N = 142) completed the Basic Knowledge Assessment Tool for Critical Care (BKAT), Cardiovascular Self-Evaluation Tool, and four computerized clinical simulations. Level of patient acuity was operationalized by two tachydysrhythmias presented by computerized clinical simulation (atrial flutter and ventricular tachycardia). Clinical decision making on the clinical simulations was measured by two outcome variables, proficiency score and patient outcome, and by three process variables, efficiency score, amount of data collected before the first intervention, and time to complete the simulation. Clinical expertise was measured by a 38 item ordinal self-evaluation tool.

Analyses of variance were used to examine the effect of patient acuity, knowledge, and experience on clinical decision making. There was a main effect of patient acuity on clinical decision making outcomes as measured by simulation proficiency score, $F(1,66) = 13.87$, $p = .000$. Patient outcome also differed by acuity, $Z = 2.91$, $p = .005$. However,

there was no main effect of patient acuity on clinical decision making processes. Only limited support was found for a relationship between knowledge and clinical decision making. BKAT score was significantly correlated with atrial, but not ventricular, proficiency score, $r = .46$, $p = .000$. The only significant main effect of knowledge on simulation performance was that of ACLS certification on atrial patient outcome, Fisher's exact test, $p = .003$. There was no main effect of critical care experience on simulation performance. However, nurses with varying levels of knowledge and experience differed on BKAT score and in self-evaluation of clinical expertise. The significant relationships found between the process and outcome of decision making were not consistent across simulations. Simulation performance was not significantly related to self-evaluation of clinical expertise.

William L. Holzemer, Chair

Suzanne Bakken Henry

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CHAPTER I

INTRODUCTION

Studies describing clinical decision making by nurses in critical care units are few in number and have used inductive approaches with relatively small sample sizes (Pyles & Stern, 1983; Baumannn & Bourbonnais, 1982; Thompson & Sutton, 1985). However, these studies have consistently identified the variables of knowledge, experience, and ability to manage rapidly changing situations as important to clinical decision making in critical care.

The American Association of Critical-Care Nurses (AACN) has explicitly identified "the nursing process" as the basis for the delivery of nursing care in the critical care unit in the Standards for Nursing Care of the Critically Ill (1989). Five comprehensive standards related to this value statement reflect the stages of the nursing process: assessment, identification of patient problems/needs, planning of care, intervention, and evaluation. Competence within the framework of the AACN standards is conceptualized as use of the nursing process for clinical decision making. Yet, there has been little empirical support for the nursing process as the method of clinical decision making in nursing (Corcoran 1986a, 1986b; Benner, 1984; Pyles & Stern, 1983; Grier, 1984).

Three classic literature reviews (Grier, 1984; Tanner, 1982, 1987) related to information processing and clinical judgment in nursing practice have synthesized the research findings in these areas and concluded that clinical decision making varies among nurses, among

situations, and among contexts. Decision maker variables and situation or task variables continue to be of great interest to nursing researchers studying clinical decision making.

Variables related to the decision maker have been examined both inductively and deductively. Benner (1984), using a phenomenologial perspective, validated the Dreyfus model of skill acquisition (Dreyfus & Dreyfus, 1986). She found nursing decision making processes reflective of five levels of skill acquisition: (a) novice; (b) advanced beginner; (c) competence; (d) proficiency; and (e) expertise. Empirical investigations examining novice-expert differences have not supported the notion of different decision making processes according to level of expertise or type of task (Westfall, Tanner, Putzier, & Padrick, 1986; Corcoran, 1986a, 1986b). The positive relationship between education and clinical decision making processes and outcomes has been validated (Verhonick, Nichols, Glor, & McCarthy, 1968; Davis, 1972, 1974). The relationship between experience and clinical decision making processes and outcomes has been less clear (Verhonick et al., 1968; Davis, 1972, 1974; Tanner, Padrick, Westfall, & Putzier, 1987; Westfall et al., 1986).

Although the original work on clinical decision making in nursing focused on the nature of the nursing task (Kelly, 1964a, 1964b, 1966; Hammond, 1964, 1966; Hammond, Kelly, Schneider, & Vancini, 1964a, 1964b, 1967; Hammond, Kelly, Castellan, Schneider, & Vancini, 1966), only a few recent studies have examined the nature of the task (Gordon, 1980; Cianfrani, 1984; Corcoran, 1986a, 1986b). Task variables investigated include the amount and relevancy of data on hypothesis testing and identification of health problems (Gordon, 1980; Cianfrani, 1984) and task complexity (Corcoran, 1986a, 1986b).

Studies attempting to measure clinical decision making have used simulation performance and/or verbal protocol analysis for the most part. The studies examining the use of simulation performance as a measure of clinical decision making have yielded only modest support for the validity of the clinical simulation as a measure of clinical decision making (Farrand, Holzemer, & Schleutermann, 1982; Holzemer, Resnik, & Slichter, 1987; Holzemer & McLaughlin, 1988). Studies using verbal protocol methodology have been compromised by small sample sizes and the possibility that verbalization of cognitive processes may affect performance (Corcoran, 1986a, 1986b; Westfall et al., 1986; Tanner et al., 1987).

Purpose

The purpose of this investigation is to examine the effect of patient acuity on clinical decision making processes and outcomes of critical care nurses with varying levels of knowledge and experience. Secondary purposes are: (a) to examine the relationship between the process and the outcome of clinical decision making and (b) to explore the relationship between clinical decision making on computerized clinical simulations and self-evaluation of clinical expertise.

Relevance to Theory, Research, and Nursing Practice

This investigation will potentially enhance the understanding of clinical decision making from an information processing theory perspective. Information processing theory is based on the assumptions

that the characteristics of the problem solver/decision maker and the characteristics of the task are the primary determinants of the decision making process and outcome. This study will test the predicted relationships between the problem solver characteristics of knowledge and experience, the task characteristic of patient acuity, and clinical decision making as measured by computerized clinical simulation performance and self-evaluation of clinical expertise.

The potential impact of this investigation on clinical decision making research is in the exploration of two psychometric properties, validity and reliability, as they relate to clinical simulation performance. This study examines the relationship between performance on the clinical simulations and performance in practice as measured by a self-evaluation of clinical expertise. If clinical decision making in practice is the construct of interest, the relationship between these two could be considered an exploration of the construct validity of clinical simulation performance. Another conceptualization would be to consider the measure of clinical decision making in practice the criterion against which clinical simulation performance is measured and the relationship between the two would be an examination of criterion related validity. Concurrent validity of the clinical simulation with a valid and reliable measure of critical care knowledge is also explored. The efficacy of using test-retest of the simulation as measure of instrument reliability is examined.

The American Association of Critical-Care Nurses adopted Donabedian's conceptual model (structure, process, outcomes) for quality assurance (1980) as the framework for the development of the Standards for Nursing Care of the Critically Ill (Sanford & Disch, 1989). Value

statements, standards, and criteria for the structure and process components of the model have been developed and the development of outcome standards and criteria is in progress. In this study, both the process and outcome of clinical decision making related to a specific task will be examined.

Clinical competencies for critical care nurses have been identified in several surveys (Breu & Dracup, 1982; Canfield, 1982; Folk-Lightly & Brennan, 1979). Since it is not feasible for one study to examine all the competencies identified, a decision was made to examine one competency in depth. All three surveys identified the recognition and treatment of dysrhythmias as an important clinical competency. Breu and Dracup (1982) reported the activities of RNs in 3,704 critical care units. RNs assess and identify dysrhythmias in 92% of the units surveyed, interpret dysrhythmias in 82%, and determine interventions in 70%. They also reported the performance of specific activities related to the treatment of dysrhythmias: administration of IV push drugs (95%), oxygen therapy (90%), defibrillation (85%), initiation of pacing per protocol (30%), and carotid massage (25%). In Canfield's (1982) study of clinical competencies for beginning critical care practitioners in the care of the patient with myocardial infarction, the recognition of major dysrhythmias and administration of appropriate medications was considered essential by 68% of nurse educators (n=57) and 71% of employers (n=107), and desirable by 27% and 21% respectively. Folk-Lightly and Brennan (1979) examined the rankings of 24 nursing activities according to amount of time spent doing each, importance of the activity as a nursing function, and the required degree of professionalism. The sample of 201 RNs ranked interpreting

electrocardiograms as ninth in time, seventh in importance, and eighth in professionalism required. These studies document the importance of recognition and management of dysrhythmias as a clinical competency for the critical care nurse and provide support for the relevance of nursing research examining the competency.

CHAPTER II

LITERATURE REVIEW, CONCEPTUAL FRAMEWORK, AND RESEARCH QUESTIONS

Literature Review

Clinical decision making in nursing has been examined from many theoretical perspectives using a variety of research methodologies. Because of the complexity of the phenomenon, no one theoretical perspective or research methodology has sufficiently described, explained, or predicted clinical decision making. Based on the premise that a multitude of perspectives and methodologies are necessary to understand this complex phenomenon, the clinical decision making studies in this review will be organized according to the major conceptual relationships identified, described, or measured, rather than a specific theoretical perspective or research methodology. The review will proceed in the following order: (a) the relationship between knowledge and clinical decision making; (b) the relationship between experience and clinical decision making; (c) the relationship between the nature of the task and clinical decision making; (d) the relationship between the process and outcomes of clinical decision making; and (e) the relationship between clinical decision making as measured by clinical simulation performance and performance in practice. Lastly, the state of knowledge about clinical decision making in nursing will be summarized.

Relationship Between Knowledge and Clinical Decision Making

The relationship between knowledge and clinical decision making has been investigated both inductively and deductively. Four studies identified the relationship between knowledge and clinical decision making using a grounded theory perspective and in-depth interviews of critical care nurses (Baumann & Bourbonnais, 1982; Bourbonnais & Baumann, 1985; Thomas & Sutton, 1985; Pyles & Stern, 1983). In Baumann and Bourbonnais (1982) and the two replication studies (Bourbonnais & Baumann, 1985; Thomas & Sutton, 1985) nurses were presented with a case study (acute myocardial infarction with sudden onset of chest pain) and asked to identify appropriate nursing interventions, rationale for interventions, and factors that played a role in their clinical decision making. Additionally, subjects were asked to discuss a patient care situation in which they had made a rapid decision. Knowledge and experience were ranked as the most important factors in the case study and critical incident reports in all three investigations. Pyles and Stern (1983), conducted in-depth interviews (n=28) to explore detection and prevention of cardiogenic shock in the acute myocardial infarction patient. They identified a process called the "Nursing Gestalt" in which nurses link together basic knowledge, past experiences, the identifying cues presented by the patients and sensory cues, and the strategies of categorization and differentiation to achieve a diagnosis.

In empirical studies knowledge has been operationalized most frequently as level of education. Differences in clinical decision making related to level of education have been identified using the research strategies of survey (Verhonick et al., 1968) verbal protocol

analysis (Westfall et al.,1986), and clinical simulation performance (Holzemer et al., 1981; McLaughlin et al., 1981). Verhonick et al. (1968) found that as level of education increased, the number of nurse observations increased in her investigation of 1576 nurses viewing five filmed patient situations.

Studies using verbal protocol analysis in medicine have supported the relationship between level of education and clinical decision making (Neufeld, Norman, Feightner, & Barrows, 1981). In nursing, research studies using verbal protocol analysis have provided only minimal support for the relationship between level of education and clinical decision making. Based on the theory of medical diagnostic reasoning proposed by Elstein, Shulman, and Sprafka (1978), Tanner and associates explored the diagnostic reasoning processes of nurses and nursing students viewing three videotaped simulations in a series of studies (Westfall et al., 1986; Tanner et al., 1988). Differences between the nurses and nursing students were not statistically significant, however, there was a trend towards more systematic data collection and diagnostic accuracy with increased levels of knowledge and experience (Tanner et al, 1988). In a related investigation, Westfall et al. (1986) found that registered nurses made more complex clinical inferences than nursing students. Two studies examined differences in clinical simulation performance between nurses and nurses with advanced preparation (nurse practitioners). Farrand et al. (1982) compared the performance of nurses and nurse practitioners on three patient management problems. The two groups had significantly different simulation proficiency scores, $\underline{F}(1,63) = 33$, $\underline{p} < .0001$. McLaughlin et

al. (1981) compared the performance of nurses, nurse practitioners, and family practice physicians with their preprofessional counterparts (nursing and premedical/medical students) on two clinical simulation tests. The hypertension clinical simulation test differentiated between the professional and preprofessional groups for both nurse practitioners and physicians.

Relationship Between Experience and Clinical Decision Making

There are two distinct conceptualizations of experience in the nursing clinical decision making literature, that of actual years of clinical experience and that of task familiarity. Historically, experience has been operationalized as passage of time (Davis, 1972, 1976; Farrand et al., 1982). Both Davis and Farrand et al. support the notion that clinical decision making peaks and then declines. Davis found that after five years of experience without continuing education, clinical decision making on five filmed patient situations declined. Farrand et al. found the lowest simulation proficiency scores in nurses with less than two years experience or more than fifteen years experience. Two recent studies have examined differences between student nurses and experienced nurses (Holden & Klingner, 1988; Itano, 1989). While it is difficult to separate knowledge and experience, these two authors have emphasized the differences in experience in their investigations. Holden and Klingner examined differences between junior and senior nursing students, nursing students who were parents, and experienced pediatric nurses on a "computer-presented social situation" involving a crying infant. The task was to diagnose the cause of crying

by collecting relevant cues and determining the correct hypothesis. Both parents and experienced nurses differed from the two student groups. Interestingly, the experienced pediatric nurses were most efficient, selecting hypotheses based on minimal data, however, the nursing students who were parents were most accurate (100%). The problem solution was that the baby was teething, so the possibility that parents may have had more experience with teething than the experienced pediatric nurses was raised by the investigators. Itano (1989) compared experienced nurses and student nurses during the initial assessment of a hospitalized patient. The interaction was tape recorded, transcribed, and coded by three raters using a judgment process scale. Results indicated that registered nurses collected significantly more cues than the student nurses and that the total rating scale scores discriminated between the student nurses and experienced nurses.

Benner (1984) used hermeneutical methods to identify domains of competencies in nursing from a phenomenological perspective and to explore the application of the Dreyfus and Dreyfus (1986) model of skill acquisition to nursing. The Dreyfus model is comprised of five levels of skill acquisition reflective of three aspects of skilled performance: movement from abstract to concrete examples as paradigms, from perception of the situation as a collection of equally relevant bits to view of situation as a whole with salient features, and from detached observer to involved performer. The five levels are novice, advanced beginner, competence, proficiency, and expert. Movement through the levels is achieved by experience. It is explicit in Benner's work that experience is not the passage of time, but "the refinement of pre-conceived notions and theory through encounters with many actual

practical situations that add nuances or shades of differences to theory" (p. 36).

Corcoran (1986a, 1986b) used three written case studies with differing levels of complexity to evaluate initial and overall approach to care planning, quality of plans, and planning processes of five novice and six expert hospice nurses. Subjects were asked to "think aloud" as they developed drug administration plans for three patients with chronic pain. There was no relationship between the initial approach and task complexity. However, experts varied their overall approach in all three cases. In the first study, verbal protocol analysis identified sources of difficulty leading to incomplete plans. Novices tended to oversimplify the problem, while experts dismissed a pain-related problem or recognized then forgot the problem. The second study focused on the planning processes of generating, evaluating, and choosing alternative actions. There was no significant difference between novices and experts in total alternative actions generated. There was no relationship between complexity and quality of the final plans, however, the experts did develop more appropriate plans than the novices. The sample size of 11 must be taken into consideration when interpreting the correlation coefficients and generalizing the results of these two studies.

Relationship Between the Nature of the Task and Clinical Decision Making

The earliest works on clinical decision making in nursing focused on the nature of the nursing task. Hammond, Kelly, and associates used Brunswick's "lens model" of behavior (1947) as the conceptual basis of

their classic series on clinical inference in nursing (Kelly, 1964a, 1964b; 1966; Hammond, 1964, 1966; Hammond, Kelly, Schneider & Vancini, 1966a, 1966b, 1967; Hammond, Kelly, Castellan, Schneider, & Vancini, 1966). The first phase of their work (Hammond et al., 1966a) involved two field studies designed to analyze the cognitive tasks representative of nursing and to discover the cue-characteristics of the most frequently occurring tasks. In the first field study, 47 nurses identified situations involving a clinical inference in a single 24 hour period. Results of the study showed that nurses were involved in a large number and wide variety of complex tasks. The second study was limited to information about nursing care decisions following a complaint of abdominal pain by post-abdominal surgery patients. From a convenience sample of 30 hospitals, 212 cognitive tasks were collected and 165 cues and 17 responses identified. Next the investigators (Hammond et al., 1966b) attempted to discover the basic information unit of the cues given by the patient. One hundred patient situations were randomly selected from the 212 cognitive tasks. A volunteer sample of six nurses read the situations and were asked to determine the general state or condition of the patient. The investigators found that no single cue conveyed more than a small amount of information and that groups of cues were not related to the inferences made. Additionally, nurse subjects did not discriminate between usefulness of various cues, or vary over cases in their confidence in their decisions. This body of work served to demonstrate the complexity of nursing tasks.

Several investigators have identified the task specificity of both the outcome and process of clinical decision making in nursing. Farrand et al. (1982) in a sample of 46 nurse practitioners and 31 nurses found

a main effect for patient management problem (PMP), $F(2, 127) = 50.63$, $p < .0001$ on simulation score, that is performance across the three simulations was inconsistent. In a related study, Holzemer and McLaughlin (1988), examined the relationship between scores on two clinical simulation tests and two PMPs in a sample of nurse practitioners ($N = 34$). The lack of significant relationship between the total score on the pulmonary clinical simulation test and pulmonary PMP can be construed either as support for the task specificity of decision making or the result of low statistical power because of small sample size. Tanner et al. (1988), in her study of the diagnostic reasoning of nursing students and practicing nurses on three videotaped simulations, found that the number of hypotheses activated, timing of the first hypotheses, and diagnostic accuracy were task-specific. However, data acquisition strategies were more generalizable across the three cases.

Recently, the variables of amount and relevance of patient data and task complexity have been manipulated in three studies to examine the effect of task differences on clinical decision making. Gordon (1980) examined the relationship between information conditions (limited or unlimited) and inferential ability on predictive hypothesis testing. Based on Gordon's underlying assumption that "strategy selection consistent with task characteristics and subject capabilities, permits the balancing of information intake, cognitive strain and failure risk" (p.39), the sample of 60 Master's candidates from four universities were divided into high and low inferential ability based on their Miller Analogies Test or Graduate Record Exam verbal score. The subjects were randomly assigned to limited or unlimited information conditions after a

pretest on the content area. Neither inferential ability alone nor the interaction of inferential ability and information conditions significantly influenced predictive hypothesis testing. Diagnostic accuracy was significantly greater in the limited information condition. However, because the limited information condition was always hemorrhagic shock and the unlimited condition, atelectasis, this may have been due to a difference in difficulty or content familiarity.

Cianfrani's (1984) investigation used a factorial design to look at the effect of the amount and relevancy of data on accuracy, number of errors, number of health problems identified, and time needed to identify health problems. The sample of 120 graduate nursing students and 60 members of the American Association of Critical-Care Nurses were randomly assigned to one of six groups. Each group viewed three vignettes with variations in the number of relevant cues and number of cues given. Results of the study indicated that more health problems were hypothesized with increased amounts of data in two of the three vignettes, the effect of relevance of data was inconsistent, errors increased with increased amounts of data and low relevant data in two out of the three vignettes and time increased with increased data in two out of three vignettes. In one vignette an interaction occurred between the amount and relevance of data.

Corcoran (1986a) investigated the planning processes of 11 hospice nurses using three written simulations of varying complexity. There was no relationship found between initial approaches to planning and task complexity. Experts, but not novices, varied their overall approach according to task complexity. The relationships among task complexity, nursing expertise, and the planning processes of generating, evaluating,

and choosing alternatives was also examined by Corcoran (1986b). No significant relationship was shown between quality of the final plans and task complexity. Interestingly, experts developed better plans for the most complex case than for the less complex case.

Relationship Between the Process and Outcome of Decision Making

Two nursing investigations have specifically addressed the relationship between the process and outcome of decision making. Corcoran (1986a, 1986b) compared the approach to planning care with the quality of the plan produced in three case studies with a small sample (N = 11) of novice and expert nurses. There was no significant relationship between approach to the plan and overall quality of the plan in any of the three case studies, Fisher's exact p = .182, .636, and .273. Holzemer (1986) compared the route taken through one PMP with simulation proficiency scores of 79 nurses practitioners. The mean proficiency score was significantly lower for the atypical group, t = 3.86, p <.05, than for the those choosing the typical route through the PMP.

Relationship Between Clinical Decision Making as Measured by Clinical Simulation Performance and Clinical Expertise

Clinical expertise or clinical decision making in practice can be conceptualized as the construct that clinical simulation performance attempts to measure and as the criterion against which clinical simulation performance is measured. Research studies have examined the

construct and criterion-related validity of two types of clinical simulations, the patient management problem and the clinical simulation test. The two types of simulations differ in structure; the patient management problem has branching capabilities while the clinical simulation test is linear.

Dincher and Stidger (1972) studied the relationship between performance on a patient management problem (PMP) and evaluation of clinical decision making by clinical instructor in their investigation of eleven nursing students. Significant correlation between the PMP and instructors evaluation was conceptualized as evidence for concurrent validity of the two instruments and construct validity for clinical simulation performance. Rank order correlation between the two instruments was significant for simulation efficiency score, but not proficiency score. Limitations in this study were the sample size (N = 11) and small number of negatively weighted simulation items. Small numbers of negatively weighted simulation items result in decreased odds of making a mistake, thereby creating artificially high proficiency scores.

The problem solving skills of nurse practitioners were investigated in a series of studies by Holzemer and associates (Holzemer et al., 1981; Farrand et al., 1982; Holzemer, 1986; Holzemer et al., 1986; Holzemer & McLaughlin, 1988). Two of these studies relate specifically to the relationship between clinical simulation performance and clinical expertise. Holzemer et al. (1981) used a multitrait-multimethod approach (Campbell & Fiske, 1959) to the exploration of construct validity of one PMP. The traits measured were cognitive knowledge, problem solving skill, and perceptions of practice. Methods were self-chart audit,

colleague evaluation, self-evaluation, multiple choice examination, and PMP. PMP proficiency score was significantly correlated with self-evaluation of clinical practice, $r = .23$, $p < .05$. There were no significant correlations between proficiency score and other indicators of clinical expertise: (a) chart audit, $r = .02$, and (b) colleague evaluation, $r = .07$. Nurse practitioner's performance on one PMP was compared with chart audit and observation of clinical performance to explore the criterion-related validity of the PMP (Holzemer et al., 1986). Neither chart audit not clinical performance was significantly correlated with simulation performance failing to provide support for the criterion-related validity of the PMP.

Summary

Although expert clinical decision making has been exquisitely described through exemplars (Benner, 1984), it is clear from this review of the research related to clinical decision making in nursing, that clinical decision making is a complex and somewhat elusive phenomenon. Studies in nursing have identified and supported the positive relationship between level of knowledge and clinical decision making (Verhonick et al., 1968; Holzemer et al., 1981; Baumann & Bourbonnais, 1982; Westfall et al., 1986) using a variety of research methods including surveys, clinical simulation performance, interviews, and verbal protocol analysis. The relationship between experience, as measured by years, and clinical decision making has been more tenuous, although several studies do support low clinical decision making skills in both inexperienced nurses and those with many years of experience

(Davis, 1976; Farrand et al., 1982). Experience as task familiarity has gained popular acceptance following Benner's (1984) validation of the Dreyfus model of skill acquisition (Dreyfus & Dreyfus, 1986) and the notion of novice-expert differences rather than actual years of experience is reflected in some studies (Corcoran, 1986a, 1986b). The task specificity of clinical decision making has been supported in numerous studies (Farrand et al., 1982; Tanner et al., 1986; Holzemer & McLaughlin, 1988), however only a few studies have examined the relationship between a specific task variable and clinical decision making (Gordon, 1980; Cianfrani, 1984; Corcoran, 1986a, 1986b). Investigation have tended to focus on either describing clinical decision making, most commonly using verbal protocol analysis (Tanner et al., 1986; Westfall et al, 1986; Corcoran, 1986a, 1986b) or measuring the outcome of clinical decision making by simulation proficiency score (Dincher & Stidger, 1972; Farrand et al., 1982; Holzemer & McLaughlin, 1988). Few studies exist that examine the relationship between the process and outcome of clinical decision making (Corcoran, 1986a, 1986b; Holzemer, 1988). Studies in nursing have provided only modest support for the construct validity of clinical simulation performance as a measure of clinical decision making/problem solving skills (Holzemer et al., 1981; McLaughlin et al., 1981). Attempts to determine criterion-related validity have not demonstrated significant relationships between simulation performance and the criterion measures of chart audit or colleague evaluation (Holzemer et al., 1981, 1986). These studies have been limited in number, scope, and type of clinical simulation. This investigation seeks to add to the understanding of clinical decision making in critical care by validating the relationship

between knowledge, experience, and clinical decision making described in the literature and by exploring three additional specific topics: (a) the effect of level of patient acuity on clinical decision making; (b) the relationship between the process and the outcome of clinical decision making; and (c) the relationship between clinical decision making, as measured by clinical simulation performance and self-evaluation of clinical expertise.

Conceptual Framework

Information processing theory or human problem solving theory (Newell, Shaw, & Simon, 1958; Newell & Simon, 1972; Anderson, 1983) is the theoretical basis of this investigation. The theory conceptualizes problem solving behavior as information processing (Newell et al., 1958). This discussion begins with a review of the general propositions of information processing theory followed by the presentation of the conceptual framework for the investigation.

General Propositions of a Theory of Human Problem Solving

Newell and Simon (1972) identified five general propositions related to a theory of human problem solving. They are as follows: (a) human problem solving is information processing; (b) information processing is dependent on the characteristics of the problem solver and the task; (c) there are individual differences in problem solving; (d) different tasks require different information processing; and (e) the nature of the task and intelligence of the problem solver determine problem solving behavior.

Substruction of the Conceptual Framework

The technique of theoretical substruction (Hinshaw, 1979; Phillips, 1986) was used to articulate the conceptual framework for this investigation. As Figure 1 demonstrates, substruction proceeds from the more abstract concepts/constructs to the operationalization of variables. Relationships among the concepts are shown by arrows. In this investigation the highest level concepts are decision maker, task, and decision making. Middle range concepts are knowledge, experience, level of patient acuity, and clinical decision making. The lower level concepts of simulation performance and clinical expertise are identified only for clinical decision making. In the following section the study variables are identified and operationalized.

Decision Maker

Decision maker characteristics examined in this investigation are knowledge and experience. Knowledge is operationalized with five variables. Four variables relate specifically to knowledge in critical care nursing, while nurse level is a general classification for all nurses within the proposed clinical site. Basic Knowledge Assessment Tool for Critical Care Nursing (BKAT) score is a continuous variable with a range of 0-100 based on the number of correct items. Nurse level is a nominal variable consisting of four levels: Clinical Nurse I or IP (new graduate with license or interim permit), Clinical Nurse II (staff nurse), Clinical Nurse III (resource nurse), and Administrative Nurse II (charge nurse). Two dichotomous variables measure presence or absence of a certification. Critical care registered nurse (CCRN) certification

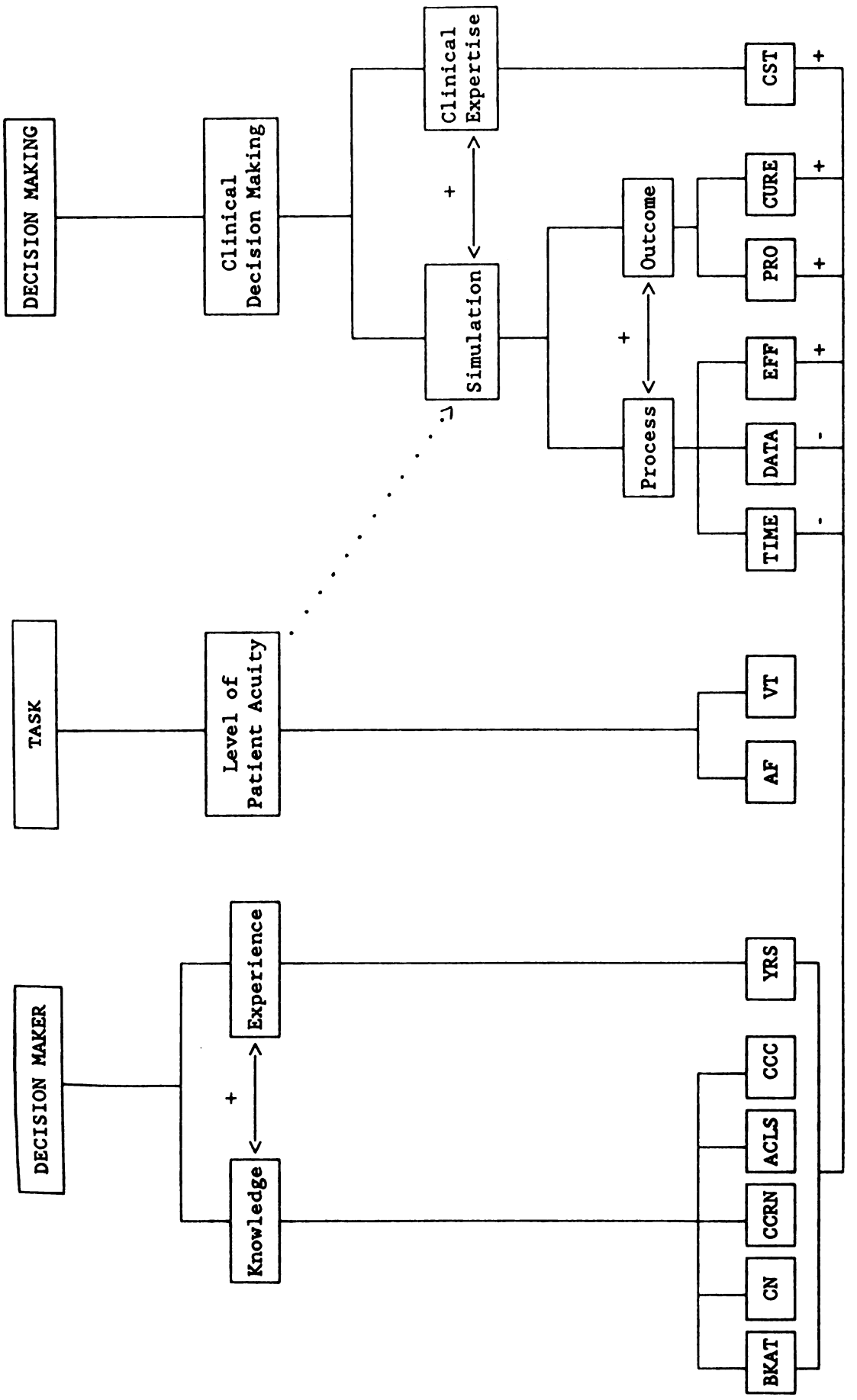

Figure 1. Theoretical substruction of the conceptual framework. Dashed line represents interaction effect.

indicates the successful completion of the CCRN examination given by the American Association of Critical-Care Nurses (AACN). Renewal of CCRN certification is required every three years and requires 90 contact hours of continuing education as well as current clinical practice (AACN, 1988). Advanced Cardiac Life Support (ACLS) certification is given by the American Heart Association. ACLS certification indicates that a knowledge exam and six skill stations have been passed. This certification is renewed every one to two years by attending a recertification course (American Heart Association, 1986). Critical care couse is a dichotomous variable indicating completion of a critical care course. A three month critical care course is provided by two critical care educators at the study site. Course attendance is not mandatory. It is at the discretion of the Head Nurse based on individual learning needs. Experience is operationalized by years of critical care experience. It will be used as a dichotomous variable for the analyses in this investigation with inexperienced defined as less than one year of critical care experience and experienced defined as one year or more of critical care experience. It will be used as a continuous variable for computing correlations with BKAT and CST scores.

Task

The task variable examined in this investigation is level of patient acuity. Two levels of patient acuity are demonstrated by two types of tachydysrhythmias in the computerized clinical simulations. Tachydysrhythmias are disturbances in the electrical activity of the heart resulting in a rapid heart rate. The resulting effect of the tachydysrhythmia on patient signs and symptoms is dependent on the

decrease in cardiac output accompanying the tachydysrhythmia. The high acuity situation is ventricular tachycardia. The moderate acuity situation is atrial flutter. Both result in a drop in cardiac output, however, ventricular tachycardia is considered to have the higher acuity because of the potential for deterioration into ventricular fibrillation (clinical death). The task variable relates only to clinical simulation performance, not to self-evaluation of clinical expertise.

Clincial Decision Making

Computerized clinical simulations. Both the process and outcome of clinical decision making will be examined by performance on four computerized clinical simulations. Process variables of interest are the amount of data collected before the first intervention, time, and efficiency score. Time is the amount of time to complete each simulation in minutes and seconds. Efficiency score is a continuous variable based on the comparison of subject performance with expert performance. It reflects the subject's number of positive choices relative to total number of choices in the simulations. Efficiency scores range from 0 - 100%. Two outcome variables will be measured, proficiency score and patient outcome. Proficiency score is a continuous variable measuring agreement with expert performance. Cure is a dichotomous variable measuring patient outcomes (cure/die) in the simulations. Both proficiency score and cure reflect the correct management of the tachydysrhythmia. The problem solver variables are hypothesized to have main effects on simulation performance as depicted in Figure 1. The task variable is hypothesized to have interaction, rather than main effects, with the problem solver variables.

Practice. Clinical decision making in practice is operationalized by a self-evaluation of clinical expertise related to care of the patient with a dysrhythmia. Cardiovascular Self-Evaluation Tool (CST) score is an interval variable with a possible range of 0-114.

Research Questions and Hypotheses

1. Will inexperienced and experienced critical care nurses differ on the BKAT score?

   Nurses with at least one year of critical care experience will score higher on the BKAT than nurses with less than one year of clinical experience.

2. Will nurses at different levels differ on the BKAT score?

   The BKAT score will increase as the nurse level increases.

3. Will CCRN certified and non-CCRN certified nurses differ on the BKAT score?

   CCRN certified nurses will score higher on the BKAT than non-CCRN certified nurses.

4. Will ACLS certified and non-ACLS certified nurses differ on the BKAT score?

   ACLS certified nurses will score higher on the BKAT than non-ACLS certified nurses.

5. Will nurses completing a critical care course score higher on the BKAT than nurses not completing a critical care course?

   Nurses who have completed a critical care course will score higher on the BKAT than nurses who have not completed a critical care course.

6. Will inexperienced and experienced critical care nurses differ on the CST score?

Nurses with at least one year of critical care experience will score higher on the CST than nurses with less than one year of critical care experience..

7. Will nurses at different levels differ on the CST score?

The CST score will increase as the nurse level increases.

8. Will CCRN certified and non-CCRN certified nurses differ on the CST score?

CCRN certified nurses will score higher on the CST than non-CCRN certified nurses.

9. Will ACLS certified and non-ACLS certified nurses differ on the CST score?

ACLS certified nurses will score higher on the CST than non-ACLS certified nurses.

10. Will nurses completing a critical care course score higher on the CST than nurses not completing a critical care course?

Nurses who have completed a critical care course will score higher on the CST than nurses who have not completed a critical care course.

11. Does years of critical care experience affect computerized clinical simulation performance as measured by proficiency score, efficiency score, amount of data collected before the first intervention, patient outcome, and time taken to complete the simulation?

Nurses with at least one year of critical care experience will have higher proficiency scores, higher efficiency scores, collect less data before the first intervention, cure more tachydysrhythmias, and take less time to complete the simulations than nurses with less than one year critical care experience.

12. Does nurse level affect computerized clinical simulation performance as measured by proficiency score, efficiency score, amount of data collected before the first intervention, patient outcome, and time taken to complete the simulation?

As nurse level increases proficiency score, efficiency score,and number of tachydysrhythmias cured will increase and amount of data collected before the first intervention and time taken to complete the simulation will decrease.

13. Does CCRN certification affect computerized clinical simulation performance as measured by proficiency score, amount of data collected before the first intervention, patient outcome, and time taken to complete the simulations?

CCRN certified nurses will have higher proficiency scores, higher efficiency scores, collect less data before the first intervention, cure more tachydysrhythmias, and take less time to complete the simulations than non-CCRN certified nurses.

14. Does ACLS certification affect computerized clinical simulation performance as measured by proficiency score, efficiency score, amount of data collected before the first intervention, patient outcome, and time taken to complete the simulation?

ACLS certified nurses will have higher proficiency scores, higher efficiency scores, collect less data before the first intervention, cure more tachydysrhythmias, and take less time to complete the simulations than non-ACLS certified nurses.

15. Does completion of a critical care course affect computerized clinical simulation performance as measured by proficiency score, efficiency score, amount of data collected before the first intervention, patient outcome, and time taken to complete the simulation?

Nurses who have completed a critical care course will have higher proficiency scores, higher efficiency scores, collect less data before the first intervention, cure more tachydysrhythmias, and take less time to complete the simulations than nurses who have not completed a critical care course.

16. Does acuity of the patient situation (ventricular tachycardia versus atrial flutter) affect computerized clinical simulation performance as measured by proficiency score, efficiency score, the amount of data collected before the first intervention, patient outcome, and time taken to complete the simulation?

> Acuity of the patient situation will not affect computerized clinical simulation performance as measured by proficiency score, efficiency score, amount of data collected before the first intervention, patient outcome and time taken to complete the simulation.

17. Is there an interaction between acuity of the patient situation (ventricular tachycardia versus atrial flutter) and critical care experience on clinical simulation performance?

> Nurses with at least one year critical care experience will collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while nurses with less than one year critical care experience will not collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation than in the atrial flutter simulation.
>
> Nurses with at least one year critical care experience will not have significantly lower proficiency scores, efficiency scores, or cure more tachydysrhythmias in the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while nurses with less than one year critical care experience will have higher proficiency scores, higher efficiency scores, and cure more tachydysrhythmias in the less acute situation.

18. Is there an interaction between acuity of the patient situation (ventricular tachycardia versus atrial flutter) and nurse level on clinical simulation performance?

> Nurses at higher levels will collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while Clinical Nurse Is will not collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation than in the atrial flutter simulation.

Nurses at higher levels on the clinical nurse ladder will not have significantly lower proficiency scores, efficiency scores, or cure more tachydysrhythmias in the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while Clinical Nurse Is will have higher proficiency scores, higher efficiency scores, and cure more tachydysrhythmias in the less acute situation.

19. Is there an interaction between acuity of the patient situation (ventricular tachycardia versus atrial flutter) and CCRN certification on clinical simulation performance?

Nurses who are CCRN certified will collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while non-CCRN certified nurses will not collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation than in the atrial flutter simulation.

Nurses who are CCRN certified will not have significantly lower proficiency scores, efficiency scores, or cure more tachydysrhythmias in the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while non-CCRN certified nurses will have higher proficiency scores, higher efficiency scores, and cure more tachydysrhythmias in the less acute situation.

20. Is there an interaction between acuity of the patient situation (ventricular tachycardia versus atrial flutter) and ACLS certification on clinical simulation performance?

Nurses who are ACLS certified will collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while non-ACLS certified nurses will not collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation than in the atrial flutter simulation.

Nurses who are ACLS certified will not have significantly lower proficiency scores, efficiency scores, or cure more tachydysrhythmias in the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while non-ACLS certified nurses will have higher proficiency scores, higher efficiency scores, and cure more tachydysrhythmias in the less acute situation.

21. Is there an interaction between acuity of the patient situation (ventricular tachycardia versus atrial flutter) and completion of a critical care course on clinical simulation performance?

> Nurses who have completed a critical care course will collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while nurses who have not completed a critical care course will not collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation than in the atrial flutter simulation.
>
> Nurses who have completed a critical care course will not have significantly different proficiency scores, efficiency scores, or cure more tachydysrhythmias in the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while nurses who have not completed a critical care course will have higher proficiency scores, higher efficiency scores, and cure more tachydysrhythmias in the less acute situation.

22. Is there a relationship among simulation performance, BKAT score, and CST score?

> There will be positive relationships among BKAT score, CST score, simulation proficiency scores, simulation efficiency scores, and positive patient outcomes.
>
> Times to complete the simulations will be negatively correlated with BKAT score, CST score, simulation proficiency scores, simulation efficiency scores, and positive patient outcomes.

CHAPTER III

METHODOLOGY

Research Design

The primary consideration in selection of a research design is the phenomena being examined (Woods & Catanzaro, 1988). Based on the level of knowledge about clinical decision making, the nature of clinical decision making, and the research purpose for this investigation, two related designs were selected. A repeated measures design examined the effect of level of patient acuity on clinical decision making by critical care nurses with varying levels of knowledge and experience. A descriptive correlational design was used to relate scores on a knowledge test and self-evaluation of clinical expertise with simulation performance.

Research Setting

A 441 bed West Coast tertiary medical center with seven areas in the Critical Care and Emergency Services Division was the study site. The areas and their bed capacity are as follows: cardiac care unit (8), burn unit (8), neurosurgical intensive care unit (10), surgical intensive care unit (12), medical intensive care unit (12), emergency room (27), and Life Flight (critical care transportation program). The medical center is the primary teaching site for a university medical school and is used as a clinical site by one baccalaureate and one

associate degree nursing school. Nursing research is well supported in the site as demonstrated by a full time doctorally prepared nurse researcher, active nursing research committee, and sponsorship of an annual nursing research symposium.

Sample

Human Subjects' Assurance

The research study was reviewed by the human research committees of two institutions. The research study received approval from the University of California, San Francisco Human Research Committee (H642-9373701) on October 12, 1988 and from the University of California, Davis on October 19, 1988 (89-189).

Nature and Size of Sample

A convenience sample of registered nurses was recruited from the critical care division of a tertiary medical center. A total of 160 nurses providing direct patient care agreed to participate in the study. The participants included staff nurses, resource nurses, and charge nurses. Nurses (n = 18) who did not complete all instruments or who had longer than one month time between completion of the written instruments and the computer simulations were dropped from the sample. The resulting sample size was 142. The potential pool of critical care nurses at the setting was approximately 300.

Data Collection Methods

Demographic Profile

Description

The demographic profile (Appendix A) was used to collect data related to the sample characteristics and information on the variables related to the knowledge and skill of critical care nurses. Potentially theoretically relevant variables include years of nursing and critical care experience, level of education, full or part time employment, ACLS certification, CCRN certification, type of unit, and critical care orientation course. Age and marital status were collected to describe the sample and provide comparisons for national normative data on critical care nurses. The demographic profile took approximately five minutes to complete.

Reliability and Validity

The instrument was reviewed for face validity by a panel of three researchers ($N = 3$). No reliability assessments were done due to the nature of the data.

Basic Knowledge Assessment Tool (BKAT)

Description

The BKAT (Toth & Ritchey, 1984; Toth, 1984, 1986) is designed to measure the basic knowledge needed for critical care nursing practice (Appendix B). It is a 100 item multiple-choice and fill-in-the-blank

test with seven subscales: cardiovascular, monitoring lines, pulmonary, neurology, endocrine, renal, nutrition, and miscellaneous. The three fill-in items related to dysrhythmia diagnosis were changed to multiple-choice items to facilitate scoring of the instrument. The distractors in the new multiple-choice items were chosen based on commonly made wrong diagnoses by participants in a critical care orientation course at the study site. BKAT scores are reported as number of answers correct (0-100). The BKAT requires 30 to 60 minutes for completion.

Reliability and Validity

The instrument's authors have reported reliability data on three samples. Cronbach's alpha was .73 (N = 84) in a sample of AACN members (Toth, 1986). Earlier versions of the exam had Cronbach's alphas ranging from .83-.86 in two groups of nurses (N = 100, N = 92) and a group of students (N = 38) in the metropolitan Washington D.C. area (Toth, 1984, 1986; Toth & Ritchie, 1984). Content validity was established through a literature review and by a panel of experts (N = 7) consisting of experts in critical care nursing practice, critical care nursing education, and educational testing. The BKAT meets only two of the minimum standards for the publication of results of psychometric testing of instruments suggested by Norbeck (1985): (a) one type of content validity, (b) at least one type of criterion-related or construct validity, (c) internal consistency reliability, and (d) test-retest reliability.

Cardiovascular Self-Evaluation Tool (CST)

Description

The CST (Appendix C) is a 38 item ordinal scale consisting of task statements related to the knowledge and skills required to care for a cardiovascular patient. It was used in this study to provide a self-evaluation of clinical expertise. The CST was created in two steps. The items were chosen by the investigator from a list of critical care competencies from the American Association of Critical-Care Nurses CCRN Validation Study (1984, 1988). The list of competencies serves as the basis of the CCRN certification exam. The items selected for inclusion on the CST are nursing process based and relate to the care of a patient with an dysrhythmia. The scale ratings were created by the investigator based on the skill acquisition models of Anderson (1982, 1985) and Dreyfus (Dreyfus & Dreyfus, 1986; Benner, 1984). The individual is asked to rate his knowledge and skill related to the designated tasks on a scale of 0 to 3. The descriptors for the scale ratings are: 0 - no knowledge or skills related to the task, 1 - theoretical knowledge about task, but limited skill related to the task, 2 - knowledge and skills necessary for task in uncomplicated patient situations, and 3 - knowledge and skills necessary for task in uncomplicated and complex patient situations. The ratings of each item are summed for the total score which ranges from 0 - 114.

Reliability and Validity

The content and construct validity of the total 200 item CCRN examination was explored by AACN in a three phase study. In the first

phase, a study task force (N = 7) identified 378 task statements describing the work behaviors of the critical care nurse. Phase Two was the documentation survey in which a sample of CCRN's rated the task statements on time spent and importance. A random sample of 960 CCRNs was asked to participate in the survey. The response rate of 25% (N = 232) must be taken into consideration when evaluating the findings of this survey. The importance ratings of the 38 items included in the CST are presented in rank order in Appendix C. Four items on the CST had importance ratings between 3 and 4. The remaining items were rated greater than 4. The descriptors associated with the ratings are as follows: 1 = I do not have this responsibility, 2 = of little or no importance, 3 = moderately important, 4 = very important, and 5 = of extreme importance. In the third phase a 200 item examination was created to reflect the task items identified as at least moderately important in the documentation survey. Using a known groups approach to construct validation (Campbell & Fiske, 1959), the examination was administered to three groups of nurses. The CCRNs (n=43) were significantly different, $p < .01$, than the medical/surgical nurses (n=31) and operating room nurses (n=41) supporting the construct validity of the examination as measure of knowledge and skills in critical care. These construct validation results can not be directly applied to the 38 item CST since it only reflects one section of the examination, however, there is support for the content validity of the 38 items. The reliability of the CST has not been previously examined, but will be explored in this investigation.

Tach-Man Simulations

Description

Tach-Man (Barrett & Power, 1985) is a computer program which generates a series of clinical simulations related to the management of tachydysrhythmias. The tachydysrhythmia simulations chosen for this project are ventricular tachycardia and atrial flutter. The task goal is to correct the tachydysrhythmia. The following parameters are randomized for each tachydysrhythmia: history of the present illness, physical examination, vital signs, past medical history, rate of dysrhythmia, patient's medications, potassium, arterial blood gases, medication allergies, and response to treatment. Each scenario ends when the dysrhythmia is corrected, the patient dies, or the subject chooses to end the task. Advantages of these simulations are the limited amount of formative feedback and the fidelity of the simulation to actual clinical situations due to random generation of patient data. The major disadvantage of Tach-Man is the lack of built-in tracking or scoring, however responses were manually tracked by observing keystrokes.

The simulations were used for two purposes: to provide a description of specific aspects of the decision making process and to compare performance with criterion performance. The descriptive data collected during simulation performance were: type and amount of data collected, type and amount of data collected before the first intervention, number of interventions, total number of items chosen, patient outcome, and time taken to complete the simulation. To compare performance with criterion performance, proficiency and efficiency scores (Farrand et al., 1981) were computed.

Two distinct versions of the atrial flutter simulation and seven distinct versions of the ventricular tachycardia simulation were generated by the computer. Simulation versions were considered distinct when the information provided in the simulation required a difference in intervention. Examples of simulation items not considered distinct were differences in current medications such as aspirin or valium and drug allergies such as penicillin or codeine. However, lidocaine or procainamide as a drug allergy were considered distinguishing characteristics because they necessitated a change in treatment. Each simulation is described in Appendix D.

Reliability and Validity

The content validity was established by a review of the literature (M.J. Barrett, August 25, 1988, personal communication, Appendix E). Because the simulation only discriminates performance based on patient outcome, that is, cure or death, a more discriminatory scoring system was developed by the investigator. The creation and validation of the scoring system involved the development of criterion performance standards and assignment of values (-1, 0, +1) to items in the simulations (Bligh, 1980).

Criterion performance standards were ascertained using two steps. First, the treatment protocols for atrial flutter and ventricular tachycardia were determined by consulting the Standards and Guidelines for Cardiopulmonary Resuscitation and Emergency Care (Montgomery, Donegan, & McIntyre, 1986). These standards are the basis of the American Heart Association's Advanced Cardiac Life Support (ACLS) certification program and the standing orders for the treatment of

dysrhythmias in many institutions. ACLS certification is often a requirement for employment in critical care areas.

Secondly, using the ACLS protocols, an expert panel consisting of five critical care educators who were also ACLS instructors, one paramedic/RN ACLS instructor, and five critical care managers: (a) defined the amount of data that is essential before treatment of atrial flutter and ventricular tachycardia occurs, (b) rank ordered the correct interventions in the simulation according to their understanding of the ACLS guidelines, (c) designated appropriate treatments when the dysrhythmia was accompanied by hypokalemia, metabolic acidosis, or respiratory acidosis, and (d) defined the relative acuity of atrial flutter and ventricular tachycardia. This was done using written descriptions of the scenarios in the computer simulations. The written scenarios are presented in Appendix F. The experts chose one to four history and data base items as essential before the first intervention in atrial flutter and zero to five in the ventricular tachycardia scenario (Table 1). For this investigation, essential data was defined as the history and data items chosen by at least 75% of the expert panel for each tachydysrhythmia. Current medications and drug allergies met this criterion for both tachydysrhythmias. All other items were chosen by less than 50% of the experts. The experts' ranking (based on modal response) of interventions was in 100% agreement with the ACLS protocol ranking for both tachydysrhythmias (Table 2). Table 3 presents the expert data on treatment for acid-base and potassium imbalances. There was perfect consensus on the treatment of both tachydysrhythmias complicated by hypokalemia. The responses for treatment of respiratory acidosis were problematic in that multiple answers were given by seven

Table 1

Frequency of Data Collected Prior to Intervention for Atrial Flutter (A) and Ventricular Tachycardia (V) Scenarios by Expert Panel (N = 11)

Type of Data	Atrial Flutter n	Ventricular Tachycardia n
History	5	5
Blood Gas	4	4
Chest X-ray	1	0
Past Medical History	2	2
Physical Exam	3	2
Electrolytes	5	5
Allergies	8	8
Medications	9	9

Table 2

Ranking of Interventions for Atrial Flutter and Ventricular Tachycardia by Expert Panel (N = 11)

Intervention	n	Rank	
		Expert[a]	ACLS[b]
Atrial Flutter			
Oxygen and Start IV	10	1	1
Carotid Sinus Massage	6	2	2
Verapamil	6	3	3
Cardioversion	4	4	7[c]
Digoxin	5	5	7
Propranolol	6	6	7
Pacemaker	8	7	7
Ventricular Tachycardia			
Oxygen and start IV	11	1	1
Lidocaine	8	2	2
Procainamide	6	3	3
Cardioversion	5	4	4
Bretylium or Propranolol	7	5	5

[a]Number of subjects who agreed with modal ranking of interventions.

[b]Rank based modal response of experts.

[c]The last four interventions are not differentially ranked in the ACLS protocol and none are considered first line treatments.

Table 3
Treatment of Dysrhythmias Complicated by Hypokalemia, Respiratory Acidosis, or Metabolic Acidosis by Expert Panel (N = 22)[a]

Complication	Treatment	n
Hypokalemia	Administer Potassium	22
Respiratory Acidosis[b]	Increase Ventilation	16
	Decrease Ventilation	2[c]
	Administer Bicarbonate	2
	Increase Oxygen	8

[a]Responses for atrial flutter and ventricular tachycardia combined.

[b]Seven experts listed multiple treatments for respiratory acidosis.

[c]Inappropriate intervention.

experts. Five responses for each scenario indicated treatments that would be considered secondary (oxygen, sodium bicarbonate), rather than primary treatment (increasing ventilation) according to AACN's Clinical Reference for Critical-Care Nursing (Kinney, Dear, Paeka, & Voorman, 1981). Two responses from one expert were incorrect. There was 100% agreement that ventricular tachycardia was the more acute tachydysrhythmia due to the potential for deterioration into ventricular fibrillation (cardiac arrest).

Items in the simulations were assigned values of -1, 0, or +1 based on expert consensus opinion. Essential or correct items in the simulations (data, interventions) were scored as +1. Items that were not essential, but not detrimental were scored 0. Harmful or detrimental items were scored -1. Essential interventions differed according to the scenario. The criterion scoring for each scenario is presented in Appendix G.

Proficiency and efficiency scores were computed from the subject's choices during the simulation. Proficiency score is the algebraic sum of the subject's choices (+1's, 0's, -1's) divided by the criterion score (experts' number of +1's) and converted to a percentage. Proficiency scores vary according to scenario because they are based on the relationship between positive and negative items. When there are a large number of negative items, proficiency scores are likely to be lower, and when most items in the simulation are scored as +1 proficiency scores will be higher. Efficiency is the number of the subject's +1's divided by his total number of choices and multiplied by 100 to convert to a percentage (Williamson, 1965; Bligh, 1980. The range of efficiency scores is 0 to 100%. Proficiency and efficiency scores are generally highly correlated (Holzemer et al., 1981; Henry, LeBreck, & Holzemer, 1989).

Procedure

Data collection took place from November 1988 to May 1989. The scheduling of the data collection was done by the director of the critical care division, the critical care manager from each unit and the investigator.

Presentations describing the study were done for all shifts on each nursing unit by the investigator. Subjects were recruited following the presentations. Nurses not attending the presentations were approached individually. After reading the explanatory letter (Appendix H) about the project, subjects completed the demographic profile, BKAT, and CST. The subjects were encouraged to complete the written instruments on the

unit during scheduled shifts. The instruments were placed into a sealed envelope by the subject and were handed to the investigator or left in a designated file. Written instruments were completed prior to the computer simulations.

Subjects completed the computer simulations in the presence of the investigator. The simulations were completed on the respective units during scheduled shifts. First, subjects were read instructions related to the simulations (Appendix I). Secondly, a simulation was demonstrated to familiarize the subject with the keyboard and simulation format. The subject then completed four simulations (2 atrial flutter and 2 ventricular tachycardia). After a random start the subjects were sequentially assigned to simulation order to prevent any systematic error due to sequence of completion. Completion of the simulations and written tools occurred within one month of each other.

Subjects were provided with individual scores on the written instruments. Simulation performance was discussed at the subject's request immediately following the four simulations. Each critical care manager was provided with unit level data for her respective unit and division level data to provide quality assurance data and to determine the need for staff development programs.

CHAPTER IV

RESULTS

This chapter is organized into two sections. The preliminary analysis section discusses the control of Type I error, presents the power analysis, reports the reliability of the instruments in this sample, and describes the demographic characteristics of the study sample. In the second section, the study hypotheses are tested. The data analysis related to the BKAT and CST is presented first followed by the analysis of computerized clinical simulation performance. Finally, the analysis examining the relationship between performance on the BKAT, CST, and the computer simulations is presented.

Preliminary Analysis

Type I Error

Many analyses were done in this investigation due to the large number of univariate research questions. In an attempt to control the experiment-wise Type I error rate, the α criterion was set at .005 to evaluate the significance of each test. This brings the family-wise error rate of each separate research question to approximately .05.

Power Analysis

Cohen (1988) defines the power of a statistical test as "the probability that it will yield statistically significant results" (p.1).

A power analysis was conducted to determine the probability that the planned statistical analyses would detect statistically significant relationships and differences. Table 4 presents the power for each statistical test used for hypothesis testing in this study. The power is reported for both medium (30) and large (40) effect sizes (ES). Using $\alpha = .05$, ES = 40, the power is at least 80 for all, but two, of the statistical tests. Using a criterion of power equal to or greater than 80, the power analysis indicates that the sample size is adequate to detect a large effect size for the majority of the planned analyses

Table 4

Power of Statistical Tests to Detect Effect Size (ES) of 30, 40, $\alpha = .05$

Test	n	ES=30	ES=40
Correlation	142	95	99
	68	81	96
t-test	142	80	95
1X3 ANOVA	142	89	99
1X4 ANOVA	142	85	98
2X2 ANOVA	68		
Between		69	91
Within		69	91
Interaction		69	91
2X3 ANOVA	68		
Between		59	84
Within		69	91
Interaction		59	84
2X3 ANOVA	63		
Between		54	80
Within		65	88
Interaction		54	80
2X4 ANOVA	68		
Between		51	78
Within		69	91
Interaction		51	78
2X2 Chi-Square	127	92	99
	94	83	97
	71	71	92
	57	60	84
	42	50	73

and a medium effect size in all analyses with samples greater than 90. However, the possibility of low statistical power must be considered in the analysis conducted with subgroups of the study sample.

Reliability Assessment of the Study Instruments

Two types of reliability assessments were done on the instruments. Internal consistency of the BKAT and CST was examined using Cronbach's alpha coefficient (Table 5). The Pearson product-moment correlation coefficient between the two administrations of each type of computerized clinical simulation was used to determine test-retest reliability.

Table 5

Reliability Assessment (Cronbach's alpha) of BKAT and CST (N=142)

Instrument	Items	alpha
Basic Knowledge Assessment Test (BKAT)	100	.80
Cardiovascular Self-Evaluation Tool (CST)	38	.98

Cronbach's alpha for the 100 item BKAT was .80 (n = 142). The instrument's authors reported alpha reliabilities of .73, .83, and .86 in previous administrations of the BKAT (Toth, 1984; Toth, 1986; Toth & Ritchie, 1984). The alpha of .80 is considered adequate for this type of instrument (Nunnally, 1978). The Cronbach's alpha for the CST was .98. Item-scale correlations ranged from .45 to .88. The high internal consistency, although adequate, indicates redundancy in the scale (Woods & Catanzaro, 1988).

Determining reliability in clinical simulations is a difficult task. Because of the interactive nature of the computerized clinical simulations used in this investigation, the number of items in each simulation varies from subject to subject and within subjects from one time to another depending on response to simulation items. Due to this limitation, the underlying assumptions of measures of internal consistency such as Cronbach's alpha or split-half reliability could not be met. The alternative was to address test-retest reliability between the first and second simulation of each simulation type. The time between the two simulations depended on simulation order. The simulations may have been sequential or as much as 45 minutes appart. The sample in this analysis was the subset of subjects receiving the same version of a scenario twice. This resulted in a sample of 71 for atrial flutter and 91 for ventricular tachycardia. As can be seen in Table 6, the test-retest correlations are below .70 and considered unreliable under classical measurement theory (Nunnally, 1978). Allen and Yen (1979) suggested that short intervals between test-retest make carry-over effects due to memory and practice likely.

To determine if there was a learning effect from the first to the second simulation of the same type an exploratory analysis was done. Table 7 presents the intercorrelations among first and second order for atrial flutter and ventricular tachycardia. Moderately strong correlations were found between the atrial flutter simulations for proficiency score, r = .52, p = .000; efficiency score, r = .57, p = .000; amount of data collected before the first intervention, r = .59, p = .000; total amount of data collected, r = .60, p = .000; and number of interventions chosen, r = .51, p=.000). Correlations were lower between

Table 6

Test-Retest Correlations (r) Between First and Second Simulation

Instrument	r
Atrial Simulation[a]	
Proficiency	.55
Efficiency	.59
Data Before First Intervention	.68
Time	.40
#Data Collected	.60
#Interventions	.66
Ventricular Simulation[b]	
Proficiency	.38
Efficiency	.26
Data Before First Intervention	.51
Time	.21
#Data Collected	.41
#Interventions	.33

[a] $n = 71$; [b] $n = 91$

the first and second ventricular tachycardia scenarios for proficiency score, $r = .33$, $p = .000$) efficiency score, $r = .18$, $p = .037$; and number of interventions, $r = .31$, $p = .000$. Moderate correlations were found for both the amount of data collected before the first intervention, $r = .55$, $p = .000$; and total amount of data collected, $r = .42$, $p = .000$.

Paired t-tests (Table 8) were conducted to determine if there were significant differences between the first and second simulation of each type. There were no significant differences between the first and second atrial flutter simulations for proficiency score, efficiency score, amount of data collected before the first intervention, number of interventions, or the total amount of data collected. However, in the second simulation the time to complete the simulation decreased. Ventricular tachycardia performance was significantly different on all variables except efficiency score.

Table 7

Intercorrelations Among First and Second Order Atrial Flutter (AF) and Ventricular Tachycardia (VT) Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1. Af1 prof.	100 .000																							
2. Af2 prof.	52 .000	100 .000																						
3. Vt1 prof.	28 .001	06 .546	100 .000																					
4. Vt2 prof.	30 .000	24 .004	33 .000	100 .000																				
5. Af1 eff.	01 .242	-12 .152	00 1.000	-05 .532	100 .000																			
6. Af2 eff.	-04 .646	-12 .145	-02 .885	-07 .416	57 .000	100 .000																		
7. Vt1 eff.	12 .175	-09 .269	42 .000	10 .227	13 .125	17 .040	100 .000																	
8. Vt2 eff.	04 .681	-08 .372	07 .416	28 .001	21 .011	26 .002	18 .037	100 .000																
9. Af1 data	37 .000	28 .000	13 .114	13 .113	-27 .001	-30 .000	-01 .932	-07 .433	100 .000															
10. Af2 data	27 .001	34 .000	08 .325	22 .009	-28 .001	-33 .000	-17 .043	-08 .337	59 .000	100 .000														
11. Vt1 data	22 .010	25 .002	13 .130	14 .095	17 .043	-17 .043	-17 .048	-05 .566	43 .000	33 .000	100 .000													
12. Vt2 data	13 .136	16 .052	13 .129	19 .022	23 .006	-20 .015	-15 .080	-15 .077	51 .000	54 .000	55 .000	100 .000												
13. Af1 time	22 .009	21 .012	12 .162	19 .027	-63 .000	-48 .000	-13 .115	-18 .031	21 .011	27 .001	13 .124	14 .105	100 .000											
14. Af2 time	-13 .117	10 .022	-09 .265	05 .550	-26 .002	-61 .000	-12 .157	-14 .091	19 .025	13 .131	13 .128	10 .227	31 .000	100 .000										
15. Vt1 time	17 .044	-05 .588	75 .000	14 .095	-12 .148	-12 .172	06 .481	-14 .107	17 .048	16 .051	22 .009	26 .002	18 .033	-08 .354	100 .000									
16. Vt2 time	16 .056	08 .368	10 .255	65 .000	-11 .178	-10 .218	-03 .756	-21 .013	15 .085	24 .004	10 .230	22 .008	29 .001	12 .172	17 .039	100 .000								
17. Af1 totdat	49 .000	34 .000	10 .215	23 .007	-56 .000	-47 .000	-09 .305	-17 .045	51 .000	46 .000	26 .002	34 .000	65 .000	21 .041	11 .202	26 .002	100 .000							
18. Af2 totdat	27 .001	48 .000	02 .807	25 .002	-39 .000	-65 .000	-17 .004	-18 .032	46 .000	57 .000	28 .001	48 .000	48 .000	52 .000	06 .454	28 .001	68 .000	100 .000						
19. Vt1 totdat	20 .017	15 .078	50 .000	17 .039	-24 .003	-28 .001	-20 .018	-16 .052	36 .000	38 .000	52 .000	43 .000	22 .008	10 .228	68 .000	15 .080	29 .001	33 .000	100 .000					
20. Vt2 totdat	22 .008	27 .001	16 .058	45 .000	-24 .005	-31 .000	-11 .204	-34 .000	36 .000	42 .000	38 .000	55 .002	26 .002	21 .013	27 .001	61 .001	48 .000	54 .000	42 .000	100 .000				
21. Af1 inter.	24 .004	25 .003	21 .012	16 .063	-57 .000	-09 .267	-07 .398	-11 .193	19 .023	21 .010	11 .195	00 .005	76 .000	29 .001	21 .016	09 .312	45 .000	28 .001	22 .009	10 .246	100 .000			
22. Af2 inter.	05 .562	23 .005	01 .897	05 .556	-27 .001	-09 .295	-07 .425	-17 .038	21 .012	11 .201	13 .134	04 .645	29 .000	78 .000	-02 .813	04 .648	24 .004	35 .000	15 .082	15 .079	51 .000	100 .000		
23. Vt1 inter.	22 .009	01 .916	81 .000	19 .026	-12 .153	-04 .627	09 .246	-07 .437	12 .162	13 .129	12 .166	11 .196	22 .010	-08 .350	86 .000	09 .285	16 .104	04 .643	52 .000	12 .168	32 .000	03 .728	100 .000	
24. Vt2 inter.	21 .014	09 .315	26 .002	74 .000	-10 .251	19 .020	-02 .836	-14 .105	07 .415	18 .033	11 .203	08 .332	24 .004	04 .633	23 .005	81 .000	22 .008	21 .012	20 .015	39 .000	22 .009	10 .247	31 .000	100 .000

pref. = proficiency
eff. = efficiency
totdat = total data
inter. = interventions

Note: Decimal points have been omitted.

Table 8

Comparison of First and Second Simulation Order for Atrial Flutter and Ventricular Tachycardia (N=142)

Variable	First M(SD)	Second M(SD)	t	df	p
Atrial Flutter					
Proficiency	49.6(23.5)	52.1(20.5)	1.4	141	.176
Efficiency	47.6(19.9)	50.8(20.9)	2.1	141	.041
Amount of Data Before First Intervention	1.5(1.8)	2.0(2.2)	2.8	141	.007
Time	6.2(3.6)	4.5(3.0)	-5.3	141	.000
Total Data Collected	3.5(2.7)	3.9(2.7)	1.9	141	.061
Number Interventions	5.6(3.2)	5.0(3.3)	-2.2	141	.031
Ventricular Tachycardia					
Proficiency	28.3(23.4)	40.9(24.4)	5.4	141	.000
Efficiency	45.5(21.6)	48.6(18.5)	1.4	141	.160
Amount of Data Before First Intervention	0.9(1.4)	1.5(2.1)	4.3	141	.000
Time	5.5(4.1)	6.8(4.2)	3.0	141	.004
Total Data Collected	2.2(2.5)	3.4(2.6)	4.8	141	.000
Number Interventions	6.9(5.1)	8.9(5.3)	4.1	141	.000

Proficiency score, $t(141) = 5.4$, $p = .000$, and the amount of data collected before the first intervention, $t(141) = 4.3$, $p = .000$, increased. In contrast to the atrial flutter simulation, time to complete the simulation, $t(141) = 3.0$, $p = .004$ increased in the second simulation.

The McNemar test was used to determine if there were differences in patient outcome between the first simulation and second simulation of each type. Table 9 compares outcomes for first and second order for atrial flutter and Table 10 for ventricular tachycardia. The sample for the atrial flutter analysis were those subjects either curing and/or causing the patients' deaths in both atrial flutter simulations (n = 112). Those subjects running out of time before the simulation was completed or deciding to end the scenario before time was up were not

Table 9

Comparison of Patient Outcome in First and Second Order Atrial Flutter Simulations (n = 112)

Frequency	Patient Outcome First	Second	Z	p
			0	1.000
87	Cure	Cure		
10	Cure	Die		
9	Die	Cure		
6	Die	Die		

Table 10

Comparison of Patient Outcome in First and Second Order Ventricular Tachycardia Simulations (n = 46)

Frequency	Patient Outcome First	Second	Z	p
			3.25	<.000
15	Cure	Cure		
1	Cure	Die		
15	Die	Cure		
15	Die	Die		

included. For the atrial flutter simulation there were no differences in patient outcome for first and second order simulation. Subjects who had patient outcomes other than curing the dysrhythymia or causing the patients' deaths were excluded from the ventricular tachycardia analysis. In ventricular tachycardia, the high acuity simulation, there was a significant difference in patient outcomes, $Z = 3.25$, $p < .000$. More subjects caused the patient's death in the first ventricular

simulation and subsequently cured the second patient with ventricular tachycardia than vice versa.

This exploratory analysis indicates that there was a carry-over or practice effect from the first to the second simulation. The effect appears broader for the ventricular tachycardia simulation than for the atrial flutter simulation. These results also provide a plausible explanation for the low test-retest reliability coefficients, particularly for the ventricular tachycardia simulations and support Holzemer et al.'s (1986) caution that once a problem is solved, the solution is remembered so test-retest reliability is inappropriate method for assessing the reliability of clinical simulations. Therefore, the reliability of the computerized clinical simulations used in this investigation is unknown and must be considered when interpreting the study results.

Demographic Characteristics of the Sample

Table 11 presents the demographic characteristics of the study sample (N = 142). Eighty-one percent of the sample was female and 27% male. The average age of the sample was 33.1 years with 8 years nursing experience and 5.7 years critical care experience. The sample was drawn from the eight units of the critical care division: Emergency Room, Medical Intensive Care Unit, Surgical Intensive Care Unit, Burn Unit, Life Flight, Coronary Care Unit, Neurosurgical Intensive Care Unit, and Special Care Unit. Approximately 50% of the registered nurses in the critical care division participated in the study. Both a clinical nurse ladder and administrative nurse ladder exist at the study site. Study

Table 11

Demographic Characteristics of the Study Sample (N = 142)

Variable	n(%)
Sex	
Female	115 (81.0)
Male	27 (19.0)
Unit	
Emergency Room	9 (6.3)
Medical Intensive Care Unit	20 (14.1)
Surgical Intensive Care Unit	31 (22.0)
Burn Unit	19 (14.4)
Life Flight	9 (6.3)
Coronary Care Unit	21 (14.8)
Neurosurgical Intensive Care	18 (12.7)
Special Care Unit	15 (10.6)
Nurse Level	
Clinical Nurse I	7 (4.9)
Clinical Nurse II	99 (69.7)
Clinical Nurse III	18 (12.7)
Administrative Nurse II	18 (12.7)
Shift	
Days	61 (42.9)
Evenings	4 (2.8)
Nights	65 (45.8)
Rotating	12 (8.5)
Nursing Education	
RN by Challange Exam	1 (.7)
Diploma	11 (7.8)
Associate Degree	53 (37.3)
BSN	76 (53.5)
MS	1 (.7)
Percentage Time Worked	
50-80%	16 (11.3)
81-100%	126 (88.7)
ACLS Certification	
Current	111 (78.2)
Not Current	11 (7.8)
Never Certified	20 (14.0)
CCRN Certification	
Current	23 (17.0)
Not Current	29 (4.4)
Never Certified	106 (78.5)
Critical Care Course	
Yes	88 (61.9)
No	54 (38.0)

	M(SD)
Age (years)	33.1 (7.3)
Nursing experience (years)	8.0 (6.9)
Critical care experience (years)	5.7 (4.9)

participants were limited to those providing direct patient care. These included Clinical Nurse I's (new graduate, n = 7), Clinical Nurse II's (staff nurse, n = 99), Clinical Nurse III's (resource nurse, n = 18), and Administrative Nurse II's (charge nurse, n = 18). Shifts in the participating units were predominantly 12 hour shifts. The majority of the sample (88.7%) worked either permanent days (42.9%) or permanent nights (45.8%). Rotating day/night shift was routine among the Life Flight nurses, but not in the other units. A few eight hour evening shifts existed in one unit. The majority of the sample worked full time. Nurses choosing part-time employment were often attending school to pursue an additional degree in nursing or another field or raising small children. The majority of the nurses participating in the study were BSN (53.5%) graduates, followed by 37.3% associate degree and 7.8% diploma graduates. One nurse was initially prepared as a Licensed Vocational Nurse and became a Registered Nurse when he passed the California Licensing Exam. One nurse had a MS in nursing. Seventy-eight percent of the sample was certified in Advanced Cardiac Life Support (ACLS). Seventeen percent were currently CCRN certified. Sixty-two percent had completed a critical care course either in the study facility or at another site.

Analysis

The analysis is divided into four main sections based on the measurement instruments and related hypotheses: (a) BKAT, (b) CST, (c) computer simulations, and (d) BKAT, CST, and computer simulations. Each of the first three sections is further divided into description of

performance on the instrument, research questions and hypotheses, and hypothesis testing. The fourth section relates performance on the three types of instruments.

Basic Knowledge Assessment Tool

The BKAT was used to measure critical care knowledge. The 100 items on the BKAT were scored as either correct or incorrect. Unanswered questions were scored as incorrect. The mean score on the BKAT was 84 with a range of 64 - 97%. The percentage of subjects correctly answering each item ranged from 37 - 99% (Appendix B).

The twenty-five most difficult items were further examined to discover any items that might specifically relate to the tachydysrhythmia simulations. Table 12 presents the categories of the most difficult items. Eight items (33%), were in the cardiovascular category, however, 35% of the BKAT items are in the cardiovascular category so this does not indicate more difficulty with that specific category. Cardiovascular items were examined in detail because of their potential relationship to performance on the tachydysrhythmia simulations. Five of the cardiovascular items were related to the identification or treatment of cardiac dysrhythmias. There were multiple choice questions requiring the identification and treatment of atrial flutter and ventricular tachycardia, which were the dysrhythmias in the computerized clinical simulations completed later in the study. Eighty percent of the subjects correctly identified atrial flutter and 83% correctly identified its treatment. Ventricular tachycardia was correctly identified by 94% of the sample while 99% identified the initial definitive treatment.

Table 12

Categories of the 25 Most Difficult BKAT Items

Category	n	%
Cardiovascular	8	33
Pulmonary	3	13
Neurological	2	8
Metabolic	4	17
Renal	4	17
Gastrointestinal/Nutrition	4	17

Questions and Hypotheses Related to BKAT

1. Will inexperienced and experienced critical care nurses differ on the BKAT score?

Nurses with at least one year of critical care experience will score higher on the BKAT than nurses with less than one year of clinical experience.

2. Will nurses at different levels differ on the BKAT score?

The BKAT score will increase as the nurse level increases.

3. Will CCRN certified and non-CCRN certified nurses differ on the BKAT score?

CCRN certified nurses will score higher on the BKAT than non-CCRN certified nurses.

4. Will ACLS certified and non-ACLS certified nurses differ on the BKAT score?

ACLS certified nurses will score higher on the BKAT than non-ACLS certified nurses.

5. Will nurses completing a critical care course score higher on the BKAT than nurses not completing a critical care course?

Nurses who have completed a critical care course will score higher on the BKAT than nurses who have not completed a critical care course.

Results of Hypothesis Testing

BKAT score was positively correlated with critical care experience, $r = .25$, $p = .003$. Group differences on the BKAT were examined using independent t-tests (Table 13) and analyses of variances (Tables 14 - 16). Nurses with at least one year of critical care experience had higher BKAT scores than nurses with less experience, $t(27) = -3.68$, $p = .001$. There was an overall significant difference related to nurse level, $F(3,138) = 7$, $p = .000$. Post hoc Scheffe' comparisons showed that Administrative Nurse II's, $p = .000$, Clinical Nurse III's, $p = .000$, and Clinical Nurse II's, $p = .001$, had higher mean scores than Clinical Nurse I's. There were no significant differences among the other clinical nurse levels. There was a significant difference due to ACLS certification, $F(2,139) = 23$, $p = .000$. Nurses who had never been ACLS certified had lower BKAT scores than those currently or previously certified, Scheffe', $p = .000$. CCRN certification revealed an overall significant difference, $F(2,132) = 5.8$, $p = .003$. Post hoc Scheffe' comparison showed that CCRN certified nurses scored higher than nurses who had never been CCRN certified, $p = .004$. There were no significant differences between those who had taken a critical care course and those who had not. With the exception of the hypothesis concerning the critical care course, hypotheses related to the BKAT score were supported.

Table 13

Group Differences (t-test) on BKAT

Variable	n	M(SD)	t	df	p
Critical Care Experience	142		-3.68	27	.000
<1 years	23	78(9)			
=>1 years	119	85(7)			
CC Course	142		1.55	85	.063
No	54	82(9)			
Yes	88	85(6)			

Note. All p-values are one-tailed and based on separate variances.

Table 14

Effect of Nurse Level on BKAT Score (N = 142)

	n	M(SD)
CN Level 1	7	73(9)
CN Level 2	99	84(7)
CN Level 3	18	87(6)
AN Level 2	18	86(7)

Source	MSS	F	df	p	eta^2
Nurse Level	351	7.3	3	.000[a]	.136
Residual Error	48		138		

Note. CN=clinical nurse; AN=administrative nurse

[a]Scheffe'- p=.000, ANII>CNI, CNIII>CN I; p=.001 CNII>CN I.

Table 15

Effect of ACLS Certification on BKAT Score (N = 142)

	n	M(SD)			
Certified	111	86(7)			
Not Current	11	85(5)			
Not Certified	20	75(6)			
Source	**MSS**	**F**	**df**	**p**	**eta^2**
ACLS	966	23.2	2	.000[a]	.250
Residual Error	42		139		

[a]Scheffe'- p=.000, ACLS certified and not currently ACLS certified>never certified.

Table 16

Effect of CCRN Certification on BKAT Score (N = 135)

	n	M(SD)			
Certified	23	84(8)			
Not Current	6	85(7)			
Not Certified	106	83(8)			
Source	**MSS**	**F**	**df**	**p**	**eta^2**
CCRN	309	5.8	2	.004[a]	.081
Residual Error	53		132		

[a]Scheffe' p=.004, CCRN certified>never certified.

The Cardiovascular Self-Assessment Tool

The CST was used to measure self-evaluation of clinical expertise in caring for a cardiovascular patient. The possible range of scores on the CST is 0 to 114. Ten subjects failed to answer at least one item.

Missing data on the CST was replaced by the mean value of the total completed items. In the study sample the scores ranged from 31 to 114. The mean score was 97. Eighty-eight percent of the sample had a score of at least 76 indicating that they felt competent caring for an uncomplicated cardiovascular patient. Sixteen subjects had scores of 114. Item means, which ranged from 2.20 to 2.85, are presented in Appendix C. The item with the lowest mean was "Evaluate the EKG to identify patient problems/needs". The item with the highest mean was "Document interventions in the permanent record".

Questions and Hypotheses Related to CST

6. Will inexperienced and experienced critical care nurses differ on the CST score?

> Nurses with at least one year of critical care experience will score higher on the CST than nurses with less than one year of critical care experience..

7. Will nurses at different levels differ on the CST score?

> The CST score will increase as the nurse level increases.

8. Will CCRN certified and non-CCRN certified nurses differ on the CST score?

> CCRN certified nurses will score higher on the CST than non-CCRN certified nurses.

9. Will ACLS certified and non-ACLS certified nurses differ on the CST score?

> ACLS certified nurses will score higher on the CST than non-ACLS certified nurses.

10. Will nurses completing a critical care course score higher on the CST than nurses not completing a critical care course?

> Nurses who have completed a critical care course will score higher on the CST than nurses who have not completed a critical care course.

Results of Hypothesis Testing

The total CST score was significantly correlated with critical care experience, r = .30, p = .000. Two types of analyses were done to examine group differences in performance on the CST. Independent group t-tests were done to examine differences between inexperienced and experienced critical care nurses and between nurses who had completed a critical care course and those who had not (Table 17). Analyses of variance were done to examine differences related to nurse level, ACLS certification, and CCRN certification (Table 18-20). Significant differences were found in all analyses. All hypotheses related to the CST were supported in the predicted direction. The p-values for separate rather than pooled variances were used for the t-tests due to lack of homogeneity of variances. Nurses with at least one year of critical care experience scored significantly higher on the CST than those with less experience, $t(25) = -5.44$, p = .000). Nurses who had taken a critical care course scored higher than those who had not, $t(85) = 2.97$, p = .004). There was a significant difference between nurses at different levels, $F(3,138) = 15$, p = .000). Post hoc Scheffe' comparison showed that Administrative Nurse II's, Clinical Nurse III's, and Clinical Nurse II's all scored significantly higher than Clinical Nurse I's, p = .000. Significant differences were also found for ACLS certification, $F(2,139) = 39$, p = .000, and CCRN certification, $F(2,132) = 5.6$, p = .005. Nurses who were currently ACLS certified or whose certification had expired scored higher than those who had never been certified according to post hoc Scheffe' comparisons, p = .000. CCRN certified nurses also had higher mean scores than nurses who were never CCRN certified (Scheffe', p = .01).

Table 17

Group Differences (t-test) on CST

Variable	n	M(SD)	t	df	p
Critical Care Experience	142		-5.44	25	.000
<1 years	23	71(25)			
=>1 years	119	101(14)			
CC Course	142		2.97	85	.002
No	54	89(24)			
Yes	88	100(14)			

Note. All p-values are one-tailed and based on separate variances.

Table 18

Effect of Nurse Level on CST Score (N = 142)

	n	M(SD)
CN Level 1	7	55(28)
CN Level 2	99	97(17)
CN Level 3	18	100(13)
AN Level 2	18	104(14)

Source	MSS	F	df	p	eta^2
Nurse Level	4456	15.2	3	.000[a]	.248
Residual Error	293		138		

Note. CN=clinical nurse; AN=administrative nurse.

[a]Scheffe'- p=.000, ANII>CNI, CNIII>CNI, CNII>CNI.

Table 19

Effect of ACLS Certification on CST Score (N = 142)

	n	M(SD)
Certified	111	101(20)
Not Current	11	100(11)
Not Certified	20	67(23)

Source	MSS	F	df	p	eta^2
ACLS	9730	39.4	2	.000[a]	.362
Residual Error	247		139		

[a]Scheffe'- p=.000, ACLS certified and not currently ACLS certified>never certified.

Table 20

Effect of CCRN Certification on CST Score (N = 135)

	n	M(SD)
Certified	23	106(9)
Not Current	6	105(9)
Not Certified	106	93(21)

Source	MSS	F	df	p	eta^2
CCRN	2052	5.6	2	.005[a]	.078
Residual Error	367		132		

[a]Scheffe'- p=.01, CCRN certified>never certified.

Simulation Performance

Computerized clinical simulations were used to describe clinical decision making processes and to compare performance with criterion (expert) performance. In this section simulation performance is examined. Following the description of simulation performance, two additional preliminary analyses are reported: (a) comparison of the versions of the atrial flutter and ventricular tachycardia simulations and (b) the impact of defibrillation as a simulation outcome. Lastly, the results of hypothesis testing are reviewed and additional exploratory analyses are discussed.

Description of Simulation Performance

Table 21 presents the descriptive statistics on the simulation variables. Mean proficiency score on the 568 simulations was 42.7%. Atrial flutter proficiency (M = 51.1%) was higher than ventricular tachycardia (M = 34.3%) proficiency. Efficiency scores were similar for both scenarios with a mean of 48.1%. There was more data collected in the atrial flutter simulations while there were more interventions in the ventricular tachycardia simulations. The average amount of data collected was 1.5 items before the first intervention with a total of 3.2 items for the entire simulation. The mean number of interventions was 6.6.

In fifty-nine percent of the scenarios (n = 333) the initial item chosen was data. In the remaining situations the initial choice was an intervention. Forty-three percent of the time, the first item chosen was the patient's current history. Starting an IV was the most frequent

Table 21

Descriptive Statistics on Simulation Variables (N=568)

	Atrial Flutter M(SD)	Ventricular Tachycardia M(SD)	Total M(SD)
Proficiency	51.1(19.3)	34.3(19.2)	42.7(15.7)
Efficiency	49.2(18.0)	47.6(15.6)	48.1(13.1)
Amount of Data Before First Intervention	1.6(1.8)	1.7(1.5)	1.5(1.5)
Time (minutes)	5.3(2.7)	6.2(3.2)	5.7(2.3)
Total Amount of Data Collected	3.7(2.4)	2.8(2.2)	3.2(2.0)
Number of Interventions	5.3(2.8)	8.0(4.2)	6.6(2.8)
Total Number of Simulation Items	8.9(4.1)	10.8(5.6)	9.9(4.2)

	Atrial Flutter n(%)	Ventricular Tachycardia n(%)	Total n(%)
First Item Chosen			
Current History	158(56)	89(31)	247(43)
IV	45(16)	67(24)	112(39)
Oxygen	27(10)	26(9)	53(9)
Physical Exam	21(7)	27(10)	48(8)
Precordial Thump	0(0)	34(12)	34(6)
Cardioversion	4(1)	13(5)	17(3)
Drug Allergies	5(2)	10(4)	15(3)
Past History	7(2)	5(2)	12(2)
Electrolytes	5(2)	2(1)	7(1)
Medications	7(2)	0(0)	7(1)
Blood Gases	5(2)	2(1)	7(1)
Defibrillation	0(0)	7(2)	7(1)
Carotid Massage	2(1)	1(0)	3(1)
Chest X-ray	0(0)	1(0)	1 (0)
First Treatment			
IV	151(53)	144(51)	295(52)
Oxygen	97(34)	81(29)	178(32)
Cardioversion	12(4)	21(7)	33(6)
Precordial Thump	0(0)	19(7)	19(3)
Defibrillation	0(0)	11(4)	11(2)
Intubation	1(0)	4(1)	5(1)
Lidocaine	0(0)	2(1)	2(0)
Dopamine	1(0)	0(0)	1(0)

Table 21 (cont.)

	Atrial Flutter n(%)	Ventricular Tachycardia n(%)	Total n(%)
First Definitive Treatment			
Lidocaine	23(8)	112(39)	135(24)
Digoxin	89(31)	2(1)	90(16)
Verapamil	63(22)	13(5)	76(13)
Cardioversion	31(11)	42(15)	73(13)
Precordial Thump	0(0)	51(18)	51(9)
Dopamine	17(6)	17(6)	34(6)
Carotid Massage	23(8)	8(3)	31(5)
Defibrillation	2(1)	14(5)	16(3)
Lasix	18(6)	4(1)	22(4)
Propranolol	5(2)	4(1)	9(2)
No Treatment	7(2)	0(0)	7(1)
Morphine	3(1)	4(1)	7(1)
Bretylium	2(1)	4(1)	6(1)
Procainamide	1(0)	3(1)	4(1)
Potassium	0(0)	4(1)	4(1)
Pacemaker	0(0)	1(0)	1(0)
Aminophylline	0(0)	1(0)	1(0)
Type of Essential Data Collected Before the First Intervention[a]			
None	162(57)	213(75)	375(66)
Medications	30(11)	9(3)	39(7)
Allergies	38(13)	38(13)	76(13)
Medications & Allergies	54(19)	24(8)	68(12)
Patient Outcome			
Cure	210(74)	54(19)	264(46)
Die	36(13)	100(35)	136(24)
Time Up	31(11)	31(11)	62(11)
Quit	7(2)	19(7)	26(5)
Defibrillation in VT	—	80(28)	—

[a]Essential data as defined by an expert panel

intervention chosen for both atrial flutter and ventricular tachycardia. Data collection was the first item chosen in more atrial flutter (n = 158) than ventricular tachycardia (n = 89) scenarios.

The majority (84%) of the first treatments (oxygen or IV) were in agreement with ACLS protocol for both tachydysrhythmias. Additionally, 7% chose precordial thump as the first treatment in ventricular tachycardia. Administering a precordial thump is an optional first treatment for ventricular tachycardia when the nurse has witnessed the patient going into the rhythm.

Definitive treatment was defined as interventions other than oxygen or starting an IV. Appropriately, the initial definitive treatment was different for the two patient situations. Digoxin, verapamil, or carotid sinus massage were chosen in 57% of the atrial flutter simulations and lidocaine or precordial thump were chosen in 47% of the ventricular tachycardia simulations. In 13% of the atrial flutter simulations and 9% of the ventricular tachycardia simulations the initial definitive treatment was aimed at treating accompanying symptoms of the tachydysrhythmia rather than on curing the rhythm itself. These included administering lasix to treat pulmonary rales, morphine for pain relief, and potassium to correct a mild hypokalemia.

The expert panel described earlier chose medication and medication allergies as the essential data that should be collected before either atrial flutter or ventricular tachycardia were treated. Both items were chosen in only 12% of the simulations. Allergies were chosen in 13% and medications in 7%. Definitive treatment was begun in 57% of the atrial flutter scenarios and 75% of the ventricular tachycardia scenarios without either item.

In the initial research plan, three types of simulation outcomes were anticipated: cure, die, and running out of time. Two additional categories emerged during data collection: chosing to end the scenario

before the fifteen minute time limit and having the computer end the scenario when defibrillation was used as an intervention. Seventy-four percent of the atrial flutter scenarios and 19% of the ventricular tachycardia scenarios ended with the tachydysrhythmia being cured for a mean cure rate of 46%. Twenty-four percent of the scenarios ended when the patient died due to an inappropriate intervention. Time ran out in 62 scenarios. Seven subjects in the atrial flutter scenario and 19 in the ventricular tachycardia scenario chose to end the simulation before the fifteen minute time limit. The reason given was that they were unsure of the appropriate intervention so they would prefer to do nothing. More problematic was the instance of defibrillation in ventricular tachycardia. There was a discrepancy in the response of the computer to defibrillation and the most recent ACLS standards (Montgomery et al., 1986)). The standards allow defibrillation of ventricular tachycardia if the patient is unstable, however, if defibrillation was chosen in the scenario, the simulation was ended by the computer and the subject given a message that the patient had died due to defibrillation of an organized rhythm. The decision was made to consider this as a separate outcome rather than death because of the discrepancy with the standards. As described in the previous chapter, an adjustment was made in the scoring of the simulation to accommodate this outcome.

Medication errors were the cause of death in 87% of the simulations (Table 22). Three types of medication errors resulted in patient death: medication overdose, administering a contraindicated medication, and administering a medication to which the patient was allergic. The most errors were associated with verapamil. It was given inappropriately 46

Table 22

Frequency and Type of Interventions Resulting in Patient Death (n=136)

	Atrial Flutter[a] n(%)	Ventricular Tachycardia[b] n(%)	Total n(%)
Drug Overdose	24(67)	17(17)	41(30)
Drug Contraindicated	1(3)	49(49)	50(37)
Drug Allergy	5(14)	29(29)	34(25)
Percutaneous Pacer	1(3)	5(5)	6(4)
Defibrillation in Atrial Flutter	5(14)	—	—

[a] n = 36; [b] n = 100

times in the ventricular tachycardia scenario. In some instances this was due to lack of knowledge about the treatment of ventricular tachycardia, however, in the majority of cases it was due to lack of recognition of the tachydysrhythmia. The ventricular tachycardia was treated as if it were a supraventricular tachycardia with aberrant conduction by these subjects. Verapamil was an appropriate treatment for the atrial flutter scenario, however, the dose was too high in 13 simulations. Other medications administered in lethal doses were digoxin, procainamide, propranolol, and lidocaine. Additionally, administering a subtherapeutic dose of medication occurred in 42 (bretylium, n = 38; verapamil, n = 4) cases resulting in a lack of cure.

Preliminary Steps

In order to test the hypotheses related to the effect of knowledge, experience, and patient acuity on simulation performance two additional preliminary steps were necessary. First, the two versions of atrial flutter and seven versions of ventricular tachycardia were assessed for comparability. Secondly, the effect of defibrillation in ventricular

tachycardia was examined to determine the impact on simulation variables. A psychometric approach was deemed most appropriate to examine the first question, while a statistical approach was used for the second question.

Comparability of versions of atrial flutter and ventricular tachycardia. Before clinical simulation performance was examined it was necessary to determine the comparability of the two versions of atrial flutter and seven versions of ventricular tachycardia. If the versions were determined to be parallel forms of the same test it would be possible to combine the two atrial flutter simulations received by each subject for a mean atrial score and to combine the two ventricular tachycardia simulations for a mean ventricular score.

The versions of each type of simulation were assessed for comparability by examining the content of each simulation and determining the number and type of parameters distinguishing the simulation versions (Appendix D). The two versions of atrial flutter differed on their responsiveness to verapamil. Both versions of atrial flutter were cured by synchronized cardioversion or transvenous pacemaker, but only version 1 was cured by verapamil. The most frequent version of ventricular tachycardia was version 1 (88%). The remaining six versions differed from version 1 on the following parameters: vital signs, arterial blood gases, potassium, medication allergies, and responsiveness to bretylium. These differences between the multiple versions of each simulation type substantiated the lack of comparable content among the versions and negated the notion that they represented parallel forms of the same test. To decrease the confounding effect of simulation version on clinical simulation performance, the decision was

made to use atrial flutter, version 2, for the lower acuity patient situation and ventricular tachycardia, version 1, to represent the high acuity patient situation. If a subject completed two simulations of either version, the first instance was used. Subjects not completing either an atrial flutter, version 2, or a ventricular tachycardia, version 1, were dropped from the sample (n = 41).

Comparison of ventricular tachycardia simulation variables in simulations ending by defibrillation and other simulations. In order to explore the potential impact of early termination of the simulation due to choosing defibrillation in ventricular tachycardia, simulation performance with this outcome was compared to the other four outcomes: (a) curing the tachydysrhythmia, (b) causing the patient's death by inappropriate intervention, (c) running out of time before either a or b occurred, and (d) choosing to end the simulation before a or b occurred. The 101 nurses who completed at least one atrial flutter, version 2, and one ventricular tachycardia, version 1, were the sample for the analysis. A series of t-tests compared subjects who defibrillated in ventricular tachycardia with those who did not. As Table 23 shows the two groups were significantly different on proficiency score, $t(83) = -4.82$, $p = .000$, and time taken to complete the simulation, $t(97) = -8.50$, $p = .000$. The impact of defibrillation in the instance of ventricular tachycardia was judged to be substantial. Therefore, the 33 subjects who defibrillated in ventricular tachycardia were dropped from the data analysis.

Based on the two preliminary analyses described, the sample size was reduced to decrease the confounding variables of (a) simulation version and (b) discrepancy between current ACLS standards and the

Table 23

Comparison of Simulation Scores of Subjects Who Defibrillated in Ventricular Tachycardia and Those Who Did Not (n = 101)

Score	Defibrillation M(SD)	No Defibrillation M(SD)	t	df	p
Proficiency	17.9(18.2)	38.9(24.8)	-4.8	83	.000
Efficiency	36.7(26.9)	49.5(19.5)	-2.4	49	.017
Time	2.6(2.1)	7.7(3.8)	-8.5	97	.000
Amount of Data Before First Intervention	0.5(1.3)	1.4(1.6)	-2.8	81	.007

Note. All p-values are two tailed and based on separate variances.

simulation's response to defibrillation in ventricular tachycardia. The sample for testing the hypotheses related to simulation performance consisted of those nurses who had completed at least one atrial flutter (version 2) and ventricular tachycardia (version 1); and who did not defibrillate in ventricular tachycardia. The resulting sample size was 68.

Hypotheses Related to Simulation Performance

11. Does years of critical care experience affect computerized clinical simulation performance as measured by proficiency score, efficiency score, amount of data collected before the first intervention, patient outcome, and time taken to complete the simulation?

> Nurses with at least one year of critical care experience will have higher proficiency scores, higher efficiency scores, collect less data before the first intervention, cure more tachydysrhythmias, and take less time to complete the simulations than nurses with less than one year critical care experience.

12. Does nurse level affect computerized clinical simulation performance as measured by proficiency score, efficiency score, amount of data collected before the first intervention, patient outcome, and time taken to complete the simulation?

> As nurse level increases proficiency score, efficiency score, and number of tachydysrhythmias cured will increase and amount of data collected before the first intervention and time taken to complete the simulation will decrease.

13. Does CCRN certification affect computerized clinical simulation performance as measured by proficiency score, amount of data collected before the first intervention, patient outcome, and time taken to complete the simulations?

> CCRN certified nurses will have higher proficiency scores, higher efficiency scores, collect less data before the first intervention, cure more tachydysrhythmias, and take less time to complete the simulations than non-CCRN certified nurses.

14. Does ACLS certification affect computerized clinical simulation performance as measured by proficiency score, efficiency score, amount of data collected before the first intervention, patient outcome, and time taken to complete the simulation?

> ACLS certified nurses will have higher proficiency scores, higher efficiency scores, collect less data before the first intervention, cure more tachydysrhythmias, and take less time to complete the simulations than non-ACLS certified nurses.

15. Does completion of a critical care course affect computerized clinical simulation performance as measured by proficiency score, efficiencyscore, amount of data collected before the first intervention, patient outcome, and time taken to complete the simulation?

> Nurses who have completed a critical care course will have higher proficiency scores, higher efficiency scores, collect less data before the first intervention, cure more tachydysrhythmias, and take less time to complete the simulations than nurses who have not completed a critical care course.

16. Does acuity of the patient situation (ventricular tachycardia versus atrial flutter) affect computerized clinical simulation performance as measured by proficiency score, efficiency score, the amount of data collected before the first intervention, patient outcome, and time taken to complete the simulation?

> Acuity of the patient situation will not affect computerized clinical simulation performance as measured by proficiency score, efficiency score, amount of data collected before the first intervention, patient outcome and time taken to complete the simulation.

17. Is there an interaction between acuity of the patient situation (ventricular tachycardia versus atrial flutter) and critical care experience on clinical simulation performance?

> Nurses with at least one year critical care experience will collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while nurses with less than one year critical care experience will not collect less data before the first intervention or take less time to complete the ventricular tachycardia simulation than in the atrial flutter simulation.
>
> Nurses with at least one year critical care experience will not have significantly lower proficiency scores, efficiency scores, or cure more tachydysrhythmias in the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while nurses with less than one year critical care experience will have higher proficiency scores, higher efficiency scores, and cure more tachydysrhythmias in the less acute situation.

18. Is there an interaction between acuity of the patient situation (ventricular tachycardia versus atrial flutter) and nurse level on clinical simulation performance?

> Nurses at higher levels will collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while Clinical Nurse Is will not collect less data before the first intervention or take less time to complete the ventricular tachycardia simulation than in the atrial flutter simulation.

Nurses at higher levels on the clinical nurse ladder will not have significantly lower proficiency scores, efficiency scores, or cure more tachydysrhythmias in the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while Clinical Nurse I's will have higher proficiency scores, higher efficiency scores, and cure more tachydysrhythmias in the less acute situation.

19. Is there an interaction between acuity of the patient situation (ventricular tachycardia versus atrial flutter) and CCRN certification on clinical simulation performance?

Nurses who are CCRN certified will collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while non-CCRN certified nurses will not collect less data before the first intervention or take less time to complete the ventricular tachycardia simulation than in the atrial flutter simulation.

Nurses who are CCRN certified will not have significantly lower proficiency scores, efficiency scores, or cure more tachydysrhythmias in the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while non-CCRN certified nurses will have higher proficiency scores, higher efficiency scores, and cure more tachydysrhythmias in the less acute situation.

20. Is there an interaction between acuity of the patient situation (ventricular tachycardia versus atrial flutter) and ACLS certification on clinical simulation performance?

Nurses who are ACLS certified will collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while non-ACLS certified nurses will not collect less data before the first intervention or take less time to complete the ventricular tachycardia simulation than in the atrial flutter simulation.

Nurses who are ACLS certified will not have significantly lower proficiency scores, efficiency scores, or cure more tachydysrhythmias in the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while non-ACLS certified nurses will have higher proficiency scores, higher efficiency scores, and cure more tachydysrhythmias in the less acute situation.

21. Is there an interaction between acuity of the patient situation (ventricular tachycardia versus atrial flutter) and completion of a critical care course on clinical simulation performance?

> Nurses who have completed a critical care course will collect less data before the first intervention and take less time to complete the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while nurses who have not completed a critical care course will notcollect less data before the first intervention or take less time to complete the ventricular tachycardia simulation than in the atrial flutter simulation.
>
> Nurses who have completed a critical care course will not have significantly different proficiency scores, efficiency scores, or cure more tachydysrhythmias in the ventricular tachycardia simulation (high acuity) than in the atrial flutter simulation (less acute) while nurses who have not completed a critical care course will have higher proficiency scores, higher efficiency scores, and cure more tachydysrhythmias in the less acute situation.

Comparison Between Simulation Variables in Atrial Flutter (Version 2) and Ventricular Tachycardia (Version 1)

The correlation matrix for the atrial flutter and ventricular tachycardia simulation variables is presented in Table 24. Atrial proficiency is positively correlated with the amount of data collected before the first intervention, r = .36, p = .002. Atrial efficiency is negatively correlated with time to complete the simulation, r = -.67, p = .000. In the ventricular simulations proficiency is positively correlated with efficiency, r = .42, p =.000 and with time to complete the simulation, r = .71, p = .000. In contrast to atrial efficiency, ventricular efficiency is not significantly correlated with time. Atrial and ventricular simulations are positively correlated on two variables, efficiency score, r = .34, p = .005, and amount of data

Table 24

Intercorrelations (r) Between Atrial Flutter (AF) and Ventricular Tachycardia (VT) Simulation Variables (N-68)

	AFpro	VTpro	AFeff	VTeff	AFtime	VTtime	AFdata	VTdata
AFpro	100							
	.000							
VTpro	25	100						
	.038	.000						
AFeff	07	- 01	100					
	.567	.929	.000					
VTeff	27	42	34	100				
	.023	.000	.005	.000				
AFtime	13	07	- 67	- 08	100			
	.303	.577	.000	.421	.000			
VTtime	- 08	71	- 13	18	03	100		
	.524	.000	.303	.071	.724	.000		
AFdata	36	22	- 29	- 03	17	21	100	
	.002	.072	.018	.781	.169	.087	.000	
VTdata	17	03	- 14	- 14	02	- 03	40	100
	.174	.815	.264	.262	.896	.807	.001	.000

Note. Decimal points have been omitted in the correlation coefficients.
pro-proficiency score;
eff-efficiency score;
time-time to complete the simulation;
data-amount of data collected before the first intervention.

collected before the first intervention, $r = .40$, $p = .001$. Although, not surprisingly, several simulation variables were highly correlated, a univariate analysis, with a stringent α (.005) to control Type I error rate, was judged to be appropriate for the data for two reasons. First, the relationships were not consistent across both types of simulations. For example, proficiency and efficiency score were significantly correlated in the ventricular tachycardia simulation, but not in the

atrial flutter simulation. Secondly, the simulation variables of proficiency, efficiency, amount of data collected before the first intervention, and time, while related, are theoretically different. Proficiency is an outcome measure of clinical decision making, for example, and amount of data collected before the first intervention is a measure of one aspect of the process of clinical decision making.

Point-biserial correlations were used to determine the relationship between patient outcome and proficiency score, efficiency score, time to complete the simulation, and amount of data collected before the first intervention. The sample for this correlation matrix (Table 25) is restricted to atrial flutter version two simulations in which the patient was either cured of the tachydysrhythmia or died from an inappropriate intervention. Simulations which ended at the subject's prerogative before completion or when 15 minutes passed were not included. Curing the tachydysrhythmia was positively correlated with proficiency score, $r = 45$, $p = .000$.

Table 26 presents the correlations on the ventricular tachycardia simulation between patient outcome and proficiency score, efficiency score, time to complete the simulation, and amount of data collected before the first intervention. Only subjects who cured the dysrhythmia or intervened inappropriately resulting in patient death are included in this analysis. Subjects who chose to end the scenario, ran out of time, or defibrillated were excluded from this analysis. Curing the tachydysrhythmia was positively correlated with proficiency, $r = .56$, $p = .000$, and efficiency, $r = .51$, $p = .000$.

Table 25

Point-Biserial Correlation (r) of Patient Outcome with Continuous Variables in Atrial Flutter (AF) Simulation (n=94)

	AFpro	AFeff	AFtime	AFDdata
AF Cure	45	26	04	05
	.00	.01	.69	.64

Note. Decimal points have been omitted in the correlation coefficients.
pro=proficiency score;
eff=efficiency score;
time=time to complete the simulation;
data=amount of data collected before the first intervention.

Table 26

Point-Biserial Correlation (r) of Patient Outcome with Continous Variables in Ventricular Tachycardia (VT) Simulation (n=57)

	VTpro	VTeff	VTtime	VTdata
VT Cure	56	51	07	07
	.00	.00	.61	.58

Note. Decimal points have been omitted in the correlation coefficients.
pro=proficiency score;
eff=efficiency score;
time=time to complete the simulation;
data=amount of data collected before the first intervention.

Results of Hypotheses Related to Simulation Performance

Three methods were used to examine the effect of knowledge, experience, and level of patient acuity on simulation performance: two way repeated measures analysis of variance, Chi-square analysis, and the McNemar test of homogeneity of proportions for qualitative variables in correlated samples. First, the results from the analyses of variance are reported followed by the Chi-square and McNemar test.

A series of two way repeated measures analyses of variance were done to examine the effect of knowledge, experience, and level of patient acuity on simulation performance. The five between group factors for the analyses were critical care experience, nurse level, CCRN certification, ACLS certification, and critical care course completion. The within group factor for all analyses was level of patient acuity with atrial flutter as the lower acuity situation and ventricular tachycardia as the high acuity situation. The four dependent variables in the analyses for hypothesis testing were proficiency score, efficiency score, amount of data collected before the first intervention, and time to complete the simulation. Additional exploratory analyses were conducted with number of interventions chosen as the dependent variable. Tables 27 to 51 present the results of the analyses. Significant main and interaction effects related to each dependent variable are summarized in the following section. Alpha was set at .005 for each effect in each analysis in an attempt to control Type I error.

Proficiency score. There was a significant main effect of patient acuity in all analyses with proficiency score as a dependent variable: critical care experience, $F(1,66) = 14$, $p = .000$; nurse level, $F(1,64) = 14$, $p = .001$; CCRN certification, $F(1,60) = 14$, $p = .001$; ACLS certification, $F(1,65) = 14$, $p = .000$; and critical care course, $F(1,66) = 14$, $p = .000$. Patient acuity accounted for 13% of the variance. Mean atrial flutter proficiency score was 52%, while the proficiency score in the more acute situation, ventricular tachycardia, was 38%. While not statistically significant, ACLS certification, $p = .033$, and nurse level, $p = .058$, accounted for 10% and 11% of the variance, respectively. There were no significant interaction effects.

Table 27

Effect of Critical Care (CC) Experience and Level of Patient Acuity on Simulation Proficiency Scores (n = 68)

Factor	n	M(SD)
CC Experience<1yr	22	38(27)
CC Experience>=1yr	114	47(24)
AF Proficiency	68	52(23)
VT Proficiency	68	39(25)
CC Experience<1yr X AF Proficiency	11	45(28)
CC Experience<1yr X VT Proficiency	11	31(25)
CC Experience>=1yr X AF Proficiency	57	53(22)
CC Experience>=1yr X VT Proficiency	57	40(25)

Source	MSS	F	df	p	eta^2
CC Experience	1330	1.91	1	.172	.028
Residual Error	696		66		
Patient Acuity	5956	13.87	1	.000	.126
CC Experience X Acuity	4	.01	1	.925	.000
Residual Error	429		66		

Table 28

Effect of Nurse Level and Level of Patient Acuity on Simulation Proficiency Scores (n = 68)

Factor	n	M(SD)
CN Level 1	4	15(10)
CN Level 2	98	46(25)
CN Level 3	24	44(22)
AN Level 2	10	57(24)
AF Proficiency	68	52(23)
VT Proficiency	68	39(25)
CN Level 1 X AF Proficiency	2	22(11)
CN Level 1 X VT Proficiency	2	8(00)
CN Level 2 X AF Proficiency	49	52(24)
CN Level 2 X VT Proficiency	49	40(24)
CN Level 3 X AF Proficiency	12	55(16)
CN Level 3 X VT Proficiency	12	33(22)
AN Level 2 X AF Proficiency	5	60(15)
AN Level 2 X VT Proficiency	13	54(32)

Source	MSS	*F*	df	*p*	eta^2
Nurse Level	1726	2.62	3	.058	.109
Residual Error	658		64		
Patient Acuity	5956	13.76	1	.001	.126
Nurse Level X Acuity	214	0.49	3	.691	.014
Residual Error	432		64		

Note. CN=clinical nurse; AN=administrative nurse.

Table 29

Effect of CCRN Certification and Level of Patient Acuity on Proficiency Score (n = 63)[a]

Factor	n	M(SD)
CCRN Certified	26	46(26)
Not Current	10	50(23)
Never Certified	90	46(25)
AF Proficiency	63	52(23)
VT Proficiency	63	38(25)
CCRN Certified X AF Proficiency	13	55(25)
CCRN Certified X VT Proficiency	13	37(26)
Not Current X AF Proficiency	5	48(22)
Not Current X VT Proficiency	5	52(27)
Never Certified X AF Proficiency	45	52(24)
Never Certified X VT Proficiency	45	37(25)

Source	MSS	F	df	p	eta^2
CCRN	155	0.20	2	.818	.007
Residual Error	763		60		
Patient Acuity	6048	13.52	1	.001	.131
CCRN x Acuity	442	0.80	2	.382	.019
Residual Error	448		60		

[a]Missing data on 5 subjects.

Table 30

Effect of ACLS Certification and Level of Patient Acuity on Proficiency Score (n = 68)

Factor	n	M(SD)
ACLS Certified	108	48(25)
Not Current	10	44(24)
Never Certified	18	31(20)
AF Proficiency	68	52(23)
VT Proficiency	68	39(25)
ACLS Certified X AF Proficiency	54	56(21)
ACLS Certified X VT Proficiency	54	41(26)
Not Current X AF Proficiency	5	48(29)
Not Current X VT Proficiency	5	40(19)
Never Certified X AF Proficiency	9	33(19)
Never Certified X VT Proficiency	9	28(22)

Source	MSS	F	df	p	eta^2
ACLS	2347	3.58	2	.033[a]	.099
Residual Error	656		65		
Patient Acuity	5956	13.87	1	.000	.126
ACLS x Acuity	218	0.51	2	.608	.009
Residual Error	429		65		

[a]Scheffe'-p=.034, ACLS Certified>Never Certified.

Table 31

Effect of Critical Care (CC) Course and Level of Patient Acuity on Simulation Proficiency Scores (n = 68)

Factor	n	M(SD)
CC Course	92	48(25)
No CC Course	44	42(23)
AF Proficiency	68	52(23)
VT Proficiency	68	40(25)
CC Course X AF Proficiency	46	55(22)
CC Course X VT Proficiency	46	40(26)
No CC Course X AF Proficiency	22	45(23)
No CC Course X VT Proficiency	22	37(23)

Source	MSS	F	df	p	eta^2
CC Course	1140	1.63	1	.206	.024
Residual Error	700		66		
Patient Acuity	5956	14.10	1	.000	.126
CC Course X Acuity	469	1.11	1	.296	.001
Residual Error	240		66		

Efficiency score. There were no significant main effects or interaction effects with efficiency score as the dependent variable. Tables 32-36 present the results of the analyses.

Table 32

Effect of Critical Care (CC) Experience and Level of Patient Acuity on Simulation Efficiency Scores (n = 68)

Factor	n	M(SD)
CC Experience<1yr	22	44(15)
CC Experience>=1yr	114	48(20)
AF Efficiency	68	45(19)
VT Efficiency	68	50(20)
CC Experience<1yr X AF Efficiency	11	50(20)
CC Experience<1yr X VT Efficiency	11	46(13)
CC Experience<=1yr X AF Efficiency	57	45(20)
CC Experience<=1yr X VT Efficiency	57	51(20)

Source	MSS	F	df	p	eta^2
CC Experience	357	0.73	1	.397	.011
Residual Error	491		66		
Patient Acuity	644	2.71	1	.104	.020
CC Experience X Acuity	458	1.93	1	.170	.014
Residual Error	237		66		

Table 33

Effect of Nurse Level and Level of Patient Acuity on Simulation Efficiency Scores (n = 68)

Factor	*n*	*M*(SD)
CN Level 1	4	31(12)
CN Level 2	98	48(19)
CN Level 3	24	45(18)
AN Level 2	10	51(23)
AF Efficiency	68	45(19)
VT Efficiency	68	50(20)
CN Level 1 X AF Efficiency	2	35(08)
CN Level 1 X VT Efficiency	2	28(18)
CN Level 2 X AF Efficiency	49	46(20)
CN Level 2 X VT Efficiency	49	50(19)
CN Level 3 X AF Efficiency	12	40(14)
CN Level 3 X VT Efficiency	12	50(21)
AN Level 2 X AF Efficiency	5	56(20)
AN Level 2 X VT Efficiency	5	47(26)

Source	MSS	*F*	df	*p*	eta^2
Nurse Level	456	0.93	3	.436	.042
Residual Error	490		64		
Patient Acuity	644	2.68	1	.106	.020
Nurse Level X Acuity	249	1.04	3	.378	.023
Residual Error	240		64		

Note. CN=clinical nurse; AN=administrative nurse.

Table 34

Effect of CCRN Certification and Level of Patient Acuity on Efficiency Score (n = 63)[a]

Factor	n	M(SD)
CCRN Certified	26	43(21)
Not Current	10	38(13)
Never Certified	90	49(19)
AF Efficiency	63	45(19)
VT Efficiency	63	49(20)
CCRN Certified X AF Efficiency	13	42(25)
CCRN Certified X VT Efficiency	13	45(17)
Not Current X AF Efficiency	5	35(08)
Not Current X VT Efficiency	5	41(16)
Never Certified X AF Efficiency	45	47(18)
Never Certified X VT Efficiency	45	51(21)

Source	MSS	F	df	p	eta^2
CCRN	796	1.58	2	.213	.050
Residual Error	505		93		
Patient Acuity	401	1.50	1	.213	.013
CCRN x Acuity	7	0.03	2	.975	.000
Residual Error	254				

[a]Missing data on five subjects.

Table 35

Effect of ACLS Certification and Level of Patient Acuity on Efficiency Score (n = 68)

Factor	n	M(SD)
ACLS Certified	108	48(20)
Not Current	10	50(16)
Never Certified	18	42(18)
AF Efficiency	68	45(19)
VT Efficiency	68	50(19)
ACLS Certified X AF Efficiency	54	46(19)
ACLS Certified X VT Efficiency	54	51(20)
Not Current X AF Efficiency	5	47(16)
Not Current X VT Efficiency	5	52(18)
Never Certified X AF Efficiency	9	42(17)
Never Certified X VT Efficiency	9	41(20)

Source	MSS	F	df	p	eta^2
ACLS	355	0.72	2	.493	.022
Residual Error	493		65		
Patient Acuity	644	2.62	1	.111	.020
ACLS x Acuity	54	0.22	2	.804	.003
Residual Error	246				

Table 36

Effect of Critical Care (CC) Course and Level of Patient Acuity on Simulation Efficiency Scores (n = 68)

Factor	n	M(SD)
CC Course	92	48(19)
No CC Course	44	46(20)
AF Efficiency	68	45(19)
VT Efficiency	68	50(20)
CC Course X AF Efficiency	46	47(18)
CC Course X VT Efficiency	46	49(20)
No CC Course X AF Efficiency	22	42(19)
No CC Course X VT Efficiency	22	50(20)

Source	MSS	F	df	p	eta^2
CC Course	99	0.20	1	.656	.003
Residual Error	495		66		
Patient Acuity	644	2.69	1	.106	.020
CC Course X Acuity	286	1.19	1	.279	.009
Residual Error	240		66		

Amount of data collected before the first intervention. There were no significant main or interaction effects for the amount of data collected before the first intervention. However, in three analyses, the between group factor contributed at least 6% of the explained variance: critical care experience, 6%; nurse level 8%; and ACLS certification, 9%.

Table 37

Effect of Critical Care (CC) Experience and Level of Patient Acuity on Amount of Data Collected Before the First Intervention (n = 68)

Factor	n	M(SD)
CC Experience<1yr	22	2.4(1.8)
CC Experience>=1yr	114	1.5(1.7)
AF Data	68	1.9(1.9)
VT Data	68	1.4(1.6)
CC Experience<1yr X AF Data	11	2.2(1.2)
CC Experience<1yr X VT Data	11	2.6(2.2)
CC Experience<=1yr X AF Data	57	1.8(2.0)
CC Experience<=1yr X VT Data	57	1.1(1.4)

Source	MSS	F	df	p	eta^2
CC Experience	17	4.05	1	.048	.060
Residual Error	4		66		
Patient Acuity	8	4.38	1	.040	.028
CC Experience X Acuity	6	3.17	1	.080	.020
Residual Error	2		66		

Table 38

Effect of Nurse Level and Level of Patient Acuity on Amount of Data Collected Before the First Intervention (n = 68)

Factor	n	M(SD)
CN Level 1	4	3.0(2.9)
CN Level 2	98	1.8(1.8)
CN Level 3	24	1.1(1.6)
AN Level 2	10	0.8(0.4)
AF Data	68	1.9(1.9)
VT Data	68	1.4(1.6)
CN Level 1 X AF Data	2	2.5(0.7)
CN Level 1 X VT Data	2	3.5(4.9)
CN Level 2 X AF Data	49	2.0(2.0)
CN Level 2 X VT Data	49	1.5(1.6)
CN Level 3 X AF Data	12	1.3(1.9)
CN Level 3 X VT Data	12	0.8(1.3)
AN Level 2 X AF Data	5	1.0(0.0)
Adm. Nurse 2 X VT Data	5	0.6(0.5)

Source	MSS	F	df	p	eta^2
Nurse Level	8	1.87	3	.143	.080
Residual Error	4		64		
Patient Acuity	8	4.13	1	.046	.028
Nurse Level X Acuity	1	0.40	3	.755	
Residual Error	2		64		.008

Note. CN=clinical nurse; AN=administrative nurse.

Table 39

Effect of CCRN Certification and Level of Patient Acuity on Amount of Data Collected Before the First Intervention (n = 63)[a]

Factor	n	M(SD)
CCRN Certified	26	1.2(1.5)
Not Current	10	2.1(2.6)
Never Certified	90	1.8(1.8)
AF Data	63	1.9(1.9)
VT Data	63	1.5(1.7)
CCRN Certified X AF Data	13	1.7(1.8)
CCRN Certified X VT Data	13	0.6(0.8)
Not Current X AF Data	5	3.2(3.5)
Not Current X VT Data	5	1.0(0.7)
Never Certified X AF Data	45	1.9(1.7)
Never Certified X VT Data	45	1.8(1.8)

Source	MSS	F	df	p	eta^2
CCRN	5.2	1.19	2	.309	.038
Residual Error	4.4		60		
Patient Acuity	7.1	3.82	1	.055	.026
CCRN x Acuity	6.4	3.42	2	.039	.047
Residual Error	1.9		60		

[a]Missing data on five subjects.

Table 40

Effect of ACLS Certification and Level of Patient Acuity on Amount of Data Collected Before the First Intervention (n = 68)

Factor	n	M(SD)
ACLS Certified	108	1.4(1.5)
Not Current	10	2.8(3.2)
Never Certified	18	2.2(1.7)
AF Data	68	1.9(1.9)
VT Data	68	1.4(1.6)
ACLS Certified X AF Data	54	1.7(1.8)
ACLS Certified X VT Data	54	1.1(1.2)
Not Current X AF Data	5	3.2(3.5)
Not Current X VT Data	5	2.4(3.2)
Never Certified X AF Data	9	1.8(0.8)
Never Certified X VT Data	9	2.7(2.3)

Source	MSS	F	df	p	eta^2
ACLS	12.9	3.17	2	.048	.089
Residual Error	4.1		65		
Patient Acuity	8.0	4.46	1	.039	.028
ACLS x Acuity	4.9	2.74	2	.072	.034
Residual Error	1.8		65		

Table 41

Effect of Critical Care (CC) Course Level of Patient Acuity on Amount of Data Collected Before the First Intervention (n = 68)

Factor	n	M(SD)
CC Course	92	1.6(1.9)
No CC Course	44	1.7(1.6)
AF Data	68	1.9(1.9)
VT Data	68	1.4(1.6)
CC Course X AF Data	46	1.9(2.1)
CC Course X VT Data	46	1.2(1.6)
No CC Course X AF Data	22	1.7(1.4)
No CC Course X VT Data	22	1.6(1.8)

Source	MSS	F	df	p	eta^2
CC Course	0	0.08	1	.784	.000
Residual Error	4		66		
Patient Acuity	8	4.26	1	.043	.028
CC Course X Acuity	3	1.34	1	.250	.009
Residual Error	2		66		

Time to complete the simulation. There were no main or interaction effects (Tables 42-46), however several trends were found in the analysis. Patient acuity contributed 6% of the explained variance. Two interactions, nurse level X acuity and CCRN certification X acuity, each explained 9% of the variance.

Table 42

Effect of Critical Care (CC) Experience and Level of Patient Acuity on Time to Complete the Simulation (n = 68)

Factor	n	M(SD)
CC Experience<1yr	22	6.5(2.7)
CC Experience>=1yr	114	7.2(3.9)
AF Time	68	6.4(3.5)
VT Time	68	7.7(3.8)
CC Experience<1yr X AF Time	11	6.0(3.5)
CC Experience<1yr X VT Time	11	7.0(1.7)
CC Experience<=1yr X AF Time	57	6.5(3.6)
CC Experience<=1yr X VT Time	57	7.8(4.1)

Source	MSS	F	df	p	eta^2
CC Experience	7	0.54	1	.466	.008
Residual Error	14		66		
Patient Acuity	55	4.16	1	.045	.057
CC Experience X Acuity	1	0.60	1	.831	.000
Residual Error	13		66		

Table 43

Effect of Nurse Level and Level of Patient Acuity on Time (minutes) to Complete the Simulation (n = 68)

Factor	n	M(SD)
CN Level 1	4	5.1(1.0)
CN Level 2	98	7.0(3.8)
CN Level 3	24	7.3(3.8)
AN Level 2	10	7.7(4.2)
AF Time	68	6.4(3.5)
VT Time	68	7.7(3.8)
CN Level 1 X AF Time	2	4.2(0.4)
CN Level 1 X VT Time	2	5.9(0.1)
CN Level 2 X AF Time	49	6.2(3.4)
CN Level 2 X VT Time	49	7.8(4.0)
CN Level 3 X AF Time	12	8.2(4.5)
CN Level 3 X VT Time	12	6.4(2.8)
AN Level 2 X AF Time	5	5.3(1.1)
AN Level 2 X VT Time	5	10.0(4.9)

Source	MSS	*F*	df	*p*	eta^2
Nurse Level	7	0.48	3	.699	.022
Residual Error	15		64		
Patient Acuity	55	4.48	1	.038	.057
Nurse Level X Acuity	29	2.38	3	.077	.090
Residual Error	12		64		

Note. CN=clinical nurse; AN=administrative nurse.

Table 44

Effect of CCRN Certification and Level of Patient Acuity on Time Taken to Complete the Simulation (n = 63)[a]

Factor	n	M(SD)
CCRN Certified	26	7.7(4.3)
Not Current	10	8.7(4.3)
Never Certified	90	6.5(3.5)
AF Time	63	6.4(3.6)
VT Time	63	7.6(3.9)
CCRN Certified X AF Time	13	8.0(4.6)
CCRN Certified X VT Time	13	7.5(4.1)
Not Current X AF Time	5	5.7(1.9)
Not Current X VT Time	5	11.8(3.9)
Never Certified X AF Time	45	5.9(3.4)
Never Certified X AF Time	45	7.1(3.6)

Source	MSS	F	df	p	eta^2
CCRN	32	2.32	2	.106	.072
Residual Error	14		60		
Patient Acuity	14	3.66	1	.060	.051
CCRN x Acuity	29	2.10	2	.054	.085
Residual Error	14				

[a]Five subjects had missing data.

Table 45

Effect of ACLS Certification and Level of Patient Acuity on Time Taken to Complete the Simulation (n = 68)

Factor	n	M(SD)
ACLS Certified	108	7.2(3.9)
Not Current	10	6.9(3.3)
Never Certified	18	6.5(2.9)
AF Time	68	6.4(3.5)
VT Time	68	7.7(3.8)
ACLS Certified X AF Time	54	6.5(3.6)
ACLS Certified X VT Time	54	7.8(4.1)
Not Current X AF Time	5	5.2(2.9)
Not Current X VT Time	5	8.6(3.1)
Never Certified X AF Time	9	6.4(3.9)
Never Certified X AF Time	9	6.6(1.8)

Source	MSS	F	df	p	eta^2
ACLS	4	0.26	2	.771	.008
Residual Error	15		65		
Patient Acuity	55	4.17	1	.045	.057
ACLS x Acuity	8	0.25	2	.536	.017
Residual Error	13		65		

Table 46

Effect of Critical Care (CC) Course Level of Patient Acuity on Time to Complete the Simulation (n = 68)

Factor	n	M(SD)
CC Course	92	7.2(3.7)
No CC Course	44	6.7(3.7)
AF Time	68	6.4(3.5)
VT Time	68	7.7(3.8)
CC Course X AF Time	46	6.4(3.3)
CC Course X VT Time	46	8.0(4.0)
No CC Course X AF Time	22	6.4(4.1)
No CC Course X VT Time	22	7.1(3.4)

Source	MSS	F	df	p	eta^2
CC Course	7	0.51	1	.477	.007
Residual Error	14		66		
Patient Acuity	55	4.19	1	.045	.057
CC Course X Acuity	5	0.40	1	.531	.005
Residual Error	13		66		

Exploratory two way repeated measure ANOVAs were done to examine the effect of critical care experience, clinical nurse level, CCRN certification, ACLS certification, and completing a critical care course on number of interventions chosen in the simulation.

Number of interventions chosen. There was a significant within group effect in all ANOVAs with number of interventions chosen as the dependent variable, $p = .001$, $eta^2 = .136$ (Tables 47-51). Only nurse level had a significant interaction effect, $F(3,64) = 5$, $p = .002$, accounting for 14% of the explained variance. The largest number of interventions were chosen by the Administrative Nurse II's in the ventricular tachycardia simulation.

Table 47

Effect of Critical Care (CC) Experience and Level of Patient Acuity on Number of Interventions Chosen (n = 68)

Factor	n	M(SD)
CC Experience<1yr	26	6.7(4.9)
CC Experience>=1yr	114	7.9(5.1)
AF Time	68	6.4(3.9)
VT Time	68	9.1(5.8)
CC Experience<1yr X AF Intervention	11	4.5(2.3)
CC Experience<1yr X VT Intervention	11	8.9(6.0)
CC Experience>=1yr X AF Intervention	57	6.7(4.0)
CC Experience>=1yr X VT Intervention	57	9.2(5.8)

Source	MSS	F	df	p	eta^2
CC Experience	27	0.96	1	.331	.014
Residual Error	29		66		
Patient Acuity	260	13.04	1	.001	.136
CC Experience X Acuity	17	0.84	1	.362	.009
Residual Error	20		66		

Table 48

Effect of Nurse Level and Level of Patient Acuity on Number of Interventions Chosen (n=68)

Factor	n	M(SD)
CN Level 1	4	4.3(1.3)
CN Level 2	98	7.7(4.8)
CN Level 3	24	7.7(4.5)
AN Level 2	10	10.2(8.8)
AF Intervention	68	6.4(3.9)
VT Intervention	68	9.1(5.8)
CN Level 1 X AF Intervention	2	3.5(0.7)
CN Level 1 X VT Intervention	2	5.0(1.4)
CN Level 2 X AF Intervention	49	6.0(3.4)
CN Level 2 X VT Intervention	49	9.3(5.4)
CN Level 3 X AF Intervention	12	8.8(5.7)
CN Level 3 X VT Intervention	12	6.7(2.8)
AN Level 2 X AF Intervention	5	5.4(1.3)
AN Level 2 X VT Intervention	5	15.0(10.8)

Source	MSS	F	df	p	eta^2
Nurse Level	36	1.30	3	.279	.057
Residual Error	28		64		
Patient Acuity	260	15.61	1	.000	.136
Nurse Level X Acuity	89	5.34	3	.002	.139
Residual Error	17		64		

Note. CN=clinical nurse; AN=administrative nurse.

Table 49

Effect of CCRN Certification and Level of Patient Acuity on Number of Interventions Chosen (n = 63)[a]

Factor	n	M(SD)
CCRN Certified	26	9.2(5.9)
Not Current	10	10.8(8.1)
Never Certified	90	7.0(4.4)
AF Intervention	63	6.4(4.0)
VT Intervention	63	9.0(5.9)
CCRN Certified X AF Intervention	13	9.2(5.6)
CCRN Certified X VT Intervention	13	9.2(6.3)
Not Current X AF Intervention	5	7.0(2.6)
Not Current X VT Intervention	5	14.7(10.3)
Never Certified X AF Intervention	45	5.5(3.2)
Never Certified X VT Intervention	45	8.4(4.9)

Source	MSS	F	df	p	eta^2
CCRN	100	3.67	2	.031	.109
Residual Error	27		60		
Patient Acuity	219	11.00	1	.002	.119
CCRN x Acuity	54	2.71	2	.074	.059
Residual Error	20		60		

[a]Five subjects had missing data.

Table 50

Effect of ACLS Certification and Level of Patient Acuity on Number of Interventions Chosen (n = 68)

Factor	n	M(SD)
ACLS Certified	108	8.2(5.5)
Not Current	10	7.0(2.9)
Never Certified	18	5.6(2.6)
AF Intervention	68	6.4(3.9)
VT Intervention	68	9.1(5.8)
ACLS Certified X AF Intervention	54	6.8(4.0)
ACLS Certified X VT Intervention	54	9.5(6.4)
Not Current X AF Intervention	5	5.6(3.3)
Not Current X VT Intervention	5	8.4(1.9)
Never Certified X AF Intervention	9	4.1(2.1)
Never Certified X VT Intervention	9	7.1(2.1)

Source	MSS	F	df	p	eta^2
ACLS	53	1.94	2	.151	.056
Residual Error	28		65		
Patient Acuity	260	12.68	1	.001	.136
ACLS x Acuity	0	0.01	2	.993	.000
Residual Error	20		65		

Table 51

Effect of Critical Care (CC) Course and Level of Patient Acuity on Number of Interventions Chosen (n = 68)

Factor	n	M(SD)
CC Course	92	7.8(5.3)
No CC Course	44	7.6(4.8)
AF Intervention	68	6.4(3.9)
VT Intervention	68	9.1(5.8)
CC Course X AF Intervention	46	6.2(3.4)
CC Course X VT Intervention	46	9.5(6.3)
No CC Course X AF Intervention	22	6.8(4.9)
No CC Course X VT Intervention	22	8.4(4.6)

Source	MSS	F	df	p	eta^2
CC Course	2	0.06	1	.812	.000
Residual Error	29		66		
Patient Acuity	259	13.11	1	.001	.136
CC Course X Acuity	24	1.22	1	.273	.013
Residual Error	20		66		

Patient Outcome. Two analyses were done to examine patient outcome. First, Chi-square analysis was used to examine the relationship between patient outcomes on the atrial and ventricular scenario and critical care experience, clinical nurse level, CCRN certification, ACLS certification, and completion of a critical care course. The data did not meet the criterion for expected frequencies of at least five subjects per cell so Fisher's exact test was used for the nominal data and Kendall's tau was used for the ordinal data. Secondly, the patient outcomes on the two scenarios were examined using the McNemar test of homogeneity of proportions for qualitative variables in correlated samples to determine if outcomes were different for the two simulations.

Table 52 presents the results of the nonparametric tests used to examine patient outcome. The samples in the analyses were limited to those subjects curing the tachydysrhythmia or causing patient death by inappropriate intervention. Subjects who ran out of time, chose to end the scenario before time was up, or defibrillated in ventricular tachycardia were excluded. For the atrial flutter scenario, ACLS certification was the only variable to demonstrate a significant difference. Subjects who had been ACLS certified or were currently certified cured significantly more atrial tachydysrhythmias than those who had never been ACLS certified, Fisher's exact test, $p = .003$). There were no significant differences found for the ventricular tachycardia scenario.

The McNemar test was used to examine differences in the frequency of outcomes in the two simulations (see Table 53). The sample for this

Table 52

The Effect of Critical Care (CC) Experience, CN Level, CCRN Certification, ACLS Certification, and Critical Care (CC) Course Completion on Patient Outcomes in Atrial Flutter and Ventricular Tachycardia Simulations

Simulation	Variable	n	Test	p
Atrial Flutter				
	CC Experience	94	Fisher's exact	.115
	CN Level	94	Kendall's Tau	.158
	CCRN Certification	89	Fisher's exact	.505
	ACLS Certification	94	Fisher's exact	.003
	CC Course	71	Fisher's exact	.102
Ventricular Tachycardia				
	CC Experience	57	Fisher's exact	.081
	CN Level	57	Kendall's Tau	.169
	CCRN Certification	53	Fisher's exact	.760
	ACLS Certification	94	Fisher's exact	.286
	CC Course	42	Fisher's exact	.102

Table 53

Comparison of Patient Outcomes in Atrial Flutter (AF) and Ventricular Tachycardia (VT) Scenarios (n=47)

Frequency	Patient Outcome AF	VT	Z	p
			2.91	<.005
21	Cure	Cure		
17	Cure	Die		
3	Die	Cure		
6	Die	Die		

analysis was the subset of subjects with both a version two atrial flutter simulation and a version one ventricular simulation whose outcomes on both simulations was cure and/or cause the patient's death. The number of subjects curing atrial flutter (moderate acuity) but causing death in ventricular tachycardia (high acuity) was significantly different than the number of subjects curing ventricular tachycardia and causing death in atrial flutter, $Z = 2.91$, $p<.005$.

The Relationship Among Simulation Performance, BKAT Score, and CST Score

Correlations were used to examine the relationship among simulation performance, BKAT score, and CST score. First, the hypothesized relationships are presented followed by the correlational analysis.

Hypotheses Related to the Relationship Among Simulation Performance, BKAT Score, and CST Score

22. Is there a relationship among simulation performance, BKAT score, and CST score?

There will be positive relationships among BKAT score, CST score, simulation proficiency scores, simulation efficiency scores, and positive patient outcomes.

Times to complete the simulations will be negatively correlated with BKAT score, CST score, simulation proficiency scores, simulation efficiency scores, and positive patient outcomes.

The relationship among simulation performance, BKAT score, and CST score was examined using Pearson Product Moment correlations for the interval variables (Table 54) and point-biserial correlations (Table 55) to compare BKAT and CST scores with patient outcomes on the computer simulations. BKAT score was significantly correlated with CST score, r = .58, p = .000 and atrial proficiency, r = .46, p = .000. Atrial patient outcome neared significance, r = .28, p = .006. There were no significant relationtionships between CST and the simulation variables. Atrial proficiency and CST score, r = .32, p = .008, though not statistically significant, demonstrated a trend in the hypothesized direction.

In order to further examine the relationship between simulation performance and performance in practice, an exploratory analysis was conducted. CST scores were dichotomized with scores 75 and lower constituting one group and scores above 75 the other. A score of 76 indicates that the subject rated themselves competent to care for an uncomplicated cardiovascular patient. Lower scores indicate less expertise. Five 2 X 2 ANOVAs were done with CST score and level of patient acuity as the independent variables. The dependent variables were proficiency score, efficiency score, time to complete the simulations, amount of data collected before the first intervention, and number of interventions. Consistent with the analyses related to knowledge and experience, there was a significant within group

Table 54

Intercorrelations (r) Among Simulation Variables, BKAT, and CST (n=68)

	AFpro	VTpro	AFeff	VTeff	AFtime	VTtime	AFdata	VTdata	BKAT	CST
AFpro	100									
	.000									
VTpro	25	100								
	.038	.000								
AFeff	07	01	100							
	.567	.929	.000							
VTeff	27	42	34	100						
	.023	.000	.005	.000						
AFtime	13	07	- 67	- 09	100					
	.302	.577	.000	.471	.000					
VTtime	- 08	71	- 13	- 11	05	100				
	.524	.000	.303	.071	.669	.000				
AFdata	36	22	- 29	- 03	17	21	100			
	.002	.072	.018	.781	.169	.087	.000			
VTdata	17	03	- 14	- 14	02	- 03	40	100		
	.174	.815	.264	.262	.896	.807	.001	.000		
BKAT	47	21	04	15	17	04	06	- 17	100	
	.000	.080	.764	.238	.162	.740	.610	.156	.000	
CST	32	24	- 06	- 09	18	22	09	- 28	58	100
	.008	.049	.650	.486	.155	.072	.477	.018	.000	.000

Note. Decimal points have been omitted in the correlation coefficients.
pro=proficiency score;
eff=efficiency score;
time=time to complete the simulation;
data=amount of data collected before the first intervention.

Table 55

Intercorrelations (r) Among BKAT, CST, and Patient Outcome

	Atrial Flutter Outcome n = 94	Ventricular Tachycardia Outcome n = 57
BKAT	28	05
	.006	.700
CST	22	08
	.036	.558

Note. Decimal points have been omitted for the correlation coefficients.

difference for proficiency score, $F(1,66) = 14$, $p = .000$. While there was no main effect of CST score on amount of data collected before the first intervention, there was a significant interaction effect between low CST score and high patient acuity. Nurses with CST scores less than 76 collected significantly more data in the ventricular tachycardia simulation, $F(1,66) = 8.4$, $p = .005$ (Table 57).

Table 56

Effect of CST Score and Level of Patient Acuity on Proficiency Score (n = 68)

Factor	n	M(SD)
CST Score<76	14	29.9(20.4)
CST Score=>76	122	47.4(24.5)
AF Proficiency	68	52.2(22.7)
VT Proficiency	68	39.0(24.8)
CST Score<76 X AF Intervention	7	36.7(21.5)
CST Score<76 X VT Intervention	7	23.1(18.2)
CST Score=>76 X AF Intervention	61	54.0(22.3)
CST Score=>76 X VT Intervention	61	40.8(24.9)

Source	MSS	F	df	p	eta^2
CST Score	3820	5.80	1	.019	.081
Residual Error	659		66		
Patient Acuity	5956	13.87	1	.000	.126
CST Score X Acuity	0	0.44	1	.975	.000
Residual Error	429		66		

Table 57

Effect of CST Score and Level of Patient Acuity on Amount of Data Collected Before the First Intervention (n = 68)

Factor	n	M(SD)
CST Score<76	14	2.3(2.0)
CST Score=>76	122	1.5(1.7)
AF Proficiency	68	1.9(1.9)
VT Proficiency	68	1.4(1.6)
CST Score<76 X AF Intervention	7	1.6(1.1)
CST Score<76 X VT Intervention	7	3.0(2.4)
CST Score=>76 X AF Intervention	61	1.9(1.9)
CST Score=>76 X VT Intervention	61	1.2(1.4)

Source	MSS	F	df	p	eta^2
CST Score	7.1	1.66	1	.202	.024
Residual Error	4.3		66		
Patient Acuity	8.0	4.71	1	.034	.028
CST Score X Acuity	14.3	8.41	1	.005	.048
Residual Error	1.7		66		

CHAPTER V

DISCUSSION

Five topics are addressed in this chapter. First, the findings of the study are presented. Next, the significance, limitations, and implications of the study are described. Lastly, directions for future research are discussed.

Findings

In the next sections the study findings are presented in the following manner: (a) relationship between knowledge and clinical decision making as measured by clinical simulation and self-evaluation of clinical expertise; (b) relationship between experience and clinical decision making as measured by clinical simulation and self-evaluation of clinical expertise; (c) relationship between level of patient acuity and clinical decision making on clinical simulations; (d) relationship between clinical simulation performance and self-evaluation of clinical expertise; and (e) relationship between the process and outcome of decision making.

Knowledge and Clinical Decision Making as Measured by Clinical Simulation and Self-evaluation of Clinical Expertise

Knowledge was operationalized in this investigation with five variables: (a) BKAT score, (b) Clinical Nurse level, (c) CCRN

certification, (d) ACLS certification, and (e) completion of a critical care course. First, the relationship between knowledge and clinical decision making as measured by the clinical simulations is presented, followed by the relationship between knowledge and self-evaluation of clinical expertise.

Computerized Clinical Simulations

Both the outcome and the process of decision making were examined on the clinical simulations. Two of the five knowledge variables were significantly related to the simulation outcomes. BKAT score was positively correlated with atrial proficiency score, $r = .46$, $p = .000$, but not with ventricular proficiency score, $r = -.21$, $p = .080$. Although they had no significant main effect on simulation proficiency, two additional knowledge variables, ACLS certification, $p = .033$, and nurse level, $p = .058$, accounted for 10% and 11% of the variance, respectively. ACLS certification had a significant main effect on atrial patient outcome, Fisher's exact test, $p = .003$. There were no significant main effects of knowledge variables on ventricular patient outcome. The knowledge variables had no significant main effects on the simulation process variables of efficiency, amount of data collected before the first intervention, and time to complete the simulation.

The significant relationship between a cognitive exam and simulation proficiency score supports the findings of Holzemer et al. (1981), that knowledge, as measured by a multiple choice cognitive exam, was related to simulation proficiency score in a sample of nurse practitioners. A plausible explanation for the lack of significant relationship between BKAT score and ventricular patient outcome

(cure/die) is found in the clinical simulation descriptive data. While 99% of the total sample (N = 142) recognized lidocaine as the first line treatment for ventricular tachycardia on the BKAT, there are clear indications of unfamiliarity of second and third line treatments for ventricular tachycardia. This is relevant because the ventricular tachycardia simulations in this study were programmed to be refractory to lidocaine or for the patient to be allergic to lidocaine. In other words, the first line treatment for ventricular tachycardia never cured the ventricular tachycardia. In 95 instances out of 284 instances of ventricular tachycardia in this study, the simulated patient died because of a medication error. These included: (a) drug overdose, 18%; (b) drug contraindicated, 52%; and (c) drug allergy, 31%. Although administering a contraindicated drug or one the patient was allergic to can be construed as failure to recognize the dysrhythmia or failure to collect adequate data before intervening, respectively, drug overdose is indicative of unfamiliarity with the medications. Another indication of unfamiliarity with treatment was demonstrated by the administration of subtherapeutic doses of the correct drug, Bretylium Tosylate, in 38 (14%) ventricular tachycardia simulations. Interestingly, the dose of bretylium is commonly taught as 5 mg/kg in ACLS classes and most subjects underdosing with bretylium chose 5 mg as the dose. The lack of main effects of clinical nurse level and CCRN certification is possibly due to the large differences in sample sizes between Clinical Nurse Is and other clinical nurse levels and between CCRN certified and non-certified nurses. The small samples may not be adequate representation of the population of Clinical Nurse Is or CCRN certified nurses.

Self-Evaluation of Clinical Expertise

Self-evaluation of clinical expertise was measured by CST score. All knowledge variables were significantly related to CST score. BKAT score had a moderately strong correlation with CST score, r = .57, p = .000. There was an overall significant effect related to clinical nurse level, $F(141)$ = 15, p = .000, with post hoc Scheffe' comparisons showing the three higher groups to be significantly different than the Clinical Nurse Is. Although the differences between the other groups were not statistically significant, CST score increased as nurse level increased. ACLS certification was also significant, F = 39, p = .000. Nurses with current or expired ACLS certification scored significantly higher on the CST than those who had never been ACLS certified, Scheffe', p = .000. It is not surprising to find no differences between those with current and expired ACLS certification because recertification takes place every one to two years. CCRN certification also demonstrated an overall significance, F = 6, p = .004. Those nurses completing a critical care course scored significantly higher on the CST than those who did not, $t(85)$ = 2.97, p = .004. These findings support the relationship between knowledge and self-evaluation provided by Holzemer et al. (1981).

Overall, there was greater support for the relationship of knowledge to self-evaluation of clinical expertise, than to clinical decision making as measured by clinical simulation performance. Two possible explanations for this are task familiarity and differences in statistical power. Nurses were possibly more familiar with completing a self-evaluation form than interacting with a computer simulation. Although all subjects were oriented to the simulation format and computer keyboard, some may have been uncomfortable interacting with the

computer, resulting in lower scores. Because study participation was voluntary, it was assumed that no one with extreme computer anxiety would volunteer to participate. The difference in sample sizes between the analyses related to simulation performance and those related to practice must be taken into consideration, however. In the analyses relating knowledge to clinical simulation performance, the sample size was 68 for all independent variables except for CCRN certification (n = 63) and for the analyses related to patient outcomes where the sample size was 94 for the atrial flutter simulations and 57 for the ventricular simulations. The sample size was 142 for detecting differences in CST score related to the knowledge variables except for the CCRN analysis where the sample size was 135. The discrepancy in sample sizes between the two sets of analyses resulted in greater power of the CST analyses to detect differences when the alpha for both analyses was held constant at .005.

Relationship Between Experience and Clinical Decision Making

Computerized Clinical Simulations

Experienced critical care nurses did not have significantly better simulation outcomes, that is, higher proficiency scores or more tachydysrhythmias cured, than nurses with less than one year of critical care experience. The two groups also were not significantly different in efficiency score, amount of data collected before the first intervention, time to complete the simulation, and number of interventions chosen. The hypothesized interactions between experience and level of patient acuity were not supported.

The lack of demonstrable differences between inexperienced and experienced nurses on clinical simulation performance is disappointing. Four possible reasons are: (a) sample characteristics of the inexperienced group; (b) nature of the task; (c) sample size; and (d) computer comfort. While ACLS certification did not have a statistically significant main effect on simulation performance, it did explain 10% of the variance, and 36% percent of the inexperienced nurses were ACLS certified. Additionally, one subject with less than one year of nursing experience had several years of paramedic experience and two had critical care internships during their nursing education. Because the size of this group is only 11 subjects, the effect of these variables may have been substantial. The task used in this investigation, managing tachydysrhythmias demonstrating two levels of patient acuity, is a well-defined and limited task. While not an easy task, there are standards that provide direction for the management of the problem. This task does not demonstrate the complexity often exhibited by a critical care patient with multisystem failure. A more complicated task may have differentiated between the two groups. The third reason for the lack of difference relates to the small sample size in the inexperienced group. Because of the low turnover rate at the study institution, there were very few inexperienced nurses. This resulted in a great discrepancy in sample size between the inexperienced and experienced groups. A sample size of 11 is not large enough to adequately represent the population of inexperienced critical care nurses. Lastly, the inexperienced critical care nurse by virtue of the recent educational experience was more likely to have been exposed to computer assisted instruction or computer assisted evaluation.

Self-Evaluation of Clinical Expertise

CST score was positively correlated with years critical care experience, r = .30, p = .000. Nurses with less than one year of experience scored significantly lower than experienced nurses, $t(25)$ = -5.44, p = .000. The significant differences between the inexperienced and experienced groups on the CST was in the hypothesized direction.

There are at least two possible explanations for the CST discriminating between the two groups while the clinical simulation scores did not. The CST required the subjects to evaluate their knowledge and skills in the care of a cardiovascular patient, not just a patient with a dysrhythmia, therefore it was looking at a broader area of clinical expertise than the well-defined and limited task in the simulation. Additionally, CST score because it is a self-evaluation score clearly relates to self-confidence about clinical abilities. Although, the inexperienced nurse may possess knowledge and skills he or she may not feel confident about the ability to apply them in actual clinical situations.

Relationship Between Level of Acuity and Clinical Decision Making

Payne (1982) discussing contingent task behavior stated that "information processing in decision making as in other areas of cognition, is highly contingent on the demands of the task" (p. 182). The notion of task specific decision making strategies has also been supported in the medical (Elstein et al., 1978) and nursing literature (Corcoran, 1986a, 1986b; Holzemer et al., 1981). Elstein and associates (1978) found that the task was the primary determinant of the approach

to the task, concluding that sampling of a variety of clinical situations was necessary to draw valid conclusions about clinical competence. Corcoran differentiated between the approaches of novice and expert nurses in care planning and found that expert nurses varied their approach to a task based on task complexity while novices did not.

In this investigation outcome was measured by two variables, simulation proficiency score and patient outcome (cure/die). There were significant differences between atrial flutter and ventricular tachycardia for both proficiency, $F(1,66) = 13.87$, $p = .000$, and patient outcome, $Z = 2.91$, $p = .005$. The atrial flutter simulation had higher proficiency scores and a higher cure rate indicating that outcomes were poorer in the high acuity simulation.

The simulation descriptive data provide some indications about reasons for lower proficiency score and fewer cures in the ventricular tachycardia simulations. Two are discussed here: (a) failure to recognize the tachydysrhythmias as ventricular tachycardia and (b) unfamiliarity with second and third line treatments for ventricular tachycardia. Failure to recognize ventricular tachycardia is not unique to nurses or to this investigation. Cooper and Marriott (1989) documented the failure of nurses to recognize ventricular tachycardia. They submitted a 12 Lead EKG tracing of ventricular tachycardia to 2,521 nurses attending advanced EKG workshops. Seventy-eight percent of the nurses diagnosed the rhythm as supraventricular tachycardia with aberration when given a choice between the two diagnoses. Ninety-four percent of the nurses in this investigation recognized ventricular tachycardia from a rhythm strip on the BKAT, however, there were indications that ventricular tachycardia was recognized less often in

the clinical simulations. The most frequent indication was that ventricular tachycardia was being treated as supraventricular tachycardia, that is treated with verapamil. Verapamil, a calcium channel blocker, is a primary treatment for supraventricular tachycardias, however, it is contraindicated in ventricular tachycardia because of its potent decrease in blood pressure and the potential for ventricular fibrillation to occur (Cooper & Marriott, 1989). Verapamil was given 46 times (16%) in the 284 ventricular simulations. While this could be construed as an example of not knowing how to treat ventricular tachycardia, the fact that 99% of the sample correctly identified lidocaine as the initial treatment for ventricular tachycardia on the BKAT provides support for the previous explanation.

The second explanation for the low proficiency scores and poor patient outcomes in ventricular tachycardia was a deficit in knowledge related to second and third line treatments for ventricular tachycardia. As discussed in the section on the relationship between knowledge and clinical decision making, medication errors were common. Ninety-five lethal medication errors were made in the ventricular simulation. They included overdosing, administering a contraindicated drug, and administering a drug to which the patient had an allergy. Underdosing with an appropriate drug also was found quite frequently (14%) in the ventricular scenarios.

Process variables investigated in this study were efficiency score, time to complete the simulation, amount of data collected before the first intervention, and total number of interventions chosen. The atrial and ventricular simulations were correlated on two process variables, efficiency, $r = .34$, $p = .005$, and amount of data before the

first intervention, r = .40, p =.001. The only significant main effect of level of patient acuity on a process variable was in the exploratory analysis done using number of interventions chosen, $F(1,66)$ = 12.68, p = .001.

This investigation concurs with the findings of task specificity reported in the medical and nursing literature (Elstein et al., 1978; Holzemer et al., 1981; Corcoran, 1986a, 1986b) for the outcome of clinical decision making based on the significant differences in proficiency score and patient outcomes found with the two levels of patient acuity. However, the results of this study provide only limited support for the task specificity of the process of clinical decision making.

Relationship Between the Process and Outcome of Clinical Decision Making

The two outcome measures, proficiency score and patient outcome, were significantly related for both atrial flutter, r = .45, p = .000, and ventricular tachycardia, r = .56, p = .000. This congruence between a measure of criterion performance and actual patient outcome is encouraging. Following the ACLS standards (the basis of the proficiency score) did result in more tachydysrhythmias cured. Intercorrelations among process variables were rare. Atrial time had a significant negative correlation with atrial efficiency score, r = -67, p = .000. There were no significant correlations among ventricular process variables.

There were significant relationships between process and outcome variables in the atrial and ventricular simulations, however, the relationships were not consistent across the type of simulation. Atrial proficiency score was only significantly correlated with the amount of data collected before the first intervention, $r = .36$, $p = .002$, while ventricular proficiency score was significantly correlated with efficiency score, $r = .42$, $p = .000$, and time to complete the simulation, $r = .71$, $p = .000$. Curing the tachydysrhythmia was significantly related with ventricular efficiency, $r = .51$, $p = .000$, and neared significance for atrial efficiency, $r = .26$, $p = .010$, although the correlation was moderately low.

Only one nursing investigation located found significant differences in decision making outcomes related to decision making processes. Holzemer (1986) compared the route taken, typical (congruent with expert performance) or atypical, through one patient management problem with the outcome measure of simulation proficiency score. He found that the proficiency score was significantly lower for the atypical group. The current investigation provides only modest support for the relationship between the process of clinical decision making and the outcome of clinical decision making.

Relationship Between Clinical Decision Making as Measured by Clinical Simulation Performance and Clinical Expertise

Using an α criterion of .005, there were no significant relationships between CST score and clinical simulation performance as measured by proficiency score, efficiency score, amount of data

collected before the first intervention, time to complete the simulation, number of interventions chosen, and patient outcome. However, modest correlations were found in the predicted direction between CST score and atrial proficiency, $r = .32$, $p = .008$; ventricular proficiency, $r = .24$, $p = .049$; number of interventions chosen in the atrial simulation, $r = -.32$, $p = .007$; and number of interventions chosen in the ventricular simulation, $r = .24$, $p = .042$.

This study demonstrates the difficulty of assessing the relationship between simulation performance and clinical expertise (Holzemer et al., 1981; Holzemer et al., 1986). At least three plausible reasons can be found for the lack of significant relationship in this investigation. First, the CST measured a broader area of knowledge and skill than the clinical simulations. While the CST was related to care of the cardiovascular patient, the clinical simulations measured the narrower task of managing a patient with a tachydysrhythmia. The item related to identifying patient problems/needs from an EKG strip had the lowest mean on the CST. A nurse might have felt competent in most areas of caring for the cardiovascular patient and received a fairly high CST score despite scoring herself low on that item. Secondly, the CST measured self-evaluation of clinical expertise, not actual expertise. Other methods of evaluation such as clinical observation, supervisor evaluation, or chart review might prove more fruitful. A third reason relates to the fairly large number of nurses treating ventricular tachycardia as if it were supraventricular tachycardia with aberration ($n = 46$). Supraventricular tachycardia with aberration is an advanced, rather than basic EKG concept. It was more likely that the more

knowledgeable and experienced nurses would be the ones that considered the possibility of this diagnosis which resulted in lethal outcomes in the ventricular tachycardia simulations.

Significance

The significant contributions of this study are in three specific areas: (a) enhancing understanding of the phenomenon of clinical decision making, (b) differentiation of varying levels of knowledge and experience using the BKAT and CST, and (c) evaluating the properties of the clinical simulation. Each will be discussed in the following section.

This investigation adds to the understanding of clinical decision making in three ways. This study has provided modest support for the relationship between knowledge and clinical simulation performance as measured by proficiency score and patient outcome. The significant correlation between a cognitive examination (BKAT) and atrial proficiency score supported the finding of Holzemer et al. (1981). However, the significant correlation did not hold true for the ventricular simulation. ACLS certification which relates specifically to the management of patients with dysrhythmias had a main effect on patient outcomes in the atrial simulation. It is significant that both a broad measure of critical care knowledge (BKAT) and a more specific indicator of knowledge (ACLS certification) were related to simulation outcomes. Secondly, this study builds on the work of Holzemer et al. (1981), Tanner et al. (1986), and Corcoran, (1986a, 1986b) in supporting the predictions of information processing theory related to the task

specificity of decision making. In this study, the two clinical simulations were more similar in content than were the simulations in Holzemer's and Tanner's investigations. However, even within the narrowly defined task of managing a tachydysrhythmia, there were significant differences in outcome when the acuity of the patient situation was changed. This task specificity held true over varying levels of knowledge and experience. Thirdly, little previous work has been done examining the relationship between the process and outcome of clinical decision making. This study provides modest evidence that the process and outcome of decision making are related on clinical simulation performance. It may provide direction for looking at the relationship between the two in other types of clinical simulations and in clinical practice.

The investigation provided evidence about the reliability and validity of both the BKAT and CST in a sample of critical care nurses. Consistent with previous research on the BKAT (Toth, 1984, 1986), adequate reliability for the instrument was demonstrated by a Cronbach's α of .80. Support for the validity of the BKAT was demonstrated by the instrument's ability to discriminate between groups expected to be different, such as experienced/inexperienced, ACLS certified/non-ACLS certified, and those who had taken a critical care course from those who had not. The Cronbach's α of .98 for the CST indicates redundancy in the scale. However, as a measure of self-evaluation of clinical expertise, the CST successfully discriminated between groups with varying levels of knowledge and experience. Although the items on the CST only relate to the cardiovascular section of the CCRN examination, the findings of this investigation are consistent with those found by

AACN (1984, 1988) in the CCRN validation study. The CST's potential as a means of identifying knowledge deficits related to care of the cardiovascular patient may be useful for critical care orientation programs and for preparation to take the CCRN examination.

The significance of the findings related to the computerized clinical simulation are in the areas of psychometric and evaluative properties. This study assessed both the reliability and the validity of two computerized clinical simulations requiring the management of patients with atrial flutter and ventricular tachycardia. The study results provide evidence that test-retest reliability is inappropriate for assessing reliability in clinical simulations because of a significant practice effect. The examination of the criterion-related validity of the clinical simulations used in the study, comparison of clinical simulation performance with BKAT score and self-evaluation of clinical expertise, demonstrated only limited relationships between atrial simulation performance and BKAT score. Self-evaluation of clinical expertise was not significantly related to simulation performance. An important finding of the investigation was the clinical simulations' ability to detect areas of knowledge deficit, not identified by the cognitive examination or self-evaluation of expertise.

Limitations

The limitations of this study will be reviewed using the framework of threats to design validity suggested by Cook and Campbell (1979). The four types of design validity examined are statistical conclusion validity, internal validity, construct validity, and external validity.

Statistical Conclusion Validity

Statistical conclusion validity is concerned with the covariance or relationship between two variables. Two threats relevant to this investigation are discussed in the following section, low statistical power and reliability of measures.

Statistical Power

The power analysis conducted during the planning phase of this study indicated that a sample size of 140 would be adequate to detect a medium effect size (30) with an alpha of .05. As the power analysis described earlier in this document suggests, the power for most analyses was adequate. However, for selected analyses, sample size was decreased in order to exclude the confounding variables of simulation version, simulation order, and simulation scoring discrepancy resulting in decreased statistical power for those analyses. The trade-off was judged to be appropriate by the experimenter.

Reliability of Measures

Reliability, as measured by Cronbach's alpha, was acceptable for both BKAT and CST. However, classical measurement theory does not provide adequate methods for assessing internal consistency reliability in clinical simulations with varying numbers of dependent items. Support for the inappropriateness of test-retest reliability for clinical simulation performance was found in this study by the demonstration of a practice effect from the first to the second simulation of each type.

Internal Validity

Although internal validity primarily relates to causal relationships in quasi-experimental and experimental designs, Woods and Catanzaro (1988) have described the application of the threats to internal validity for descriptive and correlational designs. Three threats that are relevant to this study are those of testing, maturation, and history.

Testing

In order to minimize the effect of testing in this study two strategies were used during data collection and one strategy during data analysis. All subjects completed the BKAT and CST before completing the computer simulations. However, it is still possible that the BKAT and CST cued the subjects about their deficits and inspired them to study diligently before the computer simulations. A strategy for future studies would be the systematic alteration of order of instrument administration in order to minimize this effect. In an attempt to control the effect of testing in the computerized clinical simulations, subjects were systematically assigned to simulation order after a random start. An exploratory analysis was conducted to determine if there was a practice effect of testing from the first to the second simulation of each type. A significant effect of testing was found so it was controlled by using only the first instance of a particular simulation version for hypothesis testing. However, all simulations were used in the section on descriptive analysis of simulation performance.

Maturation

Because the study participants completed the study instruments during their scheduled shifts and required two hours of time, it was usually impossible to complete all the study instruments at one sitting. In order to decrease the risk of maturation from increased knowledge or experience with the simulation content between the time of completing the BKAT and CST and completing the clinical simulations a limit was placed on the length of time between the two data collection points. Due to the larger potential for maturation in the very inexperienced nurse (new graduate, interim permitee), they were required to complete the clinical simulations within one week of the written instruments. While no formal education affecting the simulation content occurred during the interim, it is still possible for learning to have taken place. Because maturation was of less concern in the more experienced nurses, they were allowed a maximum of one month between completing of the written instruments and completion of the computer simulations. Subjects unable to comply with this were dropped from the data analysis. However, in order to provide both a positive research experience and individual scores, data collection was completed for these subjects.

History

The threat of history must be considered in this study. ACLS certification is offered every three weeks at the study site. The possibility that recentness of ACLS certification might have affected scores on the study instruments should be taken under consideration. However, the study data suggest that those with current and expired ACLS certification did not differ on simulation performance, self-evaluation of clinical expertise, and knowledge.

Construct Validity

Three confounding variables related to clinical simulation performance were identified as a threat to construct validity in this investigation: (a) simulation version; (b) simulation order; and (c) discrepancy between Tach-Man response to defibrillation in ventricular tachycardia and the current ACLS standards. Each identified confounding variable was examined empirically to determine its effect on clinical simulation performance. Since the effect of each of the three confounding variables was judged to be substantial, all were controlled for in the two way analyses of variances done for hypothesis testing. Subjects who did not complete a version 2 atrial flutter or a version 1 ventricular tachycardia or who defibrillated in ventricular tachycardia were dropped from the analysis. Simulation order was controlled by using only the first instance of each simulation version in the analysis.

External Validity

External validity reflects the extent to which one can generalize across settings, persons, and times. The threats to the generalizability of the findings in this investigation are the interaction of setting and treatment and the interaction of selection and treatment.

Interaction of Setting and Treatment

The type of units represented in the study sample are the type of units that 70% of the membership of the American Association of

Critical-Care Nurses are employed (AACN, personal communication, 8/3/89). Notable exceptions lacking in the sample are cardiovascular-surgical intensive care unit, pediatric and neonatal intensive care unit, and progressive care unit. However, the AACN membership data also indicates that only 19.7% of their membership is employed in a university affiliated medical center. While AACN membership is not synonymous with being a critical care nurse, 63,000 of the 209,500 critical care nurses in the United States are AACN members. Because there may be differences in clinical decision making in different types of health care institutions, the findings of this study are limited to university affiliated medial centers.

Interaction of Selection and Treatment

The sample for the study was a nonprobability convenience sample. While the sample was representative of the critical care nurses in the study setting, comparisons with national data on critical care nurses (National Association for Health Care Recruitment, 1989) suggest that the study sample differs in terms of age, education, number of males, and percentage of full-time employees. The national mean age reported was 35.4, while mean age in the study sample was 33.1. The study sample had a higher level of education than the national sample. Fifty-four percent of the study sample had baccalaureate degrees compared with 40% nationally. The percentage of males employed in nursing was reported as 3.1% and in critical care nursing, 6.6%, while the study sample was 27% male. The percentage of full-time employees was 89% compared with 70% nationally. The differences between the study sample and the national sample, especially in terms of age and level of education, limit the generalizability of the study findings.

Implications for Theory, Research, and Nursing Practice

This study has provided evidence supporting the predictions of information processing theory as it relates to decision making. While information processing theory relates to human problem solving in general and not specifically to clinical decision making, the predictions held true in this investigation. The data supported the prediction that both the nature of the decision maker and the nature of the task were the determinants of decision making. The evidence for the predictions of the characteristics of the decision maker were limited to two measures of knowledge, one measuring general critical care knowledge, and the other knowledge specifically related to the study task, management of a tachydysrhythmia. The evidence for the task specificity of the outcome of clinical decision making was substantial and supported the findings of previous research examining clinical decision making from an information processing perspective. The evidence for the task specificity of the process of clinical decision making was more modest. The study data provide support for the adequacy of information processing theory in explaining clinical decision making in a narrowly defined task, such as the management of tachydysrhythmias.

The major implications of this study for clinical decision making research are methodological. To increase the validity of the findings of clinical decision making research, clinical decision making needs to be examined over many instances. However, this study provided evidence of a practice effect when the tasks were similar. This affects the ability to determine test-retest reliability of clinical simulations. The practice effect, along with the interdependent items, make

traditional ways of examining internal consistency inappropriate. While this study offered no solutions to the problem of determining the reliability of clinical simulations, it did empirically document the problem for future research studies.

The implications for nursing practice are in two areas, knowledge related to the management of tachydysrhythmias and clinical decision making. It is clear when examining the proficiency scores of the ventricular tachycardia simulation that knowledge deficits existed in two specific areas: (a) differentiation of ventricular tachycardia versus supraventricular tachycardia with aberration and (b) second and third line drug treatments for ventricular tachycardia. The ability of the study participants to recognize ventricular tachycardia on a static strip, yet fail to recognize it or inappropriately treat it on a computerized clinical simulation may substantiate the importance of using clinical simulations which more closely approximate the clinical encounter than paper and pencil tests to augment other methods of teaching and evaluation. The implications of the study findings relating to clinical decision making are related to the task specificity of clinical decision making and to the amount of data collected before intervening. The findings of this study support the findings of earlier researchers suggesting that clinical decision making is task specific. Nurse educators must be conscious of this fact and provide student nurses and nurses in staff development programs ample opportunity to develop their clinical decision making skills over a wide variety of cases. Furthermore, this study demonstrated that nurses tended to intervene with minimal or no data in ventricular tachycardia. Intervening without basic information such as medication allergies

resulted in poor patient outcomes in this study. While time is critical in the event of patient emergency, it is possible a few seconds spent in information gathering may result in superior patient outcomes.

Future Research

Directions for future research are in two specific areas: (a) further explication of the construct of clinical decision making and (b) exploration of the role of computer technology in the measurement of clinical decision making. Continued explication of the construct of clinical decision making from a variety of theoretical perspectives and research methodologies is necessary. Of particular importance are studies examining clinical decision making over a substantial number of cases to determine if this study's finding of task specificity holds true. Additionally, because decision making in critical care often involves group rather than individual decisions, studies are needed that compare the process and outcome of group, as well as individual decisions.

Studies examining the role of computer technology in the measurement of clinical decision making are needed to further investigate the relationship between clinical simulation performance and clinical expertise and to explore the potential of computer assisted interactive video as a means of presenting clinical simulations. A top priority for future research is relating clinical simulation performance with clinical expertise. The possibility of clinical simulations being implemented as part of the NCLEX licensing examination make this essential. In addition to the self-evaluation of clinical expertise

used in this study, methods of supervisor evaluation, patient evaluation, chart audit, clinical observation, and exemplars of critical incidents are potentially useful and warrant close examination. The capability of computer assisted video technology to present a more realistic clinical encounter than previously possible offers several research possibilities including investigating the role of visual cues in clinical decision making and comparison of verbal and nonverbal cues.

In conclusion, this investigation has examined the effect of patient acuity on clinical decision making processes and outcomes of critical care nurses with varying levels of knowledge and experience. Two knowledge variables, BKAT score and ACLS certification, had significant relationships with or main effects on clinical decision making outcomes as measured by proficiency score and patient outcome in the atrial flutter simulation. There were no main effects on outcome measures in the ventricular simulation or on process variables in either type of simulation. Experienced and inexperienced critical care nurses did not differ on clinical simulation performance. Both the BKAT and CST discriminated between nurses with varying levels of knowledge and experience. There was a main effect of patient acuity on clinical decision making outcomes, but not clinical decision making processes. Although significant relationships were found between the process and outcome of decision making the relationships were not consistent across simulations. Clinical decision making as measured by clinical simulation performance was not significantly related to self-evaluation of clinical expertise. Clinical decision making remains an intriguing, yet elusive, phenomenon. The vital nature of clinical decision making to critical care nursing practice validates the need for continued investigation.

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Appendix A

Demographic Profile

DEMOGRAPHIC PROFILE

IDENTIFICATION NUMBER:_____ TODAY'S DATE:_____

AGE:_____ SEX_____

DATE OF EMPLOYMENT IN PRESENT CRITICAL CARE UNIT:_____

NAME OF UNIT:_____ CURRENT CLINICAL NURSE LEVEL:_____

SHIFT (DAYS, EVENINGS, NIGHTS):_____ 8-HOUR OR 12-HOUR:_____

8 HOUR SHIFT
PERCENTAGE OF TIME WORKED (NUMBER OF DAYS IN 2 WEEKS):

10 DAYS = 100%_____	9 DAYS = 90%_____
8 DAYS = 80%_____	7 DAYS = 70%_____
6 DAYS = 60%_____	5 DAYS = 50%_____
4 DAYS = 40%_____	3 DAYS = 30%_____
2 DAYS = 20%_____	1 DAY = 10%_____

12 HOUR SHIFT
PERCENTAGE TIME WORKED (NUMBER OF DAYS IN 2 WEEKS)

7,6 DAYS = 100%_____	3 DAYS = 50%_____
5 DAYS = 83%_____	2 DAYS = 33%_____
4 DAYS = 66%_____	1 DAY = 16%_____

NURSING EXPERIENCE (IN YEARS AND MONTHS):_____

CRITICAL CARE EXPERIENCE (IN YEARS AND MONTHS):_____

ACLS CERTIFICATION: CURRENT____ NOT CURRENT____ NEVER CERTIFIED____

CCRN CERTIFICATION: CURRENT____ NOT CURRENT____ NEVER CERTIFIED____

CRITICAL CARE COURSE:
AT UC DAVIS: YES____ NO____ ANOTHER SITE: YES____ NO____

HIGHER NURSING DEGREE:
LPN/LVN____ DIPLOMA____ ASSOCIATE DEGREE____ BSN____ MASTERS____

HIGHEST NON-NURSING DEGREE:
NONE____ ASSOCIATE DEGREE____ BS/BA____ MASTERS____

Appendix B

Basic Knowledge Assessment Tool for Critical Care (BKAT)

BASIC KNOWLEDGE ASSESSMENT TOOL (BKAT)
IN CRITICAL CARE NURSING

Version Three

Directions: Select the best answer for the following multiple choice questions. Mark the answer on the Scantron answer sheet using a #2 pencil.

1. initial measures for the treatment of angina pectoris include all of the following EXCEPT :

   a. rest
   b. morphine
   c. oxygen
   d. nitroglycerine

2. The classical ECG change in myocardial infarction is a:

   a. normal Q wave
   b. ST segment elevation
   c. prolonged Q-T duration
   d. prolonged P-R interval

3. Elevated cardiac iso-enzymes can occur in all of the following EXCEPT :

   a. congestive heart failure
   b. pericarditis
   c. myocardial infarction
   d. cardiac surgery

4. The major therapeutic goal in the treatment of cardiogenic shock is to:

   a. increase afterload
   b. lower the BUN
   c. increase the cardiac output
   d. decrease extracellular volume

5. Mr. Hart is 2 days post MI. During his first time getting out of bed his pulse increases from 86/min to 96/min. Based on this response the nurse should:

   a. ask him to slow his pace
   b. allow him to continue as this is an appropriate cardiac response
   c. have him lie down immediate
   d. check his vital signs and question him about chest pain

6. During the early stages of myocardial infarction one might normally expect all of the following reactions EXCEPT :

   a. denial
   b. suicidal thoughts
   c. anxiety
   d. anger

7. In dealing with a depressed patient during the first days post MI the most appropriate nursing action would be:

a. encourage the patient to ventilate his concerns
b. restrict visits from the family
c. provide for privacy by leaving the patient alone
d. provide a quiet environment

8. Patients confined in critical care units at times become confused and disoriented. One of the best ways to prevent or modify this reaction is to:

a. provide frequent orientation to time and place
b. make sure that the patient is adequately sedated
c. limit the length of visits by the family
d. keep the lights on at night

9. The following monitor pattern would indicate that the Swan Ganz is in which position?

a. RA
b. RV
c. PA
d. wedge

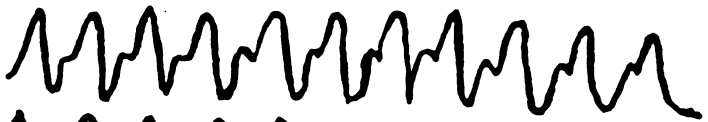
10. The use of an arterial line would be indicated for all of the following conditions EXCEPT :

a. shock with blood pressure too low to be determined by cuff
b. patients being treated with IV nitroprusside
c. mechanical ventilation requiring frequent arterial blood gases
d. for IV administration of drugs

11. Which of the following wave patterns would indicate proper function of an arterial line?

a.

b.

c. 

d.

12. After an arterial catheter is removed, direct pressure should generally be applied to the artery:

a. for a full minute
b. for 5 to 10 minutes
c. until no blood oozes from the puncture site
d. until a pressure dressing is applied

13. A central venous pressure reading directly reflects pressure in the:

    a. LA
    b. RA
    c. LV
    d. PA

14. An elevated CVP reading may indicate:

    a. right heart failure
    b. a fall in hematocrit
    c. dehydration
    d. peripheral vasodilation

15. If the monitor shows a wedge pattern, all of the following actions are appropriate EXCEPT :

    a. withdrawing air to check for accidental inflating of the balloon
    b. repositioning the patient
    c. flushing the line
    d. keeping the patient immobile

16. The pulmonary capillary wedge pressure (PCWP) reflects pressure in the:

    a. right ventricle
    b. left ventricle
    c. right atrium
    d. vena cava

17. The normal pulmonary artery pressure is:

    a. 10-20 mean 5-10
       0-4

    b. 21-30 mean 11-20
       5-15

    c. 31-40 mean 21-30
       16-20

    d. 41-50 mean 31-40
       21-30

18. The normal PCWP is:

    a. 1-3 mm Hg
    b. 4-12 mm Hg
    c. 15-20 mm Hg
    d. 21-26 mm Hg

19. An elevated PCWP may indicate:

    a. hypovolemia
    b. left ventricular failure
    c. peripheral blood pooling
    c. systemic hypotension

20. The wave in the cardiac cycle that represents atrial depolarization is the:

    a. P
    b. Q
    c. R
    d. T

21. The normal P-R interval is:

    a. .04 - .10
    b. .12 - .20
    c. .22 - .26
    d. .28 - .32

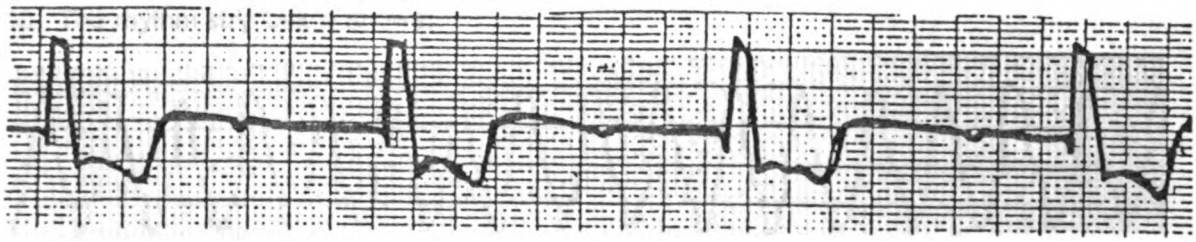
22. A QRS complex wider than 0.12 seconds most likely indicates:

    a. normal ventricular conduction
    b. bundle branch block
    c. second degree heart block
    d. myocardial infarction

23. A strong ventricular stimulus is potentially dangerous in which period of the cardiac cycle?

    a. U wave
    b. P wave
    c. T wave
    d. QRS

24. The following rhythm strip represents:



    a. idioventricular rhythm
    b. junctional rhythm
    c. complete heart block
    d. second degree heart block, Type II

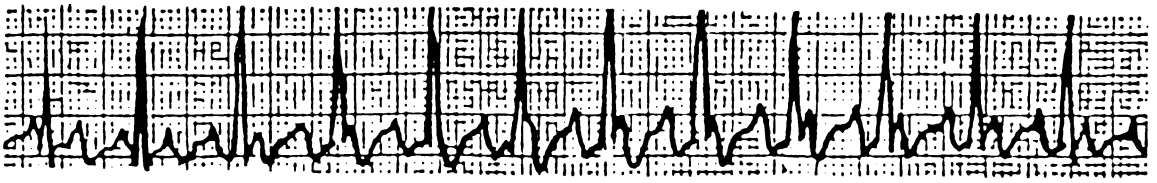
25. The ventricular rate in question #24 is approximately:

    a. 56
    b. 70
    c. 90
    d. 38

26. One of the first drugs to be administered to treat the rhythm in question #24 would be:

    a. Atropine
    b. Lidocaine
    c. Nipride
    d. Digoxin

27. The arrhythmia in the following strip is:



a. sinus tachycardia
b. atrial flutter
c. atrial fibrillation
d. ventricular flutter

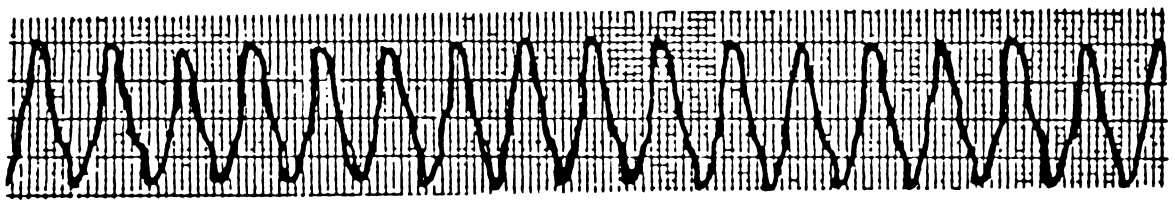
28. The rhythm in question #27 is:

a. benign is most people
b. normal in elderly people
c. hazardous, as the ventricular rate may increase
d. hazardous, as it may progress to complete heart block

29. Therapy for the rhythm in question #27 includes:

a. cardioversion, Digoxin, Quinidine
b. Lidocaine, sodium bicarb, cardioversion
c. Lidocaine, KCL, pacemaker
d. Isordil, Nitropaste, Pronestyl

30. The rhythm strip below shows:

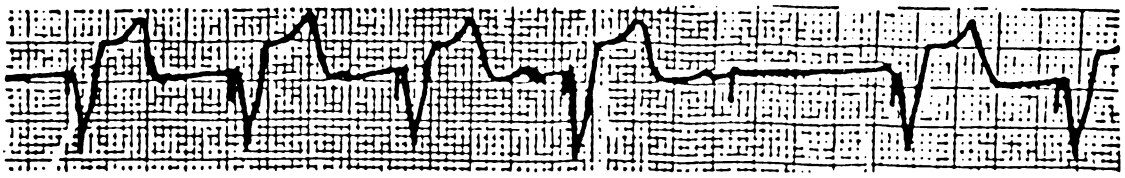


a. ventricular fibrillation
b. atrial fibrillation
c. ventricular tachycardia
d. atrial tachycardia

31. The initial treatment for the rhythm in question #30 is:

a. Isuprel 1.0 mg in 250 ml D5W drip
b. Propranolol 2.0 mg IV bolus
c. Atropine 0.6 mg IV bolus
d. Lidocaine 50-100 mg IV bolus

32. In the following strip the pacemaker is exhibiting:



a. failure to sense
b. failure to capture
c. normal function
d. demand function

33. The main purpose of enclosing a pacemaker generator in a rubber glove or similar apparatus is to:

a. keep the pacemaker clean
b. prevent moisture from corroding the pacemaker
c. prevent accidental change in settings
d. prevent electrical interference with the pacemaker

34. The rhythm strip below shows:

a. ventricular tachycardia
b. atrial tachycardia
c. atrial fibrillation
d. ventricular fibrillation

35. Upon recognizing the rhythm in question #34 the nurse should <u>first</u>:

a. perform a precordial thump
b. establish unresponsiveness
c. give Lidocaine IV push
d. check the ECG leads

36. The correct energy setting for defibrillation is:

a. 25-30 watt/seconds
b. 50 watt/seconds
c. 100 watt/seconds
d. 200-300 watt/seconds

37. A patient becomes apneic and pulseless. The monitor shows asystole. The drug that would most likely be used initially is:

a. calcium gluconate
b. Atropine
c. epinephrine
d. Lidocaine

38. The initial action of Bronkosol is to:

a. dilate the bronchioles
b. dilate the alveoli
c. increase the surface tension
d. increase residual volume

39. Mr. Gee has an endotracheal tube. While you are making rounds, you ask if his breathing is okay. In an audible tone, he says "yes". You should first:

a. suction the patient
b. add air to the cuff
c. notify the doctor immediately
d. check for minimal leak

40. A routine check of your patient's blood gases show a pH of 7.40, pO_2 of 100 mm Hg, pCO_2 of 38 mm Hg, and HCO_3 of 25 mEq. These results reflect:

a. metabolic acidosis
b. metabolic alkalosis
c. normal values
d. respiratory alkalosis

41. Before suctioning a patient, you adjust the vacuum pressure so that it is:

a. 120 mm Hg of vacuum
b. as high as necessary
c. 40 mm Hg of vacuum
d. 10 mm Hg below the systolic blood pressure

42. Before starting chest physical therapy (PT) on a post-operative patient with a chest tube, you auscultate the lung fields bilaterally and note that you hear diminished breath sounds in the right posterior base. This would most likely be due to:

a. pleuritis
b. consolidation
c. atelectasis
d. the chest tube

43. Routine chest PT for a post-operative cardiac patient may have all of the following indicated EXCEPT:

a. coughing and deep breathing exercises
b. percussion
c. vibration
d. reverse and Trendelenberg postural drainage

44. Chest percussion would generally be contraindicated for which of the following conditions?

a. atelectasis
b. thick sputum
c. pulmonary hemorrhage
d. lobectomy

45. Your patient is on a ventilator. The low volume alarm sounds. This may be due to:

a. pulmonary edema
b. decreased secretions
c. a disconnected tube
d. biting the tube

46. The high pressure alarm on a volume ventilator may be triggered by all of the following EXCEPT:

a. biting on the tube
b. pulmonary edema
c. leaking cuff
d. decreased lung compliance

47. To assess proper positioning of an endotracheal tube, the most appropriate nursing action would be to:

a. listen for minimal leak of the cuff
b. listen for bilateral breath sounds
c. check for chest expansion
d. check the tidal volume indicator on the ventilator

48. The earliest sign of increased intracranial pressure generally involves changes in:

a. response to pain
b. level of consciousness
c. equality of pupillary reactions
d. respirations

49. Increased intracranial pressure is also characterized by all of the following EXCEPT:

a. decrease in briskness of pupillary reaction
b. increase in blood pressure
c. decrease in pulse pressure
d. decrease in level of consciousness

50. A drug used specifically to reduce increased intracranial pressure is:

a. Aldomet
b. phenobarbital
c. mannitol
d. Dilantin

51. A positive Babinski response:

a. indicates lower motor disease
b. is a normal finding
c. is an abnormal finding
d. is associated with flexion of the toes

52. In a patient with a cervical spine injury, the most important observations the nurse makes deal with which body system?

a. cardiovascular
b. respiratory
c. renal
d. gastrointestinal

53. The nursing care of a patient during the acute period after a stroke includes all of the following EXCEPT:

a. providing a quiet environment
b. control of secretions
c. preventing injury
d. increasing sensory input

54. All of the following are included in a hourly neuro check EXCEPT:

a. motor strength
b. urinary output
c. response to stimulation
d. pupillary response to light

55. Nursing care of a patient on a hypothermia blanket includes:

a. administering vasodilators to prevent shivering
b. avoiding moving the patient to provide maximum cooling
c. removing the hypothermia blanket q2h to prevent overcooling
d. making frequent observations of the skin to prevent tissue injury

56. Signs and symptoms of diabetic ketoacidosis include:

a. dry warm skin, fruity breath, deep and rapid breathing
b. vomiting, hyperactivity, diaphoresis
c. slow and shallow breathing, pallor, headache
d. dilated pupils, coma, flushed skin

57. Impending insulin shock should be suspected when the diabetic patient complains of or manifests:

a. decreased skin turgor, abdominal pain, fever
b. flushed skin, tachycardia, Kussmaul breathing
c. thirst, hypotension, fruity odor to breath
d. weakness, headache, diaphoresis

58. Measures that would be taken to treat a patient in diabetic ketoacidotic coma would include all of the following EXCEPT:

a. dextrose 50% IV infusion
b. insulin IV infusion
c. potassium replacement
d. sodium bicarbonate administration

59. A newly diagnosed diabetic patient who is on a sliding scale of regular insulin complains of feeling very nervous and afraid that she is going to faint. Nursing actions might include all of the following EXCEPT:

a. testing the urine for acetone
b. administering the PRN order for regular insulin
c. drawing a blood sample for sugar
d. giving her a glass of juice to drink

60. Patients with diabetes mellitus who are acutely ill generally require a:

a. higher dose of insulin
b. lower caloric intake
c. higher fat intake
d. lower dose of insulin

61. The psychophysiologic stress response of acute illness generally results in:

a. increased HR, increased BP, increased urine output
b. decreased HR, decreased BP, decreased urine output
c. increased HR, decreased BP, increased urine output
d. increased HR, increased BP, decreased urine output

62. Which of the following types of insulin will have peak action within 2 to 4 hours:

a. Lente
b. NPH
c. Regular
d. Ultralente

63. If a patient receives his regular dose of NPH insulin at 7 AM but does not eat because he is NPO, in how many hours might you expect an insulin reaction to occur?

a. 1-2
b. 4-6
c. 8-10
d. 12-14

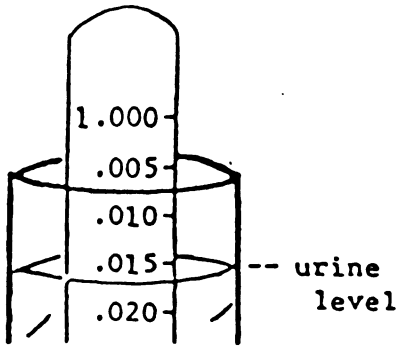
64. Signs and symptoms of thyroid storm (crisis) include:

a. coma, hypothermia, respiratory acidosis
b. bradycardia, depression, respiratory failure
c. elevated temperature, tachycardia, delirium
d. hypotension, edema, low urine output

65. Mr. Smith, who is a post-operative craniotomy patient has a fasting blood sugar of 100 mg, complains of extreme thirst and has a urine specific gravity of 1.001. You should suspect:

a. diabetes mellitus
b. hyperthyroidism
c. acute adrenal insufficiency
d. diabetes insipidus

66. What does the following urine specific gravity reading indicate to you?



a. dilute urine
b. normal urine concentration
c. concentrated urine
d. glycosuria

67. A patient is admitted with a diagnosis of acute renal failure. The minimal acceptable urine output per hour is:

a. 60 cc
b. 45 cc
c. 30 cc
d. 10 cc

68. The following lab tests are good indices of renal function EXCEPT:

a. catecholamines
b. electrolytes
c. creatinine
d. osmolality

69. Your patient has acute renal failure. Medications that are normally excreted through the kidneys will probably be:

a. decreased in dosage
b. administered as usual
c. increased in dosage
d. increased in frequency

70. Dietary management in acute renal failure commonly includes:

a. high protein, low potassium, low sodium
b. restricted protein, high potassium, low sodium
c. high protein, high potassium, high sodium
d. restricted protein, low potassium, low sodium

71. Sudden development of dyspnea, sinus tachycardia, and rales in an acute renal failure patient would most likely indicate which of the following:

a. fluid overload
b. infection
c. hyperkalemia
d. pericarditis

72. ECG changes commonly seen in hyperkalemia are:

a. narrow QRS, inverted T wave
b. narrow QRS, flattened P wave
c. wide QRS, inverted T wave
d. wide QRS, tall peaked T wave

73. Generally, peritoneal dialysis solutions do NOT contain:

a. chloride
b. glucose
c. creatinine
d. sodium

74. Complications of peritoneal dialysis include all of the following EXCEPT:

a. hypotension
b. respiratory distress
c. peritonitis
d. hyperkalemia

75. Following the first exchange of peritoneal dialysate solution, the outflow drainage return is brownish in color. Which of the following observations is correct?

a. commonly seen following the first exchange
b. characteristic finding in peritonitis
c. indicates possible bowel perforation
d. indicates possible abdominal bleeding

76. Nursing care measures for the patient receiving peritoneal dialysis include all of the following EXCEPT:

a. careful intake and output
b. warming the dialysis solution
c. maintaining sterility of the dialysate
d. maintaining immobility

77. Detecting a thrill or bruit near the venous insertion site of an A-V shunt indicates a:

a. developing clot
b. leaking cannula
c. patent shunt
d. occluded shunt

78. In the event of accidental separation of an A-V shunt the nurse would apply:

a. direct pressure
b. cannula clamps
c. a tourniquet above the site
d. any of the above techniques

79. When feeding a patient using continuous tube feedings, the most important intervention in preventing aspiration is to:

a. keep the head of the bed elevated
b. do frequent chest PT
c. check the position of the feeding tube q4h
d. aspirate stomach contents q4h

80. The most important step in preventing central venous catheter-related sepsis is:

a. using an in-line IV fluid filter
b. preparation of solutions under a laminar flow hood
c. checking the patient's temperature q6h
d. aseptic placement and care of the catheter

81. Hyperosmolar, non-ketotic dehydration and coma can be easily prevented in total parenteral nutrition therapy if detected early. A method of early detection is checking:

a. CPK, SGOT, LDH
b. urine for sugar and acetone
c. for abnormal pupillary response
d. for a decrease in urine output

82. Ms. Phillips has a Blakemore tube in place for the control of active bleeding from her esophageal varicies. The most important aspect of her acute care is:

a. periodically releasing the pressure in the balloons to prevent necrosis
b. maintaining the pressure in the balloons
c. accurately checking intake and output
d. encouraging the patient to verbalize her feelings

83. Low intermittent suction of gastric contents is generally used in all of the following situations EXCEPT:

a. to reduce abdominal distention
b. to prevent aspiration
c. when bowel sounds are absent
d. to control bleeding

84. Acute gastrointestinal bleeding in critically ill patients may occur as a result of:

a. being NPO
b. the body's response to stressors
c. decreased gastric motility
d. alteration in eating patterns

85. Nursing activities for patients receiving iced gastric lavage to control acute gastrointestinal bleeding include all of the following EXCEPT:

a. observation for abdominal distention
b. accurate intake and output
c. using distilled water for the lavage
d. monitoring of hemoglobin and hematocrit

86. Your patient, who is actively bleeding from the gastrointestinal tract and is receiving a blood transfusion, has a sudden increase in body temperature. Your initial response is to:

a. notify the blood bank
b. chart your finding
c. check for urticaria
d. stop the transfusion

87. Which of the following measures generally results in the earliest detection of gastric bleeding in patients who have gastric tubes?

a. testing the gastric contents for microscopic blood
b. observing the color of the gastric contents
c. noting the presence of abdominal distention
d. noticing a slow fall in blood pressure

88. While caring for a cholecystectomy patient post-operatively, you notice "coffeeground" material coming from her nasogastric tube. You should:

a. know this is a normal finding
b. irrigate the tube
c. test the drainage for blood
d. listen for bowel sounds

89. Special care should be exercised when administering IV Dopamine because:

a. infiltration leads to tissue necrosis
b. high doses cause a bradycardia
c. precipitation can occur when used in a dextrose solution
d. low doses decrease renal perfusion

90. Dilantin will crystallize when given IV in all of the following solutions EXCEPT:

a. dextrose 5% in water
b. dextrose in saline
c. normal saline
d. ringer's lactate

91. Precautions in using IV nitroprusside include all of the following EXCEPT:

a. protection from light
b. careful monitoring for a sudden increase in heart rate
c. alertness to the development of hypertensive crisis
d. use of a fresh mixture at appropriate intervals

92. The dosage of which drug must be tapered off slowly to prevent acute adrenal insufficiency?

a. nitroprusside
b. cortisone
c. streptokinase
d. pitressin

93. All of the following may be manifestations of digitalis toxicity EXCEPT:

a. rapid A-V conduction
b. premature ventricular contractions
c. nausea
d. yellow vision

94. The most common symptom of a toxic blood level of Lidocaine is:

a. elevated blood pressure
b. confusion
c. abnormal clotting time
d. metal taste

95. The patient complains of a sudden headache one minute after a drug is administered. Which of the following drugs would most likely cause this symptom?

a. Lidocaine
b. Quinidine
c. Digoxin
d. nitrates

96. If the patient did not use Atropine for a bradycardia, which of the following could be used to increase the heart rate?

a. propranolol (Inderal)
b. Quabain
c. Isuprel
d. Verapamil

97. When administering Lidocaine to a patient, the proper function of which body system would be useful to know for correct dosage?

a. hepatic
b. nervous
c. respiratory
d. endocrine

98. How many micrograms are in one milligram?

a. 10
b. 100
c. 1,000
d. 10,000

99. In caring for the patient with infectious hepatitis, it is important for the nurse to observe which of the following?

a. respiratory precautions
b. reverse isolation .
c. needle precautions
d. urine isolation

100. Symptoms of a mild blood transfusion reaction include:

a. decreased temperature, chills, headache
b. urticaria, cold skin, drowsiness
c. increased temperature, headache, chills
d. flushing, drowsiness, slow pulse

THIS IS THE END OF THE TEST

BKAT-3

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Kathleen A. Ritchey, RN, MSN
Veterans Administration Medical Center
Washington, DC 20422

Jean C. Toth, RN, CCRN, DNSc
The Catholic University of America
Washington, DC 20064

Appendix C

Cardiovascular Self-Evaluation Tool (CST)

CARDIOVASCULAR SELF-ASSESSMENT TOOL

The following items describe specific tasks related to the care of a cardiovascular patient. Please use the Scantron answer sheet and a #2 pencil to rate your knowledge and skills related to the following tasks. A is lowest on the scale and D is highest, where:

A = No knowledge or skills related to the task
B = Theoretical knowledge, but limited practical skills related to the task
C = Knowledge and skills related to the task in uncomplicated patient situations
D = Knowledge and skills related to the task in complex patient situations

1. Collect subjective and objective data to determine the gravity of the patient's condition in order to maintain a current database.

2. Interview patient or significant other and review hospital records in order to obtain present and past medical history and signs/symptoms of cardiovascular problems.

3. Inspect cardiovascular system including the skin, neck veins, extremities and precordium.

4. Palpate precordial area, arteries and veins.

5. Auscultate for heart sounds, systemic blood pressure, and venous blood flow.

6. Assure completion of appropriate cardiovascular laboratory studies, radiological exams, and diagnostic tests.

7. Obtain cardiac rhythm strip and measure intervals.

8. Obtain hemodynamic parameters.

9. Document in patient record and convey to other health team members pertinent cardiovascular physical assessment findings within a time frame consistent with the gravity of the patient's condition.

10. Gather psychological, social, and spiritual data from patient and significant others in relation to present cardiovascular condition.

11. Perform a 12-lead EKG.

12. Assemble and interpret data obtained from patient records and cardiovascular assessment to identify patient problems/needs.

13. Use pertinent cardiovascular physical assessment findings to identify patient problems/needs.

14. Use pertinent serum and urine lab studies, radiological examinations and diagnostic tests to identify patient's cardiovascular problems/needs.

15. Evaluate the EKG to identify patient problems/needs.

16. Evaluate the hemodynamic parameters to identify problems/needs.

17. Collaborate with patient, significant others, and other health care team members to identify cardiovascular problems/needs.

18. Establish the priority of the cardiovascular problems/needs according to the actual/potential threat to patient, and reassess as the database changes.

19. Record in patient record and communicate the identified cardiovascular problems in a timely manner consistent with the gravity of the patient's condition.

20. Devise a plan of care, identify appropriate goals and determine nursing interventions for patient with dysrhythmia.

21. Specify cardiovascular interventions that communicate acceptance of the patient's and/or significant other's beliefs, culture, religion and socioeconomic background.

22. Develop and organize the cardiovascular plan of care to reflect the priority of identified problems/needs in collaboration with the patient, significant others, and other health care team members.

23. Identify areas for education of the patient and significant others based on specific cardiovascular problems/needs.

24. Revise the plan of care to reflect the patient's current status and specific cardiovascular problems/needs.

25. Communicate the cardiovascular plan to those involved in the patient's care.

26. Record the cardiovascular plan of nursing care in the patient's hospital record.

27. Implement care for patient with dysrhythmias in an organized and humanistic manner.

28. Provide care for patient with dysrhythmia in such a way as to prevent complications and life-threatening situations.

29. Implement the plan of nursing care in collaboration with the patient, significant others, and other health care team members.

30. Coordinate care delivered by health care team members.

31. Document interventions in the permanent record.

32. Evaluate results of nursing care continuously.

33. Collect data from all pertinent sources for evaluation within an appropriate time interval after intervention.

34. Compare the patient's response to expected results and attempt to determine the cause of any signifcant differences.

35. Determine the relevance of the nursing intervention to the identified problems/needs.

36. Collaborate with the patient, significant others, and other health care team members in the evaluation process.

37. Review and revise the plan of care based on evaluation results.

38. Document evaluation findings in the patient's hospital record.

Table C-1
Means and Standard Deviations for CST in Rank Order (N = 142)

Rank	Statement	M(SD)
1	Document interventions in the permanent record.	2.80(0.44)
2	Evaluate the results of nursing care continuously.	2.75(0.52)
3	Document in patient record and convey to her health team members pertinent cardiovascular assessment findings within a time frame consistent with the gravity of the patient's condition.	2.73(0.57)
3	Collect subjective and objective data to determine the the gravity of the patient's condition in order to maintain a current database.	2.73(0.60)
5	Obtain cardiac rhythm strip and measure intervals.	2.72(0.61)
6	Obtain hemodynamic parameters.	2.70(0.65)
7	Communicate the cardiovascular plan to those involved in the patient's care.	2.69(0.59)
8	Record in patient record and communicate the identified cardiovascular problems in a timely manner consistent with the gravity of the patient's condition.	2.68(0.66)
9	Document evaluation findings in the patient's hospital record.	2.67(0.57)
10	Collect data from all pertinent sources for evaluation within an appropriate time interval after intervention.	2.66(0.52)
11	Interview patient or significant other and review hospital records in order to obtain present and past medical history and signs/symptoms of cardiovascular problems.	2.64(0.60)
12	Provide care for patient with dysrhthmia in such a way as to prevent complications and life-threatening complications.	2.63(0.70)
13	Collaborate with the patient, significant others, and other health care team members in the evaluation process.	2.61(0.71)
13	Collaborate with patient, significant others, and other health care team members to identify cardiovascular problems/needs.	2.61(0.71)

Table C-1 (cont.)

Rank	Statement	M(SD)
15	Determine the relevance of the nursing intervention to the identified problems/needs.	2.60(0.65)
16	Review and revise the plan of care based on evaluation results.	2.60(0.63)
17	Assure completion of appropriate cardiovascular laboratory studies, radiological exams, and diagnostic tests.	2.58(0.75)
17	Peform a 12-lead EKG.	2.58(0.75)
19	Gather psychological, social, and spiritual data from patient and significal others in relation to present cardiovascular condition.	2.57(0.61)
20	Use pertinent cardiovascular physical assessment findings to identify patient problems/needs.	2.55(0.66)
21	Auscultate for heart sounds, systemic blood pressure, and venous blood flow.	2.54(0.64)
21	Assemble and interpret data obtained from patient records and cardiovascular assessment to identify patient problems/needs.	2.54(0.65)
23	Implement the plan of nursing care in collaboration with the patient, significant others, and other health care team members.	2.53(0.78)
23	Inspect cardiovascular system including the skin, neck veins, extremities and precordium.	2.53(0.67)
23	Implement care for patient with dysrhythmias in an organized and humanistic manner.	2.53(0.77)
26	Coordinate care delivered by health care team members.	2.52(0.67)
27	Compare the patient's response to expected results and attempt to determine the cause of any significant differences.	2.50(0.69)
27	Revise the plan of care to reflect the patient's current status and specific cardiovascular problems/needs.	2.50(0.75)
27	Record the cardiovascular plan of nursing care in the patient's hospital record.	2.50(0.77)

Table C-1 (cont.)

Rank	Statement	M(SD)
30	Establish the priority of the cardiovascular problems/needs according to the actual/potential threat to patient, and reassess as the data base changes.	2.49(0.77)
31	Devise a plan of care, identify appropriate goals and determine nursing interventions for patient with dysrhythmia.	2.47(0.82)
32	Evaluate the hemodynamic parameters to identity problems/needs.	2.45(0.81)
33	Develop and organize the cardiovascular plan of care to reflect the priority of identified problems/needs in collaboration with the patient, significant others, and other health care team members.	2.38(0.79)
34	Identify areas for education of the patient and significant others based on specific cardiovascular problems/needs.	2.33(0.82)
35	Use pertinent serum and urine lab studies, radiological examinations, and other diagnostic tests to identify patient's cardiovascular problems/needs.	2.24(0.81)
36	Specify cardiovascular interventions that communicate acceptance of the patient's and/or significant other's beliefs, culture, religion, and socioeconomic background.	2.24(0.82)
37	Palpate precordial area, arteries, and veins.	2.22(0.91)
38	Evaluate the EKG to identify patient problems/needs.	2.16(0.88)

Note. 0 = No knowledge or skills related to the task; 1 = Theoretical knowledge, but limited practical skills related to the task; 2 = Knowledge and skills related to the task in uncomplicated patient situations; 3 = Knowledge and skills related to the task in complex patient situations. importance; 3 = Moderately important; 4 = Very important; 5 = Of extreme importance

Table C-2

Means and Standard Deviations for Importance Rankings of CST Items from AACN's (1988) Validation Study (N=232)

Rank	Statement	M(SD)
1	Evaluate the results of nursing care continuously.	4.66(0.29)
2	Provide care for patient with dysrhthmia in such a way as to prevent complications and life-threatening complications.	4.58(1.33)
3	Establish the priority of the cardiovascular problems/needs according to the actual/potential threat to patient, and reassess as the data base changes.	4.52(1.12)
4	Collect data from all pertinent sources for evaluation within an appropriate time interval after intervention.	4.50(1.32)
5	Evaluate the hemodynamic parameters to identity problems/needs.	4.48(1.18)
5	Implement care for patient with dysrhythmias in an organized and humanistic manner.	4.48(1.28)
5	Compare the patient's response to expected results and attempt to determine the cause of any significant differences.	4.48(1.32)
8	Devise a plan of care, identify appropriate goals and determine nursing interventions for patient with dysrhythmia.	4.47(1.23)
9	Document in patient record and convey to her health team members pertinent cardiovascular assessment findings within a time frame consistent with the gravity of the patient's condition.	4.46(0.99)
9	Record in patient record and communicate the identified cardiovascular problems in a timely manner consistent with the gravity of the patient's condition.	4.46(1.18)
11	Use any pertinent cardiovascular physical assessment findings to identify patient problems/needs.	4.45(1.02)
12	Document interventions in the permanent record.	4.44(1.34)
13	Determine the relevance of the nursing intervention to the identified problems/needs.	4.42(1.32)

Table C-2 (cont.)

Rank	Statement	M(SD)
14	Obtain hemodynamic parameters.	4.41(1.03)
15	Auscultate for heart sounds, systemic blood pressure, and venous blood flow.	4.49(0.98)
16	Inspect cardiovascular system including the skin, neck veins, extremities and precordium.	4.38(0.99)
16	Coordinate care delivered by health care team members.	4.38(1.35)
18	Collect subjective and objective data to determine the the gravity of the patient's condition in order to maintain a current database.	4.37(1.09)
18	Collaborate with the patient, significant others, and other health care team members in the evaluation process.	4.37(1.31)
20	Assemble and interpret data obtained from patient records and cardiovascular assessment to identify patient problems/needs.	4.36(1.04)
21	Implement the plan of nursing care in collaboration with the patient, significant others, and other health care team members.	4.35(1.36)
22	Use pertinent serum and urine lab studies, radiological examinations, and other diagnostic tests to identify patient's cardiovascular problems/needs.	4.34(1.18)
22	Review and revise the plan of care based on evaluation results.	4.34(1.35)
22	Document evaluation findings in the patient's hospital record.	4.34(1.41)
25	Evaluate the EKG to identify patient problems/needs.	4.30(1.19)
26	Collaborate with patient, significant others, and other health care team members to identify cardiovascular problems/needs.	4.26(1.12)
27	Obtain cardiac rhythm strip and measure intervals.	4.25(1.11)
28	Communicate the cardiovascular plan to those involved in the patient's care.	4.21(1.29)
29	Revise the plan of care to reflect the patient's current status and specific cardiovascular problems/needs.	4.12(1.29)

Table C-2 (cont.)

Rank	Statement	M(SD)
30	Develop and organize the cardiovascular plan of care to reflect the priority of identified problems/needs in collaboration with the patient, significant others, and other health care team members.	4.08(1.31)
31	Interview patient or significant other and review hospital records in order to obtain present and past medical history and signs/symptoms of cardiovascular problems.	4.06(1.10)
31	Identify areas for education of the patient and significant others based on specific cardiovascular problems/needs.	4.06(1.33)
33	Record the cardiovascular plan of nursing care in the patient's hospital record.	4.00(1.11)
33	Assure completion of appropriate cardiovascular laboratory studies, radiological exams, and diagnostic tests.	4.00(1.16)
35	Palpate precordial area, arteries, and veins.	3.83(1.18)
36	Specify cardiovascular interventions that communicate acceptance of the patient's and/or significant other's beliefs, culture, religion, and socioeconomic background.	3.82(1.84)
37	Gather psychological, social, and spiritual data from patient and significal others in relation to present cardiovascular condition.	3.67(1.04)
38	Peform a 12-lead EKG.	3.01(1.61)

Note.
1 = I do not have this responsibility;
2 = Of little or no importance;
3 = Moderately important;
4 = Very important;
5 = Of extreme importance.

Appendix D

Descriptions of Computerized Clinical Simulations

APPENDIX D

Descriptions of Computerized Clinical Simulations

Atrial Flutter (Version 1)

Vital Signs: HR-144, R-35, BP-90/68

Current History: shortness of breath without chest pain or five days post-operative coronary artery bypass graft surgery

Past Medical History: rheumatoid arthritis or peptic ulcer

Physical Exam: pale and diaphoretic; pulse weak and regular

Chest X-ray: normal heart size with moderate pulmonary congestion

Arterial Blood Gases: pO2-82, pCO2-43, pH-7.37, HCO3-24 or pO2-67, pCO2-49, pH-7.31, HCO3-24

Potassium: 4.5

Drug Allergies: sulfa or penicillin or codeine or lidocaine or none

Medications: aspirin or valium

*Definitive Treatment: verapamil or synchronized cardioversion or overdrive transvenous pacemaker

---

* = parameter differentiating this version of atrial flutter from other versions of atrial flutter

Atrial Flutter (Version 2)

Vital Signs: HR-144, R-35, BP-90/68

Current History: shortness of breath without chest pain or five days post-operative coronary artery bypass graft surgery

Past Medical History: rheumatoid arthritis or peptic ulcer

Physical Exam: pale and diaphoretic; pulse weak and regular

Chest X-ray: normal heart size with moderate pulmonary congestion

Arterial Blood Gases: pO2-82, pCO2-43, pH-7.37, HCO3-24 or pO2-67, pCO2-49, pH-7.31, HCO3-24

Potassium: 4.5

Drug Allergies: sulfa or penicillin or codeine or lidocaine or none

Medications: aspirin or valium

*Definitive Treatment: synchronized cardioversion or overdrive transvenous pacemaker

---

* = parameter differentiating this version of atrial flutter from other versions of atrial flutter

Ventricular Tachycardia (Version 1)

*Vital Signs: HR-139, R-36, BP-73/0

Current History: chest pain for two hours accompanied by nausea and vomiting or atypical chest pain for 20 minutes

Past Medical History: hyperlipidemia or peptic ulcer

Physical Exam: skin cool and clammy; pulse weak and thready

Chest X-ray: normal heart size with moderate pulmonary congestion

*Arterial Blood Gases: pO2-67, pCO2-46, pH-7.31, HCO3-24

*Potassium: 3.3

*Drug Allergies: sulfa or penicillin or codeine or none

Medications: aspirin or valium

*Definitive Treatment: bretylium or propranolol

---

* = parameter differentiating this version of ventricular tachycardia from other versions of ventricular tachycardia

Ventricular Tachycardia (Version 2)

*Vital Signs: HR-156, R-19, BP-79/57

Current History: chest pain for two hours accompanied by nausea and vomiting or atypical chest pain for 20 minutes

Past Medical History: hyperlipidemia or peptic ulcer

Physical Exam: skin cool and clammy; pulse weak and thready

Chest X-ray: normal heart size with moderate pulmonary congestion

*Arterial Blood Gases: pO2-54, pCO2-55, pH-7.26, HCO3-24

*Potassium: 4.6

*Drug Allergies: sulfa or penicillin or codeine or none

Medications: aspirin or valium

*Definitive Treatment: propranolol

---

* = parameter differentiating this version of ventricular tachycardia from other versions of ventricular tachycardia

Ventricular Tachycardia (Version 3)

*Vital Signs: HR-156, R-19, BP-79/57

Current History: chest pain for two hours accompanied by nausea and vomiting or atypical chest pain for 20 minutes

Past Medical History: hyperlipidemia or peptic ulcer

Physical Exam: skin cool and clammy; pulse weak and thready

Chest X-ray: normal heart size with moderate pulmonary congestion

*Arterial Blood Gases: unknown

*Potassium: 4.6

*Drug Allergies: sulfa or penicillin or codeine or none

Medications: aspirin or valium

*Definitive Treatment: propranolol

---

* - parameter differentiating this version of ventricular tachycardia from other versions of ventricular tachycardia

Ventricular Tachycardia (Version 4)

*Vital Signs: HR-156, R-19, BP-79/57

Current History: chest pain for two hours accompanied by nausea and vomiting or atypical chest pain for 20 minutes

Past Medical History: hyperlipidemia or peptic ulcer

Physical Exam: skin cool and clammy; pulse weak and thready

Chest X-ray: normal heart size with moderate pulmonary congestion

*Arterial Blood Gases: pO2-54, pCO2-55, pH-7.26, HCO3-24

*Potassium: 4.6

*Drug Allergies: lidocaine

Medications: aspirin or valium

*Definitive Treatment: propranolol

---

* - parameter differentiating this version of ventricular tachycardia from other versions of ventricular tachycardia

Ventricular Tachycardia (Version 5)

*Vital Signs: HR-156, R-19, BP-79/57

Current History: chest pain for two hours accompanied by nausea and vomiting or atypical chest pain for 20 minutes

Past Medical History: hyperlipidemia or peptic ulcer

Physical Exam: skin cool and clammy; pulse weak and thready

Chest X-ray: normal heart size with moderate pulmonary congestion

*Arterial Blood Gases: unknown

*Potassium: 4.6

*Drug Allergies: lidocaine

Medications: aspirin or valium

*Definitive Treatment: propranolol

---

* = parameter differentiating this version of ventricular tachycardia from other versions of ventricular tachycardia

Ventricular Tachycardia (Version 6)

*Vital Signs: HR-156, R-19, BP-79/57

Current History: chest pain for two hours accompanied by nausea and vomiting or atypical chest pain for 20 minutes

Past Medical History: hyperlipidemia or peptic ulcer

Physical Exam: skin cool and clammy; pulse weak and thready

Chest X-ray: normal heart size with moderate pulmonary congestion

*Arterial Blood Gases: pO2-54, pCO2-55, pH-7.26, HCO3-24

*Potassium: 4.6

*Drug Allergies: procainamide

Medications: aspirin or valium

*Definitive Treatment: propranolol

---

* -parameter differentiating this version of ventricular tachycardia from other versions of ventricular tachycardia

Ventricular Tachycardia (Version 7)

*Vital Signs: HR-156, R-19, BP-79/57

Current History: chest pain for two hours accompanied by nausea and vomiting or atypical chest pain for 20 minutes

Past Medical History: hyperlipidemia or peptic ulcer

Physical Exam: skin cool and clammy; pulse weak and thready

Chest X-ray: normal heart size with moderate pulmonary congestion

*Arterial Blood Gases: unknown

*Potassium: 4.6

*Drug Allergies: procainamide

Medications: aspirin or valium

*Definitive Treatment: propranolol

---

* -parameter differentiating this version of ventricular tachycardia from other versions of ventricular tachycardia

Appendix E

Letter from Tach-Man Author (Michael Barrett, MD)

MICHAEL J. BARRETT, M.D.
555 CITY LINE AVENUE
BALA CYNWYD, PA 19004
(215) 667-3988

August 25, 1988

Susan Henry, RNMS
School of Nursing
Office of Research Evaluation In Computer Resources - N-339
Box 0604
University of California
San Francisco, CA 94143-0604

RE: TACHMAN

Dear Ms. Henry:

Thank you for your letter of August 15th. In answer to your questions about TACHMAN, I was the senior content author when the program was written in 1984. The drugs mentioned and the arrhythmias used were drawn from my 15 years of experience in private practice, as well as a full time faculty member at the Medical College of Pennsylvania. Content validity was established on an empiric basis using my experience teaching medical students, and nurses and residents and documenting the treatment recommended by referring to specific references at the end of each case.

TACHMAN was reviewed in JAMA in 1986 by a Dr. Ross Simpson and you may obtain a copy of that review. Since the time of that review the references have been updated but very little else in TACHMAN has changed. Besides Dr. Simpson, TACHMAN has been reviewed by at least five other cardiologists on behalf of certain book publishers. In fact TACHMAN will appear this Fall combined with other programs in a educational setting entitled INTERN to be marketed by Mc-Graw-Hill.

I should point out that unlike other educational programs where the drug of choice always works the first time, TACHMAN has been configured so that on occasions a second or even a third line agent must be utilized to obtain a successful outcome. This is in keeping with my experience with patients who do not always respond to the drug of first choice.

This is a relatively new concept particularly for authors of print media and has been somewhat slow to be excepted by the cardiologic community.

I should be very interested in the results of your research and I look forward to receiving a copy when it is completed.

Sincerely yours,

Michael J. Barrett

Michael J. Barrett, M.D.

MJB/nzm

Appendix F

Data Collection Instrument for Expert Panel

APPENDIX F

Data Collection Instrument for Expert Panel

To: Head Nurses, Critical Care Division; ACLS Instructors, and Critical Care Educators

From: Suzanne Henry, Principal Investigator, " The Evaluation of Clinical Decision Making in Experienced and Inexperienced Critical Care Nurses"

In order to determine the criterion or optimal performance on the computerized clinical simulations to be used in this project, a panel of experts is needed. I invite you to serve on this expert panel. The scoring system for the variations of atrial flutter and ventricular tachycardia presented in the simulation can be created from your responses on the enclosed two page questionnaire. I have enclosed the relevant pages of the ACLS protocols for you to refer to in making your responses.

Thank you for consideration of my request. The information would be most useful if I received it by September 10. I have enclosed a stamped envelope for your response.

Mr. X is an acute MI patient in ventricular tachycardia. He is conscious, pulse is present (HR=140-160), BP 70/0-90/50. Please answer the following questions.

Which of the following data is <u>essential</u> (as opposed to nice to know) to collect before your initial intervention for Mr. X?

History Past Medical History Physical Exam

Medications Drug Allergies Electrolytes

Chest X-Ray Arterial Blood Gases

According to you understanding of ACLS protocols please rank the following interventions for ventricular tachycardia, as described above. #1 is the first intervention and #5 is the last intervention.

Bretylium or Propranolol

Lidocaine

Oxygen and Start IV

Procainamide

Synchronized Cardioversion

If Mr. X is unresponsive to the interventions above, what data that you did not choose before would you like to have now?

History Past Medical History Physical Exam

Medications Drug Allergies Electrolytes

Chest X-Ray Arterial Blood Gases

What additional interventions would be appropriate if the ventricular tachycardia was complicated by:

Metabolic Acidosis_____

Respiratory Acidosis_____

Hypokalemia_____

Mr. X is an acute MI patient in atrial flutter at a rate of 140-170, BP 90/60-70/40. Please answer the following questions.

Which of the following data is <u>essential</u> (as opposed to nice to know) to collect before your initial intervention for Mr. X?

History Past Medical History Physical Exam

Medications Drug Allergies Electrolytes

Chest X-Ray Arterial Blood Gases

According to your understanding of ACLS protocols please rank the following interventions for atrial flutter, as described above. #1 is the first intervention and #7 the last intervention.

Carotid Sinus Massage

Digoxin

Oxygen and Start IV

Overdrive Pacing

Propranolol

Synchronized Cardioversion

Verapamil

If Mr. X is unresponsive to the interventions above, what data that you did not choose before would you like to have now?

History Past Medical History Physical Exam

Medications Drug Allergies Electrolytes

Chest X-Ray Arterial Blood Gases

What additional interventions would be appropriate if the atrial flutter was complicated by:

Metabolic Acidosis?_____

Respiratory Acidosis?_____

Hypokalemia?_____

Lastly, which of these situations (ventricular tachycardia or atrial flutter) would you consider more acute and why?

Name_____ Phone_____

Appendix G

Scoring for Computerized Clinical Simulations

APPENDIX G

Scoring for Computerized Clinical Simulations

Atrial Flutter (Version 1): Responsive to Verapamil or Pacemaker or Cardioversion

History and Data Base	
History	0
Arterial Blood Gases	0
Chest X-ray	0
Past Medical History	0
Physical Exam	0
Electrolytes	0
Drug Allergies	1
Current Medications	1
Interventions	
Dopamine	0
Procainamide	0, -1 if allergic or too high
Procainamide Drip	0, -1 if allergic or too high
Propranolol	0, -1 if dose too high
Lidocaine	-1
Lidocaine Drip	-1
Digoxin	0, -1 if dose too high
KCL	0
Bretylium	-1
Bretylium Drip	-1
Morphine	0, -1 if dose too high
Oxygen	1
Intubation	-1
Furosemide	0, -1 if dose too high
Aminophylline	-1
Precordial Thump	-1
Carotid Sinus Massage	1
Defibrillation	-1
IV	1
Percutaneous Pacemaker	-1

Only one of the following will be scored as 1 since any one will solve the simulation:

Verapamil	0 if subtherapeutic, -1 if too high, 1 if therapeutic
Cardioversion	0 if subtherapeutic, 1 if therapeutic
Transvenous Pacemaker	0 if subtherapeutic, 1 if therapeutic

1's = 6

Atrial Flutter (Version 2): Responsive to Pacemaker or Cardioversion

History and Data Base	
History	0
Arterial Blood Gases	0
Chest X-ray	0
Past Medical History	0
Physical Exam	0
Electrolytes	0
Drug Allergies	1
Current Medications	1
Interventions	
Dopamine	0
Procainamide	0, -1 if allergic or too high
Procainamide Drip	0, -1 if allergic or too high
Propranolol	0, -1 if dose too high
Lidocaine	-1
Lidocaine Drip	-1
Digoxin	0, -1 if dose too high
KCL	0
Bretylium	-1
Bretylium Drip	-1
Morphine	0, -1 if dose too high
Oxygen	1
Intubation	-1
Furosemide	0, -1 if dose too high
Aminophylline	-1
Precordial Thump	-1
Carotid Sinus Massage	1
Defibrillation	-1
IV	1
Percutaneous Pacemaker	-1
Verapamil	0 if subtherapeutic, -1 if too high, 1 if therapeutic

Only one of the following will be scored as 1 since any one will solve the simulation

Cardioversion	0 if subtherapeutic, 1 if therapeutic
Transvenous Pacemaker	0 if subtherapeutic, 1 if therapeutic

1's = 7

Ventricular Tachycardia (Version 1): Responsive to Bretylium or Propranolol

History and Data Base	
History	0
Arterial Blood Gases	0
Chest X-ray	0
Past Medical History	0
Physical Exam	0
Electrolytes	0
Drug Allergies	1
Current Medications	1
Interventions	
Dopamine	0
Verapamil	-1
Procainamide	1, 0 if subtherapeutic, -1 if dose too high
Procainamide Drip	0, -1 if dose too high
Lidocaine	1 X 3, 0 if subtherapeutic, -1 if dose too high
Lidocaine Drip	0, -1 if does too high
Digoxin	0, -1 if dose too high
KCL	0
Bretylium Drip	-1
Morphine	0, -1 if dose too high
Oxygen	1
Intubation	-1
Furosemide	0, -1 if dose too high
Aminophylline	-1
Precordial Thump	0
Carotid Sinus Massage	0
Defibrillation	0
IV	1
Percutaneous Pacemaker	-1
Cardioversion	1 X 4, then 0
Transvenous Pacemaker	0

Only one of the following will be scored as 1 since either one will solve the simulation

Bretylium	1, 0 if subtherapeutic, -1 if dose too high
Propranolol	1, 0 if subtherapeutic, -1 if dose too high

1's = 13

Ventricular Tachycardia (Version 2): Responsive to Propranolol, Carbon Dioxide = 55

History and Data Base	
History	0
Arterial Blood Gases	0
Chest X-ray	0
Past Medical History	0
Physical Exam	0
Electrolytes	0
Drug Allergies	1
Current Medications	1
Interventions	
Dopamine	0
Verapamil	-1
Procainamide	1, 0 if subtherapeutic, -1 if dose too high
Procainamide Drip	0, -1 if dose too high
Lidocaine	1 X 3, 0 if subtherapeutic, -1 if dose too high
Lidocaine Drip	0, -1 if does too high
Digoxin	0, -1 if dose too high
KCL	0
Bretylium Drip	-1
Morphine	0, -1 if dose too high
Oxygen	0
Intubation	1
Furosemide	0, -1 if dose too high
Aminophylline	-1
Precordial Thump	0
Carotid Sinus Massage	0
Defibrillation	0
IV	1
Percutaneous Pacemaker	-1
Cardioversion	1 X 4, then 0
Transvenous Pacemaker	0
Bretylium	1, 0 if subtherapeutic, -1 if dose too high
Propranolol	1, 0 if subtherapeutic, -1 if dose too high

1's = 14

Ventricular Tachycardia (Version 3): Responsive to Propranolol (Carbon Dioxide <55)

History and Data Base	
History	0
Arterial Blood Gases	0
Chest X-ray	0
Past Medical History	0
Physical Exam	0
Electrolytes	0
Drug Allergies	1
Current Medications	1
Interventions	
Dopamine	0
Verapamil	-1
Procainamide	1, 0 if subtherapeutic, -1 if dose too high
Procainamide Drip	0, -1 if dose too high
Lidocaine	1 X 3, 0 if subtherapeutic, -1 if dose too high
Lidocaine Drip	0, -1 if does too high
Digoxin	0, -1 if dose too high
KCL	0
Bretylium Drip	-1
Morphine	0, -1 if dose too high
Oxygen	1
Intubation	-1
Furosemide	0, -1 if dose too high
Aminophylline	-1
Precordial Thump	0
Carotid Sinus Massage	0
Defibrillation	0
IV	1
Percutaneous Pacemaker	-1
Cardioversion	1 X 4, then 0
Transvenous Pacemaker	0
Bretylium	1, 0 if subtherapeutic, -1 if dose too high
Propranolol	1, 0 if subtherapeutic, -1 if dose too high

1's = 14

Ventricular Tachycardia (Version 4): Responsive to Propranolol (Carbon Dioxide = 55), Allergic to Lidocaine

History and Data Base	
History	0
Arterial Blood Gases	0
Chest X-ray	0
Past Medical History	0
Physical Exam	0
Electrolytes	0
Drug Allergies	1
Current Medications	1
Interventions	
Dopamine	0
Verapamil	-1
Procainamide	1, 0 if subtherapeutic, -1 if dose too high
Procainamide Drip	0, -1 if dose too high
Lidocaine	-1
Lidocaine Drip	-1
Digoxin	0, -1 if dose too high
KCL	0
Bretylium Drip	-1
Morphine	0, -1 if dose too high
Oxygen	0
Intubation	1
Furosemide	0, -1 if dose too high
Aminophylline	-1
Precordial Thump	0
Carotid Sinus Massage	0
Defibrillation	0
IV	1
Percutaneous Pacemaker	-1
Cardioversion	1 X 4, then 0
Transvenous Pacemaker	0
Bretylium	1, 0 if subtherapeutic, -1 if dose too high
Propranolol	1, 0 if subtherapeutic, -1 if dose too high

1's = 11

Ventricular Tachycardia (Version 5): Responsive to Propranolol, Carbon Dioxide <55, Allergic to Lidocaine

History and Data Base	
History	0
Arterial Blood Gases	0
Chest X-ray	0
Past Medical History	0
Physical Exam	0
Electrolytes	0
Drug Allergies	1
Current Medications	1
Interventions	
Dopamine	0
Verapamil	-1
Procainamide	1, 0 if subtherapeutic, -1 if dose too high
Procainamide Drip	0, -1 if dose too high
Lidocaine	-1
Lidocaine Drip	-1
Digoxin	0, -1 if dose too high
KCL	0
Bretylium Drip	-1
Morphine	0, -1 if dose too high
Oxygen	1
Intubation	0
Furosemide	0, -1 if dose too high
Aminophylline	-1
Precordial Thump	0
Carotid Sinus Massage	0
Defibrillation	
IV	1
Percutaneous Pacemaker	-1
Cardioversion	1 X 4, then 0
Transvenous Pacemaker	0
Bretylium	1, 0 if subtherapeutic, -1 if dose too high
Propranolol	1, 0 if subtherapeutic, -1 if dose too high

1's = 11

Ventricular Tachycardia (Version 6): Responsive to Propranolol, Carbon Dioxide = 55, Allergic to Procainamide

History and Data Base	
History	0
Arterial Blood Gases	0
Chest X-ray	0
Past Medical History	0
Physical Exam	0
Electrolytes	0
Drug Allergies	1
Current Medications	1
Interventions	
Dopamine	0
Verapamil	-1
Procainamide	-1
Procainamide Drip	-1
Lidocaine	1 X 3, 0 if subtherapeutic, -1 if dose too high
Lidocaine Drip	0, -1 if does too high
Digoxin	0, -1 if dose too high
KCL	0
Bretylium Drip	-1
Morphine	0, -1 if dose too high
Oxygen	0
Intubation	1
Furosemide	0, -1 if dose too high
Aminophylline	-1
Precordial Thump	0
Carotid Sinus Massage	0
Defibrillation	0
IV	1
Percutaneous Pacemaker	-1
Cardioversion	1 X 4, then 0
Transvenous Pacemaker	0
Bretylium	1, 0 if subtherapeutic, -1 if dose too high
Propranolol	1, 0 if subtherapeutic, -1 if dose too high

1's = 12

Ventricular Tachycardia (Version 7): Responsive to Propranolol, Carbon Dioxide <55, Allergic to Procainamide

History and Data Base	
History	0
Arterial Blood Gases	0
Chest X-ray	0
Past Medical History	0
Physical Exam	0
Electrolytes	0
Drug Allergies	1
Current Medications	1
Interventions	
Dopamine	0
Verapamil	-1
Procainamide	-1
Procainamide Drip	-1
Lidocaine	1 X 3, 0 if subtherapeutic, -1 if dose too high
Lidocaine Drip	0, -1 if does too high
Digoxin	0, -1 if dose too high
KCL	0
Bretylium Drip	-1
Morphine	0, -1 if dose too high
Oxygen	1
Intubation	0
Furosemide	0, -1 if dose too high
Aminophylline	-1
Precordial Thump	0
Carotid Sinus Massage	0
Defibrillation	0
IV	1
Percutaneous Pacemaker	-1
Cardioversion	1 X 4, then 0
Transvenous Pacemaker	0
Bretylium	1, 0 if subtherapeutic, -1 if dose too high
Propranolol	1, 0 if subtherapeutic, -1 if dose too high

1's = 12

Appendix H

Explanatory Letter for Study Participants

UNIVERSITY OF CALIFORNIA, DAVIS

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

UC DAVIS MEDICAL CENTER
2315 STOCKTON BOULEVARD
SACRAMENTO, CALIFORNIA 95817

November 14, 1988

Nursing Staff
Critical Care Division
UC Davis Medical Center

We are conducting a staff development quality assurance project in the Critical Care Division. The purpose of this study is a) to identify unit learning needs and b) to examine the ability of different types of educational instruments to discriminate between inexperienced and experienced critical care nurses. The study will be conducted in collaboration with William L. Holzemer, RN, PhD, and Suzanne Henry, RN, MS (University of California, San Francisco, School of Nursing), with Don Waltmire II, RN, BSN (University of California, Davis, Medical Center, Hospital Clinical Education), as the UCDMC sponsor.

All nurses in the Critical Care Division will be asked to participate in this quality assurance project. If you choose to participate, the primary investigator will administer three written instruments (one hour) and four computer simulations (one hour) during your scheduled shift. Until both written instruments and computer simulations are completed, a master list will be kept by the primary investigator linking your code number and name. To maintain confidentiality, this list will be destroyed immediately after data collection. Before the list is destroyed, your individual scores will be shared with you, at your request. Trends will be shared with your head nurse to determine unit needs. Only summary data will be used in quality assurance reports and journal publications.

Your questions can be answered by contacting Suzanne Henry, 415/283-7636, COLLECT or Don Waltmire, 453-2587. We are very excited about the ability to conduct such a broad scale project that provides the opportunity for full participation of all nursing staff in the Critical Care Division. Thank you for your cooperation in this effort.

Sincerely,

Carol Robinson

Carol Robinson, RN,
Assistant Director, Hospital and Clinics
Critical Care/Emergency Services

Mary Ellen Watson

Mary Ellen Watson, RN, MSN
Assistant Director of Nursing
Hospital Clinical Education

cc: Laurel Kersten
Suzanne Henry

Appendix I

Instructions for Computerized Clinical Simulations

APPENDIX I

Instructions for Computerized Clinical Simulations

After I do a short demonstration to familiarize you with the simulation format and the computer keyboard, you will be completing four clinical simulations. The patients in the simulations are cardiac patients with dysrhythmias. Your goal is to correctly manage and treat the dysrhythmia in a timely manner appropriate for the patient's condition. You are limited to 15 minutes for each simulation. You may choose any option on the menu except stat consultation or drug dosages. Except for the cardiac monitor, the patients have received no interventions such as oxygen, IV's, or anti-arrhythmic drugs. Patient parameters such as history, physical exam, vital signs, and lab values are randomly generated by the computer so even if two rhythms look similar, everything about the case many not be the same. I will be recording your choices as you move through the simulations. Any questions?