A STUDY OF THE RELATIONSHIP AMONG KNOWLEDGE BASE, ACCURACY, COMPREHENSIVENESS AND COMPLEXITY OF DIAGNOSTIC PROBLEM-SOLVING BY BACCALAUREATE NURSING STUDENTS AND PRACTICING CLINICIANS

by

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CHAPTER I

INTRODUCTION

Problem-solving is an important function performed by health care professionals, and a fundamental element of nursing practice. This cognitive process involves using knowledge to formulate a clinical inference, which is a judgment made about the needs or state of a patient. The accuracy of the inference guides appropriate interventions, and determines if successful outcomes can be attained. There is, however, very little understanding of the basic components that underlie this intellectual process (Kassirer and Gorry, 1978). The observation and evaluation of this mental process is important in relation to nurses if improvement of patient care is to be achieved.

Research has indicated that nurses possess poor diagnostic capabilities (Aspinall, 1976). Some believe that there is poor retention of theoretical knowledge and/or an inability to apply existing knowledge to solve clinical problems. Others criticize educational institutions for emphasizing nursing action instead of cultivating and using cognitive abilities of future nurses (Hammond, 1966 and Aspinall, 1976).

It is often assumed that the ability to solve complex clinical problems is largely based upon the clinician having a sound theoretical knowledge base. The use of this knowledge base in analyzing patient information is crucial if a correct assessment and plan of action for delivering quality patient care is to be realized (Benner and Wrubel, 1982; Elstein, Shulman and Sprafka, 1972, 1978).

The overall purpose of the present study is to explore the relationship between having theoretical knowledge and the capacity to derive accurate nursing inference. More specifically, the questions addressed by this study are:

1. Is there a difference in knowledge base, degree of accuracy of diagnostic inference, and comprehensiveness and complexity of diagnostic problem-solving between three levels of nursing experience: novice, mid-level and expert?

2. What is the relationship between knowledge base, degree of accuracy of diagnostic inference, and comprehensiveness and complexity of diagnostic problem-solving among the three levels of preparation?

This research topic is part of a large-scale comprehensive study currently in progress entitled: "Diagnostic Reasoning: An Analysis of Cognitive Strategies Used by Nursing Students and Nurses", by Tanner, Putzier, Westfall and Padrick. The general purpose of the parent investigation is to question the extent to which a diagnostic reasoning model derived from studies of physicians represents the processes employed by nursing students and practicing nurses. Specifically, it seeks to examine and describe thinking strategies that are commonly exercised by junior and senior nursing students and practicing clinicians; to identify thinking strategies that are unique to each level, and to identify strategies that are task specific and used by each level. This study attempts to better comprehend the role of knowledge in the problem-solving process used by nurses. Clarification of this phenomenon will influence teaching methods in particular and clinical practice in general.

Review of the Literature

This review of the literature summarizes research conducted on the cognitive processes of problem-solving in the health care professions. Two terms that are relevant to this review and are mentioned throughout the literature are inference and diagnosis. These terms are often used interchangeably, resulting in a great deal of confusion in meaning. The Social Policy Statement of the American Nurses' Association (1980) describes diagnosis as, "a beginning effort to objectify a perceived difficulty or need by naming it, as a basis for understanding and taking action to resolve the concern" (p. 11). Hammond (1964) defines an inference as "a conclusion or judgment drawn from data" (p. 315). For the purposes of this study, the term "diagnostic inference" will be used to mean a statement of a patient problem derived from data presented by the patient.

The study and understanding of problem-solving is relatively new, but interest in the area appears to be growing rapidly. The majority of studies regarding this process center primarily on the problem-solving abilities of medical students and physicians (Elstein, et al, et al, 1978; Kassirer and Gorry, 1978; and Neufeld, Norman, Feightner and Barrows, 1981). The reason for this selective focus centers on the fact that medical problem-solving tasks differ from other types of problems in that there is, in most cases, not a clear definitive goal. Connelly and Johnson (1980) reported that "the medical problem-solver converts his open-ended problem into a series of closed ones by setting up trial states or diagnostic hypotheses" (p. 415). Early generation of hypotheses allows the practitioner to

integrate knowledge and experience, in conjunction with information elicited from the patient, to arrive at a solution.

Most of the above mentioned studies used similar techniques to test their hypotheses, namely, patient simulations with verbal protocol analyses. Simulated patient encounters are designed to be representative of actual patient situations. The simulation may take the form of a written clinical problem situation, a videotaped vignette portraying an interaction of a health professional with a patient, or the simulation may be done by a trained actor who feigns signs and symptoms representative of a true patient. Subjects are instructed to ask for information, and verbalize their thinking and rationale for action in regard to the test situation. Responses or verbal protocols are then analyzed and evaluated in accordance with established criteria. The use of simulations does allow for a certain amount of control by the researcher over the information available to the subject. As a testing method, simulations have been helpful in appraising the thinking processes of the problem-solver.

Simulations are not without controversy. Limitations most often discussed are: 1) simulations do not accurately portray actual patient situations; 2) presentation of "actual" cues are limited in number; and 3) the problem-solving process depicted in the test situation may not be valid in representing the process actually used in practice (deTornyay, 1968; Sherman, Miller, Farrand and Holzemer, 1979).

The most extensive studies designed to examine the cognitive processes involved in problem-solving were developed by Elstein, et al (1972, 1978). A general model of diagnostic reasoning, based on

information processing theory, has evolved as a result of these studies. In one study, three simulated medical problems portrayed by trained actors were presented to twenty-four experienced physicians in the field of internal medicine. Instructions were given to the participants that data could be obtained from the "patients" whenever necessary. The physicians were asked to think aloud and provide an ongoing account of their reasoning processes. Significant findings from this first study include the following: 1) hypotheses are generated early in the problem situation; 2) total number of hypotheses considered usually varied from four to seven; 3) strategies used are often dependent on the specific case presented; and 4) diagnostic accuracy was associated with thoroughness in cue acquisition and accuracy of cue interpretation.

The second study involved fifteen of the original twenty-four physicians used in the first study. Four patient-management problems (PMP's) were used as the testing mode. PMP's are paper and pencil narratives in which subjects are presented with simulated but realistic problems. Feedback is given to the subject in regard to decisions and actions made. Each action affects subsequent decisions, and therefore, alters the presenting problem. The test terminates when the subject resolves the problem. Findings in this study indicated that the physicians were not consistent in their problem-solving strategies, that is, they varied depending on the presenting problem.

In the final study, Elstein et al. found that premature closure can lead to diagnostic error because contradictory or additional information is ignored. It was noted that successful problem-solving is based upon sufficient information and knowledge, as well as experience. The presence of knowledge, however, does not guarantee correct application.

The overall approach to diagnostic reasoning was consistent in each of the studies and included the following components: 1) cue acquisition, which is the process of collecting data regarding the specific problem; 2) hypothesis generation; 3) cue interpretation; and 4) hypothesis evaluation. Implicit in the findings is the potential function of the clinician's knowledge base. With few cues, the clinician is able to activate diagnostic hypotheses, an activity dependent on knowledge. The finding that the strategies used vary dependent on the specific case may be due to differences in the clinician's knowledge relevant for each case.

Several subsequent investigations have supported the findings of Elstein et al. (1978). Kassirer and Gorry (1978) analyzed the tape recorded responses of six experienced physicians engaged in obtaining illness histories of simulated patients. Similar to Elstein and associates, they found that diagnostic hypotheses were produced early and often with little information, and that hypotheses were tested and eliminated as data were collected and verified. A relationship between the organization of knowledge in long term memory and the quantity and quality of generated hypotheses, and performance was identified. They found that "a large amount of knowledge, highly organized for the task at hand, is an essential ingredient in expert performance" (p. 254). Results further suggested that differing levels of clinical expertise influence the style and purpose in gathering information.

In a cross-sectional and longitudinal study of medical students, Neufeld et al. (1981) examined and evaluated the clinical problem-solving abilities of the participants using simulated patients. Each subject was given one "patient" to examine and findings were then recorded in a

medical record. The proceedings were videotaped in order to evaluate the reasoning of the student and rate the therapeutic relationship between student and patient by two researchers. Subjects were asked to view the videotape and recall thinking processes used during the situation. Using a typed transcription of the encounter, they were also asked to indicate what questions asked by them during the situation directly related to their diagnostic hypotheses. Results showed that several hypotheses were usually considered at the same time, an occurrence known as parallel processing. They also found that the level of education influenced the accuracy and content of the diagnostic hypotheses generated.

The authors did find similarities between the clinical reasoning process of medical students and practicing physicians. The factors common to each include:

1) the application of knowledge and clinical experience retrievable from memory for use in an encounter with a patient;
2) the elements of the clinical reasoning process -- the weighting of elicited data against these hypotheses, and the search for additional data;
3) the interviewing and physical examination techniques required to obtain information from the patient;
4) the interpersonal attributes needed to establish rapport and maintain communication (p. 321).

All of the investigations involving medical subjects indicated similar findings, i.e., physicians produced diagnostic hypotheses early in a problem situation, and hypotheses were limited in number but

exerted a great deal of influence on the type and sequence of information acquired during the problem presentation. Findings also indicated that the nature and success of problem-solving is predominately task specific. The reason for this has not been clearly defined. One explanation proposed is that sufficient knowledge of the content of the task is important to the problem-solving process and to the accuracy of the outcome.

Studies in Nursing

It has been argued that the practice of nursing is essentially the practice of problem-solving (Johnson, Davis and Bilitch, 1970). The systematic approach nurses use to help in problem-solving is called the nursing process. The four phases involved in this procedure include assessment, planning, implementation and evaluation. Carrieri and Sitzman (1971) state that the nursing process "requires the use of both theory and expert clinical practice in order that valid nursing actions can be derived and evaluated for effectiveness" (p. 123).

Because most of the studies have dealt with subjects in the medical profession, a void appears to be present in regard to the study and understanding of the problem-solving processes of nurses. It is not known if the processes used by nurses are the same as or different from those used by physicians and medical students.

Most of the studies in nursing have focused on the components of the reasoning process, information-gathering strategies (Hammond, 1966; Gordon, 1973 and 1980; Matthews and Gaul, 1979; Tanner, 1977; and Kraus, 1976) and the relationship between these strategies and diagnostic hypotheses (Robinson, 1980). At least two studies have been conducted to test instructional methods (Aspinall, 1979; and Tanner, 1977). Four

studies have examined the performance differences between novice and experts, and differences within each group in relationship to knowledge base (Broderick and Ammentorp, 1979; Benner, 1983; Aspinall, 1979; Matthews and Gaul, 1979). This present study attempts to continue their efforts in explaining this important relationship between knowledge and performance.

The most extensive research on the subject of problem-solving, in general, and clinical inference, in particular, was conducted by Hammond and associates (1964, 1966, 1967). He attempted to build a depository of knowledge about the dynamics involved in the inferential process. He was the only researcher whose primary focus was on the overall processes involved in problem-solving. Hammond believes the nurse must be proficient in information-seeking and have an extensive background of theoretical knowledge in order to evaluate clinical situations.

In 1966, Hammond, Castellan, Vancini, Kelly and Schneider, analyzed the information-seeking strategies used by nurses. They concentrated on two forms: simultaneous scanning, which involves maximizing the probability that bits of information are accepted or rejected; and successive scanning strategies, an organized search for information in a sequence. In a small study involving five nurses, it was found that the majority of nurses (three) used more successive scanning strategies than simultaneous.

According to Hammond (1966), knowledge affects the type of information-seeking strategies that will be used by the problem-solver. For those who possess an abundance of empirical knowledge, the focus of attention will be on facts rather than on hypotheses. If the individual possesses theoretical knowledge, the focus will be on confirming or rejecting hypotheses (Hammond, 1966).

Extensive research on the information-seeking processes has been done by Gordon (1980). She described three information-gathering strategies used by nurses: 1) single hypothesis, which is characterized by testing one hypothesis at a time, discarding the unproven, 2) multiple hypotheses testing, using information simultaneously to test hypotheses; 3) predictive testing, a form of multiple hypotheses testing which involves using related attributes to limit the number of possible hypotheses.

Gordon found that all but two of the sixty graduate nursing students used a mixed hypothesis testing strategy with single hypothesis testing more prevalent. The nurses initially used predictive hypothesis testing but later changed to single hypothesis testing with a greater level of accuracy. Gordon believes the basis for predictive hypothesis testing is knowledge of theoretical and statistical relationships. This knowledge must be stored in the memory in such a manner that it can be efficiently retrieved to effectively influence diagnostic strategies.

Robinson (1981) looked at the relationship between parts of the problem-solving process of nurse practitioners. While accuracy of diagnosis was not a primary consideration, the study did center on two segments of problem-solving, information-gathering and hypothesis generation. Seventy-nine participants were given a PMP involving a patient complaining of chest pain and difficulty breathing. Knowledge was indirectly tested by a cognitive exam that was used to validate the the PMP and a significant correlation was found ($r = .54$; $p = <.01$). Participants were allowed to choose information from a given list that they felt was needed to formulate a diagnosis, identify problem areas and develop a plan of action. Despite a number of methodological flaws

suggested by the investigator, the study discovered that an inverse relationship existed between the number of diagnoses hypothesized and the information obtained which was essential to the assessing, diagnosing, and managing the patient problem; and a positive relationship between the number of hypothesized diagnoses and the number of items of information selected. This study corroborated results from studies cited earlier in medicine that showed hypotheses are generated early in an encounter and decrease as the simulation progresses.

Certain factors, such as preinformation, may influence the information-gathering process. The presence of preinformation, information that is received prior to direct observation and a form of knowledge, can hinder or assist the nurse in the interpretation of specific patient characteristics, that is, it can bias the process. Kraus (1976) sought to examine the effect of preinformation on the characteristics identified by nurses as being descriptive of a patient. A three group experimental design involving eighty registered nurses was conducted. Subjects were given preinformation prior to seeing a film of a patient situation. Findings indicated that preinformation did influence nurses to direct observations toward specific patient characteristics based on the type of preinformation given. Furthermore, it influenced the degree of certainty of selected characteristics to specific disease states and suggested the degree of importance of certain characteristics.

Several researchers have focused their attention on the information-processing capabilities of experts and novices (Broderick and Ammentorp, 1979; Benner, 1983; and Aspinall, 1976). In a study involving 23 associate degree nurses and 37 first-year associate degree nursing

students, Broderick and Ammentorp (1979) found that experts asked for more items of information, including unavailable information, when a simulated patient problem was presented and subjects were instructed to ask for specific bits of information to derive a diagnosis. The authors discovered that "nurses take action from a general common base of information" (p. 110). Because of the close categorizations of information by both expert and novice, the authors suggested that nursing education has a lasting impact on the manner in which information is organized and considered.

Benner (1983) studied the differences between expert and novice clinicians in regard to competencies in a variety of acute patient care situation. It was found that experienced clinicians combine theoretical knowledge with experiences from past situations to influence nursing interventions. This combination allows the nurse to be more proficient, accurate and thorough in nursing actions.

To determine how well nurses do successfully identify causes for medical problems, Aspinall (1976) presented 187 hospital nurses of varied educational backgrounds and experience with a written case study of a patient who experienced a sudden change in cognitive ability. There were twelve possible reasons or causes for the condition. None of the subjects listed all twelve. Answers varied from one to nine with a mean of 3.44. An important finding of this study was that in comparing nurses with less than ten years experience with nurses having more than ten years experience, the difference in the mean number of problems they identified was significant at the $<.01$ level. The experienced nurses did not appear to possess the necessary ability to identify possible causes of clinical problems.

This study appears to support the studies done by Hammond (1964, 1966, and 1967). Nurses easily recognize changes in a patient's condition, but fail to comprehend the underlying cause for the changes. The author suggests that the nurses lacked basic theoretical knowledge regarding possible causes and a means to evaluate pertinent cues that could focus on the cause. In summary, Aspinall believes that in order to form a correct diagnosis, nurses need "adequate theoretical knowledge of the typical constellations of symptoms and the ability to combine analytical and intuitive methods of clinical thinking" (p. 434).

Matthews and Gaul (1979) examined two relationships, the relevancy between concept attainment and cue perception and the correlation between critical thinking and the ability to deduce a nursing diagnosis. They sought to identify differences in performance between baccalaureate and graduate nursing students, thus examining the factors of education and experience. Two case studies were used, each containing specific cues for deriving a nursing diagnosis. Content validity was established for the case studies, but reliability was not. Two tests were also given in conjunction with the case studies: the Concept Mastery Test and the Watson-Glaser Critical Thinking Appraisal Test. The authors found no significant difference between the two groups in their ability to think critically. In analysis of the case studies, the undergraduate students identified only half of the possible nursing diagnoses, while the graduate students faired only slightly better with 62% of diagnoses identified. Because of an increased knowledge base, one would expect that the graduate students would be significantly more accurate than what was reported. A possible explanation for the poor results is that the graduate students may not have been familiar with the nomenclature

used in nursing diagnoses.

The only study which examined directly the relationship between knowledge and diagnostic performance was by Tanner (1977). This researcher studied 54 senior baccalaureate nursing students in regard to the use of diagnostic strategies. Subjects were shown videotapes of patient situations and asked to verbalize their thinking. The Watson-Glaser Critical Thinking Appraisal and a written test of knowledge was also used. Students were randomly assigned to one of six treatment groups: the experimental method; the traditional method; or no instruction, which was the control group; each crossed with clinical experience or no clinical experience. Results of the study showed that subjects in the experimental group, who also had clinical experience, generated more diagnostic hypotheses than those in the other groups. Accuracy of diagnosis was only moderately correlated with the number of early diagnostic hypotheses. The study also found a positive relationship between knowledge and diagnostic accuracy, statistically significant at a level of $p < .001$ with a correlation coefficient of 0.63.

In summary, medical and nursing literature has shown several important commonalities in regard to the relationship between knowledge and the diagnostic process. Studies have shown that problem-solvers generate hypotheses, though limited in number, early in a problem situation. It has been suggested that knowledge is a requirement for generation of relevant hypotheses as well as for confirming or rejecting generated hypotheses needed in the problem-solving process. Only one study in nursing literature has documented specifically the relationship between number of hypotheses and knowledge (Tanner, 1977). Other studies in nursing which have examined the effects of education and experience

have failed to support this finding.

Studies have also confirmed that problem-solving is predominately task specific (Elstein, et al., 1972). It has been suggested that this task specificity is related to the success and accuracy of this cognitive process which is dependent upon sufficient knowledge of the content of the task.

The present study is designed to address the question of the role of knowledge in the diagnostic reasoning process. It is believed that an adequate knowledge base is essential in solving all diagnostic tasks.

Conceptual Framework

The conceptual framework for this study of the relationship of knowledge and accuracy of diagnostic inference is based on information-processing theory, which is largely founded on the work of Newell and Simon (Newell, Shaw and Simon, 1958; Newell and Simon, 1972; and Simon, 1978). According to this theory, there are three components of problem-solving behavior: 1) information processing; 2) task environment; and 3) problem space.

Information-processing theory stresses that human problem-solving is marked by the individual's ability to adapt to limitations in information processing. One limitation is the amount of information that can be processed at a given time, and the other is factors that determine the interpretation of the information by the problem-solver, namely the psychology of the problem-solver and the structure of the problem itself, also known as the task environment. Effective problem-solving relies on the ability of the problem-solver to adapt to these limitations.

The basic component of the information-processing approach, and a crucial factor in determining the amount and accessibility of information to the problem-solver, is the memory system. It is a complex process that involves continuous receiving, altering, storing and retrieving useful pieces of information.

The memory is divided into two systems; short-term memory (STM) and long-term memory (LTM). One characteristic of the STM is a limited capacity. Information is usually lost within approximately fifteen seconds if it is not repeated over and over via the process of rehearsal (Simon, 1978). It is thought that humans have the ability to choose the type of information they wish to be held longer by use of rehearsal, allowing other types of knowledge to disappear (Loftus and Loftus, 1976). In a classic series of studies, Miller (1956) described the human capacity to process information. He found that judgment is limited by the amount of information present, and that STM is limited by the number of items, usually five to seven symbols. These limitations affect the amount of information that can be received, processed and retrieved.

The capacity of the STM can be drastically increased by coding and clustering given data into hypotheses (Elstein, et al., 1978). Large amounts of clinical data can then be reduced to a more workable format. This process can reduce the experience of "cognitive strain" by problem-solvers faced with vast amounts of information and complex problems (Bruner, Austin, and Goodman, 1956).

Long-term memory is a relatively unlimited capacity storage area for information that is more or less permanently available to the human.

The LTM is unique in that stored information is efficiently categorized and cross-referenced according to related concepts, facilitating retrieval of necessary information. Studies have shown that medical knowledge is stored in a hierarchical manner, influencing activation of diagnostic hypotheses (Elstein, et al., 1972; Kassirer and Gorry, 1978). The process of retrieval and usage of stored knowledge consists of transferring information from LTM to STM.

The second component of problem-solving, the task environment, as described by Simon (1978), refers to the characteristics of the given problem. Two factors must be identified when defining the task environment: 1) the complexity of the task; and 2) the content of the task (Tanner, 1979). Features that may be present to hinder the clinical problem-solving process and in essence make the situation more unmanageable include: 1) the number of cues; 2) the number of diagnostic hypotheses and/or possible interventions; 3) reliability of cues in relation to diagnosis; 4) the number of additional cues and their reliability needed to solve problem situations; and 5) the cue-diagnosis relationship (Tanner, 1979).

Another aspect of the task environment that must be recognized and the one most relevant to this study is the content of the task. Content refers to the knowledge base that is required to solve the problem task. This knowledge must have a broad base that encompasses various aspects of the problem situation. The individual must possess the cognitive ability, based on substantiated knowledge, to systematically process cues and other pertinent data, eliminating irrelevant information. The problem-solver must use his knowledge to actively generate and evaluate diagnostic hypotheses, and must be cognizant of appropriate interventions.

When comparing expert and novice problem-solvers in regard to knowledge, it is widely assumed that the expert will have a broader base because of additional information acquired in the form of experience. This assumption does not mean that the expert will necessarily be the better problem-solver. Tanner (1979) states that "although the student may demonstrate adequate knowledge prerequisite to the problem-solving task, s/he may be unable to complete the task successfully" (p. 10). Knowledge is an absolute requirement for problem-solving, but in order for it to be successful, knowledge must be accurately processed.

Tanner (1984) also suggests that experts differ dramatically from novices in their ability to hold a vast amount of complex bits of knowledge in the long-term memory, and effectively retrieve maximal information with minimal effort. The middle level clinician possesses knowledge, but it is not as developed or as effectively stored as the expert. The beginner must struggle with a limited amount of available knowledge, which is usually inefficiently stored, making retrieval difficult.

The final component of problem-solving behavior is problem space, which represents the individual's interpretation of the problem. Based on knowledge of the task environment stored in the individual's memory bank, Simon (1978) believes that it is possible to predict, though not completely, characteristics of the problem space and possible strategies needed to solve problems.

Using the information-processing theory as a framework, the basic tenet of this study is that the manner in which an individual views a presenting problem, as well as the strategies used for solution, will largely be dependent upon his or her knowledge of the problem situation.

It can be hypothesized that by increasing one's knowledge base, and storing it in an efficient manner for effective retrieval, the act of clinical inference will be more accurate. Furthermore, an expanded knowledge base will usually elicit a more comprehensive mode of problem-solving with obvious benefits to the patient.

The following research hypotheses will be tested in this study:

Hypothesis 1: Experts will be more knowledgeable, more accurate in diagnostic inference, more comprehensive in problem-solving and generate more complex inferences than the novice and mid-level students.

Hypothesis 2: There will be a positive relationship between knowledge base, degree of accuracy of diagnostic inference and comprehensiveness and complexity of diagnostic problem-solving among the three levels of nursing preparation.

Significance of the Study to Nursing

Since its earliest inception the nursing profession has had as a major goal the identification of health related problems, and the institution of nursing actions to mitigate or alter their effects (Carlson, Craft and McGuire, 1982). The problem-solving process seeks to achieve this goal, and is therefore a fundamental and essential component of all nursing interventions.

The practice of problem-solving is not an effortless nor naturally acquired skill. It requires extensive knowledge of facts and behaviors, and a great deal of motivation. Nurse educators can and must respond to the challenge of instilling new thinking habits and guiding their

students to think more systematically. The importance of this process has been recognized by many nursing programs. Institutions have fashioned their curriculums around this concept, for it is acknowledged that "the process known as problem-solving gives organization and direction to the various and distinct elements of nursing practice" (Johnson, Davis and Bilitich, 1970, p. 5).

This study, in conjunction with the parent investigation of diagnostic reasoning (Tanner, et al.), could make a significant contribution to nursing in general, and to educational practices in particular. The more we learn about the strategies of learning and application of knowledge in a problem situation, the more educational efforts can be specifically directed toward teaching students effective methods of problem-solving. Presently, nursing research has been void of studies investigating the cognitive processes involved in processing knowledge to solve complex patient care problems (Kritek, 1978).

The present study examines the extent knowledge is used to derive accurate diagnostic inferences. It is an area that needs additional research. Understanding of the processes involved will enhance the scientific foundation upon which nursing practice is based.

CHAPTER II

METHODOLOGY

This descriptive study was correlational in design and was conducted to explore the relationship between knowledge base, comprehensiveness, complexity, and accuracy of nursing inference of practicing registered nurses and junior and senior baccalaureate nursing students at The Oregon Health Sciences University. In the following pages, the setting, subjects and design will be described; instruments and data collection procedures used in this study will be discussed, as well as an explanation of the data analysis. Also included in this section are the limitations of the study.

Setting and Subjects

The investigators in the parent study entitled, "Diagnostic Reasoning: An Analysis of Cognitive Strategies Used by Nurses and Nursing Students" (Tanner, et al.) tested 42 individuals in a convenience sample. Fifteen junior nursing students and 13 senior nursing students registered at The Oregon Health Sciences University School of Nursing were selected from volunteering students. To control for knowledge content, students were not accepted if currently enrolled in a medical-surgical nursing course. Fourteen consenting clinicians currently employed as staff nurses at a large teaching hospital were chosen. The following criteria were used for selection of nurses:

1) A Bachelor of Science Degree in Nursing
2) Rated by head nurse as being excellent nurses who consistently made sound clinical judgments
3) A minimum of two years nursing experience on a surgical or general medical unit.

The purpose of the investigation and possible contributions to the profession of nursing were fully explained by the primary investigator prior to agreement of participation. Written consent was secured and anonymity of the subjects as well as confidentiality of the data was assured (Appendix A and B).

A description of the 42 participants in regard to age is summarized in Table 1. The sample ranged in age from 20 years to 54 years. The average age was 26 years. Of the 42 subjects, 92.9% (39) were female, 7.1% (3) were male (see Table 2).

Table 1

Age of Sample in Years

Junior (N=15)	Senior (N=13)	RN (N=14)	Total (N=42)	
Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	Range
24.27 (4.62)	25.15 (2.99)	29.07 (7.41)	26.14 (5.65)	20-54

Table 2

Sex of Sample

	Junior (N=15)		Senior (N-13)		RN (N=14)		Total (N=42)	
	N	%	N	%	N	%	N	%
Male	2	13.3	1	7.7	0	0	3	7.1
Female	13	86.7	12	92.3	14	100	39	92.9

To determine if the subjects from the junior and senior group were a representative sample of their respective classes, the grade point average for each member of the class was obtained from the Registrar at The Oregon Health Sciences University for the term in which the data were collected. The mean and standard deviation were then calculated for the class and participants in the study. Comparison between the sample and class group using a t-test yielded no significant differences (see Table 3). However, analysis of variance summaries (see Appendix F) did show a significant difference between the two groups ($F=13.58$, $p < .001$) in regard to G.P.A. The senior sample presented with a grade point average of 3.65. In contrast, the G.P.A. of the junior subjects was 2.78. It should be remembered that the participants in the study were chosen by means of a convenience sample, but this important difference in G.P.A. could be considered a limitation of the study because it may increase the chances of finding differences between the two groups.

Table 3

Representativeness of Sample on Educational Preparation

	Sample Average (n=28)	Class Average (J=106) (S=100)	Calculated t Value
Grade Point Average of Juniors (n=15)	2.78 (0.74)	3.09 (0.54)	1.94
Grade Point Average of Seniors (n=13)	3.65 (0.43)	3.47 (0.46)	1.29
Grade Point Average of RN's	a	a	a

[a] Not applicable, not available for the practicing nurses

Note: Numbers in parentheses represent standard deviations

There was no significant variance among the baccalaureate students in regard to age, present employment and previous experiences. The number of college degrees held was only slightly higher for the senior group. This information was obtained from questionnaires which each subject completed.

The practicing clinicians had a mean age of 29 years. The number of years since graduation ranged from 2 to 8 years. The years of hospital experience ranged from 1 year and 10 months to 7 years and 6 months.

Instruments

This study used the data collected in the parent investigation which used two measures: a written examination, and one of nine patient simulations. The first was a 130-item written multiple-choice examination of the content relevant to the videotaped vignettes. The test used combined-response multiple-choice items. Content was selected by the investigators to reflect major areas which included both the pathophysiological and psychosocial components necessary for the subject to respond accurately to each simulation. The questions were developed to evaluate the ability of each of the subjects to assess a patient's general health status, identify possible causes of a disease state, and plan nursing interventions. Content validity was established by means of a table of specifications. To determine internal consistency, the Kuder-Richardson method was used.

The present study used a subscale consisting of 29 items. These items directly related to the one selected simulation and were used to assess the knowledge base of the nursing students and the practicing nurses (see Appendix C). A reliability coefficient of 0.78 ($p < .01$) using the Kuder-Richardson formula was estimated for the subscale.

A formula similar to one chosen by Robinson (1981) was used to evaluate the level of knowledge. It is as follows:

$$\text{Knowledge Base} = \frac{\text{Number of Correct Answers Chosen}}{\text{Total Number of Questions}} \times 100\%$$

The second measure used was a videotaped simulation involving a hospitalized patient who was contending with several acute problems for which the nurse must make a clinical judgment. The simulation, developed for use by Tanner, et al, sought to depict prevalent diagnostic problems encountered by nurses in a hospital setting to elicit various kinds of reasoning strategies needed to attain a diagnosis. Three distinct sources of information were available to the subjects. The first consisted of a verbal interchange by nurses at a change of shift report in the simulation. The second was nonverbal cues depicted in the simulation. Finally, information could be sought by asking direct questions about the patient to the examiner.

Requests for information were followed by asking the subjects to verbalize their thinking and rationale for the inquiry and the way in which he or she would use the additional knowledge. The testing process terminated when the subject decided upon a specific action, identified a diagnosis or concluded questioning. Responses to the entire test simulation were tape recorded and transcribed for analysis. The information seeking and the verbalized thinking formed the primary data for analyses in this study.

The simulation chosen for analysis described an elderly man admitted to the hospital for abdominal pain. He also presented with a history of alcoholism and adult onset of diabetes mellitus. This case was chosen because the primary content focus of the script portrayed both

physiological and psychosocial components. The simulation is described in detail in Appendix D.

A list of both accepted and possible diagnoses directly related to the patient simulation were determined by the investigators and are delineated in Appendix E. The list of possible diagnoses, although suggested in the simulation, could be eliminated as probable cause with additional information provided by the examiner. Diagnostic performance was assessed by seven measures: two were reflective of accuracy, two were measures of comprehensiveness, and three assessed the complexity of the diagnostic inference (see Table 4).

The first accuracy scale dealt with the number of accurate diagnoses accepted. This was based on the three diagnoses which were determined by the primary investigators as the direct cause of the patient problem. They include the following: Sundowners Syndrome; Sensory Deprivation, and Cimetadine side effects. Criteria for determining from the transcript that a diagnosis had been accepted were: 1) the subject states that the accurate diagnosis is definitely ruled in to explain given data; 2) accurate diagnosis was specifically stated in the summary as the cause, and/or 3) direct action was indicated or speculated by the subject, such as putting the glasses and hearing aid in place.

The accuracy score was the product of two components: the number of points assigned to the accurate diagnoses, and the actual number of accurate diagnoses accepted. Each of the three accurate diagnoses was assigned two points. If the subject did not specifically label the diagnosis, but related to it indirectly, one point was given. An example of this would be if the subject labeled as one of the problems the fact that the patient did not have his glasses and hearing aid in place,

Table 4

Measurement Scales to Determine Accuracy, Comprehensiveness and Complexity of Diagnostic Inferences

Accuracy Scales	Criteria	Scoring Procedures
1. Accurate diagnoses accepted	1. Definitely ruled in to explain the data 2. Specifically stated in summary as cause 3. Direct action indicated or speculated	Points / Accurate Diagnoses 2 Sundowners Syndrome 2 Sensory Deprivation 1 Hearing Aid and Glasses 2 Cimetadine Side Effects 1 Related to medication (non-specific label) Scoring: Number of total pts. (0-6) X number of diagnoses (0-3)
2. Inaccurate diagnoses accepted	Same criteria as accurate diagnoses accepted	One point for each inaccurate diagnosis accepted
Comprehensiveness Scale		
1. Accurate diagnoses considered	Mentioned in any portion of transcript	Same as accurate diagnoses accepted
2. Number of possible diagnoses considered	Mentioned diagnosis in any portion of the transcript	One point for each diagnosis considered. Range 0-10
Complexity Scale		
Based on availability of cues 1. Direct 2. Indirect 3. No data given	Any of 10 possible diagnoses mentioned	1. Direct -- 1 point 2. Indirect -- 2 points 3. No data given -- 3 points

instead of correctly labeling it as sensory deprivation. The total number of points for the diagnoses accepted was multiplied by the actual number of diagnoses, which ranged from 0 to 3. A maximum score of eighteen could be achieved if the subject accepted all three of the accurate diagnoses.

Accuracy measurement would not be complete without a means to measure incorrect responses. The second accuracy scale dealt with a number of diagnoses that were accepted incorrectly. The same criteria used in the first measurement scale were used to determine that subjects had accepted an inaccurate diagnosis. One point was awarded for each inaccurate diagnosis accepted. A high score would indicate poor performance.

The first comprehensiveness scale assessed the number of accurate diagnoses considered. The criterion for determining from the transcript that a diagnosis had been considered was that it was mentioned in any portion of the transcript. The scoring for this scale was the same as that for the accurate diagnoses accepted scale: the product of the number of diagnoses multipled by the total points assigned to the diagnosis.

The second comprehensiveness scale assessed the extensiveness of diagnostic performance. It was felt that although an accurate diagnosis is important, possible explanations for patient conditions need to be mentioned and ruled out are also important. This procedure would need a more comprehensive knowledge base upon which to reason cause and effect. The comprehensiveness scale consisted of the total number of possible diagnoses considered. The ten possible diagnoses were: hypoxemia, hypo or hyperglycemia, delirium tremens, fever, psychological history,

electrolyte imbalance, alcoholic consumption, pain, liver dysfunction, and narcotic side effects.

The last three scales assessed the ability of the subjects to make a diagnostic inference based on the availability of cues given; in essence the complexity of inferences was measured. Each of the ten diagnoses was categorized into three sublevels: 1) direct cues were given, which supported the diagnoses of fever, pain and alcohol consumption; 2) indirect cues, which supported the diagnoses of hypoxemia; delirium tremens and liver dysfunction; 3) little or no specific data given, which pertained to the diagnoses of psychological history, electrolyte imbalance and narcotic side effects.

Validity and Reliability

Validity in regard to simulations is a possible limitation. It is virtually impossible to present in a simulation all of the cues to which a subject might respond (Dreyfus, 1979). In addition, it is not known whether the diagnostic process represented in the verbal protocols is an accurate depiction of the process actually used in practice (Ericsson, 1980).

In an effort to test the reliability of the scoring of the measurement tool, an interrater agreement with one of the primary investigators was examined. A worksheet containing written guidelines for scoring was provided. The researcher was asked to score a random sample of twenty-one completed transcripts. An interrater agreement of 80% or greater was sought. An agreement level of 86% was achieved on two of the seven scales; accurate diagnoses considered and accurate diagnoses accepted. A high level of 90% was achieved for the first scale

of complexity, and a score of 82% for the third scale of complexity. Agreement levels of 67%, 52%, and 57% were achieved on the three remaining scales. These low scores were believed to be due to problems in interpreting data and acts of omission. After reconciliation, 100% agreement was reached on the given sample of transcripts.

Other forms of reliability are inadequate in estimating the degree of consistency to which the simulation measures the problem-solving abilities of subjects. Moreover, because learning probably takes place during simulations, it is doubtful that the same results could be obtained on repeated administration of the simulation. Equivalence and internal consistency reliability measures are also inapplicable to simulations if multiple situations are used because performance on one situation may or may not correlate with performance on another, due to the demonstrated task-specific nature of problem-solving processes.

Data Collection Procedure

To insure anonymity and confidentiality of data, participants in the study were assigned code numbers. Prior to data collection, each individual was instructed in the thinking aloud procedure using two test simulations.

The subjects were scheduled for four individual sessions, each lasting from one to two hours. In the first session, the participants completed the 130-item multiple-choice examination. The remaining three sessions dealt with analyzing nine clinical situations, one of which will be used for this study, in the form of vignettes. The entire test process was administered by an examiner who was specifically trained to give the tests and provide requested information, which was given to

her in written form. This additional information about the patient included complete medical history; physical examination data; laboratory test results; nursing information; and social history.

To measure the variable identified as knowledge, responses on twenty-nine of the 130-item multiple-choice examination were recorded for each subject and results scored according to the previously described formula.

Accuracy, comprehensiveness, and complexity were determined by analysis of transcribed responses of each of the subjects, using the seven scale measurement tool developed especially for this study.

Data Analysis

To determine the relationship between knowledge base and the five measures of diagnostic inference, Pearson coefficients of correlation were computed. One-way analyses of variance (F test) were used to test the difference between the three groups on each of the eight measures, with a level of significance at .05. In addition, a priori comparisons (t-test) were used to further explore the degree of differences between the three groups.

LIMITATIONS

The limitations of this study include:

1) Data have been collected by the parent study and variables cannot be manipulated or altered by this investigator.
2) Only one patient simulation was analyzed for accuracy of nursing inference. This may not be representative of standard clinical problems encountered by nurses.

3) A non-random convenience sample was chosen for testing purposes, thus limiting generalizability of the results.

4) There is reason to question the representativeness of the sample. There was a significant difference in grade point average between the junior and senior samples. This divergence may increase the chances of finding differences between the groups on the selected measures.

5) The multiple-choice examination was prepared by the four primary investigators, all of whom were nurse educators with varied areas of clinical expertise. A panel of experts not directly associated with the study were not consulted to assure content validity.

6) Subjects who were in the experienced category may not have been representative of clinical nurses since they were recommended by specific individuals.

CHAPTER III

RESULTS

The purpose of this chapter is to describe in detail the analysis of data and to present the results. The study focused on the relationship among knowledge, degree of accuracy of diagnostic inference, and comprehensiveness and complexity of diagnostic problem-solving between three levels of nursing experience: novice, mid-level and expert. Two hypotheses were tested:

1) Experts will be more knowledgeable, more accurate in diagnostic inference, more comprehensive in problem-solving and generate more complex inferences than the novice and mid-level students.
2) There will be a positive relationship between knowledge base, degree of accuracy of diagnostic inference, and comprehensiveness and complexity of diagnostic problem-solving among the three levels of nursing preparation.

The decision to accept or reject these hypotheses is included in the conclusion of this chapter.

Two instruments were used to assess the knowledge and diagnostic performance of the 42 subjects: a written examination comprised of twenty-nine questions, and a patient simulation. Diagnostic performance was assessed by seven measures: two were reflective of accuracy, two were measures of comprehensiveness, and three assessed the complexity of the diagnostic inference.

Analysis Pertaining to Exam Score

A twenty-nine item subscale of the written multiple-choice

examination was used to assess the knowledge base of the nursing students and the practicing nurses. Scores between the three groups on the written multiple-choice examination varied considerably (see Table 5). A one-way analysis of variance was performed which revealed statistically significant differences between the three groups ($F=12.97$, $p < .001$). A priori comparisons revealed that the seniors earned a higher score than the juniors ($p < .001$), and the practicing nurses scored higher than the juniors ($p < .001$). Unexpectedly, the nurses did not score significantly higher than the seniors.

Analysis of Accuracy

Two scales assessing diagnostic accuracy were used. The first accuracy scale dealt with the number of accurate diagnoses accepted. This was based on the three diagnoses which were determined to be the direct cause of the patient problem. The accuracy score was the product of two components: the number of points assigned to the accurate diagnoses, and the actual number of accurate diagnoses accepted. The second accuracy scale dealt with the number of inaccurate diagnoses accepted. One point was awarded for each inaccurate diagnosis.

On the overall F test (see Appendix F), there were no significant differences among the three groups on either the score for acceptance of correct diagnoses or on the number of inaccurate diagnoses. However, the a priori comparisons revealed a significant difference between the students and the practicing nurses (see Table 6). The nurses earned significantly more points for acceptance of accurate diagnoses ($p < .05$), but they also accepted significantly more inaccurate diagnoses ($p < .05$). No significant differences were found between the juniors and seniors on

Table 5

Comparison of Means Between the Three Groups
on the Written Examination

	Juniors (J) n=15		Seniors (S) n=13		RN (N) n=14		Overall F	A Priori Comparisons
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Exam Scores	51.27	(14.37)	70.77	(14.71)	74.86	(10.59)	12.97***	S > J*** N > J*** N > J+S**

*p < .05
**p < .01
***p < .001

Table 6

Comparison of Means Between the Three Groups on the Selected Indexes

	Juniors (J) n=15		Seniors (SO n=13		RN (N) n=14		Overall F	A Priori Comparisons
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Accurate Diagnoses Accepted	1.73	(1.62)	2.08	(2.33)	3.29	(2.87)	1.77	J < N* J+S < N*
Total # Inaccurate Diagnoses Accepted	0.60	(0.74)	0.31	(0.48)	0.79	(0.98)	1.34	S < N*
Accurate Diagnoses Considered	4.00	(2.90)	3.46	(2.73)	5.93	(4.80)	1.78	S < N* J+S < N*
Total Possible Diagnoses Considered	3.80	(2.46)	3.31	(2.10)	3.64	(1.69)	0.19	ns
Total # Complex I Diagnoses Chosen	1.40	(0.74)	0.54	(0.66)	1.00	(0.55)	5.99**	S < J*** N < J* S < N*
Total # Complex II Diagnoses Chosen	2.00	(1.51)	2.62	(2.06)	3.71	(1.54)	3.71*	J < N** S < N* J+S < N**
Total # Complex III Diagnoses Chosen	1.20	(1.90)	1.38	(1.56)	1.29	(1.94)	0.04	ns

*p < .05
**p < .01
***p < .001

either points earned for acceptance of accurate diagnoses or number of inaccurate diagnoses accepted.

Analysis of Comprehensiveness

Comprehensiveness was measured by two scales: accurate diagnoses considered, and the number of possible diagnoses considered. The scoring for the first scale was the same as that for the accurate diagnoses accepted scale. The second comprehensiveness scale assessed the extensiveness of diagnostic performance. This scale consisted of the total number of possible diagnoses considered. Ten diagnoses were identified as possible causes of the patient problem.

Results similar to those cited in the accuracy scale were found. On the overall F test, there were no significant differences among the three groups on either the score for accurate diagnoses considered or the number of possible diagnoses considered. As with the accuracy scale, the a priori comparisons revealed a significant difference between the students and the practicing nurses in the number of accurate diagnoses considered (see Table 6). The nurses earned significantly more points for the number of accurate diagnoses considered ($p < .05$). No significant differences were found between the groups in the number of accurate diagnoses considered on either the overall F test or the a priori comparisons.

Analysis of Complexity

The last three scales assessed the ability of the subjects to make a diagnostic inference based on the availability of cues given; in essence the complexity of inferences was measured. Each of the ten diagnoses was

categorized into one of three sublevels, dependent on the availability of cues given. The lowest level of complexity revealed significant findings in the overall F test and a priori comparisons. The F test showed statistically significant differences among the three groups ($F=5.99$, $p < .01$; see Table 6). The a priori comparisons revealed that the juniors considered a significantly greater number of diagnoses categorized in the lowest level of complexity than did the seniors ($p < .001$) and nurses ($p < .05$). The nurses considered more of these diagnoses than did the seniors ($p < .05$).

The second measure of complexity also had significant findings. The overall F test showed significant differences between the three groups ($F=3.71$, $p < .05$). The a priori comparisons revealed that the nurses considered more diagnoses in this mid-level complexity than did the juniors ($p < .01$) or seniors ($p < .05$). In addition, the nurses scored higher than the juniors and seniors combined ($p < .01$). No significant differences were found between the juniors and seniors.

The last scale measuring complexity did not reveal significant differences in the F test or a priori comparisons for the three groups.

Intercorrelations Among Variables

Pearson correlation coefficients were computed to determine the relationship between the eight variables measuring knowledge, accuracy, comprehensiveness and complexity (see Table 7). Of particular interest to this study was the correlation of knowledge with any of the other variables. Only one was found. A positive relationship was shown between the number of complex II diagnoses considered and the primary measure of knowledge, the exam score ($r=.32$, $p < .05$).

Table 7

Intercorrelations Among the Eight Variables

Variables	1	2	3	4	5	6	7	8
ACCURACY								
1. Accurate Diagnoses Accepted	-	-.26	.54***	-.24	-.30*	.07	-.11	.08
2. Inaccurate Diagnoses Accepted		-	-.09	.30*	.48***	.17	-.02	.10
COMPREHENSIVENESS								
3. Accurate Diagnoses Considered			-	-.03	-.06	.21	.03	.14
4. Total Possible Diagnoses Considered				-	.58***	.64***	.54***	.08
COMPLEXITY								
5. Total # Complex I Diagnoses Considered					-	.22	.11	-.09
6. Total # Complex II Diagnoses Considered						-	.19	.32*
7. Total # Complex III Diagnoses Considered							-	.10
KNOWLEDGE								
8. Exam Scores								-

Note: Sample size is N=42 for all Pearson's coefficients.

*p <.05
**p <.01
***p <.001

A negative relationship was found between accuracy of diagnosis and complexity. The more possible diagnoses considered in the lowest level of complexity, the fewer accurate diagnoses accepted ($r = -.30$, $p < .05$).

Two hypotheses were tested in this study:

1) Experts will be more knowledgeable, more accurate in diagnostic inference, more comprehensive in problem-solving and generate more complex inferences than the novice and mid-level students.
2) There will be a positive relationship between knowledge base, degree of accuracy of diagnostic inference and comprehensiveness and complexity of diagnostic problem-solving among the three levels of nursing preparation.

Hypothesis 1. Four specific areas were of interest: knowledge, accuracy, comprehensiveness and complexity. In regard to knowledge, results from this study revealed that the nurses were more knowledgeable than the juniors but were not significantly higher in knowledge than the seniors. The accuracy findings showed that the nurses accepted more accurate diagnoses, but they also revealed that the nurses chose more inaccurate diagnoses than did the nursing students. Results concerning comprehensiveness revealed no significant differences between the three groups. In regard to complexity, the nurses considered more complex II diagnoses than the juniors and seniors. No differences were found between the juniors and seniors on the level of complexity. Therefore, this hypothesis was not supported.

Hypothesis 2. Results from the Pearson correlation coefficients showed only one positive relationship between knowledge and any of the other variables. The relationship was shown to be between knowledge and

the number of complex II diagnoses chosen. No relationship was found between knowledge and accuracy of diagnostic inference among the three levels of nursing experience. Therefore, this hypothesis was not supported.

CHAPTER IV

DISCUSSION

This study sought to explore the relationship among knowledge base, accuracy, and comprehensiveness of nursing inferences of practicing registered nurses and junior and senior baccalaureate nursing students. This is an important area for research because the ability to solve complex clinical problems is presumed to be largely based upon sound theoretical knowledge. The accuracy of the inference guides appropriate interventions, and determines if successful outcomes can be attained.

A total of 42 participants were tested for this study. The sample consisted of three groups: junior and senior baccalaureate nursing students and practicing clinicians. Two measures were used to evaluate the relationship among knowledge, accuracy, comprehensiveness and complexity: a written examination, and one of nine patient simulations.

The multiple-choice examination sought to evaluate the knowledge level of each of the three groups. The examination scores clearly identified significant differences between the juniors and seniors. The seniors achieved scores that were much higher than the juniors ($p < .001$). Although the nurses did score significantly higher on the exam than the juniors, they did not score significantly higher than the seniors. One plausible explanation for this outcome is that additional information, in the form of experience, may not add to the theoretical knowledge base of problem-solvers. Indeed, experience may even limit or impede the process of knowledge utilization.

A patient simulation involving a hospitalized patient who was contending with several acute problems was the second measure which sought to evaluate accuracy and comprehensiveness of the subjects. Responses, which were tape recorded and transcribed, were evaluated using seven scales specifically developed for this study. Two of these measurements were reflective of accuracy, two were measures of comprehensiveness, and three assessed the complexity of the diagnostic inference.

Results from the accuracy scale clearly showed that the nurses were more accurate in their diagnostic performance than the juniors or seniors. This, of course, was expected. An interesting and somewhat disturbing finding was that the nurses also accepted more inaccurate diagnoses than the juniors or seniors ($p < .05$). One may ask how can expert clinicians be both accurate and inaccurate in their inferences at the same time? It can be speculated that because of a broader knowledge base, the nurses sought an intensive search for probable causes for the patient problem. Another explanation for the inaccuracy could be due to the type of experiences they were exposed to in their clinical setting or mobility within the hospital. If the nurses cared for patients who were predominately diabetics for example, their focus of attention might center on adverse diabetic reactions, or other specialized areas. The nurse would use her practical experience with patients to justify probable cause and effect of patient problems.

Another possible explanation for the inaccuracy could be attributed to a methodological flaw in the accuracy scales. Criteria established to determine if an accurate diagnosis was accepted may have been too stringent. For instance, diagnostic inferences were scored only if they

were stated in the summary, or a specific action was taken. These restrictions may have missed correct responses. Further analysis of this scale is indicated.

Within the student groups, results showed that there was no significant difference between juniors and seniors on either the number of accurate diagnoses accepted or the number of inaccurate diagnoses accepted. It was expected that the seniors would have been significantly more accurate than the juniors because of more knowledge and experience.

The two scales which measured comprehensiveness revealed some significant findings. As with the accuracy scale, results showed that the nurses earned significantly more points for the number of accurate diagnoses considered than did either the juniors or senior students ($p < .05$). This was an expected result because one must first consider a diagnosis before accepting it. The juniors and seniors had no significant differences between them in regard to the number of correct diagnoses considered. The second scale of comprehensiveness dealt with the number of possible diagnoses considered as the cause of the patient problem. No significant differences were found between the students and the practicing nurses. It was expected that the nurses would score much higher in this area than either the seniors or the juniors. The absence of differences where they were anticipated could be attributed to a flaw in the verbal protocol process. The participants may have indeed considered one or more of the possible diagnoses, but did not verbalize this to the examiner; or mentally considered and eliminated it as a cause. The thinking aloud approach carries with it no inherent reward system that encourages subjects to verbalize all of their thought processes. In addition, it is not known if verbal reports actually alter

the content and/or thought processing of the problem-solver (Ericsson, 1980).

Studies which concerned comprehensiveness were conducted by Elstein and associates (1972, 1978). They found that there was a direct relationship between thoroughness in cue acquisition, which is influenced by an adequate knowledge base, and accurate interpretation of cues. This finding was not supported by this study. No relationship was found between knowledge and comprehensiveness among the three levels of preparation.

Additional studies by Neufeld et al., (1981) found few differences in the number of hypotheses generated by three classes of medical students. Results from this study support this finding. No significant differences were found between the nurses and students regarding the number of diagnoses considered to be the cause of the patient problem.

The final three scales assessed the ability of the subjects to make a diagnostic inference based on the availability of cues given in the patient simulation; in essence the complexity of inferences were measured. It was expected that the juniors would dominate the lowest level of complexity, the seniors the second, and the nurses the third level of complexity. As predicted, the juniors did indeed consider a significantly greater number of diagnoses categorized in the lowest level of complexity than did the seniors ($p < .001$) and nurses ($p < .05$). In addition, the nurses considered more of these diagnoses than did the seniors ($p < .05$).

The second measure of complexity was dominated by the nurses. They considered more diagnoses in the mid-level of complexity than did the juniors ($p < .01$) or seniors ($p < .05$). These results have direct

implications in regard to knowledge. The second scale of complexity required a broader knowledge base than the first level of complexity because cues concerning these chosen diagnoses were only indirectly given during the simulation. The last scale measuring complexity did not reveal significant differences among the three groups. The failure to find significant differences is most likely due to a narrow range of possible scores (0 to 3) in the scoring scheme.

In summary, the complexity scales showed that the nurses used a moderately broad knowledge base to form a diagnostic inference. They were able to use both direct and indirect cues to solve the problem. The juniors, as expected, used basic knowledge based on direct cues to form an inference. Because of a more advanced knowledge base and more clinical experience, the seniors should have been more distinguishable from the juniors. Except for the lowest level of complexity, the juniors performed as well as the seniors in the areas of accuracy, comprehensiveness and one level of complexity. These results however, are inconclusive because of the possible methodological flaws with verbal protocol analyses.

It is widely assumed that variations in diagnostic performance by novice and experts can be directly attributed to the differences in level of knowledge. Unfortunately, there has been an absence of studies substantiating this assumption. An adequate knowledge base is absolutely essential when focusing on thoroughness of cue acquisition, which has shown to be directly related to diagnostic accuracy. This study found that the expert clinicians were more accurate in their choice of correct diagnoses, but this was not related to a higher knowledge base. It can be speculated that in addition to an adequate level of knowledge,

the experts were more accurate because of experience, and one cannot rule out intuitive abilities based on theoretical knowledge. Further understanding of the cognitive processes used by expert clinicians is needed.

The majority of studies based on information processing theory have focused their attention on the cognitive abilities of expert and novice problem-solvers. Researchers such as Elstein (1972, 1978); Kassirer and Gorry (1978); Neufeld et al. (1981); and Tanner (1977) corroborated on the opinion that diagnostic hypotheses are generated early in a problem situation, and that this procedure is related to the amount and storage of knowledge. It is believed that this process aids the problem-solver in increasing the capacity of the short-term memory system (Elstein, 1978). This early generation of hypotheses also influences the type of data selected for solution of the problem.

In addition to early hypothesis generation, most of the studies involved with information seeking propose that expert clinicians use task specific strategies to focus on the problem situation. This process may be concerned with the complexity of the task as reviewed by the clinician, or it may center on the expert's knowledge required for the task.

For the novice problem-solver, educational efforts must be directed toward teaching the students to be thorough in their data collection and to defer clinical judgment until this is accomplished (Gordon, 1973). As stated earlier, thoroughness in cue acquisition is related to diagnostic accuracy.

It is important to mention a few possible methodological errors inherent in this study which may have influenced the results. First of

all, a one-way analyses of variance (F test) were used to test the differences between the three groups on each of the eight measures. Although the overall F scores were significant for only two variables, a priori comparisons were done for all the variables. It was recognized that by proceeding to the a priori comparisons without significant findings on the F test, the possibility of committing a Type I error could be enhanced. It was felt however, that the purpose of this study was to explore in depth and search for possible relationships among the chosen variables. In addition, analysis of variance summaries did show a level of significance for four variables, one of which was grade point average which allowed further study.

Other possible methodological problems pertain to the validity of the written examination. Upon reexamination of the questions, it was found that very few pertained to the three accurate diagnoses chosen as the cause of the patient problem. It was also found that the majority of questions related to the more complex diagnoses. Analysis showed that 55% of the questions pertained to the complex II diagnoses and 34% to the complex III diagnoses. Therefore, there was not an equal representation of all three levels of complexity. The validity of the written examination is also in question because it is not known what knowledge is needed to solve the patient problem.

Failure to find differences among the three groups and relationships among the variables of knowledge, accuracy, comprehensiveness and complexity could be attributed to the lack of refinement in the instruments or measures used. They may not have been reflective of clinical problems or knowledge base. There may indeed be other components

of the reasoning process that the instruments were not able to measure. All of these limitations further emphasize the need for research into finding more refined and sensitive instruments to measure diagnostic performance.

CHAPTER V

SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

This chapter will summarize the purpose, conceptual framework, methodology, and results of this study. A discussion of the results in relation to the conceptual framework is presented and interpreted. Recommendations for further study are also made.

Summary

The purpose of this study was to explore the relationship between having theoretical knowledge and the capacity to derive accurate nursing inference. More specifically, the questions addressed by this study were:

1. Is there a difference in knowledge base, degree of accuracy of diagnostic inference, and comprehensiveness and complexity of diagnostic problem-solving among three levels of nursing experience: novice, mid-level and expert?
2. What is the relationship among knowledge base, degree of accuracy of diagnostic inference, and comprehensiveness and complexity of diagnostic problem-solving among the three levels of preparation?

The theoretical basis for the study is drawn from information-processing theory. According to this theory, there are three components of problem-solving behavior: 1) information processing; 2) task environment; and 3) problem space. The amount of information that can be processed at one time is dependent upon the memory system. It is here that continuous receiving, altering, storing and retrieving useful

pieces of information is controlled. The capacity of one part of this system, short-term memory, can be dramatically increased by coding information and clustering data into hypotheses. This process would aid the problem-solver in retrieving wanted information in a problem situation efficiently.

The major proposition of this study is that successful problem-solving is dependent upon the complexity of problem situation, the interpretation of the situation by the problem-solver, and the knowledge base that is required to solve the problem task. The individual must possess the cognitive ability, based on substantiated knowledge, to systematically process cues and other pertinent data, eliminating irrelevant information. The problem-solver must use his knowledge to actively generate and evaluate diagnostic hypotheses, and must be cognizant of appropriate interventions.

It is generally accepted that expert problem-solvers, when compared to novice and mid-level, have a broader knowledge base because of additional information acquired through study and experience. Experts also differ dramatically from novices in their ability to hold a vast amount of complex bits of knowledge, and effectively retrieve maximal information with minimal effort. The middle level clinician possesses knowledge, but it is neither as developed nor as effectively stored as the expert. The beginner or novice problem-solver must struggle with a limited amount of available knowledge, which is usually inefficiently stored, making retrieval difficult (Tanner, 1984).

The basic tenet of this study is that the manner in which an individual views a presenting problem, as well as the strategies used for solution, will largely be dependent upon his or her knowledge of the

problem situation. It can be hypothesized that by increasing one's knowledge base, and storing it in an efficient manner for effective retrieval, the act of clinical inference will be more accurate. Furthermore, an expanded knowledge base will usually elicit a more comprehensive mode of problem-solving.

Methodology

Two measures were used to explore the relationship among knowledge base, accuracy, and comprehensiveness of nursing inference of practicing registered nurses and junior and senior baccalaureate nursing students; a written examination, and one of nine patient simulations.

The written examination was a 130-item multiple-choice test of the content relevant to the videotaped vignettes. Twenty-nine of the total 130 questions directly related to the one selected simulation and were used to assess the knowledge base of the nursing students and the practicing nurses. A high score would indicate that the individual possessed an adequate knowledge base needed to solve the clinical problem. A low score would indicate that the individual did not possess adequate theoretical knowledge and would unlikely be able to identify patient problems or causes.

The second measure used was a videotaped simulation of a patient problem. The subjects were provided information and additional facts that could be sought by asking direct questions about the patient to an examiner. Subjects were asked to verbalize their thinking and rationale for information seeking. Responses to the entire test simulation were tape recorded and transcribed for analysis. These transcribed responses were analyzed to evaluate accuracy and comprehensiveness of nursing

inference. Seven measurement scales were used to assess diagnostic performance: two were reflective of accuracy, two were measures of comprehensiveness, and three assessed the complexity of the diagnostic inference.

Results

The examination score appeared to be an adequate instrument to measure knowledge. Significant differences were found between two of the three groups, with nurses scoring higher than the juniors, and seniors scoring higher than the juniors.

The accuracy scales showed a significant difference between the students and the practicing nurses. The nurses earned significantly more points for acceptance of accurate diagnoses, but they also accepted significantly more inaccurate diagnoses. No differences were found between the juniors and seniors on either accurate diagnoses accepted or number of inaccurate diagnoses accepted.

Comprehensiveness included measures of accurate diagnoses considered, and number of possible diagnoses considered. Results similar to those cited in the accuracy scale were found. The nurses scored higher than either the juniors or seniors in the number of accurate diagnoses considered. No significant difference was found between the students and the practicing nurses on the number of possible diagnoses considered.

Complexity was measured by assigning each of the ten possible diagnoses into one of three categories, dependent on the availability of cues given in the patient situation. Results showed that the juniors considered a significantly greater number of diagnoses categorized in the lowest level of complexity than did the seniors and nurses.

In addition, the nurses considered more of these diagnoses than did the seniors. In regard to the second level of complexity, results showed that the nurses considered more diagnoses in this category than did the juniors or seniors. No significant differences were found between the juniors and seniors. The third level of complexity showed no differences between the three groups.

Findings from this study were helpful but not conclusive in answering the two questions initially proposed for this investigation. A difference in knowledge level did exist between the juniors and seniors, but not for the seniors and nurses. The nurses were shown to be both more accurate and inaccurate in their diagnostic performance than the students. No differences were found between the juniors and seniors in regard to accuracy. No differences were shown to exist between the three groups concerning comprehensiveness.

This study also did not find a direct relationship among knowledge, degree of accuracy of diagnostic inference, and comprehensiveness and complexity of diagnostic problem-solving among the three levels of preparation.

It is felt that a major limitation of this study is that the instrument used to evaluate accuracy, comprehensiveness and complexity may not have been sensitive enough to detect subtle differences between the three groups. The research cannot be certain that all of the diagnoses which each of the subjects hypothesized and/or eliminated mentally were recorded as possible inferences. It is suggested that further refinement of the instrument is necessary. Another limitation of the study was the written examination. It is thought that some of the questions may not have been pertinent to the three correct diagnoses

chosen as the cause of the patient problem. In addition, there was not an equal number of questions for each level of complexity. Further studies are definitely indicated to investigate the cognitive processes involved in making diagnostic inferences. It is only with better understanding of this vital component of problem-solving that effective strategies can be taught to novice decision makers.

Recommendations for Further Study

The nursing process requires a continuous evaluation of patient data in order that choices among alternatives can be made. Judgments about given patient problems (diagnostic inferences) and specific modes of action are the essence of nursing. While accuracy and comprehensiveness are vital to practice, discerning and improving strategies that will aid the problem-solver in identifying, organizing, and processing nursing information is crucial.

Very little information is available regarding the role of knowledge in clinical judgment. It is not known if expert clinicians store nursing knowledge in a hierarchical form as do physicians and medical students. Such information would be helpful in facilitating the storage and retrieval of necessary knowledge in a problem situation. Another area in need of research is the role of knowledge on the types of strategies used by expert clinicians.

Further research must be devoted to developing valid instruments for measuring diagnostic reasoning processes. One suggested method is to validate the patient simulation with actual clinical experiences. In addition, further training of subjects in the use of simulations, to include a reward system for verbalizing all thought processes, is

strongly encouraged.

Of particular interest to this researcher would be further investigation into how the nurses could be both accurate and inaccurate in their diagnostic performance. What level of inaccuracy is expected and/or permissible to still be a good practitioner?

In addition, the focus of future research should be to distinguish and evaluate information processing strategies of both expert nurses and novice problem-solvers. It is only with indepth understanding of this process that structured and systematic procedures for collecting, using, and storing valuable patient data can be taught by nurse educators. Effective problem-solving strategies are the basis for making complex nursing decisions.

Further research into the areas of knowledge, accuracy, comprehensiveness and complexity might yield more significant findings and/or different conclusions if testing measures included more than one patient simulation. This extension would help determine if the results found in this study were associated with this one particular simulation or could be generalizable to a number of patient simulation problems. Further refinement of instruments for measuring accuracy, comprehensiveness, and complexity is definitely needed. Revision of the multiple-choice examination to reflect content of the simulation is also necessary. Other measures to evaluate knowledge base are needed.

Nursing research regarding clinical problem-solving is still in its beginning stages. Because results could have a profound influence on both practice and education, further investigation into the above mentioned problem areas is definitely indicated.

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APPENDIX A

Informed Consent

Staff Nurse

APPENDIX A

Oregon Health Sciences University

School of Nursing

Informed Consent

As a staff nurse at University Hospitals you have been selected to participate in the study entitled: "Diagnostic Reasoning: An Analysis of Cognitive Strategies." The study is being conducted by Christine Tanner, R.N., Ph.D., Dee J Putzier, R.N., M.S., Una Beth Westfall, R.N., M.N. and Karen Padrick, R.N., M.N., faculty members in the Department of Adult Health and Illness Nursing. It is part of a larger, interdisciplinary project with faculty in the Schools of Medicine and Dentistry.

The purpose of the study is to describe the thought processes used by students and practitioners in deriving a diagnosis and developing a plan of care. Hopefully the results of this study will help us understand the processes involved in making clinical decisions and will better enable us to teach these processes.

If you consent to participate, you will be asked to participate in two major activities. The first is responding to a written, multiple choice examination on adult health and illness nursing which will take approximately two hours to complete. The second activity is a series of clinical simulations which will be administered in three, 1 to 1½ hour sessions. In this activity, you will be presented with patient situations and asked to think out loud as you go through your decision-making process. Your descriptions of your thinking will be tape recorded and transcribed.

Your participation will not be graded and the results will be accessible to and used only by project staff in data analysis. You will be assigned a code number known only by Dr. Tanner and Deborah Rathert, Research Assistant. All results will be kept strictly anonymous.

You may refuse to participate in the study and you are free to withdraw your consent and discontinue participation at any time without jeopardizing your relationship with the Oregon Health Sciences University.

Any of the project staff would be glad to answer questions you may have about the study. They may be reached at 225-7796.

Please check one:

_____ I have read the foregoing and agree to participate in this study.

_____ I choose to not participate in this study.

_____ _____

Signature Date

APPENDIX B

Informed Consent

Nursing Student

Oregon Health Sciences University

School of Nursing

Informed Consent

As a nursing student enrolled in either Nursing 358 or Nursing 457 you have been selected as a prospective subject in the study entitled: "Diagnostic Reasoning: An Analysis of Cognitive Strategies." The study is being conducted by Christine Tanner, R.N., Ph.D., Dee J Putzier, R.N., M.S., Una Beth Westfall, R.N., M.N. and Karen Padrick, R.N., M.N., faculty members in the Department of Adult Health and Illness Nursing. It is part of a larger, interdisciplinary project with faculty in the Schools of Medicine and Dentistry.

The purpose of the study is to describe the thought processes used by students and practitioners in deriving a diagnosis and developing a plan of care. Hopefully the results of this study will help us understand the processes involved in making clinical decisions and will better enable us to teach these processes.

If you consent to participate, you will be asked to respond to a series of clinical simulations taking approximately one hour to complete. You will be presented with two to three patient situations and asked to think out loud as you go through your decision-making process. Your descriptions of your thinking will be tape recorded and used by project staff in data analysis.

Your participation will not be graded and the results will be accessible to and used only by project staff in data analysis. You will be assigned a code number known only by Dr. Tanner and Deborah Rathert, Research Assistant. All results will be kept strictly anonymous.

You may refuse to participate in the study and you are free to withdraw your consent and discontinue participation at any time without jeopardizing your relationship with the Oregon Health Sciences University.

Any of the project staff would be glad to answer questions you may have about the study. They may be reached at 225-7796.

Please check one:

_____ I have read the foregoing and agree to participate in this study.

_____ I choose to not participate in this study.

_____ _____

Signature Date

APPENDIX C

Written Examination

Appendix C

Written Examination

Rest is necessary for the body to repair itself. However, patients confined to bed with too little exercise are prone to develop several untoward effects. For the problem listed below, mark (a) if the problem may result from prolonged immobility; (b) if it does not result from immobility.

A Pneumonia

A patient's perception of pain severity may be increased by the following:

1. Analgesics
2. Circulatory stasis
3. Anxiety
4. Distraction
5. Desire to void

a. 1, 2, 3
b. 1, 3, 4
c. 2, 3, 4
(d.) 2, 3, 5
e. 3, 4, 5

The pain threshold may be lowered by:

1. Persistent pain
2. Warmth
3. Alcohol consumption
4. Physical weakness
5. Anger

a. 1, 3, 4
(b.) 1, 4, 5
c. 2, 3, 4
d. 2, 3, 5
e. 3, 4, 5

ITEMS 52 THROUGH 56 ARE MATCHING.

Match the following causes with the most appropriate electrolyte imbalance. ANSWERS MAY BE USED ONLY ONCE.

	CAUSE	ELECTROLYTE IMBALANCE
A	Acute pancreatitis	a. Hyperphosphatemia
E	Chronic alcoholism	b. Hypercalcemia
D	Oliguria	c. Hyponatremia
B	Prolonged immobility	d. Hyperkalemia
C	Potent diuretic therapy	e. Hypomagnesemia

Extracellular fluid volume excess can be manifested by all of the following EXCEPT:

a. Shortness of breath
b. Edema
c. Weight gain
(d.) Decreased blood pressure
e. Confusion

Signs and symptoms of anemia include:

1. Pallor
2. Shortness of breath
3. Fatigue
4. Increased temperature

a. 1 only
b. 1 and 3
(c.) 1, 2, 3
d. 2 and 3
e. All of the above

Restless is a common occurrence in hospitalized patients. All of the following are common causes of restlessness EXCEPT:

a. Urinary retention
(b) Hypokalemia
c. Pain
d. Cerebral anoxia
e. Intestinal distention

Which of the following are normal changes in vision in the aging process?

1. Acuity decreased
2. Visual fields decreased
3. Decrease in the minimal threshold for light perception
4. Change in color perception
5. Decreased ability to see size, distance and position of objects at a distance

a. All of the above
b. 1, 3, 5
c. 2, 3, 4
(d.) 1, 2, 4, 5

71. Confusion is a common sign occurring in hospitalized patients. Which of following are common causes of confusion in the hospitalized elderly?

a. Impairment of sight and hearing
b. Untoward effects of medication
c. Altered environmental stimuli
d. Two of the above
(e.) All of the above

72. Of the following patients, the one who is most likely to suffer from sensory deprivation is the patient who has had:

a. Chest surgery and is in a four-bed room
b. Orthopedic surgery and is in traction
(c.) Eye surgery and is in a semiprivate room
d. Heart surgery and is in an ICU

90. Of the following phrases, which one best describes the typical onset of a chronic organic brain disorder?

a. Abrupt, with no forewarning
b. Rapid, with many precursory signs
c. Slow, with obvious symptomatology
(d.) Gradual, with lucid intervals interspersed throughout

94. Ms. Baxter, a 44-year-old homemaker, entered the hospital for treatment of cirrhosis of the liver. She has a seven-year history of drinking a six-pack of beer and some wine every day. Ms. Baxter receives the appropriate medical and nursing treatment for her liver disorder and her condition improves slightly. However, after five days in the hospital, she begins to thrash about in bed, hitting the sheets and yelling, "Go away, bugs, go away!" Several times she was overheard asking, "What, what did you say?" when alone in her room. Which one of the following nursing notes best sums up Ms. Baxter's behavior?

a. Restless and disorienting; hallucinating
b. Agitated; having auditory and visual hallucinations
c. Fidgety; out of contact with reality; overheard talking to herself in room
(d.) Seeing "bugs" in her bedclothes and slapping at them; responding to unseen voices with "What?"

95. In relation to untreated alcoholism, which one of the following conditions best describes the type of mental disturbance the person who chronically abuses alcohol is most likely to develop in the future?

a. Alcoholic stupor
(b.) Organic brain disorder
c. Pathologic intoxication
d. Alcoholic hallucinosis

Mr. H is a 68-year-old man with insulin-dependent diabetes. He is on a 2000 calorie ADA diet and takes Lente insulin 20 units every morning. He is currently hospitalized for a hernia repair. In caring for Mr. H, the nurse should know which factors influence exogenous insulin requirements in the diabetic. For items 96 through 100, indicate if the factor:

a. increases insulin requirements
b. decreases insulin requirements
c. has no effect on insulin requirements

A 96. Illness
B 97. Exercise
A 98. Surgery
B 99. Malabsorption

101. If Mr. H receives his Lente insulin at 7:00 a.m., when is his blood sugar likely to be lowest?

a. 12 noon
(b.) 5:00 pm
c. 9:00 pm
d. 12 midnight

Mr. H. should be observed for signs of both hypoglycemia and hyperglycemia. For each sign listed in items 102 through 107 indicate if it is associated with:

a. hypoglycemia
b. hyperglycemia
c. both hypo- and hyperglycemia
d. neither hypo- nor hyperglycemia

A 102. Profuse diaphoresis
B 103. Warm, dry skin
B 104. Fruity breath
A 105. Increased appetite
A 106. Sudden change in behavior
A 107. Tachycardia

115. Of the following manifestations of hypoxia, which one is usually "later-appearing"?

a. Anxiety
(b.) Cyanosis
c. Fatigue
d. Headache
e. Tachycardia

APPENDIX D

Patient Situation Summary

Appendix D

Patient Situation Summary

The patient is a seventy-year-old male who was admitted to the hospital three days prior with adult onset diabetes, history of alcoholism, and abdominal pain. He receives 10U of NPH insulin every morning and regular insulin on a sliding scale. He developed a fever with a coarse, unproductive cough two days after admission. The cough was attributed to viral pneumonia. An intravenous solution of ½ Normal Saline is infusing. He has rested comfortably all day. All of the above information was given in a verbal shift report which each subject heard.

The videotape begins by showing a dimly lit hall of the hospital in the evening. The scene involves a nurse making his evening medication rounds. He enters a room occupied by two patients, one soundly asleep and snoring; the other is sitting up in bed talking about horses. The television is on and very loud. The nurse introduces himself to the patient who is awake. A conversation progresses, one in which the nurse is thought to be the patient's wife. The patient continues to converse with his "wife" about his farm, animals and other aspects of his life. The nurse tries to reorient him by speaking loudly and in a low pitch. While he continues to speak to the patient, the nurse is shown putting medication in the IV. The final segment focuses on the night stand with a pair of thick lensed glasses with a hearing aid attached.

Other information that is available to subjects upon request includes: medications; vital signs; laboratory values; general medical history; history of present illness; current living situation; and psychosocial history.

APPENDIX E

List of Accepted and Possible Diagnoses

Appendix E

List of Accepted and Possible Diagnoses

ACCEPTED DIAGNOSES

1. Sensory Deprivation
2. Sundowner's Syndrome
3. Cimetadine Side Effects

POSSIBLE DIAGNOSES

1. Hypoxemia Related to Pneumonia, and/or Immobility, and/or Anemia
2. Hypoglycemia or Hyperglycemia
3. Delirium Tremens
4. Fever
5. Psychological History (Usual Pattern of Behavior)
6. Electrolyte Imbalance
7. Alcoholic Comsumption
8. Pain
9. Liver Dysfunction
10. Narcotic Side Effects

APPENDIX F

Analysis of Variance Summaries

Analysis of Variance Summaries

Scale	SS	df	MS	F
Accurate Diagnoses Accepted				
Between Ss	18.93	2	9.46	1.77
Within Ss	208.71	39	5.35	
Total # Inaccurate Diagnoses Chosen				
Between Ss	1.56	2	0.78	1.34
Within Ss	22.73	39	0.58	
Accurate Diagnoses Considered				
Between Ss	46.32	2	23.16	1.78
Within Ss	506.16	39	12.98	
Total Possible Diagnoses Chosen				
Between Ss	1.74	2	0.87	0.19
Within Ss	174.38	39	4.47	
Total # Complex I Diagnoses Chosen				
Between Ss	5.17	2	2.58	5.99**
Within Ss	16.83	39	0.43	
Total # Complex II Diagnoses Chosen				
Between Ss	21.69	2	10.84	3.71*
Within Ss	113.93	39	2.92	
Total # Complex III Diagnoses Chosen				
Between Ss	0.24	2	0.12	0.04
Within Ss	128.33	39	3.29	
Exam Score				
Between Ss	4620.88	2	2310.44	12.97***
Within Ss	6948.96	39	178.18	
GPA (Junior & Senior)				
Between Ss	5.18	1	5.18	13.58***
Within Ss	9.92	27	0.38	

*$p < .05$
**$p < .01$
***$p < .001$

AN ABSTRACT OF THE THESIS OF

JOAN M. URBANSKI

For the MASTER OF NURSING

Date Receiving this Degree: June 8, 1984

Title: A Study of the Relationship Among Knowledge Base, Accuracy, Comprehensiveness and Complexity of Diagnostic Problem-Solving by Baccalaureate Nursing Students and Practicing Clinicians

Approved: [redacted]

Christine A. Tanner, Ph.D., Thesis Advisor

The purpose of this descriptive correlational study was to explore the relationship among knowledge base, comprehensiveness and complexity, and accuracy of nursing inference in practicing registered nurses and junior and senior baccalaureate nursing students.

A convenience sample of fifteen junior and thirteen senior students registered at the Oregon Health Sciences University were selected from volunteering students. Fourteen consenting clinicians employed as staff nurses at a large teaching hospital affiliated with the Oregon Health Sciences University were also chosen. The data collection was accomplished by using two instruments: a written examination, and one patient simulation. Diagnostic performance was assessed by seven measures: two were reflective of accuracy, two were measures of comprehensiveness, and three assessed the complexity of the diagnostic inference.

The results indicated that the nurses were more knowledgeable than

the juniors, but not the seniors. In addition, they also were more comprehensive in their diagnostic performance than the seniors or juniors. There were mixed findings on the accuracy measure, with nurses accepting significantly more accurate and inaccurate hypotheses. Surprisingly, the seniors were not significantly more accurate or comprehensive in their diagnostic performance than the juniors, despite a documented higher knowledge base. As expected, the juniors scored lower in all of the variables, except for one, than the other two groups. The variable of knowledge was positively correlated with only one measure, that of the second level of complexity.

Limitations affecting this study include the fact that the data analyzed was collected by the present study and therefore could not be altered or manipulated. In addition, a non-random convenience sample was chosen and only one patient simulation was chosen for analysis. Finally, the junior and senior subjects were significantly different from each other in regard to grade point average, which may have biased the findings. Reasons for not finding significant relationships among the chosen variables could be atrributed to a flaw in the verbal protocol process, problems with scoring, unrefined measurement tools and/or questionable validity of the written examination.

Based upon these findings, it is suggested that the presence of knowledge and/or experience does not necessarily mean that the problem-solver will be more accurate and comprehensive in their diagnostic performance. Questions still remain about the role of knowledge in diagnostic reasoning. Further research efforts should be directed toward the refinement of tools measuring both diagnostic reasoning and task-related knowledge.