LOYOLA UNIVERSITY CHICAGO

NURSES' INFORMATION PROCESSING RELATED TO SURVEILLANCE AS AN INTERVENTION IN THE CARE OF STROKE PATIENTS

A DISSERTATION SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL IN CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

PROGRAM IN NURSING

BY
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ABSTRACT

Background

The phenomena ‘failure to rescue’, defined as the inability to recognize a complication and consequently to save a patient’s life, has recently received much attention. Surveillance is a term describing a nursing intervention that involves nurses’ cognitive work to identify and prevent patient complications. Surveillance is characterized by frequent assessment of patients, attention to cues, and recognition of complications. Previous research focused on novice/expert differences during simulated tasks such as developing a plan of care but more recently attention has focused on early recognition of patient complications. Despite this focus on early recognition, there is a paucity of research related to surveillance, and in particular, during the delivery of care.

Purpose

The purpose of this study was to explore the nursing intervention of surveillance from an information processing framework. Research questions addressed how surveillance was expressed by nurses during the care of stroke patients and the relationship of cues identified to the focus of care.

Methods and Design

A descriptive, exploratory design was employed. Data were collected by think aloud and the resulting text analyzed with content analysis. Participants were ten nurses working on a medical neurology unit in a large Midwestern academic health center and
ten patients in the first three days of hospitalization following stroke. While providing care to a stroke patient, the nurses were prompted to think aloud as they 1) received report; 2) performed an initial assessment/initital interaction with patient; and 3) concluded the shift.

Findings and Conclusion

Surveillance by medical neurology nurses in this study was expressed as forming a mental image of the patient which was subsequently used as the basis for evaluation of the patient’s status. The overall theme representing the relationship of cues to the focus of nursing care was creating a vision. Cognitive processes used included understanding the past, observing the patient, looking back, and forming an impression. Looking ahead was the second theme identified and included making a plan, anticipating discharge, seeking information, and communicating needs.

Implications for these findings include opportunities in both education and practice arenas for the development and use of communication skills to convey an accurate picture of the patient, especially, the importance of handoff communication in creating an accurate vision of the patient that is used for early recognition of complications.
CHAPTER ONE

INTRODUCTION

The phenomenon of interest in this study is information processing in the context of clinical decision making. Growing interest in the cognitive work that nurses do provides the impetus for this study. Information processing involves both conscious and unconscious processing of information (Greenwood, 2000). Information processing theory is predicated on the fact that attentional resources limit humans' ability to process information. Because humans can process only five to seven plus or minus 2 items or chunks of information at a given time (Simon, 1974), there is a tendency for individuals to organize information in hierarchies that allow faster and more automatic processing (Newell & Simon, 1972). This strategy reduces the cognitive strain associated with large volumes of information and allows the individual to make the information meaningful (Newell & Simon, 1972).

The author's experiences and observations gained from working with both new and experienced nurses and nursing students sparked an interest in the cognitive processes of nurses. Of particular interest is the way nurses take in and process a vast amount of information in the course of a patient encounter and then use that information to make a decision to act or not to act. The author's exploration of nursing practice and literature related to patient safety in the context of evidence-based practice has raised an awareness and sparked interest in how nurses identify the focus of their nursing actions.
Clinical decision making has been described as the professional nurse’s most essential function (Boblin-Cummings, Baumann, & Deber, 1999; Hughes & Young, 1990) because it is central to delivering safe and effective nursing care (Greenwood & King, 1995). Decision making skills have been described as “generic information-processing skills used by individuals to solve problems and make decisions” (Sampson, Peterson, Reardon, & Lenz, 2000, p. 156). A decision is simply defined as a choice between two or more discrete alternatives (Lamond & Thompson, 2000). Clinical decision making has been narrowly defined as formulation of hypotheses, diagnoses, and/or the selection of interventions (Tschikota, 1993) and more broadly as the process used to gather information, evaluate the information and make a judgment that ends in the provision of patient care (White, Nativo, Norbert, & Engberg, 1992).

Given the current and projected nursing shortage and an aging population with chronic illnesses and multifaceted care needs, nurses will be required to process even larger amounts of more complex information in order to make decisions about the appropriate care of the patient. Understanding the cognitive work of nurses, particularly the processing of information in complex clinical situations, has implications for nursing education, nursing administration, and nursing practice. Knowledge of nurses’ information processing behaviors can impact both the basic preparation and ongoing professional development of registered nurses. This knowledge in turn can lead to the creation of infrastructures that decrease nurses’ cognitive burden, enhance measurement of nursing outcomes, and drive implementation of technological advances that support the information processing needs of nurses.
Significance for Nursing

Social and economic factors have greatly influenced the environment for providing healthcare in the past decade (Boblin-Cummings et al., 1999) and drive a need to understand the cognitive work of nurses. As Lewis (1997) points out, society at large expects nurses to be competent decision makers. As organizations strive to implement cost-effective ways to deliver quality healthcare within the constraints of funding and reimbursement cutbacks, coupled with nursing personnel shortages and patients' multifaceted and chronic health care needs, the explosion in technology and knowledge in healthcare exerts further influence on the need for understanding nurses' processes for managing complex and vast amounts of information. This is important not only to the development of mental models, but also of technological models and tools that will assist in the management of information (Reischman & Yarandi, 2002). These technological tools include decision support systems that require nursing language classification strategies to enable the communication and retrieval of nursing work via electronic means.

Recent publications highlight the influence of nurses' decision making and subsequent actions on patient outcomes. The Institute of Medicine (IOM), in its recent report (Committee on the Work Environment for Nurses and Patient Safety Board on Health Care Services, 2004), describes the invisible work of nursing as the cognitive work that incorporates knowledge gained through both formal education programs and experience. This cognitive work, as described by the IOM, includes activities related to assessing a patient's health, monitoring for changes that require nursing intervention(s),
and coordinating and providing for an individual patient’s health care needs in collaboration with a variety of health care providers to create a plan of care. These activities reflect the registered nurse’s knowledge work.

The important work of keeping patients free of complications has been highlighted by Aiken and colleagues (Clarke & Aiken, 2003). They suggest this is accomplished through a nursing activity termed surveillance. Surveillance is described as the frequent assessment of patients, attention to cues, and recognition of complications (Clarke & Aiken, 2003; Committee on the Work Environment for Nurses and Patient Safety Board on Health Care Services, 2004). These activities are considered by Aiken and colleagues to represent nursing work required to prevent a phenomena termed ‘failure to rescue’ which is defined as the inability to recognize a complication and in turn to save a patient’s life. Failure to rescue has been studied in the context of nurse staffing and nurses educational preparation, however the nurse’s cognitive work in the activities associated with surveillance has not been examined.

Nursing shortages and patient safety mandates require nurse administrators to examine and implement new ways of understanding and managing the complex work and work environments of today’s nurses (Ebright, Patterson, Chalko, & Render, 2003). Buerhaus and colleagues (Buerhaus, Staiger, & Auerbach, 2000a, 2000b) emphasize the impact of an aging nursing workforce on the delivery of patient care. According to them, development of ways to maximize use of scarce RN resources will be required in the declining supply of RNs. These strategies include identifying ways in which the expertise and cognitive skills of the aging RN can be taken advantage of while limiting the
physical burden of patient care for older nurses who might otherwise leave nursing. According to Buerhaus et al. (2000b), preparation of RNs to assume new roles and responsibilities, particularly supervisory skills, is critical in an environment where fewer RNs will be available to meet the healthcare needs of society. Finally, Buerhaus suggests that conducting research related to the nursing workforce and nursing’s contribution to quality of care will raise visibility and attention to the importance of the nursing workforce in the public policy arena.

This paper will provide a state of the science review and synthesis of the theoretical and research literature related to information processing in the contexts of clinical decision making and early recognition of patient problems. Gaps in the literature along with research questions are identified.

Purpose of the Study

Little is known about how nurses process the vast amounts of information or cues encountered in actual clinical situations. Review of the extant literature in nursing demonstrates a relative paucity of literature during the last and present decades. A large interest in this topic is evident by the volume of papers on information processing in the 1970’s, 1980’s and early 1990’s. Interest and publication concerning information processing and decision making were mostly limited to researchers in the United Kingdom as a result of changes in the basic nursing education program requirements in that country. Information processing research provided one way to evaluate these changes. Further research is needed to increase and deepen the understanding of information processing by nurses and its relationship to clinical decision making in the
present day. The purpose of this study is to explore the nursing intervention of surveillance from an information processing framework. The research questions this study will address are:

1. How is the nursing intervention known as surveillance expressed during nurses’ think aloud in the course of nursing care?

2. What is the relationship between the data (cues) identified by nurses and the nurse’s decision about the focus of care for a stroke patient?
CHAPTER TWO
LITERATURE REVIEW

The purpose of this chapter is to review the literature which serves as a background for this research in the area of information processing and surveillance. The chapter begins with a summary of information processing theory which provides the theoretical framework for this study. Relevant studies in nursing and other disciplines are reviewed and findings synthesized. Gaps in the literature are identified and the research questions stated.

Search Strategy

Computerized literature searches using the following databases were conducted related to information processing theory: PsycINFO, CINAHL, Medline, Dissertation Abstracts, ERIC, Business Source Elite, Articles First, and EBSCO host. Search terms included information, information processing, cue(s), cue recognition, cue utilization, decision-making, clinical reasoning, and clinical judgment. Other sources of literature arose through dialogue with faculty and peers and manual searches of journals, bibliographies of selected articles, course syllabi from related courses, and library catalogs. Limits applied to the search included English and readily available or accessible through inter-library loan and works from the 1990s forward, with the exception of seminal work of any period. Limits regarding article type (e.g. letters, anecdotal or case accounts) were not applied to the search but instead were screened and selectively...
utilized to provide insight into historical development, issues, and context for the phenomena of interest. Articles selected for more comprehensive review were those identified as seminal works (appeared in reference list of many papers), and information processing theory could be identified either explicitly or implicitly as a theoretical framework underlying the research. Appendix A depicts the results of the literature search by database and keyword.

Information Processing Theory

Human Problem Solving

First described by cognitive scientists Newell and Simon (1972), information processing theory is described as an approach to problem solving. According to Newell and Simon, all humans are information processing systems (IPS) and problem solving behaviors are an interaction between the problem solver and the task environment. The basic components of information processing are symbols which represent words, sensory and motor input, and goals. Symbols are encoded and represented in memory as nodes which are connected through their relationships.

Information processing theory is dependent on the functions of short term memory (STM) and long term memory (LTM). STM is limited to 5-7 items or chunks while LTM has an infinite capacity. The most important mechanism that seems to prevent the person from adopting an efficient information processing or decision making strategy is the limit on the number of symbols that can be retained and manipulated in STM. All information processes take their inputs from STM and then leave their outputs in STM.
According to Newell and Simon (1972) information processing requires interaction between the problem solver and the task environment. Likewise, the relationship (interdependence) between the task environment and the goal is crucial for separating the task-relevant from the task-irrelevant components of the problem space. From an information processing perspective, human problem solving is understood by describing the task environment in which it takes place, the space the problem solver uses to represent the environment, the task and the knowledge about it that is gradually accumulated by the problem solver, and the program the problem solver assembles for approaching the task.

The steps involved in human information processing are summarized in Table 1.

Table 1

Steps of Human Problem Solving (Newell & Simon, 1972)

<table>
<thead>
<tr>
<th>Steps</th>
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<tbody>
<tr>
<td>A. Produce an internal representation of the external environment</td>
</tr>
<tr>
<td>• Concurrently select a problem space</td>
</tr>
<tr>
<td>B. Select a problem solving method</td>
</tr>
<tr>
<td>C. Apply the method (may result in the production of new problems)</td>
</tr>
<tr>
<td>D. Terminate the method:</td>
</tr>
<tr>
<td>• Accept solution</td>
</tr>
<tr>
<td>• Attempt another method</td>
</tr>
<tr>
<td>• Reformat the problem using a different representation</td>
</tr>
<tr>
<td>• Abandon the attempt to solve the problem</td>
</tr>
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</table>
The task environment refers to an environment that is coupled with a goal, problem, or task. According to Newell and Simon (1972), the task defines a point of view about the environment and allows the environment to be delimited thus defining the context for the decision making activity.

The problem space is the space in which problem solving activities take place (Rashotte & Carnevale, 2004). In the problem space, the subject encodes components of the situation such as defining goals and rules to form a representation of the situation. The problem space consists of 1) a set of elements; 2) a set of operators; 3) an initial knowledge state; 4) a problem; and 5) the total knowledge available to a problem solver when in a given knowledge state.

In the problem space, the person forms a representation of the problem. The representation includes symbol structures, each representing a state of knowledge about the task. As a result, the problem space defines the set of possibilities for the solution as seen by the problem solver. Operators are the information processes applied in the production of new knowledge states from existing states of knowledge. A problem is defined by specifying a set of final, desired states or goals to be achieved by applying the operators. The initial knowledge state is knowledge about the task that the problem solver has at the start of problem solving. The total knowledge available to the problem solver in a given knowledge state includes a variety of information types ranging from information used only within a single knowledge state to reference information that is available in long term memory and is stable over the course of problem solving. These are further described in Table 2.
Table 2
Total Knowledge Available to a Problem Solver (Newell & Simon, 1972)

<table>
<thead>
<tr>
<th>Stability</th>
<th>Knowledge type</th>
<th>Purpose</th>
</tr>
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<tr>
<td>Most transient</td>
<td>Temporary dynamic information</td>
<td>Used only within a single knowledge state</td>
</tr>
<tr>
<td></td>
<td>Knowledge State</td>
<td>Dynamic information about the task</td>
</tr>
<tr>
<td></td>
<td>Access information (symbol structures)</td>
<td>Links to additional symbol structures in long term memory</td>
</tr>
<tr>
<td></td>
<td>Path information</td>
<td>How a knowledge state was arrived at and other actions taken in this state if it was visited before</td>
</tr>
<tr>
<td></td>
<td>Access information (other knowledge states)</td>
<td>Links to other knowledge states that have been reached on prior occasions and are now stored in long term memory</td>
</tr>
<tr>
<td></td>
<td>Reference information</td>
<td>Information available in long term memory that is constant over the problem solving course</td>
</tr>
</tbody>
</table>

According to information processing theory, a problem or task arises when a person is faced with a problem in which one does not know immediately what series of actions to perform in order to achieve something. Newell and Simon (1972) describe a well defined problem as one for which a test exists that will determine whether a proposed solution is in fact a solution. Newell and Simon measure the difficulty of a problem by a) whether a solution is reached; b) the time required to find a solution; and c) the quality of the solution. The difficulty of the problem is determined by the
interaction between the task environment and the information processing system’s program.

A program is a set of methods with an executive structure for selecting and applying them to the task. The function of the program is to search the problem space. An important aspect of information processing theory is that the only information available to the program is that which is embedded in the problem space after being extracted from the task environment. Through the application of operators, new states of knowledge are produced from existing knowledge states. The knowledge state of the individual is the proportion of total knowledge that represents a person’s dynamic information about the problem task. According to Newell and Simon (1972), movement from one knowledge state to another generally involves the storage of some new information.

When a problem is first encountered, it must be recognized and understood. A problem space must then be either constructed or retrieved from LTM. The problem space contains not only the actual solution, but also all potential solutions available to the problem solver. According to Newell and Simon (1972), the structure of the problem space is largely determined by the structure of the task environment. They state that the task environment is actually responsible for delimiting the structure of the problem space. Features and operators that are eliminated through the abstraction process are labeled as inessential while those that are retained are called essential. The resulting problem space retains most of the information that is important for finding paths in the original space.

In summary, Newell and Simon’s (1972) information processing theory was developed to describe human problem solving. At the foundation of information
processing is the ability to encode information and search in memory for potential solutions. Newell and Simon's approach to information processing and human problem solving has been the most influential theory applied to decision making in medicine and nursing (Rashotte & Carnevale, 2004). Yet, other theoretical approaches to information processing have been described in disciplines such as healthcare, sociology, education, and organizational psychology.

Information Processing in Healthcare

Elstein, Shulman, and Sprafka (1978) were among the first to explore information processing theory in the discipline of medicine through The Five-Year Medical Inquiry Project. The development of artificial intelligence was a motivator for Newell and Simon's (1972) information processing theory. In contrast, the motivation for Elstein and colleagues' work was the changing emphasis in medical education from content acquisition to problem solving processes. This seminal research provided important insight into diagnostic decision making. A primary finding of the studies in the medical inquiry project concerned the early generation of hypotheses that aid in narrowing alternatives and as a result guides the search during problem solving activities.

Four phases describe medical problem solving: 1) cue acquisition; 2) hypothesis generation; 3) cue interpretation; and 4) hypothesis evaluation, (Elstein & Bordage, 1979; Elstein et al., 1978). Cue acquisition refers to the obtaining of information which may come from a variety of sources. Hypothesis generation describes the process of retrieving alternative problem representations from memory. Only a few cues are required to find links in the individual's long-term memory but because of the limits of short-term
memory, the number of hypotheses simultaneously considered is limited to four or five (Elstein, Shulman, & Sprafka, 1990). Cue interpretation involves the interpretation of the acquired cues in relation to the alternative hypotheses being considered. Finally, during hypothesis evaluation, the cues or data are examined and weighed to determine if one of the hypotheses under consideration can be confirmed. If not, the process is repeated until verification of a hypothesis is achieved. This process converts an ill-defined, open ended problem such as “what is wrong” into a series of better defined problems such as “could it be...? or “could it be caused by...” (Blois, 1984; Elstein & Bordage, 1979; Elstein et al., 1978).

Blois (1984) depicts this process of narrowing the patient’s problem during an encounter with a funnel, in which the large opening of the funnel represents all the information available at the beginning of the visit and narrows as more and more information is obtained. During this process the alternatives become not only fewer in number but relationships among them emerge and the problem becomes better structured. Examining this model in light of the data-information-knowledge continuum and information processing theory (Figure 1), the initial encounter is characterized by a large unstructured task domain consisting of indifferent and neutral facts. As the funnel narrows, knowledge and experience are retrieved from memory and irrelevant information is discarded resulting in a small, well-structured task domain in which a decision can be made. This domain is in part determined through the individual’s unique paradigm. An individual’s paradigm, by framing the context of the problem, could also influence the recognition of data as relevant or irrelevant.
Information Processing in Non-Healthcare Disciplines

Information processing literature emerges in many disciplines outside of the healthcare professions. Some disciplines represented in the literature are education, communication, language, sociology, psychology, human relations, and business/management. The difficulty in accessing a full representation of information processing literature arises from the lack of explicitly stated information processing theoretical frameworks. An example of this situation is found in a series of four articles introduced by Newhagen (2000). Newhagen, (2000) describes the articles as “working from common ground of the information processing paradigm” (p. 99), yet in only one of
the papers does information processing appear in the abstract or title. The four articles were identified in the literature search only because Newhagen's introduction included information processing in the title. Review of the papers suggests that information processing, while not explicitly stated, is inherent in the conceptual frameworks for each study.

The same difficulty emerges in locating information processing literature in the domain of education. Again, few explicitly state information processing theory as providing the conceptual underpinning of the study but when discussed, information processing is presented or easily inferred in the description of the conceptual frameworks that are described. In general, these descriptions of information processing are brief and thus do not emerge as key words that enable ready retrieval of appropriate literature. As in the communication literature discussed above, it appears that information processing theories are well accepted as the building blocks of various education perspectives and thus are not explicitly stated, making identification of relevant works challenging. Therefore, select articles representing information processing in non healthcare disciplines are reviewed.

*Information Processing in Education*

Gagne (1985), a contemporary of Newell and Simon (1972), is credited with defining an information processing model of learning. This view of learning arose in response to growing interest in computer models of human learning along with perceived limitations of the behavioral perspective of learning which postulates that learning can be maximized by controlled reinforcement of desired behaviors (Gagne, 1985).
The processes in Gagne's model of information processing focus on the movement of data and information from the environment to long term memory. When the learner receives a stimulus from the environment it enters a structure(s) called the sensory register where it remains for only a brief period (a few hundredths of a second). As a result, only a few components of the representation can remain and thus become the focus of attention. Remaining components of the representation simply die away.

Certain features of the contents of the sensory register are attended to while others are ignored through a process Gagne (1985) termed selective perception. The features attended to then enter short-term memory. Like Newell and Simon (1972), Gagne recognizes the importance and limitation of short term memory including the five to seven item limit of short term memory. The most important aspect of the process, according to Gagne (1985), is the transformation of information from short-term to long-term memory. This process is called encoding and is characterized by not only the movement of information from short to long-term memory, but also by the transformation of the perceptual features stored in short term memory to conceptual nodes in long term memory. One way this happens is through a process called rehearsal in which silent, mental repetition of the information extends the time information is held in short term memory. Verification that learning has occurred is provided to the learner through the provision of feedback.

In summary, differences exist between Gagne's information processing model of learning and memory and Newell and Simon's information processing theory of human problem solving. However, the similarities are more striking than the differences. Both
are directed and limited by short-term memory function. Additional similarities are in the importance of the cues attended to in order to search long term memory for potential matches. The main difference in the two theories is the outcome: Gagne's emphasis is learning whereas Newell and Simon focus on problem solving.

Social Information Processing

Psychologists, sociologists, and organizational behaviorists have examined information processing from a social perspective, called social information processing. Social information processing models were initially developed with the aim of understanding variations in social behavior (Crick & Dodge, 1994; Daleiden & Vasey, 1997). While the emphasis in social information processing is on the social behaviors resulting from the processing of information, it shares many of the attributes and processes of information processing as described by Newell and Simon (1972). Crick and Dodge are the most influential theorists in the area of social information processing. Assumptions underlying the social information processing model described by them include: (a) individuals come to a situation with a limited set of biologic capabilities and a database of past memories, (b) input comes in the form of a wide array of cues, and (c) the individual's behavioral response is a result of the processing of those cues. Their proposed social information processing model consists of six stages that describe the flow of information through the processing system. These stages include (a) encoding of internal and external cues, (b) interpretation and mental representation of cues, (c) selection or clarification of a goal, (d) response access or construction, (e) response decision, and (f) behavioral enactment (Daleiden & Vasey, 1997). According to Crick
and Dodge, the responses are evaluated in terms of self-efficacy and outcome expectations and response appropriateness. Enactment, involves the production or implementation of the selected cognitive and/or behavioral response(s).

Another approach to social information processing is described by Salancik and Pfeffer (1978). Like Crick and Dodge (1984), these authors describe behavior as the result of social influences. Salancik and Pfeffer’s model developed as an alternative to needs satisfaction theories and applies specifically to job attitudes and needs, that is, the ability of the job’s characteristics to match the individual’s needs, resulting in worker satisfaction. The underlying premise of this model is that individuals adapt attitudes, behaviors, and beliefs to their prior behavior and situation (Salancik & Pfeffer, 1978).

One difference between these two models of social information processing and Newell and Simon’s human problem solving is that social information processing takes the process from attending to salient cues to carrying out the selected response while human problem solving stops short of producing the identified action.

Information Processing and Language

In the discipline of speech and language, children’s language performance has been examined in relation to information processing. Language performance and other academic skills are broken down to their underlying mental operations (Windsor, 2002). Just as short term memory limits information processing in Newell and Simon’s theory (1972), those working in the area of language impairment site the finite pool of attentional resources in working memory as a major influence that impacts the automaticity and efficiency in which cognitive processes are performed. Thus, there are
direct impacts on performance on standardized tests such as those used to evaluate children for language impairments (Gillam et al., 2002).

A general model of information processing applicable to language acquisition and/or impairment is described by Montgomery (2002). This model has three components: representation which is the symbolic coding and storing of information in long term memory; processes, which are mental operations that generate, transform, or otherwise manipulate representations; and attentional resources which are the cognitive resources used to activate and maintain knowledge in an active state. In short, "human performance, especially language performance, can be limited by the data available to the individual, the resource demands of tasks, and the capacity that the individual brings to the task" (Snyder, Dabasinskas, & O'Connor, 2002, p. 7). These are all features consistent with Newell and Simon's (1972) view of information processing theory and in particular emphasize the interaction between the problem solver and the task environment.

*Information Processing and Consumer Marketing*

The consumer information processing theory is a direct descendant of Newell and Simon's (1972) study of human problem solving and information processing (National Cancer Institute, 2003). The general assumptions of consumer information processing are similar to those defined by Newell and Simon: limitations in the amount of information an individual can process and chunking of information to increase usability and create decision rules. According to the National Cancer Institute, information processing is an intellectual process, yet motivation is a key component of the theory in
that motivation drives the search for information and plays a role in how much attention an individual gives it.

*Information Processing and Organizational Management/Human Resources*

In addition to social information processing as an approach to the study of human resource and organizational issues, cognitive information processing has also been used to provide a conceptual framework for study in the domain of organizational management. In one example (Sampson et al., 2000), two concepts are used to describe key constructs in cognitive information processing related to problem solving and decision making about career issues. The key concepts describe both the content and process of career problem solving and decision making (Sampson et al., 2000). The content is addressed in the pyramid of information processing domains which include self-knowledge, occupational knowledge, decision-making skills, and executive processing (Walsh, 1995). The process of career decision making is reflected in the communication, analysis, synthesis, valuing, and execution (CASVE) cycle which is described by Sampson and colleagues (2000) as one schema describing problem solving and decision making. In the CASVE cycle, communication refers to awareness of gaps between existing and desired state as a result of either internal or external cues. This phase is followed by analysis in which the person forms a mental model of the problem and identifies relationships among the components of the representation. During synthesis, the individual narrows the alternatives under consideration. In the valuing phase, costs and benefits of each option are considered, resulting in a tentative first choice. Finally, in the execution phase, the individual creates and commits to a plan to
implement the selected option. Clear links can be drawn between the model proposed by Sampson et al. and that of Newell and Simon. Identification of the problem to be solved, the desired goals, tentative solution or hypothesis, and execution of a solution are the consistent threads from Newell and Simon’s information processing theory.

Overlaps in the steps of information processing described in the aforementioned information processing frameworks are presented in Table 3. This summary view demonstrates the considerable similarities in information processing frameworks across a number of disciplines. In general, the steps of information processing are the acquisition or recognition of cues which are encoded to form a mental representation of the situation. Identification of goals aids the individual in determining potential responses or solutions which are then evaluated for fit and a decision made. Unique steps in the information processing view of learning and social information processing extend the endpoint of information processing from making a decision to actually carrying out the action or behavior resulting from the decision making process.

**Summary of Information Processing**

The basic components of information processing are symbols which represent words, sensory and motor input, and goals. While a number of discipline specific information processing models have been used, the differences seem to concern the outcome of the problem solving activities: remembering/learning in education; behavioral response in sociology, and diagnosis in healthcare. The cognitive processes of information processing include encoding of cues from the environment, construction of a
mental representation of the problem, a search of long term memory for solution options and strategies, and a decision.

Table 3

Process Overlaps across Information Processing Models

<table>
<thead>
<tr>
<th></th>
<th>Newell and Simon</th>
<th>Elstein, Shulman, and Sprafka</th>
<th>Gagne</th>
<th>Crick and Dodge</th>
<th>Montgomery</th>
<th>Sampson</th>
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<tbody>
<tr>
<td>Cue acquisition/encoding</td>
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<td>Internal/mental representation</td>
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<td>Goal identification/clarification</td>
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<tr>
<td>Hypothesis generation/potential response generated/narrow alternatives</td>
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<td>Cue interpretation</td>
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<td>Evaluation/Decision</td>
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<td>Action/Behavior</td>
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<td>Cost/benefit analysis</td>
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<td>feedback</td>
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Data, Information, Knowledge Continuum

In Newell and Simon’s (1972) information processing theory, problem solving is concerned with finding paths from initial states to desired states. More recently, others have described the data, information, knowledge continuum. Data, information, and knowledge can be considered as three aspects of a phenomenon generally called information (Davenport & Prusak, 2000; Graves & Corcoran-Perry, 1996). The tools of knowledge work are data, information and knowledge.
Data

Data are a set of discrete entities that are objective facts about events (Davenport & Prusak, 2000). According to Davenport and Prusak, data says nothing about its own importance or irrelevance. Blois (1984) describes data as indifferent and neutral facts. Data are generally evaluated in quantitative terms of cost, speed, and capacity and in qualitative terms of timeliness, relevance, and clarity (Blois, 1984; Davenport & Prusak, 2000; Graves & Corcoran-Perry, 1996).

Information

Information has been described as data to which meaning has been added (Blois, 1984). Information has also been discussed in relation to its function in communication and has been described as a choice of one message over others (Blois, 1984; Davenport & Prusak, 2000) and as: “...a message, usually in the form of a document or an audible or visible communication.” (Davenport & Prusak, 2000, p. 3). Information, a communication tool, is meant to shape the person who receives it (Davenport & Prusak, 2000). However, it is the receiver, not the sender, who determines if the message is information or not (Graves & Corcoran-Perry, 1996). Data are transformed to information by adding value. Data processing, according to Graves and Corcoran-Perry involves transforming raw data to data that are organized and meaningful. The attributes of information include accuracy, timeliness, accuracy and utility, which includes relevance and quality (Davenport & Prusak, 2000). Davenport and Prusak identify the activities that add meaning and value to transform data to information. These activities are: contextualize, categorize, calculate, correct, and condense.
Knowledge

Knowledge is derived from information and is defined as “a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating & incorporating new experiences and information” (Davenport & Prusak, 2000). According to Graves and Corcoran-Perry (1996), the processing of information to knowledge is more complex than data processing because it must deal with the meaning attached during the transformation of data to information. Davenport and Prusak (2000) describe the actions involved in the transformation of information to knowledge as comparison with other situations, consequences and implications for actions, connections with other bits of knowledge, and conversations indicating what others think about the information. Knowledge is evaluated by the decisions or actions to which it leads (Benner, Hooper-Kyriakidis, & Stannard, 1999). Knowledge can move up and down the ‘value chain’ returning to information and data. According to Graves and Corcoran-Perry (1996) knowledge is processed by clinicians to generate decisions and discover new knowledge.

Knowledge Work

Knowledge work is defined as nonrepetitive, nonroutine work that entails substantial levels of cognitive activity and involves analyzing information and applying expertise to solve problems (Drucker, 1992, 1994; Snyder-Halpem, Corcoran-Perry, & Narayan, 2001; Weaver & Sorrells-Jones, 1999). Sorrells-Jones and Weaver (1999) define the outcome of knowledge work as information and the core task of knowledge work as thinking. Davenport and Prusak (2000) describe the ideal knowledge worker as
one that is well rounded or possesses a balance of 'hard skills' such as technical know-how, professional experience, and structured knowledge and 'soft skills' such as knowledge of the political, cultural, and personal aspects of knowledge.

Knowledge work takes place in a knowledge society. Our age has been described as a time of sharp transformation (Drucker, 1992, 1994; Snyder-Halpern et al., 2001; Sorrells-Jones & Weaver, 1999a, 1999b). According to Drucker (1992), who has published extensively on social transformation, the GI Bill of Rights which gave every returning World War II soldier the money to attend a university heralded the current shift from an industrial age to an information age, a shift that Drucker predicts will not be complete until 2010 or 2020. Drucker further notes that at one time knowledge work was primarily discussed in terms of business, but now pervades every profession.

The knowledge work of nurses is accomplished through their roles as data gatherer, information user, knowledge user, and knowledge builder (Snyder-Halpern et al., 2001). These roles all reflect tasks associated with human information processing (Snyder-Halpern et al., 2001). As healthcare settings transition from an industrial age perspective to an information perspective, it is imperative that clinical practice environments support the knowledge work of nurses including recognition that the nurse knowledge worker is the fulcrum on which practice activities and patient outcomes are balanced (Snyder-Halpern et al., 2001). One means to support nurses' knowledge work is through the development and deployment of computerized decision support mechanisms. These mechanisms can enhance nursing practice by decreasing cognitive and memory burdens (Snyder-Halpern et al., 2001) associated with large volumes of highly complex
information in a clinical situation. Snyder-Halpern and colleagues suggest that an additional means in which cognitive burden can be decreased by decision support systems is by facilitating recognition of clinical patterns and meanings which results in improved patient outcomes.

In summary, a major component of the cognitive processes underlying knowledge work is the individual's ability to take in and process the various cues inherent in a situation. According to its originators, information processing theory was developed to advance knowledge about how humans think (Newell & Simon, 1972). Information processing is a function of long- and short-term memory. Long-term memory has an infinite capacity while short-term memory is limited to five to seven chunks or bits of information that can be attended to at any one time. Newell and Simon refer to this limit as bounded rationality. The organization and retrieval of items in memory is key to biological and social behavior (Greenwood, Sullivan, Spence, & McDonald, 2000). Without the ability to recognize previously encountered stimuli, each stimulus would be novel and individuals would not be able to plan and perform an appropriate response. The ability to construct, recognize, and respond to experiences allows humans to render their worlds meaningful and manageable (Greenwood et al., 2000). A core aspect of these abilities is the ability to identify relationships among components of an experience.

**Knowledge Organization and Retrieval**

*Knowledge types*

An important feature of the information processing theories reviewed is the development of and reliance on relationships between the components of the problem.
These relationships are generally described in terms of the mental representation of the problem or situation. As described in information processing theory, these relationships are developed from unique personal experiences and knowledge. These relationships are important in information processing as they aid in defining the problem space and search strategies. According to Kurfiss (1988), the nature of one's knowledge in a particular discipline influences the approaches individuals take when solving complex thinking tasks related to that discipline. What one knows and how one performs is embedded in the socially and institutionally structured context that is shared by a discipline (Peden-McAlpine, 2000).

In nursing, sound decisions and nursing treatment are a result of the use of appropriate generic or discipline specific knowledge that is contextually adjusted to match each unique patient situation (Rashotte & Thomas, 2002). Peden-McAlpine (2000) identified two types of domain specific information used by clinicians in the decision making process: universal and particular information. Universal information is information known to be true in most situations. Universal information is acontextual and provides the theoretical foundation to for gathering context specific information. As a result, universal information assists the clinician in defining the boundaries of a given problem, thereby narrowing the possible solutions. Establishing the boundaries of the problem and narrowing of possible solutions decreases the decision maker’s cognitive burden (Bordage, Grant, & Marsden, 1990; Elstein & Bordage, 1979; Elstein et al., 1978; Newell & Simon, 1972) which in turn is thought to impact decision making quality. Particular information is described as information related directly to the patient’s specific
clinical situation (Peden-McAlpine, 2000). Particular information is contextual and learned through engagement in the situation. The relationships within the mental representation of the problem or situation are the knowledge structures at the heart of information processing (Fiske & Taylor, 1984; Walsh, 1995). As defined by Walsh, "a knowledge structure is a mental template that individuals impose on an information processing environment to give it form and meaning" (p. 281). Schema is a synonym for knowledge structures or mental templates.

*Schema*

Common across information processing models is the formation of mental representations which are often referred to as schema. The word schema comes from the Greek language and is prominent in the writings of the ancient Greek Philosophers Plato and Aristotle (Marshall, 1995). Immanuel Kant also employed the term schema for which the ancient as well as the modern meaning is form or shape (Marshall, 1995). While Plato and Aristotle primarily used the term to describe an object or concept, Kant extended the idea of schema by describing schema itself. In Kant’s view, schema is the link between concepts, which are information gained from sensory perception (Marshall, 1995). The work of Thomas Kuhn (1995) concerning paradigms is also salient in discussion of schema. While Kuhn uses paradigms to describe the advancement of science or scientific revolution, some of his concepts are relevant to an individual’s cognitive processing as well. A paradigm, according to Kuhn, refers to the scientific achievements acknowledged by a scientific community as the foundation for its practice. A paradigm is an accepted
model or pattern and "what mainly prepares the student for membership in the particular scientific community in which he will later practice" (Kuhn, 1995, p. 11).

Schema are defined as organized knowledge structures that represent knowledge of a specific concept (Fiske & Taylor, 1984; Walsh, 1995). Greenwood et al. (2000) state that concepts are the building blocks of schema, that is, concepts are organized into larger chunks of well integrated knowledge called schema. Marshall (1995) similarly defines schema as a "vehicle of memory" (p. 39) but emphasizes its role in organizing similar experiences which is consistent with Kuhn’s description of paradigms. As noted by Marshall, this organization allows the individual to discriminate between similar and dissimilar experiences; access a generic framework that contains the essential elements of similar experiences including verbal and nonverbal aspects of these experiences; draw inferences, create goals, and develop plans; and use the associated skills, procedures, or rules when encountering a problem for which the schema is relevant.

Marshall (1995) states that each of the four schema functions described above requires its own type of knowledge based on the outcomes elicited by the function. The four associated knowledge types are identification knowledge, elaboration knowledge, planning knowledge, and execution knowledge. Identification knowledge, according to Marshall, is the most common means of schema activation. The main function of identification knowledge is pattern recognition which contributes to the initial recognition of an experience. Marshall’s conceptualization of pattern recognition resonates with that of Benner and colleagues and others (Benner et al., 1999; Benner, Tanner, & Chesla, 1996; Kurfiss, 1988) in that is characterized by rapid identification of similar and
dissimilar features of a situation. Kuhn (1995), referring to the functions of a paradigm asserts that in the absence of a paradigm all facts that could possibly inform a given problem would be viewed as equally relevant (1995). Marshall notes that the key to identification knowledge is the result of simultaneous cognitive processing of many features. Thus, no single feature cues recognition. Another important characteristic of identification knowledge is that different configurations of features present different patterns, but are all recognized as the same basic situation.

Elaboration knowledge allows the individual to create a mental model about the current problem and contains elaborations about the main features of the situation around which the schema was developed. Once the general situation is recognized through identification knowledge, the details of the current situation can be fit into the schema for the current situation. Identification and elaboration knowledge together allow the individual to form and test a tentative hypothesis (Benner et al., 1999; Benner et al., 1996). Elaboration knowledge is used to determine whether the situation should be recognized and the associated schema accepted.

A key element regarding schema is that they consist of organized knowledge and thus include not only content of memory but also the links between memory components (Walsh, 1995). Marshall (1995), from an education perspective, cites the contributions of developmental psychologist Jean Piaget to schema theory. Piaget's key contributions, according to Marshall, are that 1) schema governs both action and cognition; and 2) schema develops only for situations, events, or patterns that occur over and over again. As more events or behaviors become associated with a schema, the schema becomes
more general, thus can be applied to a broader range of experiences. Consistent with information processing theory, experience is associated with the ability to more readily access domain knowledge from schemas of individuals with greater amounts of knowledge in a particular information domain than those who do not (Marshall, 1995; Walsh, 1995). Marshall suggests that this is because recognition of and discrimination between stimuli (cues) is enhanced as a result of exposure to larger numbers of stimuli.

Once the schema has been accepted, planning knowledge is used to make plans and set goals. Goal setting or clarification is likewise an important step in information processing theory. Planning knowledge as described by Marshall (1995) is gained through experience and is updated with each use. In order to implement or carry out the steps of the plan, execution knowledge is applied. Execution knowledge consists of skills that lead to action and are generally shared among schema. Greenwood et al. (2000) state that action schemata represent an individual's procedural or how-to knowledge and are known as scripts.

Knowledge Retrieval

Memory is a key component in information processing. Carnevali and Thomas (1993) describe four stages in students' development of memory for use in clinical practice. The first stage is the pre-clinical stage in which classroom oriented experiences provide factual or theoretical knowledge related to the discipline of nursing. In the second stage, early clinical experiences, students seek to link information from clinical experiences with the theoretical knowledge gained in the classroom. At stage three, increasing clinical experience, the student begins to develop problem scripts. They begin
to add more variability to typical cases and begin to see relationships between
phenomena. The final stage, developing patient instance scripts, involves memories of
specific patient situations. The student uses these specific instances as a basis for
comparison in new situations. Inherent in the process of decision making is not only the
acquisition, but also, and perhaps, more importantly, the organization of vast amounts of
patient-generated cues (Greenwood, 2000; Greenwood et al., 2000; Kurfiss, 1988).

Knowledge in memory is organized to aid retrieval. One way in which retrieval of
knowledge from memory is thought to occur is through the construction of scripts
(Greenwood, 2000; Greenwood et al., 2000). Nursing scripts as described by Greenwood
(2000) are collections of ‘if...then’ rules which are developed in a three phase process. In
the cognitive phase, the nurse commits to memory sets of facts relevant to the skill or
procedure. In the associative phase, the nurse connects or ‘chunks’ symbolic information
with motor activity to create or refine new productions. In the autonomous phase, the
scripts are automatically and unconsciously triggered by the ‘if’ stimulus or cue found in
a given practice situation (Jenks, 1993). According to Greenwood (2000), it is the
availability and use of these nursing scripts that make everyday practice situations
meaningful and manageable for the nurse. Expertise in this framework results from the
conversion of increasing amounts of declarative knowledge into production rules. As a
result, experts have more attention and cognitive resources to consciously devote to
unfamiliar or atypical situations. As engagement in greater numbers of situations occurs,
the number of if-then rules increases as does the speed with which knowledge is
accessed.
The development and unconscious deployment of scripts can be viewed as intuition. The role of intuition as a component of expert practice has generated much discussion in nursing. Intuitive processes develop over time as nurses gain experience in patient care (Jenks, 1993). Intuition has been described in many ways but is thought to relate to the development of acute sensory observation of subtle changes in patient behavior (King & Appleton, 1997). Intuition has also been referred to as the recognition of the patient ‘falling out of the pattern’ or the recognition that the patient generated cues do not match known patterns (King & Appleton, 1997). A more formal definition of intuition is the ability to experience the elements of a given situation as a whole in order to solve a problem or make a decision with limited concrete information (King & Appleton, 1997). Other definitions of intuition depict it as immediate possession of knowledge or knowledge that occurs independently from a linear reasoning process (Paul & Heaslip, 1995). More traditional thoughts related to intuition are that it represents a ‘gut feeling’, however, as noted with the above definitions; intuition is more than a mystical understanding of a patient situation. Intuition, then, represents the ability of the expert nurse to utilize his or her extensive schema, patterns, or scripts to match patient generated cues with knowledge stored in memory. Knowledge is organized in the memory in such a way that it is immediately accessible to the expert clinician and thus serves to increase the cognitive resources available to react to more complex or novel situations. When information is processed, integrated with previous knowledge, and shaped into a recognizable pattern, the knowledge base for intuitive practice is formed (Benner et al., 1999; Duchscher, 1999). However, experiential learning does not happen
merely with the passage of time, it requires active engagement on the part of the learner (Carnevali & Thomas, 1993; Daly, 1998; Lamond & Farnell, 1998).

Information Processing and Patient Safety

One of the most influential characteristics of today’s healthcare environment is complexity. Complexity has specifically been identified as one influence on patient safety (Clancy & Delaney, 2005; Ebright et al., 2003). According to Clancy and Delaney (2005), improved access to information is the underlying cause of increases in health care complexity. Clancy and Delaney focus on an organizational perspective of information processing but also describe the contribution of individual information processing as a contributor to ineffective decision making stating that it is the interplay between organizational design and information flow that may lead to overload and ineffective decision making. One reason for this is that healthcare providers at the point of care are involved in constantly evolving situations (Ebright et al., 2003) in which causal relationships between stimulus and response blur (Clancy & Delaney, 2005).

Clancy and Delaney (2005) further point to information processing influences, or rather, limitations in terms of implementing change. Consistent with the information processing models discussed earlier, Clancy and Delaney state that selection of the correct decision is dependent on both the accuracy of the information available and the mental model of the individual. Problems arise because of the limits of human information processors’ ability to interpret the structure and dynamics of complex systems (Clancy & Delaney, 2005).
The cognitive tasks involved in responding to these evolving, complex situations are knowledge, mindset and goal conflicts (Ebright et al., 2003). Knowledge factors are the formal or contextual knowledge base that clinicians apply to solve problems in context. Mindset refers to the “immediate attentional focus and factors that affect control of attention during real work” (Ebright et al., 2003). This definition is consistent with Kuhn’s (1995) view of a paradigm as the source of context for problem solving. Goal conflicts refer to the tradeoffs related to values or costs (risks) associated with particular actions (Ebright et al., 2003). These three factors are closely aligned with the characteristics of information processing. That is, the knowledge stored in memory, the attention to particular cues and identification of relevant information, and goal directed. This increasing complexity in health care drives the need to understand how to best support and enhance decision making (Ebright et al., 2003).

Ebright and colleagues (Ebright et al., 2003) examined cognitive factors driving RN decision making and strategies experienced nurses use to manage work from the perspective of a human performance framework. Content analysis was used to sort and categorize both observation and interview data to identify common meanings and patterns. Twenty-two patterns reflecting work complexity (eight patterns), cognitive factors (eight patterns), and strategies to manage care (six patterns) emerged. Relative to the scope of this paper, findings related to cognitive factors are considered. Cognitive factors driving performance and decision making were grouped into goal and knowledge patterns. Goal patterns included maintaining patient safety; preventing getting behind; avoiding increasing the complexity; appearing competent and efficient to coworkers, and
maintaining patient/family satisfaction. Knowledge patterns included knowing individual patient information; knowing typical patient profiles; and knowing unit routines/workflow. As noted by the authors, this study also provides insight into cognitive research in the context of patient assignments within a complex environment. In addition, the investigator's use of observation data to guide selection of situations on which to focus the interviews adds to the theoretical and practical significance of the study in that the interviews were focused on situations in which the participant immediately responded to a patient situation in response to new information. As a result there is a linkage between action and thought that fills a gap in the information processing literature.

**Surveillance**

Recent emphasis on patient safety and the environments in which patient care is delivered has led to the recognition of phenomena known as surveillance and failure to rescue. Failure to rescue is a term that first appeared in the early 1990s and refers to the inability to save a patient's life after a complication develops (Clarke, 2004; Clarke & Aiken, 2003; Silber, Williams, Krakauer, & Schwartz, 1992). This beginning work focused on patient morbidity in the 30 days following elective surgical procedures. Failure to rescue has now become a measure of quality of healthcare which is calculated as the proportion of patients who die among those who experience complications (Clarke, 2004; Clarke & Aiken, 2003; Silber et al., 1992). The opposite of failure to rescue, a negative outcome, is rescue of patients at risk for adverse events. According to Clarke
(2004), two phases are involved in rescuing patients from potential danger: surveillance and rescue response.

The concept of surveillance is grounded in the field of intelligence related to espionage (Dougherty, 1999). According to Dougherty, surveillance in the context of intelligence involves making a judgment that the monitored behavior falls outside the range of legitimate activities. As a result, the events or activities under surveillance are categorized as potentially threatening and actions are taken to avoid or minimize adverse consequences associated with the threat (Dougherty, 1999; Schoneman, 2002).

Surveillance, according to Dougherty (1999), is closely related to observation and assessment but distinctly different. The most important difference is that surveillance occurs over time and involves the ongoing collection and interpretation or evaluation of information while assessment refers to collection and interpretation of data at a single point in time. Dougherty defines observation as a means of collecting data by watching, feeling, or touching but notes that surveillance includes a wider range of methods to gather data such as inspection, palpation, percussion, auscultation, and monitoring devices.

In nursing, surveillance is synonymous with monitoring. As a nursing intervention, surveillance is defined as “purposeful and ongoing acquisition, interpretation, and synthesis of patient data for clinical decision making” (Dochterman & Bulecheck, 2004, p. 687). The goal of surveillance is early identification, and as a result, prevention of potential complications or problems. Because it involves not only identification of complications but also prevention of potential problems, surveillance
requires both cognitive and behavioral skills (Committee on the Work Environment for Nurses and Patient Safety Board on Health Care Services, 2004; Dougherty, 1999; Schoneman, 2002). The behavioral skills required for surveillance are those data gathering tools discussed earlier that provide observation and other assessment data. The cognitive component of surveillance includes “studying, interpreting, analyzing, and evaluating data to indicate a range of possibilities and to isolate those factors influencing a situation” (Dougherty, 1999; Schoneman, 2002).

The cognitive processes of surveillance are closely aligned with the cognitive process of information processing. At a basic level, information processing and surveillance share similar defining features (Table 4).

Table 4
Definitions of Information Processing and Surveillance

<table>
<thead>
<tr>
<th>Information processing</th>
<th>An approach to the study of <strong>cognitive activity</strong> that focuses on the <strong>structures and processes underlying knowledge acquisition</strong> and use (Newell &amp; Simon, 1972; K. L. Taylor &amp; Dionne, 2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveillance</td>
<td>“The application of behavioral and <strong>cognitive processes</strong> in the systematic collection of information <strong>used to make judgments and predictions</strong> about a person’s health status” (Dougherty, 1999)</td>
</tr>
</tbody>
</table>

Both information processing and surveillance involve cognitive processes that are involved in the acquisition and use of information. Similar relationships likely exist between the cognitive processes involved in information processing and surveillance.
(Table 5). Unfortunately, the cognitive processes underlying surveillance have not been enumerated substantially enough to allow comparison with information processing. However, Clarke and Aiken (2003) state that surveillance involves frequent assessment of patients, attention to cues, and recognition of complications or potential for complications to develop. Again, these activities are closely linked to those of information processing.

Table 5

Cognitive Processes of Information Processing Compared to Surveillance

<table>
<thead>
<tr>
<th>Information Processing</th>
<th>Surveillance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Elstein &amp; Bordage, 1979; Elstein et al., 1978)</td>
<td>(Dougherty, 1999; Schoneman, 2002)</td>
</tr>
<tr>
<td>Cue acquisition</td>
<td>Studying</td>
</tr>
<tr>
<td>Hypothesis generation</td>
<td>Interpreting</td>
</tr>
<tr>
<td>Cue interpretation</td>
<td>Analyzing</td>
</tr>
<tr>
<td>Hypothesis evaluation</td>
<td>Evaluating</td>
</tr>
</tbody>
</table>

*Surveillance Research*

Little research surrounding surveillance or early recognition as a nursing activity exists (Peden-McAlpine & Clark, 2002) (see Dougherty (1999) and Schoneman (2002) for reviews). However, a body of research surrounding failure to rescue is emerging. This research focuses on organizational factors such as nurse staffing and nurse education in relation to the outcome failure to rescue (see for example (Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Aiken &
No studies that examine failure to rescue or surveillance from a specifically stated information processing approach are available. However, two studies (Cioffi, 2000; Peden-McAlpine, 2000) examined nurses’ decision making for situations in which patients are “at risk”.

Cioffi (2000) used interviews to explore the experiences of nurses who had been involved in calling a Medical Emergency Team (MET) for their patients. This team was called when a nurse identified a patient needed early medical intervention to prevent the occurrence of cardiac arrest and its complications. Analysis of the transcripts involved extraction of statements and phrases pertaining to the experience of calling the MET. Similar items were clustered into five main categories (uncertainty associated with calling; identification of change in patient’s condition; identification of at-risk situation; associated feelings; and valuing of MET) with a number of subcategories were identified.

Early Recognition

Peden-McAlpine (2000) similarly examined nurses’ thinking process in relation to a phenomenon called early recognition. Each subject participated in three reflective interviews in which they were asked to relate situations in which they were able to identify a change in a patient’s condition and status prior to the appearance of objective signs and to describe a situation in which they thought they had made a difference in patient outcomes. Interviews were analyzed using the hermeneutic phenomenological approach. Findings are described as three common elements of thinking in the recognition ability of nurses and include: types of information used in thinking; activity of understanding the unique meaning inherent in each patient situation; and a temporal
perspective that allowed future learning to occur. Peden-McAlpine identifies two types of information used in thinking. Universal information refers to abstract information that is known to be true in most situations and includes principles from the literature relevant to the care of specific patient populations. Particular information is practical, perceptual information that provides a perspective unique to the context of a specific patient situation. In terms of unique meaning, patient situations were not immediately perceived as a whole but were actively constructed over time. Thus, the universal information provided a boundary or frame for a specific problem. The addition of particular information either confirmed or changed the meaning of the situation. According to Peden-McAlpine, the temporal perspective reflected the dynamic nature of the recognition process and the nurses' attention to the patient's past status in relation to his present status, that is, the changing of particular information over time. These findings are consistent with other studies (Elstein et al., 1978; Fonteyn & Grobe, 1994; Fonteyn, Kuipers, & Grobe, 1993; Grobe, Drew, & Fonteyn, 1991) in suggesting an influence of context, relationship between facts, knowledge, experience, and the focus of intervention(s) to avoid harm.

Building on these findings, Peden-McAlpine and Clark (2002) conducted a second analysis of the transcripts from the earlier study in order to examine how time informed the thought processes of expert nurses during the experience of early recognition. Findings of the study demonstrated nurses' interaction with the situation over time. Application of knowledge from past as well as the present situation led to identification of potential actions. Specific elements of time found to inform thinking
are: learning the particulars of the patient situation over time; recognizing changes in the
patient situation over time; and recognizing the time is right for appropriate ethical
intervention (Peden-McAlpine & Clark, 2002). Time with the patient and continuity of
care were identified as one way in which nurses were able to identify and intervene for
subtle changes in patient status which were identified through comparison with past and
present knowledge of the specific patient as well as prior experiences.

Interpretive Phenomenology was the method used by Minick and Harvey (2003)
in their exploration of early recognition. As in the two studies conducted by Peden-
McAlpine (2000; 2002), participants were asked to describe a situation in which they had
made a difference, a time when they had recognized a problem early. Different from the
other studies, participants were interviewed in groups of two to four nurses in sessions
lasting from 45-90 minutes. The data were further coded and then similar codes grouped
together to form categories. When possible, codes similar to those identified by Peden-
McAlpine’s earlier studies were used for similar findings in this data set. Three themes
related to early recognition of patient problems were identified: knowing the patient
directly, knowing the patient through the family, and knowing something is not as
expected. Like Peden-McAlpine and Clark (2002), these authors identified both time with
a particular patient and time gained through experience as key aspects of early
recognition of patient problems by nurses.

Use of the same interview questions for both the critical care nurses (Peden-
McAlpine, 2000; Peden-McAlpine & Clark, 2002) and medical surgical nurses (Minick
& Harvey, 2003) as well as adoption of the same coding scheme when applicable allows
ready comparison across the studies. Time with the patient and/or family clearly emerges as one component that allows the nurse to identify subtle changes in a patient situation over time. The early recognition studies reviewed here are true to the philosophical assumptions of the methods used, adding to the internal validity of the studies. In summary, these studies provide a strong foundation for additional study into nurses' early recognition of patient problems. Yet, gaps exist in that the studies employed retrospective recall. The passage of time since the events described is not known, however, it is known that with passing time, perceptions of events can be altered based on additional knowledge or experience. Continued research using the information processing theory approach with concurrent think aloud may provide additional insight into nurses' early recognition of patient problems. In addition, further conceptual work needs to be done to understand the relationship(s) between early recognition and surveillance.

*Communication and Patient Safety*

Accurate communication of information is key in meeting healthcare quality and safety goals (Haig, Sutton, & Whittington, 2006; Leonard, Graham, & Bonacum, 2004; Patterson, Roth, Woods, Chow, & Gomes, 2004; Streitenberger, Breen-Reid, & Harris, 2006). According to Patterson and colleagues (2004), shift change handoff is one important vehicle for the communication of relevant information and allows the person accepting responsibility a fresh perspective. The miscommunication, forgetting, or misunderstanding of information communicated during change of shift handover is costly (Patterson et al., 2004). Costs associated with these communication errors include incomplete model(s) of the system's state; lack of awareness of significant data or events;
ill preparation to manage effects of previous events; inability to anticipate future events; lack of knowledge necessary to perform skills/tasks; rework or failure to follow through on activities in progress; and shifts in goals, priorities and plans (Patterson et al., 2004).

Patterson and colleagues (Patterson et al., 2004) examined change of shift handoff in four settings considered to have high consequences for failure. These settings were NASA Johnson Space Center, two Canadian nuclear power plants, a railroad dispatch center in the U.S. and a Canadian ambulance dispatch center. Twenty-one handoff strategies and their objectives were identified through prior research on space station handoffs and researchers’ experiences and observations during data collection across a variety of studies including nursing shift report.

The authors suggest that the strategies found in this study could be tailored to health care, in particular nursing handoffs. However, the study is descriptive and does not explore the effectiveness of each strategy or whether the strategies could even be applied in health care settings. The study builds on knowledge that handoffs influence outcomes in settings considered to have significant consequence if errors occur and attempts to translate that knowledge to healthcare which has been identified as a high risk setting (Committee on the Work Environment for Nurses and Patient Safety Board on Health Care Services, 2004). Yet, as noted by the authors (Patterson et al., 2004), whether the strategies identified are accurate representations is not clear. The study does, however, lay important groundwork for future work, including both experimental and descriptive designs, related to communication and handoff in health care and other high risk settings.
The 21 strategies identified by Patterson and colleagues (2004) were used for analysis in a subsequent study specifically focused on handoff during nursing shift changes (Patterson, Roth, & Render, 2006). An interesting finding in this study was the relative lack of questions (49 in 236 shift change reports) asked of the outgoing shift during the handoff to gather additional information. In the instances where face-to-face handoff occurred, more questions were asked. The questions asked were coded using the five-item coding scheme derived from prior studies: update initiation; topic initiation; obtaining more details; confirmation; and error checking. Only the last, error checking occurred rarely and generally was used by the nurse manager who listened to the report. Additional categories were identified and included system improvement, comment, interpret utterance, and tape management. Another finding that differed from the authors’ previous findings was around “stance information” defined as the team’s stance or view of a decision. In this study of nursing handoff, there were more parties included in the stance information than in the mission control study and nurses’ knowledge of other’s stances was not as clear as in mission control. Of the original 21 handoff strategies, 11 were not observed, six were always used, and 4 were occasionally or rarely used. The authors note the large variability across and within units in terms of how handoff is conducted. Finally, the authors briefly mention that information was not conveyed in the same order in handoffs, suggesting that the most important information tends to be positioned first and that by ordering information according to importance, the oncoming nurse is aided in anticipating future events and prioritizing nursing care. These findings
confirm that nursing change of shift is an important element in communication of one individual to another.

Summary of Information Processing and Patient Safety

The impact of nurses’ cognitive work on patient outcomes, specifically, patient safety is generally accepted as true. Emerging research regarding nurses’ activities and abilities in recognizing and communicating patient problems early provides a strong foundation on which to build additional programs of research. Specifically, application of an information processing perspective to the study of nurse activities such as surveillance or early recognition can aid in not only understanding the essential cues a nurse attends to, but can influence nursing education and staff development programs, administrative practices, and support measures to guide nurses in clinical practice. Knowledge and experience are key elements in the cognitive activity known as information processing. In the changing environment of nurses, understanding of expert knowledge will impact the ability to provide decision support and documentation systems that can more readily support nurses’ cognitive work.

Information Processing Research in Non Healthcare Disciplines

Social Information Processing Research

Social information processing has been applied to the study of childhood anxiety (Harvey, Fletcher, & French, 2001), aggressive children (Daleiden & Vasey, 1997; van Manen, Prins, & Emmelkamp, 2004), perception of fairness (Goldman, 2001; Jones & Skarlicki, 2005), and job characteristics and attitudes (Pollock, Whitbred, & Contractor, 2000; Salancik & Pfeffer, 1978). Daleiden and Vasey suggest that the encoding
processes of anxious children are distorted so that focus is narrowed to threatening information. Thus, the child interprets ambiguous information as threatening. This interpretation is followed by adoption of goals aimed at maintaining personal safety by avoiding or escaping threatening cues, resulting in behaviors that are avoidant. Similarly, Harvey et al. state that there is a strong relationship between aggressive behavior in children and deficits in social information processing, particularly in terms of the situational cues they extract from the environment, the attribution of hostile intent they make when the situational cues are ambiguous, and their ability to generate appropriate solutions to problem situations, with a preference for aggressive responses which is directly linked to the social interaction experiences stored in memory.

According to Goldman (2001), when work environments are ambiguous, workers are likely to use social information processing to define their perceptions of the work environment. In this case, social information theory as a model of work motivation asserts that work attitudes and behaviors are to a large extent the result of the processing of information from the social environment rather than a result of individual predispositions.

In an interdisciplinary study conducted by communication, computer science, and engineering researchers, Pollock, Whitbred, and Contractor (2000), only the friendship network significantly predicted social environment. In addition, an individual’s past experience did not moderate the influence of the social environment on job satisfaction. Findings also suggest that individuals scoring high on self monitoring are influenced more by their social environments than low self monitors who tend to pay less attention
to social information. The authors conclude that "individuals job satisfaction was significantly predicted by the objective characteristics of the job...an individual’s level of job satisfaction is significantly influenced by the job satisfaction of others within whom the individual interacts" (Pollock et al., 2000), p. 324).

Similarly, a study of the relationships between variables and terminated employees’ filing of employment discrimination claims (Goldman, 2001) found that social guidance was the only variable “significantly related with almost every subcategory of decision to claim” (Goldman, 2001, p. 372) supporting the theoretical perspective of social information processing that claiming behavior is related to the social context.

**Information Processing Research in Communications/Media**

Five articles examine information processing in the domain of communications. Four articles (Berger, 2000; Lombard, Reich, Grabe, Bracken, & Ditton, 2000b; Schenck-Hamlin, Procter, & Rumsey, 2000; Walma van der Molen & van der Voort, 2000) provide insight into individual information processing. One article (Lombard, Reich, Grabe, Bracken, & Ditton, 2000a) examines individual information processing in the context of group communication.

Berger (2000) conducted two studies to examine whether hearing base-rate data indicating increasing population size would decrease apprehension associated with news stories depicting threatening phenomena. Participants were randomly assigned to receive a booklet containing one of two burglary stories: steadily increasing burglary rates in the city the university was located in or declining burglary rates in which the frequency rates
for burglary were reported as declining with the same numbers as in story one presented in reverse order. Following each story, participants reacted to the news story by rating the degree to which the news item was newsworthy and informative and estimate of the likelihood that they would become a victim of a burglary. In addition, participants responded to a series of five bipolar adjective scales regarding how they felt as they read the story. As expected, those who received the increasing burglary story exhibited more apprehension than did those exposed to the decreasing burglary rate story. No significant main effects were found in relation to perceived victimization and burglary rate. There was however, an interaction effect between population story and gender. Men who received the population increase story demonstrated lower levels of perceived victimization risk than men who did not. Interestingly, there was no significant difference in victimization risk in women who did, as compared to those who did not, receive the population increase story. Questioning whether these results might be related to the population increase story serving as a distracter rather than a salient cue, the authors continued with experiment two in which the cues in stories read prior to the burglary story included base rate cues embedded in a more everyday social context. Participants were randomly assigned to one of four conditions: burglary story only; steady population increase story; social contacts story; and distraction condition story. Subjects responded to the same items as in experiment one. Findings were similar to those of experiment one with men demonstrating lower levels of perceived victimization risk when the news story depicting increasing burglary rates was preceded by a story showing increasing population rates. Women did not demonstrate these differences in
perceived risk. As the authors predicted, when exposed to stories unrelated to population or social contact rates, perceived threat was not diminished.

Berger (2000) offers a number of reasons for the differences between threat appraisal between men and women including gender role difference response sets, women’s ability to imagine threatening experiences differently than men, women’s identification or empathy with the victim in the news story, and higher levels of apprehension in threatening situations decreasing women’s ability to draw the necessary links. However, because there was not a consistent difference between men and women’s apprehension and victimization risk levels in the burglary increase only story, Berger suggests that when confronted with threatening situations, men and women may deploy different information processing strategies and background data. That is, according to Berger, ability to focus on particular cues may differ with gender.

Similarly, gender differences were identified in a study of television screen size and participants’ sense of presence (Lombard et al., 2000). Participants watched short movie clips on either a large (46 inch) or small (12 inch) screen and then responded to a questionnaire about the experience. All participants reported a sense of presence in the action scenes, with those viewing the videos on large screen scoring higher on all measures (sense of physical movement, movements in scenes faster, enjoyment of sense of movement, closeness of vehicle to terrain, excitement of scene, and danger of activity). Males significantly enjoyed the movement scenes more than females, while females appraised the scenes as significantly more dangerous than did males. In addition, females reported more intense responses to the large screen while males showed little change in
response to screen size condition. The authors suggest that one reason for this differences
might be a result of the content shown, in other words, males may have been more
experienced and comfortable with the scenes used in the study. They also suggest that
males may have been more accustomed to watching television on larger screens. A
second explanation offered by the authors concerns gender differences in perceptual
processing, in particular, visual field dependency (females generally more than males)
which increases the illusion of self movement and ability to screen stimuli in order to
decrease the information to be absorbed (males more than females). Gender differences
have not been investigated in medical and nursing information processing studies, thus
these studies are thought provoking. In addition, the study may have methodological
implications for information processing research in which video is used to present cues to
participants.

Like Berger (2000), Schenk-Hamlin, Proctor, and Rumsey (2000) explored the
impact of media, particularly political advertising on people’s thoughts and feelings in
response to campaign advertising. The theoretical framework for this study is framing,
which is closely linked to information processing. In short, frames connect messages to
cognitive elements such as thoughts and feelings and result in the activation of particular
responses over others (Schenck-Hamlin et al., 2000). The cognitive elements that are
activated in memory are more likely to influence a person’s attitudes and decisions, thus
the more accessible the cognitive elements, the more salient they are. Each subject read
transcripts of six political advertisements of political candidates. The authors found no
support for their hypothesis that increasing numbers of negative ads would result in
increased citizen cynicism. Limitations to the study discussed by the authors include the fact that all candidates’ names were changed to fictitious male names and that the ads were not viewed in the context of an actual election. Findings did support the hypothesis that negative candidate ads as compared to candidate theme or platform ads resulted in increased subject cynicism.

The influence of information contained in television versus print news was the focus of a study by Walma van der Molen and van der Voort (2000) in which a sample of fourth and sixth graders in the Netherlands were given news in a variety of forms in order to examine children’s superior recall of television news over other news forms. The children were randomly assigned to one of four experimental conditions (watch television news stories; read literal transcripts of television news stories; read literal transcripts of news stories illustrated with a photo; and listen to audiotapes of television news stories). Conditions. After receiving the news, students were given a recall test. As predicted, recall was better for television news stories than audio-taped news stories and print stories. There was no difference in recall from text only as compared to text plus photo. In addition, television news stories supplemented with visual information were recalled better. The authors suggest that perhaps the superior recall of television news is a result of not only the verbal information but also the nonverbal cues such as gestures and facial expressions that are available to the television watcher. While the authors found that reading proficiency had no significant effect on recall, the authors speculate that because television may be more interesting for children of this age, their attention is perhaps enhanced.
In a novel application of information processing theory, fruit and vegetable purchasing behaviors of 70 low income African American women were examined (Reicks et al., 2003). The investigators accompanied each woman to a grocery store at a mutually agreed upon time and location. Participants wore a tiny microphone clipped to their lapel and attached to a small purse worn around the waist or shoulder. In this case, because the think aloud was conducted in a public setting, the subjects were allowed to talk to the investigator accompanying them. To minimize bias, the investigators were trained in data collection/interview techniques so that they could convey interest and attentiveness. Verbal data was transcribed verbatim and analyzed by segmenting text by specific food products and coding them by categories that described the factors considered by the subjects when deciding to purchase or not purchase fruits and vegetable products. This study is important as it uses think aloud in a real setting by lay persons. The authors did ask study participants to comment on the think aloud process at the end of the think aloud. Many subjects indicated that they often thought aloud to themselves or to their children while carrying out this task so the think aloud was not identified as obtrusive. In fact, some participants indicated that the think aloud procedures helped them to keep focused on the shopping task or that they felt as if they were talking to a friend while shopping. On the other hand, the authors note that the think aloud and/or the presence of the investigator did affect the verbalizations of a small proportion of the women.
Recognizing the rich information environments available to consumers, Lurie (2004) states that the structure of information has important implications for acquisition and processing of information and, as a result, decision quality. In a series of three studies (Lurie, 2004), 143 undergraduate students were asked to imagine they intended to purchase a calculator for a friend. In experiment one, information structure was the experimental variable and was operationalized as number of alternatives (18 vs. 27) and distribution of attributes across alternative (even vs. uneven). Findings support the hypothesis that information structure, not number of choices, is the critical factor that determines information overload. In experiment 2, a similar design was used in which participants selected a calculator for a friend’s birthday from 24 alternatives. Findings further supported the influence of information structure on not only decision quality, but also on information acquisition. When more information was given, subjects spent a higher proportion of their time examining the attribute deemed most important, thus were less likely to process all available information. In experiment three, computer simulation was used with time constraint as the experimental variable with no time constraint or a limit of 64 information processing steps. Not surprisingly, an increase in the amount of information increased the number of information processing steps in the no time constraint condition. Significant interactions were found for distribution of attribute levels and decision strategy. Decision strategy moderated the effects of number of attribute levels on information processing steps. As noted by the authors, this study provides unique insights into not only decision outcomes but also decision processes.
Ball and colleagues (Ball, Langholtz, Auble, & Sopchak, 1998) used verbal protocol analysis to examine the cognitive processes of college students engaged in a resource allocation task. The task was to determine the number of meals they could obtain in a 7 day week for each of four weeks when given a fixed amount of time and money. Half of the students were assigned to more vs. fewer resources ($75.00 and 15 hours or $72 and nine hours). Meal choice conditions were two choices (home and restaurant meals) or three choices (home, restaurant and take-out meals). The problems were presented to subjects on a computer and the subjects were instructed to think aloud as they solved the problems. Codes applied were goal, calculate, read, and select.

Findings were first, that none of the participants use a solution strategy prescribed by linear programming (mathematical solutions). Two other strategies were identified in the analysis of processes: solve-and schedule and consume-and-check. A small number (4 or 21%) of participants used the solve and schedule strategy in which they tried to identify the maximum meals possible in a week before planning the daily meals. Interestingly, once the first day’s calculations were complete, subjects who used the solve and schedule strategy carried out no further cognitive calculation, they simply applied the first week’s strategy to subsequent weeks. In contrast, a majority (79%) of subjects preferred the consume and check strategy in which they made meal choices daily. The authors note that there were clear differences between the consume and check strategies as compared to the solve and schedule strategy transcripts, enough so that they conclude protocol analysis may not be necessary to determine the strategy used, meal selections themselves
depict the underlying allocation strategy. Particularly, subjects who used a solve and schedule approach rarely changed their meal selections from week to week while the consume and check strategy users consistently varied their meal selections from week to week. It was expected that increased task complexity would result in changes in cognitive strategy applied and, as a result, less cognitive demanding strategies (consume and check) but the findings did not support this hypothesis. The authors suggest this may be because overall, performance on the task was very high, thus the participants did not need to change to a different strategy. Given the small sample size, further research is needed before these findings can be generalized. Participants were required to participate in the study as part of their course which may influence the findings. In addition, the sample included only two men, which also influences generalizability. Ball and colleagues suggest that the task itself may not have been harsh or difficult enough to influence changes in strategy as anticipated with increasing task complexity. This observation has methodological implications for the current study in relation to selection of appropriate tasks, environments, and measures in the study of information processing and decision making research.

*Information Processing Research in Education*

Research in education specifically using information processing theory framework is difficult to identify despite the fact that an ERIC (database of education publications and research reports) search of information processing theory resulted in over 500 citations. In review of those research papers available to the author (many are conference proceedings or other documents not readily available), information and
information processing occur with great frequency however, information processing is seldom explicitly identified as a theoretical framework. Rink (2001) in a discussion of theories of learning in relation to education research offers potential reasons for this. An important consideration is that much of the research done on instruction has been done to "establish direct links between what a teacher does and what a student learns" (Rink, 2001, p. 123). Rink goes on to suggest that this research paradigm has limited research to a particular kind of learning rather than taking a more holistic view of learning. This results in the assumption that a particular learning process is occurring in the student because a particular teaching method is being used. Rink concludes that research in education should not only include methodology studies that answer the question “which is best” but also process studies that can answer “what is happening here?” Rink’s assertion that “those direct lines...between learning theory and student learning and between teaching and learning are mostly not out there” (p. 124) may be an underlying reason for the paucity of education studies in which information processing provides the theoretical framework.

*Information Processing Research in Healthcare*

According to Tanner (1986) research into nurses’ clinical decision making has been informed either by decision theory or information processing theory. Research using decision theory attempts to describe mathematically how a person should weigh cues to derive an answer or choose an action that has the highest probability of achieving the most desired outcome (Tanner, 1986). Thus, the emphasis in decision theory research is the decision to be made (i.e. the correct decision) rather than the processes used in
making a decision. Information processing theory, the conceptual framework underpinning this study, allows insight into the cognitive processes involved in decision making. Therefore, this review will be limited to studies in which information processing theory provides the theoretical foundation.

Methods

Beginning with Newell and Simon's (1972) initial work on information processing theory and continuing to the present day, think aloud has been the data collection approach associated with research using an information processing approach. Because think aloud represents participant's verbalization, these verbalizations are generally tape recorded and subsequently transcribed for analysis. These transcriptions are referred to as verbal protocols. Because think aloud with verbal protocol analysis is the most common approach to research concerning information processing, a discussion of the methods is presented here to aid the reader in interpreting and understanding the research in this arena.

A major assumption underlying information processing research is that information that is heeded can be verbalized (Ericsson & Simon, 1993). Thus, the use of verbal report has been established as an appropriate means of capturing information processing. Verbal reports can be viewed as two types: concurrent verbal reports and retrospective verbal reports. In concurrent verbal reports, referred more commonly to as think aloud or talk aloud reports, the heeded information is verbalized directly, that is, during the task with the assumption that the heeded information is verbalized at the time it is available in short term memory. Evidence exists that concurrent verbal reporting
does not influence or modify what information is heeded and verbalized (Ericsson & Simon, 1993).

Retrospective verbal reports, on the other hand are elicited just after the task is completed. The heeded information is accessed from either short or long term memory and verbalized. According to Ericsson and Simon (1993), the main difference between concurrent and retrospective verbal reports is that because at least some information in retrospective verbal reporting is retrieved from long term memory, additional retrieval processes are required which can lead to errors. These errors often result from accessing information acquired prior or subsequent to the episode of interest (Ericsson & Simon, 1993). Despite these potential errors, Ericsson and Simon assert that both concurrent and retrospective verbal reports are direct and valid verbalizations of specific cognitive processes.

Think aloud and talk aloud are terms that are often used synonymously. Subjects are instructed to ‘think aloud as you...’ As in other research methods that employ verbal data such as phenomenology or grounded theory, probes are generally used to remind subjects to think aloud. These include statements such as ‘please, think aloud’, ‘keep talking’, or ‘please tell me what you are thinking’ (Kuipers, Moskowitz, & Kassirer, 1988). Ericsson and Simon recommend the probe ‘keep talking’ as the preferred prompt because it is less directive than others.

Once transcribed, protocols can be divided into syntactic units or segments. In their early work Newell and Simon (1972) discuss the process of dividing the protocol into short phrases. These short phrases are described as content associated with a single
assertion or reference. Subsequently Ericsson and Simon have published two editions of a text on verbal protocol analysis, the latest in 1993. Ericsson and Simon provide additional insight into information processing theory and serve as an excellent resource for data collection using think aloud. Yet, little direction is provided in terms of analyzing the resulting data. Work on protocol analysis by Kuipers, Moskowitz, and Kassirer (1988) builds on the assumptions of information processing and defines methods for protocol analysis.

The steps involved in protocol analysis include: referring phrase analysis, assertional analysis, and script analysis (Fonteyn et al., 1993) (Table 6). Referring phrase analysis is used to identify the objects that the subject was concentrating on in short term memory. These phrases represent the concepts or objects. These phrases are generally noun phrases. Assertional analysis identifies the relationships participants form between objects. Assertions serve to convey explanations or draw previously identified objects together. Assertions, according to Grobe et al. (1991), serve to focus attention on the objects and their relationships. Script analysis is used to identify the structure of individual’s reasoning processes. According to Fonteyn et al. (1993) at the beginning of script analysis a set of operators (reasoning processes) is identified that explains the predominant reasoning processes common to all study participants. In addition to illuminating the overall reasoning processes used, information participants attend to while problem solving, the manner in which they structured the problem, the rationale for their choices, and the plan developed for problem resolution can also be illustrated (Ericsson & Simon, 1993; Newell & Simon, 1972).
Table 6

Steps of Protocol Analysis

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Action</th>
<th>Describes</th>
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<tbody>
<tr>
<td>Referring phrase analysis</td>
<td>Phrases and their referents (objects)</td>
<td>Information subject concentrating on</td>
</tr>
<tr>
<td>Assertional analysis</td>
<td>Relationships between objects</td>
<td>Focus attention on objects and their associations</td>
</tr>
<tr>
<td>Script analysis</td>
<td>Individual’s reasoning process</td>
<td>Overall explanation/structure</td>
</tr>
</tbody>
</table>

Grobe, Drew, and Fonteyn (1991) describe a subsequent step in verbal protocol analysis which involves creating a visual representation of each subject’s objects (problems and interventions) and their linkages or relationships. This visual representation is similar to what has been described as problem behavior graphs by Simon and colleagues (Ericsson & Simon, 1993; Newell & Simon, 1972).

Novice/Expert Differences

A number of studies have examined differences in decision making between novice and expert practitioners. Comparison across these studies is difficult because of inconsistencies in definition of novice and expert as well as diversity in the outcome variables examined. Thus, this review will be structured by study focus.

Definitions of novice and expert practitioner found in the studies reviewed in this paper are provided in Table 7. Attributes associated with novice/expert clinicians include years of practice, nomination by peer or manager, or role. Operational definitions of
novice clinicians are the most variable ranging from practicing nurses with less than three years experience to beginning junior nursing students.

Table 7

Novice/Expert Practitioner Criteria

<table>
<thead>
<tr>
<th>Study</th>
<th>Novice Definition</th>
<th>Expert Definition</th>
</tr>
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<tbody>
<tr>
<td>Corcoran (1986a)</td>
<td>Staff nurse Less than 6 months experience in hospice program</td>
<td>RN Employed in leadership position 18 months experience in hospice nursing One professional activity (published articles on hospice nursing or pain control, presentations on hospice nursing or pain control to professional groups) labeled as an expert in hospice nursing or pain control by at least 5 hospice nurses</td>
</tr>
<tr>
<td>Corcoran (1986b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fonteyn and Grobe (1994)</td>
<td>NA</td>
<td>Practicing in critical care at least 2 days/month BSN (two had master's degree in nursing) Certified in critical care nursing</td>
</tr>
<tr>
<td>Greenwood and King (1995)</td>
<td>Not enrolled in graduate nurse program Permanent member of orthopedic unit staff Minimum 3 months continuous orthopedic nursing experience</td>
<td>Acknowledged expertise in orthopedic nursing 4-8 years orthopedic experience Orthopedic nursing certificate (preferred) Wide range of medical-surgical experience Bachelor of nursing or equivalent (preferred) skill in communication and leadership professional development (ongoing education, participation in professional organization, conference attendance)</td>
</tr>
<tr>
<td>Grobe, Drew, and Fonteyn (1991)</td>
<td>NA</td>
<td>BSN graduates Licensed to practice 2 years full time With chronically ill patients in hospital</td>
</tr>
<tr>
<td>Lamond and Farnell (1998)</td>
<td>Peer review less than 2 years experience Manager definition as novice in wound care</td>
<td>Peer review more than 3 years experience Manager definition as expert in wound care</td>
</tr>
<tr>
<td>Reference</td>
<td>Education/Experience</td>
<td>Other Qualifications</td>
</tr>
<tr>
<td>---------------------------------</td>
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<td>---------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Lewis (1997)                    | NA                                                                                   | 2 years experience in critical care  
Experience in weaning patients from mechanical ventilator at least 10 times in the past year |
| Reischman and Yarandi (2002)    | Nursing student within one semester of graduation from BSN program  
Student critical care clinical experience for at least 90 hours | RN license  
Full or part time in one of study units  
Routine assignment to care for cardiovascular critical care patients  
5 years experience with cardiovascular critical care patients  
Identified as cardiovascular critical care expert by nurse manager |
| Simmons, Lanuza, Fonteyn, Hicks, and Holm (2003) | NA                                                                                   | Employed full time 2-10 years  
Medical surgical nursing |
| Tabok, Bar-Tal, and Cohen-Mansfield (1996) | Senior nursing students in academic nursing program in Israel                           | Hospital nurses with at least three years experience (59% staff nurses) |
| Westfall, Tanner, Pettiier and Padrick (1986) | Beginning junior nursing student  
Beginning senior nursing student                                               | Staff nurse with at least 2 years experience  
BSN  
Supervisor rating as excellent nurse with consistently sound clinical judgments |

**Decision Making Strategies**

Elstein and colleagues (Elstein et al., 1978) were among the first researchers to apply information processing theory to the study of diagnostic decision making in a series of studies making up the five year medical inquiry project. Despite the passage of time, citations referencing Elstein and colleagues (Elstein & Bordage, 1979; Elstein et al., 1978) coupled with Newell and Simon (1972) are found in nearly all medicine and nursing studies concerning decision making and/or information processing in medicine and nursing. The outcome of the medical inquiry project is the hypothetic-deductive model of expert reasoning.
The studies making up the medical inquiry project employed a number of strategies to examine novice/expert differences. These include the use of videotape recording along with think aloud to collect data, the use of trained actors, written case presentations, pencil and paper simulations, fixed order presentation of one to two cues at a time, and videotaped vignettes of patient/physician interactions to present cases to subjects. Findings in this study suggest that the only general strategies consistent across physicians and tasks were early hypothesis generation and data gathering to test diagnostic hypotheses. The total number of hypotheses considered ranged from four to seven, supporting the idea that hypotheses serve as chunking mechanisms to conserve space in short term memory. Notably, no significant differences existed between expert and novice groups. In addition, within-person variance suggests that individual subjects do not apply consistent strategies, but that variation in strategies is a function of the problem space.

A surprising finding, according to Elstein and colleagues, is that subjects tended to generate more hypotheses when all of the cues were consistent with a single diagnosis than when some data was inconsistent with the diagnosis. They conclude that this finding suggests that inconsistencies in data are ignored rather than stimulating consideration of alternative possibilities. The authors further conclude that clustering cues to generate a diagnostic hypothesis and ignoring cues inconsistent with a hypothesis suggests the dependency of diagnostic thinking on finding matches between the case at hand and patterns or lists retrieved from memory. This could represent the influence of paradigm in defining the context for decision making.
Four characteristics of the initial hypothesis were identified: 1) they tended to be hierarchically organized with a general diagnostic category consisting of several subcategories; 2) the initial set of hypotheses usually included competing formulations, giving alternative explanations for a symptom group; 3) they included formulations of varying levels of specificity (e.g. organ system to specific diagnoses); and 4) the set of initial hypotheses often included diagnoses with functional relationships to one another. An interesting finding is that regardless of instruction not to generate hypotheses early; early hypothesis generation occurred 85% of the time, further supporting the idea that hypothesis generation serves to limit and organize the problem space.

Information Importance

The relationship between problem attributes and information needed to make a preliminary diagnosis was the focus of a study by Stavri (1996). Specifically, the urgency of the problem and the presence of etiologic information were examined as attributes that might underlie the subjects’ identification of “the most important thing” (MIT). The most important thing was defined as the information-seeking question that a subject indicated would be most important in making a preliminary diagnosis given the information available. Vignettes of four presenting conditions varied with respect to the two variables of interest (urgency and etiology). Subjects received the vignettes and were asked to think aloud as they as they identified the most important thing. Once the subject identified a final MIT, the investigator confirmed it by restating it and giving the subject the opportunity to change it. Semantic function categories assigned are verification, disjunctive, concept completion, feature specification, quantification, causal antecedent,
and other. According to the author, the only planned contrasts supported concerned quantification questions and urgency or etiology/urgency conditions. Additional analysis using post hoc Schaffer comparisons demonstrated significantly more verification questions in the base condition than in all other conditions. Limitations of the study described by the author include potential violation of the assumption that the resident groups used in the study were homogenous in terms of knowledge. In addition, it is possible that the subjects may have interpreted the instructions inconsistently as evidenced by the author's note that two subjects emphasized that what they needed to know to make a diagnostic decision was secondary to what actions they needed to take to stabilize and treat the patient. This supports the findings of other studies (Offredy, 2002) that problems and interventions are seldom considered independently of one another.

The differences in decision making processes between general practitioners (GPs) and nurse practitioners (NPs) was the focus of a study by Offredy (2002). While not explicitly framed as a novice/expert study, Offredy conceptualizes the nurse practitioners in the study as novices and the GPs as novices. In addition to the case scenario, a reference model was developed for each scenario. The reference models defined critical and relevant cues. Critical cues were defined as those “necessary for successful diagnosis” (Offredy, 2002); relevant cues were those that “provided potentially important information” in making a correct diagnosis. Think aloud in combination with an interview format was used to capture data. The author describes this approach of think aloud and questioning as a means to determine participant’s clinical knowledge. Participants were given the patient’s age, name, and chief complaint or request. They
were then asked to think aloud while responding to the query ‘how would you proceed?’
If the participant indicated they would examine the patient, if available (for four cases: shingles, cigarette burn, chest infection, and pelvic inflammatory disease), a photograph was offered. According to Offredy, participants were then informed they could request whatever information they wanted in order to make a diagnosis. It appears that this information was exchanged verbally. No measures are described that indicate efforts to ensure all participants received the same information in response to a query or to minimize potential bias resulting from the verbal exchange of information. In addition, a retrospective think aloud was used at the end of the scenario by asking questions that would assist in identifying the cues used in reaching the decision.

Using the computer software, Offredy (2002) applied a coding strategy that elicited nine stages of decision making that represent two types of decisions. The first decision type was diagnostic decision making and was coded using the four stages of decision making described by Elstein et al. (1978): cue acquisition, hypothesis generation, cue interpretation, and hypothesis evaluation. An additional five codes were identified by the investigator to describe the second decision type, therapeutic decision making. These codes were diagnosis, treatment, advice, further treatment/advice/refer to outside agency, and refer to GP. According to Offredy, each of the nine codes was further subdivided but no information on that is provided. The authors indicate that participants in at least two scenarios indicated that the problem was outside their role scope. Conclusions drawn by the author are that there were more similarities than differences in identifying relevant information between the two groups. Offredy further suggests that
what differences do exist are the result of differences in knowledge and experience, with GPs having more of each, therefore, the assertion that in this study, NPs functioned similarly to novices.

Information Consistency

Two nursing studies (Dowding, 2001; Tabok, Bar-Tal, & Cohen-Mansfield, 1996) have examined the effects of information consistency and decision making. Tabok et al. examined the effect of information consistency in a diagnostic task completed by senior nursing students and experienced hospital nurses. Each participant received two brief case scenarios, one with a description inconsistent with the diagnosis (dehydration) and the other consistent with the diagnosis (stroke). Study participants rated their certainty that the patient did have the diagnosed condition and answer four questions related to the difficulty of the decision task. Findings demonstrated that subjects perceived less difficulty and more certainty in the consistent information task. In the consistent information task, nurses were more certain than the students yet in the inconsistent information task, nurses were less certain than students, suggesting that perhaps students were unable to see the inconsistencies in the situation. Further analysis using a chi square (2x3 test) with two levels of expertise and three certainty levels: uncertain, certainty in given diagnosis, and certainty in an alternative diagnosis was carried out. Significant results (p<.01) indicate a relationship between expertise and certainty. In addition, expert nurses tended to be more certain when the information was consistent with the diagnosis. Students, however, were more uncertain in the consistent information task but more certain in the diagnosis when the information was inconsistent with the diagnosis. Thus,
novices are less likely to consider alternative diagnoses, which results in more certainty when information is inconsistent with the diagnosis. These findings are consistent with earlier studies (Newell & Simon, 1972) in which task complexity was related to the number of alternatives generated. In this study, the authors suggest that the expert nurses are better able to identify alternative diagnoses consistent with the patient information. However, participants were not asked to define alternative diagnoses they may have considered.

Dowding (2001) examined the effect of manipulating information contained in change of shift report on nurse's care planning ability. Participants were received one of four simulated change of shift reports (prospective report with schema consistent information; prospective report with schema inconsistent information; retrospective report with schema consistent information; or retrospective report with schema inconsistent information). After receiving change of shift report participants generated care plans that were subsequently analyzed by comparison with 'gold standard' care plans constructed by a panel of experts and scored by giving points for items matching the items identified by the expert panel resulting in an overall score. Participants' recall of information from the change of shift report was also examined. Type of shift report had little effect on the amount of information accurately recalled but did have a significant effect on the ability to plan care. That nurses' ability to recall information influences their ability to plan care is a major tenet of this study, yet this link between recall ability and ability to plan care has not been established. In addition, no significant interactions were found between the type of information and report type.
Task Complexity

Information processing theory describes problem solving as an interaction between a problem solver and a problem task (Corcoran, 1986a, 1986b; Lewis, 1997; Newell & Simon, 1972), thus, the task component of decision making has been the focus of several studies. In seminal work, Corcoran (1986a), examined task complexity and expertise in relation to the ability to generate and evaluate alternatives and the quality of care plans. The problem task involved developing a written care plan for pain control in response to three written patient scenarios representing three levels of complexity. Complexity was determined by number of sources of pain presented by the patient, the interrelatedness of the sources of pain, and the extent to which established hospice protocols could be applied to the case. Final care plans were coded and scored using criteria established by the gold standard plan developed by an expert consultant. Subjects were asked to read the case aloud and then think aloud as they developed and wrote a drug administration plan. No significant expert-novice differences were found for total number of alternatives generated. Findings related to evaluation of alternative interventions demonstrated that in only nine of 33 verbal protocols did subjects evaluate all the alternative actions generated with no subject evaluating all the alternatives in the most complex case. Those subjects who did evaluate all the alternatives generated fewer alternatives to evaluate. The author notes that experts provided more specific rationale for both the alternatives generated and evaluation of those alternatives than did novices. Complexity of the case was not related to quality of the final care plan but experts developed better final plans than novices. Novices developed better plans in the least
complex case than in the more complex cases while experts had more difficulty in
developing plans in the least complex case.

Corcoran (1986b) used the same sample of novice and expert nurses and
procedures to describe the initial and overall approaches to care planning. Quality of care
plan was determined by comparison with one developed by an expert consultant and
coded using four categories (consistent with the consultant’s plan, appropriate for the
case but not consistent with the consultant’s plan, incomplete, or erroneous). Initial and
overall approaches to planning were coded and scored using pre-established rules.
Findings demonstrated that experts used broad initial approaches significantly more than
did novices. However, neither novices nor experts varied their approaches across cases
thus demonstrating no significant relationship between case complexity and initial
approach to the problem task. Similar to findings by Corcoran (1986a), there was no
significant relationship between overall approach and quality of plan but experts varied
their overall approach significantly across cases with most experts using opportunistic
approaches in the two more complex cases and a systematic overall approach in the least
complex case. In contrast novices tended to use opportunistic approaches in all cases.
Interpretation of these findings is limited by the lack of operational definitions for the
approaches. While examples of opportunistic and systematic protocols are provided, the
criteria applied to reach these determinations are not clear. In addition, the terms broad
and narrow are used in figures, yet opportunistic and systematic are used in text which
adds to confusion about the findings.
Lewis (1997) used a case study modified from another study to test her decision-making task complexity model. The decision making task was whether or not to attempt a trial of ventilator weaning for the case patient. Fourteen cases representing combinations of the four decision making characteristics of interest (irrelevance, ambiguity, conflict, and change) were rated on the complexity of the decision. Findings suggest that conflicting information increased uncertainty while irrelevant data was more likely to be ignored by participants.

Schema

Schema theory and information processing theory have been used together to provide a conceptual framework for the investigation of nurses' and physicians' cognitive processing (for example Greenwood, 2000; Greenwood & King, 1995; Greenwood et al., 2000; Higgins & Tully, 2005; Lamond, 2000)). Greenwood and King explored Australian nurses' clinical reasoning as they assessed and planned care for their patients. Concurrent report was given at the bedside with the patient present and interacting with the nurse. A retrospective report was given in a quiet office away from the patient. At this time the investigator also probed for the rationale behind subjects' interpretations as they thought aloud about their assessments. Basic and subordinate concepts and cognitive strategies were identified and plotted on problem behavior graphs. Problem behavior graphs allow a pictorial representation of the concepts and cognitive strategies uncovered during think aloud and represents the problem solver's search of the problem space (Newell & Simon, 1972). A coding strategy derived from the literature was used to code the think aloud data. Coding categories were collect, review, interpret and relate information, and
diagnose. Findings suggest that while experts and novices shared many basic concepts, experts used more concepts in reasoning than did the novices. Experts also used more strategies to manipulate the information they gained, thus more frequently related items of information—a "striking" finding according to Greenwood and King. Novices exceeded experts in use of the collection of information strategy which the authors attribute to novices' lack of sufficient knowledge to discriminate between salient and non-salient cues.

Information Types

The information used in making clinical decisions and the accuracy of those decisions is another variable explored in novice-expert decision making literature. In one study (Lamond & Farnell, 1998) how knowledge specific to wound care was organized and the accuracy of subject's decisions for treatment was explored. Card sorts were used to examine knowledge organization. Subjects were asked to sort the cards depicting pressure ulcers and various dressing material into categories so that each group had something in common and was different from other categories and then to explain the reasons for placing the cards in the selected grouping. Findings from this component of the study demonstrated two different categorizing systems that were not expertise dependent. In the second component of the study, three patient cases that included a picture of a pressure ulcer and cue cards containing information about the patient such as age, nutrition, mobility, and continence status, medical diagnosis, and wound exudate were presented to subjects. Each subject was asked to decide on the treatment for the three pictured pressure ulcers. Subjects could access additional information about the
patient or wound by turning over one of the cue cards containing addition information about the patient. Accuracy scores demonstrated that experts made significantly more accurate decisions than novices. Little difference was found between groups in amount of information used but experts focused on specific information (e.g. mobility and nutrition status and amount of exudates) more often than novices who used more nonspecific information. No relationship between decision accuracy and organization strategy used in the card sort was identified.

Reischman and Yarandi (2002) compared cue utilization between expert and novice cardiovascular critical care nurses. Participants were asked to think aloud as they made a diagnosis for simulated patients presented in written patient scenarios. Novices in this study recalled more total cues (all cues provided in the scenarios) than experts, but there were no differences in the groups on highly relevant cue (as defined by a panel of experts) recall. One limitation to this study is that the diagnoses nurses were expected to arrive at were medical, not nursing diagnoses (left ventricular dysfunction, cardiac tamponade, sepsis, and right ventricular failure with infarction). This may account for the low rate of accurate diagnosis in this sample (72% correct by experts, 28% correct by novices).

Cognitive Processes

To describe the cognitive processes employed by novice and expert nurses, Taylor (1997) employed direct observation and in-depth interviews. This study focused on five specific procedures (showering a patient, taking a blood pressure, complex dressing change, urine testing, and blood glucose testing) carried out during the delivery of care.
Data were coded according to the stages of the diagnostic reasoning process described by Carnevali and Thomas (1993): attend to available cues, generate tentative hypotheses, gather data to rule in or out the tentative hypotheses, and evaluate each hypothesis based on the data to determine a diagnosis.

Pre-encounter data suggested that nursing handover or change of shift report was the most obvious source of information used by the participants, although there were novice-expert differences in how this information was used. Experts asked in-depth questions to create a picture of the patient; the novice and intermediate groups relied on written material and notes with little interaction in handover although all attended handover. The author (C. Taylor, 1997) suggests that this difference occurred because the students recognized few cues due to their limited experience. In addition, the author noted that novices tend to examine a variety of documents without a specific reason or goal for doing so. Experts focused on specific sections of the progress notes. During the procedure, novices noted minimal patient cues, focusing solely on performing the task but experts used a wide range of cues to assess the patient during the procedure. An important finding in this study is that experts classified patient cues into what the authors define as risks and strengths for the patients. This assessment of risk resulted from the incorporation of all information into a total patient picture. Novice-expert differences in activating hypotheses were also observed. Novices used single cues to trigger hypotheses and ignore cues that did not fit; experts used multiple cues and activated several hypotheses concurrently, even linking cues across hypotheses.
Prime and Le Masurier (2000) explored the clinical decision making of diagnostic radiographers with the aim of mapping the thought processes used during clinical situations in order to understand how radiographers make decisions and what information (cues) they use to make the decisions. Videotapes employing actors for both patient and radiographer were viewed by subjects who generated verbal protocols which were subsequently coded by the researchers. Codes used in the analysis include: describes the scene and does not engage in the scenario; observations of the patient's history and presentation; observations based on practical knowledge of radiography; observation based on clinical knowledge from experience or reading; and observations about the actors. The authors concluded that radiographers in the study joined together concepts as packets of information rather than focus on discrete concepts.

Diagnostic Accuracy

Comparison of novice, intermediate, and expert medical student and pathologist subjects’ accuracy in diagnosing a set of breast pathology slides was the focus of a study by Crowley, Naus, Stewart, and Friedman (2003). Participants were asked to think aloud as they examined each of four slides in the absence of the patient history until they reached a diagnosis. Subjects were then given the clinical history and allowed to re-examine the slide and change the diagnosis if desired. In addition to think aloud protocols, video recordings of the microscopic pathology session were made using a camera mounted on the subjects’ microscope. Two independent coding schemes, one for coding of cognitive processes and one for coding of errors. Using information processing theory as describe by Newell and Simon (1972), the individual protocol segments were...
coded as an operator and action that defines the process and arguments composed of descriptors and values that encode the content.

The final coding scheme consisted of 48 operators covering five general categories: data examination, data exploration and explanation, data interpretation, control processes, and operational processes (Crowley, Naus, Stewart, & Friedman, 2003). Data examination included the selection and examination of visual and historical information. Data exploration and explanation included higher level abstractions such as evaluating salience. Data interpretation included hypothesis generation and testing. Operational processes, in this case, were related to the use of the microscope. Significant improvements did not result from the addition of the clinical history. When the subject established the final diagnosis, a determination of certainty in the diagnosis and case complexity were made using visual analog scales. As in other studies, novices found the cases to be more difficult and were less certain in their findings. Intermediates' certainty was lower in the cases in which diagnoses were inaccurate, and experts had the highest certainty levels and the lowest difficulty ratings.

**Experienced Clinicians**

A number of investigators have studied the cognitive processes of experienced clinicians. Joseph and Patel (1990) focused on the relationship between domain-specific knowledge, hypothesis generation and problem representation by senior physicians while solving a problem. Subjects were grouped into high domain-knowledge and low domain knowledge groups. The high domain knowledge group consisted of four endocrinologists as the problem task involved diagnosis of an endocrine disorder. The low domain
knowledge group consisted of five cardiologists. Case information was presented on a computer one segment at a time. Subjects were instructed to verbalize their thoughts about the role and importance of the information in each segment in reaching a diagnosis. After viewing the entire case, subjects were asked to provide a summary of the case and to state a final diagnosis. Coding of the organization of information was carried out by identifying whether the cue was critical (necessary for successful diagnosis), relevant (provides potentially important information for reaching an accurate diagnosis), or irrelevant (not directly related to the accurate diagnosis) and then each of these cue types linked to the accurate diagnosis components. In addition, a reference model was developed to explain the underlying pathology of the condition in the case. Each subject's interpretation of a given segment was mapped onto the reference model by doing an overlay of the subject's representation on the reference model. No differences between groups were found for number of cues selected. However, significant differences did exist between groups in terms of types of cues selected. High domain knowledge subjects focused on more critical and relevant cues than the low domain knowledge group. Low domain knowledge subjects who arrived at accurate diagnoses did so at later segments of the case than did the high domain knowledge group. According to the authors, because there were no differences between groups in selection of relevant information, the lag in arriving at accurate diagnoses is a function of the organization of relevant knowledge. Analysis of hypothesis generation revealed that not only did the subjects generate the accurate hypothesis at different times, but also that the two groups arrived at the hypotheses by different means. High domain knowledge subjects generated few new
hypotheses after generating the accurate diagnostic components early in the problem, instead focusing on confirming the diagnosis but low domain knowledge subjects continued to generate and test new hypotheses throughout the diagnostic activity. Thus, according to the authors, high domain knowledge subjects decreased uncertainty about the problem but low domain knowledge subjects increased uncertainty. The authors conclude that two phases are associated with clinical problem solving. The first phase includes the processes of cue acquisition, hypothesis generation, and cue interpretation. The second phase involves hypothesis evaluation, in this case, evaluation of the problem representation(s) produced.

Grobe, Drew, and Fonteyn (1991) used think aloud to examine the data nurses verbalize during a task and describe the clinical reasoning of nurses during this task. A single written case study derived from the record of one home health client was presented to each subject who verbalized their thoughts as they planned a home health care referral for the hospitalized client. Protocol analysis as described by Kuipers, Moskowitz, and Kassirer (1988) was used for data analysis. An additional step was added to data analysis in which a visual representation of the subjects’ objects and linkages was developed. These objects and linkages were further represented as “organized constellations” of problems and interventions. However, each subject’s visual representations demonstrated different patterns of linkages. To investigate these differences, the investigators established four levels of relationship. Level one relationships were characterized as links between problems and interventions both within and across categories (problems and interventions). Level two relationships demonstrated links between a problem and one or
more interventions. At level three, links occurred only within a single category. At level four, no links existed; a problem or intervention was mentioned in isolation. Final analysis involved the comparison of subjects’ reasoning on the basis of their levels of linkages. All but one subject used level one and two linkages in their reasoning demonstrating that subjects tend to link problems with other problems and interventions. Because only two subjects used level three linkages, the authors suggest that problems and interventions are seldom considered independently of one another. An additional finding was that specific goal statements did not emerge as distinct objects in the analyses. Because information processing theory describes problem solving as goal directed, this is somewhat unexpected. In further exploring this phenomenon, the authors found that some phrases did imply goals but served as assertions to link problems with interventions rather than explicit goal statements.

Fonteyn and Grobe (1994) examined the reasoning processes of experienced nurses by identifying the information used and how that information is structured. A single case study was presented to subjects in segments with each segment typed on a single sheet of paper. Subjects were asked to think aloud as they planned care for the critically ill case study patient. Four processes were defined to describe the reasoning processes subject’s used to structure the case information. These processes are study, conclude, choose, and explain. The process labeled as study involved the careful consideration of information. Conclude occurred when subjects verbalized a judgment about the value of information. The process called choose occurred when subjects selected nursing interventions. Explain was described as subjects provision of a rationale
for the interventions chosen. As in the earlier study, goals were not explicitly stated but according to the authors, could be identified in the rationale given for choosing an intervention (the process labeled as explain). The authors further describe the identified goals as more general than those of the nursing process and more likely to be goals that might be shared with other members of the healthcare team. These goals were additionally found to be hierarchical in nature and interrelated. As a result, some goals changed as the case evolved, but some persisted across case study segments which fits with the information processing perspective that goals are retained until met (Grobe et al., 1991).

Fowler (1997) used verbal protocol analysis to describe the cognitive processes of home health nurses while planning care for newly admitted chronically ill clients. The participants were audiotaped thinking aloud following the prompt to verbalize ‘any plans or thoughts you have about this case’ immediately before and after visiting each newly referred client. Content analysis was used to identify the operators and processors used in producing judgments. The cognitive operators found in the verbal protocols in this study were describing, explaining, evaluating, connecting, planning, and judging. Describing occurred when the participant gave details of the representation of a situation. In explaining, the subject gave rationale for an action or representation. Evaluating occurred when subjects compared the presence or absence of cues against prior experience or some other standard. Connecting occurred when the possible relationships among cues were considered. Planning was defined as the formulation of possible future actions. Judging involved forming conclusions based on evaluation. The author notes that these cognitive
operators were used in combination rather than in a particular linear sequence. In addition to the cognitive operators, Fowler identified six cognitive strategies. Cognitive strategies are defined by the author as strategies that help to reduce cognitive strain associated with the processing of multiple cues. The six strategies identified included cue logic, framing, hypothesizing, testing, reflexive comparison, and prototypical case reasoning. Cue logic refers to the cognitive approach (inductive or deductive) applied to cues. Framing involves the use of specific cues to direct one's approach to the situation. Hypothesizing was defined as formation of possible explanations. Testing involved the evaluation of cues against prior knowledge and comparison of cues to desired outcomes. Reflexive comparison resulted when subjects made judgments about the state of a situation after gauging the presence of some quality against a standard. Prototypical case reasoning represented the use of past cases as typical examples or case references. In terms of pre- and post-visit planning, the author noted differences in reasoning processes which are attributed to the context. Pre-visit information tended to be written information from the referral form and medical record. In contrast, post-visit data was reported in the context of patient safety, compliance, and independence.

Similarly, Simmons and colleagues (Simmons, Lanuza, Fonteyn, Hicks, & Holm, 2003) examined experienced nurses' thinking during patient assessments. The subjects independently assessed their patient during the shift selected for data collection, and then at a time selected by the subject, the investigator arrived and asked the participant to think aloud as they reasoned about the assessments of their patients. Transcripts of the think aloud were analyzed following the phases of verbal protocol analysis (referring
phrase analysis, assertional analysis, and script analysis). The five reasoning processes identified were describe, explain, evaluate, plan, evaluate, and conclude.

The cues used by expert nurses when making decisions about suctioning critically ill children were examined using think aloud and semi-structured interviews in a study by Thomas and Fothergill-Bourbonnais (2005). Cue recognition and weighing the evidence were the two core components of decision making identified. Cue recognition involved both perceptual awareness (sensing of patient cues) and knowing (this patient, this practice environment, and this type of patient). Weighing the evidence reflected nurses' judgments as they determined the importance of the cues and confirmed their impressions about the importance of a cue. Like findings from other studies, these authors (Thomas & Fothergill-Bourbonnais, 2005) found that nurses did not separate "sensing, thinking and doing processes" (p. 335). That is, cue recognition, weighing the evidence and performing the activity were interwoven.

Diagnosis

Building on Elstein et al. (1978) findings regarding early hypothesis generation, Westfall and colleagues (Westfall, Tanner, Putzier, & Padrick, 1986), in a seminal study, explored decision making in sample of beginning and intermediate nursing students and staff nurses. Simulated patient situations consisting of a verbal change of shift report, short video vignette, and complete set of patient health data were presented to each subject. After hearing report and viewing the video vignette, subjects were asked to describe their initial thoughts. They were then instructed to ask the interviewer for any additional information they needed in making a decision regarding diagnosis. Two
categories of inference were identified apriori based on information presented in the simulation: accurate diagnostic hypotheses and plausible but inaccurate diagnostic hypotheses. An additional three types of inferences were identified from subject’s responses: implausible hypotheses, related hypotheses, nursing action inferences. Analysis of variance demonstrated no significant differences in number of accurate hypotheses or earliness of hypothesis activation. All groups activated at least 64% of hypotheses within the first half of the transcript.

Further exploration of the cognitive activities of the nursing students and staff nurses are provided by Tanner, Padrick, Westfall, and Putzier (1987). Using the same procedures described by Westfall et al., 1986), Tanner et al. (1987) analyzed the subjects’ responses to three of the simulated cases which were chosen to represent diverse diagnoses commonly encountered by nurses caring for ill adults and representing task characteristics thought to influence diagnostic reasoning (complexity of the diagnosis and complexity of cues and cue-diagnosis relationships). Complexity of the diagnosis was defined as single or multiple final diagnoses. Complexity related to cues was defined as subtle and/or ambiguous cues or numerous extraneous cues. As in the earlier report (Westfall et al., 1986), subjects listened to report, watched the vignette, and were instructed to think aloud as they formulated their initial response and subsequent diagnoses. Data for this study were the questions the subjects asked to elicit further information and data acquisition was scored as the number of questions asked by subjects and a rating of the strategy used. Five data acquisition strategies were defined through examination of the content of questions and subject’s stated reasons for asking the
questions. The five strategies are hypothesis driven; cue-based; review of systems or routine; answers to one question leads to the next; and random, nonsystematic. Hypothesis driven strategies were those in which the question could be clearly linked to the stated hypothesis. Cue based strategies were those in which subject’s stated that the question was to explore a cue or the question was not related to a hypothesis but was related to cues presented. The strategy labeled review of systems or routine resulted from questions that were unrelated to a hypothesis or cue and represented a systematic review as well as subject’s statement that the purpose of the question was to assess other body systems. Strategies defined as answers to one question lead to the next question include those in which a clear link to the preceding question is present and the questions was not clearly related to the hypothesis or another cue. Random, nonsystematic strategies were those that the subject provided no reason for asking the question or it was not possible to trace the rationale for a particular question. Findings demonstrated that the most frequently used strategies were cue based and hypothesis driven with 95% of subjects using cue based strategies and 91% using hypotheses driven strategies predominately.

Summary of Information Processing Research

Like information processing theory itself research approaches to study information processing vary by discipline and conceptual model used. Comparison across studies is challenging because of the differences in foci, data collection and analysis procedures, and interpretation. In healthcare disciplines, the research priorities surround understanding expert information or differences in experts’ and novices’ information processing while in non healthcare disciplines, there is more emphasis on understanding
the resulting behaviors. Methodological variations include the use of simulations versus more ‘real life’ situations. While healthcare disciplines, particularly nursing, have tended to use verbal protocol analysis to analyze data, more quantitative approaches to data analysis pervade the research literature of non healthcare disciplines. These variations in approaching information processing research provide a broad foundation for further research but a research agenda concerning any one particular decision making process as the focus of information processing research is not evident.

**Gaps in the Literature**

While information processing theory has been used in nursing to describe the cognitive processes involved in nurses’ knowledge work, the body of knowledge concerning this phenomenon remains incomplete. Review of the theoretical and research literature related to information processing from the perspectives of a variety of disciplines identifies few studies that focus on recognition of specific cues that influence decision making in clinical situations. Many of the studies that have been conducted utilize simulated clinical experience that may not include all of the cues generally available to a nurse in a given clinical situation. Thus, exploration of the context in which cues are recognized is needed. Further research is needed regarding the specific cues and sources of cues used in making decisions. In addition, specific aspects of nursing care in which nurses make decisions have not been explored.

Newell and Simon’s (1972) information processing theory of human problem solving has been widely accepted as the information processing framework in medicine and nursing. There has not been exploration of the contributions of other information
processing frameworks such as social information processing (Crick & Dodge, 1994) or information processing view of learning (Gagne, 1985).

Adequate conceptual and operational definitions to guide study and aid in data analysis are needed. Simulations are often used to study information processing. Simulations offer an advantage in their ability to offer a stable case with known variables which allows the investigator to identify and compare overall information processing of the same problem by many participants. However, simulations do not offer the same levels of complexity, time constraint and environmental considerations as real clinical situations (Higuchi & Donald, 2002). As a result many of the outcomes of information processing research reflect an evaluation of one’s ability to arrive at the same diagnosis as a panel of experts. This outcome, however, is often inconsistent with the stated purpose of describing the information processing activities of participants. While studies of ability to reach a diagnosis consistent with that achieved by and expert have made a significant contribution to the understanding of expert/novice differences, they do not advance understanding of information processing influences on patient outcomes. In particular, nursing activities such as surveillance have not been examined in the context of information processing.

Kim (1997) suggests a number of broad questions that can and should be addressed in order to advance knowledge of information processing. These questions include:

“What is the decision problem at hand?  
What is being decided?  
What are the objectives that need to be achieved through the decision?  
What information is needed (and is it obtainable) as one proceeds?
What and where are the main uncertainties and risk factors? What is the approach used in weighing the issues in relation to one another?” (p. 139)

These questions while posed from the disciplinary perspective of management information systems can help in defining a program of nursing research in nurse decision making within an information processing framework. The aim of this study is to explore the nursing intervention of surveillance from an information processing framework. Specific questions are:

1. How is the nursing intervention known as surveillance expressed during nurses’ think aloud in the course of nursing care?
2. What is the relationship between the data (cues) identified by nurses and the nurse’s appraisal of overall patient status?
CHAPTER THREE
METHODS

This chapter presents the methods for a study in which the purpose was to explore the nursing intervention of surveillance from an information processing framework. The study design, population and setting, recruitment strategies and procedures are described in this chapter. Specific research questions were:

1. How is the nursing intervention known as surveillance expressed during nurses’ think aloud in the course of nursing care?
2. What is the relationship between the data (cues) identified by nurses and the nurse’s decision about the focus of care for a stroke patient?

Assumptions

Assumptions underpinning this study included:

1. Information recently attended or heeded is kept in short term memory (STM) and is directly accessible for further processing.
2. Cognitive processes are not modified by concurrent verbal reporting.
3. Information that is heeded can be verbalized.
4. Verbalization does not influence what information is attended to.

Design and Setting

This study was conducted using a descriptive exploratory research design. Specifically, Think Aloud (Ericsson & Simon, 1993) and Content Analysis (Krippendorff, 2004) methods were employed for data collection and analysis,
respectively. The study was conducted during the routine delivery of patient care which allowed the researcher to obtain concurrent verbalization of the information being attended to in the participant’s STM as the nurse provider carried out normal patient care. As discussed in the last chapter, thinking aloud while performing a task can be used to identify the information that a person is attending to at a given time (Ericsson & Simon, 1993). Furthermore, it has been demonstrated that thinking aloud does not interfere in performing a task. According to Ericsson and Simon (1993), “the only feature common to the whole range of techniques used to obtain verbal data is that the subject responds orally to an instruction or probe” (p. 15).

There are two forms of verbal reports used in the thinking aloud method. The first is concurrent verbal reports, also known as think aloud or talk aloud reports, in which the heeded information represents the underlying cognitive processes is verbalized directly, that is without the mediating or intervening processes of time. The instruction for talk aloud is for subjects to “say out loud whatever they are saying silently to themselves” (Ericsson and Simon, 1993, p. 226).

The second type of verbal report used in think aloud is the retrospective verbal report in which a memory trace of information heeded during a task is laid down in short- or long-term memory. Just after a task is completed, this memory trace can be obtained from short- or long-term memory. However, when retrospective verbal reports originate from long term memory, additional retrieval processes are required thus potentially resulting in errors related to memory. Yet, Ericsson and Simon state that both concurrent and retrospective verbal reports are equivalent in that both are direct verbalizations of
specific cognitive processes despite the temporal differences. This study employed both concurrent and retrospective reports. According to Ericsson and Simon, the most marked difference between concurrent and retrospective verbal reports is that heeded information gained through retrospective report cannot be altered or changed, thus, subjects cannot report on information that was never heeded in the first place.

The most common probe associated with retrospective think aloud, according to Ericsson and Simon (1993) is “Why did you do that”? Ericsson and Simon further suggest that in the ideal use of retrospective report, the verbal report is given by the subject immediately after the task is completed. In this study, concurrent verbal report was obtained while the participant received report from the off-going nurse. These hand-off reports are received by reviewing a written nurse-to-nurse communication that is part of the electronic medical record for each patient, concurrent verbal report is feasible as the participant received report in a relatively quiet place and did not involve one to one interaction with the off-going nurse during the exchange of information. In order to ensure think aloud occurred as report was received, the investigator was present at change of shift report and reminded the nurse to think aloud while receiving change of shift report. To ensure confidentiality and promote participant’s comfort during this initial think aloud, the investigator offered the participant the opportunity to receive report in a separate location.

**Sample Criteria**

Study participants were a convenience sample of nurses working on a medical neurology unit of a large academic medical center in the Midwestern United States. This
site was selected because the patient population represents a broad range of neuroscience patients with particular emphasis on stroke and epilepsy programs. The investigator was familiar with nursing care delivery in this setting which enhanced interpretation of the findings through understanding of the clinical practice in this setting. Participants eligible for this study were: a) licensed registered nurse, 2) providing care to a stroke patient on the specified unit and 3) employed on the study unit for a minimum of twelve weeks to ensure completion of orientation. Nurses employed in the float staff or floating from another unit were excluded from participation in the study. Similarly, nurses who had not yet completed orientation to the unit were excluded from the study.

Nurses providing care to stroke patients units are appropriate for study of information processing in surveillance because of the multitude of potential complications of stroke that require surveillance by nurses. It was believed that this population of patients would yield rich data regarding the nursing activity referred to as surveillance.

The sample size was determined by volunteers meeting the inclusion criteria and reaching the point of redundancy in the analysis of the data. Fonteyn et al. (1993) reported that most think aloud studies have no more than 5-10 participants due to the extensive time required to analyze the vast amounts of data that can be generated using the think aloud method. In other studies using the method, the following samples sizes were used: four experienced triage nurses (Corcoran, Narayan, & Moreland, 1988); seven registered nurses, (Fonteyn et al., 1993); 15 experienced nurses, (Simmons et al., 2003); three expert physicians, (Kuipers et al., 1988); and 7 expert nurses (Thomas & Fothergill-
In this study, ten nurse participants were enrolled. Data saturation was thought to occur after eight participants but two additional participants were recruited to ensure no new categories or themes emerged.

**Recruitment Procedure**

Discussion with the collaborative practice leadership team (Nurse Administrator, Nurse Manager, Clinical Nurse Specialist and Nursing Education Specialist) for the specified unit occurred prior to subject recruitment to a) establish support for the study; b) ensure procedures are clear and appropriate for the unit and c) identify mechanisms to inform nurses about the study. Following this discussion with the collaborative practice leadership team a letter explaining the study (Appendix B) was distributed to unit staff via electronic mail. In addition, the nurse manager provided information about the study in the unit’s monthly newsletter. While subjects were not asked to respond to the invitation, during the first week following the invitation, four nurses responded by e-mail with an interest to participate in the study. Because the sample criteria hinged on patient assignment, none of these volunteers were eligible to participate in the study as they were either not present on the data collection days or were not assigned to care for a stroke patient during data collection.

**Procedure**

**Protection of Human Subjects**

The investigator completed the required protection of human subjects training at both Mayo Clinic Rochester and Loyola University Chicago. The research protocol was submitted for review and approval by the Institutional Review Boards at both Loyola
University Chicago and Mayo Clinic Rochester following approval by the investigator’s dissertation committee. Required review and approval was also obtained from the Nursing Research Committee, Department of Nursing, Mayo Clinic Rochester prior to submission to the Mayo Clinic Rochester Institutional Review Board. Funding to support the study was requested and received from the Nursing Research Committee, Mayo Clinic Department of Nursing. Purchase of audio recording equipment was funded by the Division of Nursing Research, Department of Nursing, Mayo Clinic Rochester. The budget for this study is provided in Appendix C.

Nurse Participants

Subjects were informed of their rights to decline participation or to end participation in the study at any time. Subjects were also informed that their decision regarding participation in the study would not impact their current or future employment in any way and that their responses would be reported in a way that will not permit recognition of them as participants in this study, for example, aliases used in place of participants’ names in direct quotes.

Participants’ were assured their privacy and confidentiality would be protected by using codes rather than names to identify tapes and in the transcriptions. Tapes and transcripts were kept in separate locked file cabinets in the researcher’s office. No identifying information other than the numeric code assigned to the participant was included on the transcript. Participation in the study did not present any risks to participants except the burden of time and effort involved in participating in the study.
Similar measures were taken to ensure the anonymity and confidentiality of the patients receiving care from the nurse participants.

*Patients*

Only nurses whose patients have consented to participate were included in the study. Demographic data (age, gender, race, diagnosis) and health status information was obtained from the medical record in order to aid analysis and interpretation of the data. Potential patient participants were identified with help from the charge nurse or nurses caring for stroke patients during the one or two shifts prior to data collection. Potential patient participants were then approached and invited to participate in the study (Appendix D). As required by the Institutional Review Boards, patient participants (or their legal representative) gave written HIPAA authorization (Appendix E) to access their medical records, and verbal consent to participate in the study. Because it is possible that patient communication with the nurse could be evident in the think aloud transcripts, all efforts to ensure confidentiality and anonymity of patients was undertaken. As noted for nurse participants, information linking the patient with the nurse was kept in separate locked cabinets. Only a code number was indicated on the tape and transcript to identify the patient. In reports and publications, aliases are used to protect patient identity. Records of patient participants and nurse participants are kept in separate locked drawers to avoid linking patient and nurse.

*Data Collection Procedures*

The investigator arrived on the unit prior to the beginning of the shift, reminded the nurse caring for a patient who had consented to participate about the study, and
verified willingness to participate. Nurses participated only once to ensure that the data was representative of the unit population and not limited to a few individuals. The investigator coordinated recruitment with the unit charge nurse to identify nurses who were assigned to care for stroke patients and met the eligibility criteria, particularly, permanent staff member of the unit, not in orientation. Specific information obtained from patient’s medical records is described in Appendix F.

Once a qualified nurse participant was linked with a patient who had consented to participate in the study, that nurse was invited to participate (Appendix G). Once willingness to participate at that time was validated, the participant was fitted with a portable audio recorder and microphone (Appendix H) and instructed in its use. The investigator asked the nurse participant to inform the investigator when he/she was ready to receive hand-off report from the off going nurse. As report was received by the receiving nurse participant, he or she was asked to think aloud about the report. Probes were used to remind the participant to talk aloud about the issues or concerns he or she had for this patient and the care they planned to provide.

When the nurse was ready to perform his or her initial patient assessment, he or she was asked to think aloud during the performance of the assessment. Following procedures described by Ericsson and Simon (1993) and others (Fonteyn et al., 1993; Simmons et al., 2003), the investigator reminded the participant to think aloud. In addition, the investigator used probes (Appendix I) to encourage the participant say out loud whatever they were thinking to themselves.
Finally, at the conclusion of the shift, the participant was again asked to think aloud about the patient. At the conclusion of the think aloud, each participant was asked to complete a demographic survey (Appendix J) and thanked for their participation in the study. Individual participants were not be remunerated for participation in the study; however, an educational resource selected by the nursing leadership team was given to the unit staff as a thank-you for participation in and support of the study. The value of this educational program was $99. A flow diagram of the study procedures is presented in Appendix K.

In order to ensure that the think aloud represented the participant’s thinking about the patient and/or situation and not responses to investigator queries, the investigator limited her interaction with participants and their patients to observation with only prompts to keep talking or to talk aloud. In addition, participant questions related to the study procedures were answered, but the investigator planned to refer participants to the charge nurse, clinical nurse specialist, or nurse manager for questions related to the care of his/her patient. None of these questions arose during data collection.

Analysis of Data

Each audiotape was transcribed in its entirety and analyzed using content analysis. At the time the study was conceived the plan was to use Verbal Protocol Analysis to analyze the data resulting from think aloud. This method was chosen as it is the most frequently used method to explore decision making. Protocol analysis is a qualitative method of studying cognitive processes first described by Ericsson & Simon,
(1993) and subsequently expanded by Kuipers et al. (1988), Fonteyn & Fisher (1995), and Fonteyn et al. (1993). As described in the previous chapter, protocol analysis involves four progressive steps: 1) review of transcripts; 2) referring phrase analysis; 3) assertional analysis; and 4) script analysis. However, as analysis progressed it became clear that Verbal Protocol Analysis was not the best approach to answer the research questions. The complexity of the concepts and their linkages was felt to be better examined through content analysis.

Each transcript was read for an initial impression and a broad meaning of the verbal report. Each transcript was coded into categories using an iterative process to assign category codes. Once all segments fit a category, themes were identified for each phase of data collection (beginning of shift, initial interaction, and end of shift).

The development of the coding scheme was incremental and iterative. The categories were defined from the first transcript; and as each subsequent transcript was analyzed, and new concepts emerge, the new concepts were defined and added to the analysis coding sheet. Data collection ended when no new concepts emerged, in this case, after the tenth nurse participant.

Reliability and Validity

To ensure reliability and validity, the researcher adhered to the rigors of qualitative research identified by Burns and Grove (2001) and Lincoln and Guba (1985). Methodologic rigor includes credibility, applicability, consistency, and relevance.

Scientific rigor was maintained in this study through the following: 1) use of a protocol to guide data collection to ensure consistency; 2) consultation with
investigator(s) experienced in coding verbal data to evaluate accuracy of concepts and assertions; 3) maintenance of an audit trail resulting from use of tape recorder to capture verbal data followed by verbatim transcription of tape recorded data; 4) congruence of the theoretical framework with the procedures and analysis; and 5) consideration of findings from previous studies to guide interpretation of findings.

Limitations of the Study

Generalizability of the study findings are limited by the sample derived from only one nursing unit in one hospital. The inability to prospectively identify patients who develop complications makes it impossible to determine any causal relationship between the nurses' information processing and patient outcome.

Summary

Think aloud and content analysis were used to explore nurses' cognitive work in the activity of surveillance. Participants were asked to think aloud at three points (during report, during and after their initial patient assessment, and at the end of the shift) as they provided care to stroke patients Chapter Four will present the study analysis findings. Discussion of the findings will be presented in Chapter Five.
CHAPTER FOUR

RESULTS

The purpose of this study was to explore the nursing intervention of surveillance from an information processing framework. Think aloud (TA) method and content analysis were used to identify the cues that nurses used to focus care and to capture the expression of the nursing intervention known as surveillance. Data were collected by think aloud in which nurse participants were asked to think aloud as they received report and provided care to patients. The data analysis plan for this study originally called for the use of verbal protocol analysis. Verbal protocol analysis is the analysis method most often used with think aloud data. The goal of verbal protocol analysis is to uncover the cognitive processes individuals use in solving a problem. However, as analysis proceeded, it was determined that content analysis would provide a more appropriate means of analyzing the data.

Content analysis was used to describe nurses' expression of surveillance and to describe the cues nurses used to focus their care of stroke patients. Transcripts of the participants' verbal think aloud were analyzed according to the procedures of content analysis described by Krippendorff (2004). Content analysis, like other qualitative methods of analysis, is iterative and incremental. Content analysis is a research method for making replicable and valid inferences from texts to the contexts of their use (Krippendorff, 2004). In this study, text arose from the transcriptions of participants'
think aloud, an acceptable source of text according to Krippendorff. One benefit of content analysis is that it is context sensitive which permits the investigators “to process textual data that are significant, meaningful, informative, and even representational to others” (Krippendorff, 2004, p. 41). The think aloud data was examined to identify core concepts and themes that answered each research question. Concepts are core ideas that can be summarized from the data (Rubin & Rubin, 2005). Concepts can include nouns, noun phrases, or gerunds. Themes are built up from the concepts and explain why something happened or what something means (Rubin & Rubin, 2005). Concepts and themes were redefined as new concepts and themes were identified. This allowed the investigator to build on new findings as they emerged and ensured that the research questions were fully answered (Rubin & Rubin, 2005).

Demographic Data

Nurse Participants

Thirteen nurses were invited to participate in the study and of these ten nurses met the sample criteria for participation in the study. Two nurses who met the eligibility criteria refused to participate (one for personal reasons; one reported being too new to think clearly). However, one of the nurses that refused to participate later consented and did participate on another day. One nurse withdrew prior to the first data collection point due to a change in assigned workload just as the shift was beginning and before data collection had begun. Demographic data is not available for one participant. The majority of nurses were female (90%). The mean age was 46.1 years with a range of 35-56 years. Participants’ years of nursing experience on the nursing unit of the study ranged from 5.5
to 34 years. None of the participants were certified in a nursing specialty. Additional
demographic characteristics are described in Table 8.

Table 8

Demographic Characteristics of Nurse Participants

<table>
<thead>
<tr>
<th>Basic Nursing Education</th>
<th>Associate Degree in Nursing N=5 (50%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baccalaureate Degree in Nursing N=4 (40%)</td>
</tr>
<tr>
<td>Highest Degree</td>
<td>Associate Degree N=4 (40%)</td>
</tr>
<tr>
<td></td>
<td>Baccalaureate Degree Nursing N=4 (40%)</td>
</tr>
<tr>
<td></td>
<td>Baccalaureate Degree not in nursing N=2 (20%)*</td>
</tr>
<tr>
<td></td>
<td>* 1 had two baccalaureate degrees</td>
</tr>
<tr>
<td>Certified in Specialty</td>
<td>No N=9 (100%)</td>
</tr>
<tr>
<td>Gender</td>
<td>Female N=9 (90%)</td>
</tr>
<tr>
<td></td>
<td>Male N=1 (10%)</td>
</tr>
<tr>
<td>Length of time a nurse</td>
<td>4-35 (mean 14.5 years) * 1 with 16 years as LPN/4 years RN</td>
</tr>
<tr>
<td>Length of time working in hospital</td>
<td>5.9-34 (mean 15.4 years)</td>
</tr>
<tr>
<td>Length of time working on unit</td>
<td>5.5-34 (mean 12.1 years)</td>
</tr>
<tr>
<td>Length of time cared for stroke patients</td>
<td>5.5-34 (mean 13.8 years)</td>
</tr>
</tbody>
</table>

Patient Participants

Seventeen patients were invited to participate in the study. Sixteen stroke patients consented to participate in the study; one patient refused after consulting with family members who were concerned that it 'might be too overwhelming for the patient'. Ten of the consenting patients participated in the study. Patients who consented but did not participate were those for whom the nurse refused to participate (n=1) or withdrew from the study (n=1); a float nurse was subsequently assigned to care for the patient (n=1), or the patient was discharged prior to data collection (n=3). All patient participants were within the first three days of admission for stroke. (mean 2.30 days). The majority of
patient participants were female. However, five males enrolled but did not participate in the study. Demographic characteristics of the patients participating in the study are summarized in Table 9.

Table 9

Demographic Characteristics of Stroke Patients

<table>
<thead>
<tr>
<th>Age</th>
<th>Range 47-84 (mean 72 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male N=4 (40%)</td>
</tr>
<tr>
<td></td>
<td>Female N=6 (60%)</td>
</tr>
<tr>
<td>Days post stroke</td>
<td>Range 1-3 (mean 2.30 days)</td>
</tr>
<tr>
<td></td>
<td>1 N=1 (10%)</td>
</tr>
<tr>
<td></td>
<td>2 N=5 (50%)</td>
</tr>
<tr>
<td></td>
<td>3 N=4 (40%)</td>
</tr>
<tr>
<td>Diagnoses</td>
<td>Stroke-like episode/possible TIA residual r leg weakness</td>
</tr>
<tr>
<td></td>
<td>Multiple recurrent cerebral infarctions Left MCA M1 stenosis</td>
</tr>
<tr>
<td></td>
<td>Right temporal parietal MCA ischemic cerebral infarction</td>
</tr>
<tr>
<td></td>
<td>Bilateral bihemispheric cerebral infarcts 1 day s/p r hip arthroplasty revision</td>
</tr>
<tr>
<td></td>
<td>Left basal ganglia hemorrhage</td>
</tr>
<tr>
<td></td>
<td>Right frontal and parietal ischemic cerebral infarction</td>
</tr>
<tr>
<td></td>
<td>Pure motor right hemispheric ischemic cerebral infarction</td>
</tr>
<tr>
<td></td>
<td>Left thalamocapsular intracerebral hemorrhage</td>
</tr>
<tr>
<td></td>
<td>R MCA branch infarction</td>
</tr>
</tbody>
</table>
Nursing Unit Factors

Data were collected on nine different shifts: two evening (three pm to 11 pm) and seven day shifts (seven am to three pm), over a 60 day period. Several unit factors influenced the conduct of this study. First, the recruitment of nurses across the novice to expert continuum to the study was difficult due to a practice change on the study unit which impacted the number and experience level of nurses eligible to participate in the study. The unit had recently implemented stroke guideline recommendations for cardiac monitoring during the first 24 hours following admission for stroke or stroke-like symptoms. As a result, only nurses who had completed education and competency testing for this monitoring were assigned to stroke patients who are located in a distinct geographical area of the unit. According to the nurse manager, it was the more senior, full time staff who had achieved this status at the time data was collected. As a result, the nurses participating in this study represented expert nurses based on standard definitions of expert nurses being those with five or more years of experience.

Second, two periods of low census occurred during the data collection process in which the unit census dropped to 50% or less than capacity. Consequently, there were fewer eligible stroke patients and nurses on the unit to draw from at those times.

Primary Findings

Research Question One

The first research question was: How is the nursing intervention known as surveillance expressed during nurses’ think aloud in the course of nursing care? Surveillance is defined as purposeful and ongoing acquisition, interpretation, and
synthesis of patient data for clinical decision making" (Dochterman & Bulecheck, 2004, p. 687). In this study surveillance was first expressed at the beginning of shift (change of shift) think aloud as the nurses stated a desire to know what to expect during the first encounter with the client.

- "...a picture of when I go in the room, of what he’s going to be like when I get in there.” (1926a)
- "...gives me an idea if I go in right away and I see that she is better or worse so I can get an idea of how she is right away” (3031a)
- "...so I know what to look for and what to take care of”. (2891a)
- "And in looking at the history too is going to tell me how the patient’s going to move.” (1926a)

Participants further went on to describe how this information influenced their thinking about the patient. Participants also used this image to anticipate the plan of care or interventions for the patient.

- “So she has had colon cancer, hypertension which is a stroke thing so she might have had some teaching in the past too; so it’s kind of good to know where they are coming from” (9321a)
- “Looks like he is weak bilateral in his lower extremities so he is going to be harder to get up out of bed so we’re probably going to be using the sling with him”. (1926a)
Participants also expressed surveillance at all three data collection points as a desire to “make sure”. Making sure was often expressed as a plan, goal, and/or intervention. Examples of making sure are:

<table>
<thead>
<tr>
<th>Beginning of Shift</th>
<th>Initial Interaction</th>
<th>End of Shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>“So I would watch throughout my shift to make sure that her mental status hasn’t changed where she starts pulling at things again. You know, that usually happens when the sun sets. So if that were the case I would want to make sure that I got a restraint form up to par.” (3031a)</td>
<td>“I would say that to be observant of his condition and make sure that he is not going to have more spells...keep an eye on him neuro wise and make sure he’s stable.” (2931b)</td>
<td>“I want to make sure they know RN 1-6 is done...make sure that’s as the nursing homes always want to know that stuff.” (2981c)</td>
</tr>
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<td>“...make sure that he is aware he’s got to put his call light on and ask for help.” (2911a)</td>
<td>“I was just making sure, it said Physical and Occupational Therapy was supposed to consult with him and just making sure that they follow through and that gets done to help him.” (1926b)</td>
<td>“My focus would be to continue monitoring her neuros and make sure her saturations stay decent through the night.” (3031a)</td>
</tr>
<tr>
<td>“...then we’ve got to make sure she is okay to go to that TEE with the secretion problems.” (3011a)</td>
<td>“So I’m going to want to just make sure that his neuros don’t change by doing neuro checks every four hours.” (2911b)</td>
<td>“I’ll make sure it (call social worker) gets done before 4, before they leave to see what they know.” (1926a)</td>
</tr>
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</table>

During the initial patient encounter, nurses’ observation and interaction with the patient included questions such as “has it been like that?” “how are you feeling?” and “is it better than yesterday?” The comparative nature of the queries to patients suggested that the nurse was concerned with the patient’s status or movement from a baseline. Nurses were able to think aloud during the initial interaction with the client, but the investigator found limited opportunity to prompt or query the participant about what he or she was...
thinking during the nurse’s interaction with the patient. To ensure the nurses’ thinking was captured as fully as possible, the investigator used an additional prompt immediately after the initial patient interaction. A prompt like “now that you’ve received report and seen the patient, what are you thinking?” was used to elicit this information. Think aloud at this point reflected participant’s evaluation of the patient in relation to their expectations. Examples of this included: “just what I expected from report”; “better than I expected”; and “not at all what I expected...I thought he’d be a lot worse”. Think aloud at the end of shift tended to include the nurse’s overall evaluation of the patient in light of the previously formed mental image of the patient. These evaluations included “...all about the same”; “...improving even throughout the day”; pretty much the same, stable”; “everything is same old, same old”.

The activities of surveillance (Dochterman & Bulecheck, 2004) include monitoring of a number of physiologic parameters. Several participants verbalized a summary evaluation of vital signs in their think aloud as “stable”, “fine”, or “doing ok”. This evaluation of vital signs was generally made as a result of information presented to the participant in the change of shift report. Additional information related to vital signs was verbalized as “a little more hypertensive later in the day”. Only one participant followed up on change of shift report information indicating “blood pressure runs high” by checking the actual values recorded in the medical record (“I’m checking her vital signs to see what they mean by high. (Here it is) BP is 160s to 170s.”) Only one participant discussed other physiologic measures, in this case, oxygen saturation monitoring. However, all ten participants included neurological assessment in their think
aloud and all performed neurological assessments during the initial interaction with the patient. No participant took vital signs during the observation periods.

Three monitoring activities were most common across participants. The first concerned the role of the interdisciplinary team members, especially physical and occupational therapists. Eight participants verbalized multidisciplinary team members’ participation or role in at least one think aloud. The second was identification of patient’s last bowel movement and was verbalized by four of the participants. The third concerned swallowing ability which was verbalized by five participants. This was often first expressed during the beginning of shift think aloud as information that was unknown but needed, again during the initial interaction, often by asking the patient or stating need to find out, and finally, at the end of shift when it was typical for the nurse to describe having gained the required information and reported the assessment intervention and outcome. For example:

“She was complaining of feeling nauseous. We went back and looked to see the last time that she had a bowel movement and it had been three days. We went ahead and gave her a suppository and she had good results with that. She is still complaining of being kind of crampy, but I would expect that that would continue for a little bit.”

The participant went on later to describe the thinking behind the intervention:

“When I did my assessment earlier they (bowel sounds) were active but after kind of having her complain of being nauseous and kind of taking a second look at her tummy it was pretty distended. So we checked, we actually bladder scanned her, to make sure that she was actually emptying out first and that was easy to rule out. She was doing fine with that. So the next step was to see if it was her bowels. If it is not her bowels, then you kind of have to think of, you know, is she coming down with a bug or is it something in the brain center that controls that that might be a little messed up because of the stroke.”

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The nurses' collaboration with members of the interdisciplinary team was evident in questions asked at the beginning of shift and carried out through the course of care. For example:

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<th>End of Shift</th>
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<tr>
<td>So she just got admitted on (date). And then I think she came from the ICU yesterday, so today would be a good day for—so we’ll just make sure that PT if they have a consult put in for rehab.</td>
<td>I would like to see if they had Physical Therapy come in so what they kind of do a quick assessment to see if there is anything that they can help her with her leg.... get something going with that.</td>
<td>Therapy has been in to see her both...well, I know for sure physical therapy was in, so they will be working with her leg, giving her exercises for that.</td>
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The focus on swallowing problems was similarly evident across all three data collection points. Cues related to swallow were report information stating the patient had dysphagia, diet order, or lack of comment on swallowing problems. Potential problems that were identified were often linked with an intervention; in this case, ensuring emergency equipment (suction) was available. Examples include:

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<tr>
<td>“Because it looks like she is eating, and it doesn’t say anything about like pocketing on the left or …but always make sure there is suction in the room, especially if it has affected the whole side”</td>
<td>“This morning our concerns were how her eating was and her bowel care, home going plans for her and all those have kind of taken care of themselves. She is eating fine.”</td>
<td>“She doesn’t have suction set up. We will have to do that, make sure ok.”</td>
</tr>
<tr>
<td>“She’s got a swallow eval so I would assume there is some impairment with that. So I would make sure that when I go in the room that there is suction in the room. You know, make sure that if there isn’t to get that setup in there...”</td>
<td></td>
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</tbody>
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"It looks like he is on a general diet so we don’t have to worry about nutrition as much because he is probably swallowing ok.”

The comprehensive nature of assessment is evident in the broad focus of these nurses’ assessment. Two of the ten participants used the observation of a stain or wet spot on the patient’s hospital gown as impetus for investigation. In addition, two others used observation of bruising and/or bandages on the patient’s arm as a trigger for further evaluation. This is demonstrated in the following example of one nurse’s think aloud (the patient was unable to speak) and subsequent explanation of thinking:

Now, what have we got here? Are you draining something? Did you dribble? What is this wet spot? From earlier? Is that incision draining at all?

I knew she had that incision there, so then I was worried when I saw that spot there, thinking it was draining, but it’s just an old incision and it’s dry and intact, so…

Surveillance as an intervention to prevent complications is evident in the transcripts of think aloud from these neuroscience nurses. However, identification of a potential problem was coupled with plans, interventions and rationale for the plan. In addition, these nurse participants often linked cues during their reasoning about a particular problem. The following example demonstrates the reasoning process used by one nurse to form a picture of the patient, identify a problem, make a plan, set goals for the patient and subsequently make a judgment about the patient’s progress toward the goals.
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<th><strong>Beginning of shift</strong></th>
<th><strong>Initial interaction</strong></th>
<th><strong>End of shift</strong></th>
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<tr>
<td>So the first thing that I like to find out when I’m taking care of a stroke patient is how, they move, what are their neuro deficits. So he came in with some incoordination, some word finding difficulties, and right gaze otherwise his neuros are good. So he is moving everything he’s just got that left field cut. So, incoordination I want to think about mobility. He has to be up with one if he’s alert and oriented. I’m gonna want to make sure that if he is awake that he is aware he’s got to put his call light on and ask for help.</td>
<td>I don’t notice any (unilateral) neglect. Maybe he had that initially. Right, he had that initially, but that’s resolved. I don’t notice any word finding difficulties. He seems to be communicating ok. He’s not confused, so I trust him in the chair. He’s got his call light right next to him. I still would want him to use the call light because even though all of his neuros are good, he still could be unsteady. So I think what I would normally do instead of trusting him totally to use the call light, I would definitely check on him a little more frequently then I would had I had more experience with him, or had taken care of him yesterday. At least for the morning, until I kind of knew him a lot better I would check on him at least every half hour. Just kind of close observation. Sometimes stroke patient’s can be alert and oriented, but forgetful or independent; and a lot of times, no offense, but men seem to be more independent than woman. Oh, I’m fine, I can get up, I can do it myself. After the morning I’ll be able to assess better whether he is fine to be up by himself at home and left alone, He seems to be okay now, but I still would want to wait for that until I know him a little better to say okay, good to go.</td>
<td>He still has a little weakness on his left side, but he doesn’t have (unilateral) neglect anymore, and he is communicating well. No word finding difficulties. He has used his call light appropriately, and he ambulates well. So, as far as discharge plan goes, when we are ready to let him go I think he can go home with his wife and still be safe. PT and OT will do the final evaluation, but, um, from a nursing standpoint I’m not too worried about it.</td>
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In summary, the answer to research question one (How is the nursing intervention known as surveillance expressed during nurses’ think aloud in the course of nursing care?) is that nurses used information gained first from change of shift data to form a mental representation of what the patient would look like. Subsequently, the nurses assessed and monitored the patient using this mental image as a baseline. Finally, the nurses evaluated the patient’s state in relation to the initial expectations. This evaluation involved comparison of patient status with the nurse’s expectation for the particular patient. These expectations were formed during change of shift report and/or the nurses’ experience with the patient.

Research Question Two

The second research question was: how do the data (cues) identified by the nurse influence the nurse’s decision about the focus of care for a stroke patient? The procedures of content analysis (Krippendorff, 2004) were used to answer this question. First, audiotapes were transcribed verbatim by professional medical transcriptionists. Then, each transcript was compared to the audiotape to ensure accuracy of transcription. Once the transcripts were judged complete, each transcript was read in its entirety to gain an overall impression of the data. Field notes regarding the initial impressions were made and were used to guide interpretation in later analysis stages.

The context units for analysis, that is the information to be considered in the description, (Krippendorff, 2004) were the segments of each participant’s think aloud. Ericsson and Simon (1993) suggest that a segment is generally equivalent to a sentence, but should be large enough to convey the thought. This principle was followed in the
procedures used to identify segments in this study. Examples of segments identified in this study are presented in Table 10.

Table 10

Examples of Segments Identified in Referring Phrase Analysis

<table>
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<th>Beginning of Shift</th>
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<tbody>
<tr>
<td>It looks like he is on a general diet so we don’t have to worry about nutrition as much because he is probably swallowing ok.</td>
<td>Well, how about I check and see if there is anything the doctor’s ordered for pain and we, we kind of at least try to alleviate that.</td>
<td>His pain. His pain resolved with the Tylenol. So we were able to control his pain with Tylenol</td>
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Each segment was coded into categories using an iterative process to assign category codes. Once all segments fit a category, themes were identified for each phase of data collection (beginning of shift, initial interaction, and end of shift).

**Beginning of Shift**

Think aloud at the beginning of shift occurred as the nurse participant received change of shift report. On this unit change of shift report was in a written form communicated via a nurse to nurse communication section of the electronic medical record. Verbal updates were then received from the off going nurse if desired by the nurse participant. Themes identified during the beginning of shift think aloud were “creating a vision”, “looking ahead” and “seeking information”. Subcategories supporting the theme will be discussed in the following sections.

**Creating a vision**

During think aloud at the beginning of the shift participants expressed receiving report as creating a vision of the patient. Categories identified during this time include
understanding the past, forming an impression, looking ahead, anticipating discharge, and seeking information.

Creating a vision: Understanding the past

Understanding the past involved description of the patient’s past history. Past history included not only information gained from the medical record, but also from the nurses knowledge of the patient if he/she had cared for the patient on a previous shift.

Examples of understanding the past include:

- “Patient usually sits in the chair all day at home” (3031a)
- “She also has a significant history and if I remember correctly, she was a patient who was not taking her medications at home.” (2901a)
- “History of constipation” (2911a)
- “So she has had colon cancer, hypertension which is a big stroke thing so she might have had some teaching in the past too; so it’s kind of good to know where they are coming from” (9321a)

Observation of participants’ while they received change of shift report revealed that some history was simply read and noted, while as depicted in the following example, some history items were viewed in light of the patient’s present condition.

- “I’m just looking at the patient’s history and admitting diagnosis. A big list. There is some surgical stuff too that he has had. I’ve never heard of that—Worthin tumor. And in looking at the history too is going to tell me how the patient’s going to move. He’s got some knee problems and Lewy Body, and he is also diabetic. So kind of looking at that is going to tell me that too.” (1926a)

Creating a vision: Forming an impression

Forming an impression involved describing the patient’s current state as well as making a judgment about the patient. Describing the current state generally was gained from reading the previous nurses’ description of the patient. In some cases, describing the
current state reflected nursing interventions, and in others, represented problems the patient had. Examples of describing the current state include:

- “She has aphasia and problems with oral secretions. She is NPO for a TEE.” (3011a)
- “I’m checking the skin. She has open areas on her coccyx. Open areas sacrum.” (2891a)
- “He has a little bit of tingling in his fingers. He is standby assist.” (1292a)
- “And he is a DNR so that is good to know. He’s on isolation.” (1926a)

Forming an impression was often a conclusion reached near the end of the beginning of shift think aloud. The impressions formed were often comparisons between the patient under consideration and the nurse’s expectation resulting from knowledge of stroke patients. Nurses also expressed the need to have ‘a picture’ of the patient in order to evaluate the patient during the initial interaction.

- “She sounds kind of like a typical stroke.” (3031a)
- “I don’t know. He seems very stable for a stroke patient. It is pretty much what I’m thinking of him right now.” (1292a)
- “So I know what to look for and what to take care of”. (2891a)
- “…a picture of when I go into the room of what he’s going to be like when I get in there” (1926a)

**Looking Ahead**

Looking ahead includes nurses’ description of plans and potential problems identified by nurse participants. In addition, anticipation of discharge emerged as a particular focus of nurses’ anticipation of needs.

*Looking ahead: Making a plan*

Making plans consisted of both the nurse’s anticipation of the patient’s needs and the nurses’ concerns and plans for the shift. Plans included not only nursing interventions
to be carried out but also timelines for providing care. Data from the change of shift
report often served as the cue or rationale for an anticipated action.

- “I might do a rectal check to make sure she doesn’t have, she is not impacted. Maybe that was what the diarrhea was all about.” (2891a)
- “One of the things he’s got hypertension and he’s got some cardiac history so watching his pressures and stuff like that. And he came in with stroke so doing neuro checks.” (1926a)
- “I am just making sure things have been done throughout the day so I have looked to see when I, how soon, I need to get in to do vital signs or neuro checks.” (3031a)
- “Then we’ve got to make sure she is ok to that TEE with the secretion problems. That would be my biggest concern, that she’d be on a cart, got to a test, and have no suction.” (3011a).
- “I’m going to call the secretary and see what she’s down as. I’m going to see what her meals are ordered as. If they’ll send them up automatically when the family is not here.” (3081a)
- “She probably already has duoderm on this so I just need to make sure that the Duoderm’s intact.” (1891a)
- “So she just got admitted on the (date) and then I think she came here from the ICU yesterday so today would be a good day for—so we’ll just make sure that PT if they have a consult put in for rehab.” (9321a)
- “Because it looks like she is eating and it doesn’t say anything about like pocketing on the left or...but always make sure there is suction in the room, especially if it has affected one whole side and we will look to see if she has any facial droop or anything like that.” (9321a)
- “So I would make sure that when I go in the room that there is suction in the room. You know, make sure that if there isn’t to get that set up in there.” (3031a)

Looking ahead: Anticipating discharge

Anticipating discharge was evident in the beginning of shift think aloud of six of the ten participants. Anticipation of discharge ranged from uncertainty about discharge plans to preparation for planned discharge.

- “Her son and daughter...so I’ll probably see them again this morning. I’m not sure what her discharge plans are yet.” (2901a)
- “Hopefully she can go back to assisted living versus a nursing home.” (3031a)
• “Looks like they’re from (state) and our social worker has already seen her.” (9321a)

Seeking information

Seeking information was a theme unique to the beginning of the shift and arose as a consequence of missing data in the change of shift report. Queries involved both requests for information from the medical record, requests made directly to the off going nurse, and information the nurse intended to gather through care of the patient. Predominant foci of the information sought were functional status/ability data, in particular concerning mobility, self care, and ability to eat/swallow.

• “All of this stuff with she, and now I’m wondering if, was this patient a hip before they stroked and yet nothing yet in this history so I’m going to check clinical notes to see if I can find out why we’re talking so much about the left leg and hip.” (2891a)
• “I have to go back. It’s not been updated so I don’t know how her night went.” (2901a)
• “…and so history of constipation. So we want to see when his last bowel movement was because they don’t have that written down here.” (2911a)
• “So it would be…it’s always a good idea to see if they are right handed or left handed and see how much assistance they are going to need like with feeding.” (9321a)
• “She gets up with a sling so you should ask the night nurse if she knows how they have been sitting; if she has been sitting like in a geri-chair or does she lean one way or is she safe to be up by herself.” (9321a)

Initial Interaction

The themes identified in the think aloud identified during the nurse’s initial interaction with the patient were creating a vision and looking ahead. Creating a vision involved observing the patient and forming an impression. Observing the patient included not only systematic and focused assessments of the patient but also general visual observation of the patient. While the nurses participating in this study were reticent
to describe this time frame as initial assessment, all participants nonetheless performed at least a focused neurological assessment in this initial interaction with the client. Assessment also included systematic assessment of pain, heart, lungs, abdomen, and/or skin.

*Creating a vision*

Creating a vision of the patient occurred through observation of the patient and then forming an impression about the patient.

*Creating a vision: Observing the patient*

Observation or assessment of the patient was evident in the think aloud of all ten participants. All ten participants performed a neurological assessment during the initial interaction. Additional individualized focused assessments were evident during the think aloud during the initial interaction. Overall well being, in the form of "how are you?" was often the initial question addressed to the patient. Assessment of comfort or pain took the form of "are you comfortable?"; "do you have any pain?" or "on a scale of one to ten how would you rate that pain?". In addition to the focused neurological assessment, assessment of heart, lungs, abdomen and skin was also performed by a small number of participants.

Five of the ten participants identified unexpected findings through the use of visual observation of the patient. In two cases a wet spot on the patient's hospital gown prompted an investigation into the source of the wetness; in two more cases, inspection of a dressing initiated further examination; and in one case, examination of an extremity for
another purpose emitted a response of surprise by the nurse. Examples of think aloud about these cues are:

- “Now what have we got here? Are you draining something? Did you dribble? What is this wet spot?...It looks dry in there...I knew she had that incision there, so then I was worried when I saw that spot there thinking it was draining, but it’s just an old incision and its dry and intact.” (3081b)
- “Is that an old one (removing a bandage)? I was looking at that. Did they draw some blood there? Or was that, must have been or maybe it was from an old IV” (2901b)
- “I saw it on her gown and I didn’t know” (3011a)
- “Oh my (looking at bruises on left arm)! When was this? Has this grown since you’ve been down here? I wonder when that was marked. It doesn’t have a date on it. Does it hurt?” (9321b)
- “Oh! Has that (looking at IV dressing) been looking like that for awhile?” (3031b)

*Creating a vision: Forming an impression*

During the initial interaction nurse participants not only described the patient based on assessment, but also formed an impression of the patient’s status. Content constituting the category forming an impression included validation of expectations and making a conclusion. Participants used data from their assessment in addition to the change of shift report data to form an impression about the patient’s status. Participants used evidence from their assessments to describe their impressions and justify actions. When the nurse had cared for the patient on a prior shift, the evidence used to form the impression often included comparison not to change of shift report data but rather to their knowledge of the patient. When the nurses were not familiar with the patient, they expressed a desire to know more about the patient before making a decision about care.

- “Otherwise, as far as the picture of what it said on report kind of fits who I saw” (3031b)
• “She doesn’t really have the secretion problems they described in report” (3011b)
• “...they said you had some swelling. Oh, it actually doesn’t look too bad. I thought it would be a lot worse.” (2981b)
• “I’m thinking she definitely feels a little more clear and feels better than what she did yesterday.” (2901b)
• “He’s not confused so I trust him in the chair. He’s got his call light next to him. I still would like him to use the call light because even though all of his neuros are good he still could be unsteady. So I think what I would normally do instead of trusting him totally to use the call light I would definitely check on him a little more frequently than I would had I had more experience with him or had taken care of him yesterday” (2911b)
• He seems to be ok now but I still would want to wait for that until I know him a little better to say okay, good to go.” (2911b)
• “And she moves really well. She just needed real minor assist to the bathroom.” (3011b)
• “She knows what she wants to say but it’s just not coming out. I can tell that you’re alert and oriented though.”
• “She seems a little more upbeat, maybe not as tired as she was yesterday.”
• “It sounds like she is feeling well and improving but I think how she gets up and sitting in a chair...” (9321b)
• “So last night when we gave you that (did it help)? (2931b)

**Looking ahead**

As in the beginning of shift think aloud, nurse participants anticipated and planned for patient needs. Again, anticipation of discharge was a common focus of nurses’ looking ahead to patient’s needs. Thus, the theme looking ahead included the categories making a plan and anticipating discharge.

**Looking ahead: Making a plan**

Much of the content of the think aloud during the nurse participant’s initial interaction with the client was focused on explaining various aspects of care, including the nurse’s plan. Interestingly, the think aloud about all six patients cared for on the day shift who were permitted to eat included communication about breakfast.
• "All right, we’re going to find out, one, if you have any tests so you can eat. Two, we’re going to see if you can have anything for pain ‘cause his shoulder hurts and his back hurts and three, we’re going to get you cleaned up. If you can eat we’ll get you cleaned up after breakfast, shave, shower, and if you can’t eat then maybe we’ll do it sooner” (2911b)

• “We were thinking maybe, would you like to get up in the chair for breakfast?” You can order your breakfast and then we’ll get you up to the chair because it usually takes a little while before breakfast actually gets here. (9321b)

• “Maybe yesterday was just from being up and about more and going for that MRI maybe started it all….but the doctor did say, you know, you could feel a bit different from what’s going on in your head. He said you could yes. I mean you shouldn’t feel exactly perfect. I mean you had some blood up there and you could feel a little different than normal.” (2911b)

• “Your next scheduled pain medicine is at suppertime. It’s Tylenol but if you need something before, you let me know.” (2981b)

• “Now we are going to get you out of bed.”

• “Well, we need to make sure that you are swallowing ok before we let you eat.” (3031b)

• “You’re probably going to have therapy over at the nursing home, ‘cause I was thinking I could probably start getting you up but I can’t with your hip. I can’t use my sling to get you up and usually Physical Therapy gets you up first because you have been in bed for quite a few days you might be significantly weak.” (2981b)

Planning was also evident in nurses think aloud when considering the patient at the completion of the initial interaction. Again, because nurse participants were focused on interacting with the patient, think aloud did not always reflect their thinking about the patient, so participants were asked a questions like “now that you’ve received report and met your patient, what are you thinking about?” Responses often included plans for the remainder of the shift. Consistent foci of these plans were nutrition, bowels, and getting up. Getting up or mobility was often considered in the context of care provided by other health care disciplines, particularly Occupational Therapy (OT) and Physical Therapy (PT).
• “It said physical therapy and occupational therapy was supposed to consult with him and just making sure they follow through and that gets done today to help him.” (1926b)

• “I can see how well she does sitting up then I can talk to social services.” (9321b)

• “So we’ll run the tube feedings and then they’ll probably write some new orders the way it sounds.” (3011b)

• “Make sure that we probably get some things in the room as far as her skin folds, get the suction set up in there.” (3031b)

• “So far his care would be just, I don’t know, to get him up and redoing the things he was doing because who knows how long he’s just been lying here not using his muscles.” (1292b)

• “Oh, oh, we, you know I never asked her about her bowels. That’s what I needed to do. It just occurred to me now so maybe I want to talk to her about that. But even if I did do that with the bowels, I’d rather do it after supper because eating is going to stimulate peristalsis. So I think the two in conjunction with one another would work best, and that’s a better time just to do it.” (2981b)

• “He’ll have to use the call light for me a couple times and then I’ll just have to watch him walk.” (2911b)

Looking ahead: Anticipating discharge

The theme anticipating discharge continued from the beginning of the shift into the initial interaction with the patient. Interestingly, during the initial interaction the cues related to discharge planning were often related to family in contrast to the uncertainty about discharge described in the beginning of shift think aloud. In particular, family availability (proximity) emerged as a key cue at this stage of care.

• “I’m also thinking about family. I’m thinking about dismissal as well. Are there any problems or issues that they can foresee?” (2911b)

• “Are you from the area? O.k. family is from here too then? ...I’m thinking he is safe to go home because he is improving. I’m not sure if he lives by himself or with who else. I’ll have to check into that too.” (1292b)

• “I think she lives around here...I’ll start thinking about her discharge planning, what we could do for her” (2901b)

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End of Shift

The end of shift think aloud occurred sixty to ninety minutes prior to the end of the eight hour shift. Think aloud at this time was more focused and brief. Themes identified at this time include creating a vision and looking ahead.

Creating a vision

At this stage creating a vision resulted from looking back over the shift and describing events and information gained. Forming an impression continued in the end of shift think aloud and supported the creation of a vision.

Creating a vision: Looking back

Looking back included review of patient care activities as well as information gained during the course of patient care. Exemplars of looking back include:

- “I guess her bowels. When I did my assessment earlier they were active but after kind of having her complain of being nauseous and kind of taking a second look at her tummy it was pretty distended. So we checked. We actually bladder scanned her to make sure that she was emptying out first and that was easy to rule out. She was doing fine. So the next step was to see if it was her bowels.” (3031c)
- “Really didn’t do well with pills whole. I ended up crushing the evening ones because it was sort of a ten minute affair giving her medications.” (2981c)
- “… also checked on his isolation and we got to take him off that. Actually he could have been off of that when he came in if we would have checked.” (1926c)

Making an impression

Making an impression represents nurses’ summarizing of the patient’s status in relation to their expectations. In particular, comparison with the impression formed at the beginning of the shift was evident.

- “So she is doing well with that. I think everything is same old, same old.” (3031c)
As in think aloud at the beginning of the shift and during the initial interaction with the patient, looking ahead was a prominent activity. As at beginning of shift and initial interaction, looking ahead concerned nurses' identification of the patient's ongoing needs. Nurses also expressed their plans and/or goals related to care. Finally, anticipating discharge continued to emerge as a key consideration in the think aloud of these nurse participants. Thus, looking ahead includes communicating needs, making a plan, and anticipating discharge are the categories supporting the theme looking ahead.

Looking ahead: Making a plan

Making a plan was expressed in nurses' think aloud as they considered what the focus of care would be from this point onward.

- "I would say that to be observant of his condition and make sure that he is not going to still have more spells, more TIAs or whatever it is that he's having and just keep an eye on him neuro-wise and make sure he's stable." (293lc)
• “And then she did make a comment about why this happened. You know one day you go from being fine and then here you are helpless, and she said ‘I wish they’d figure out why this happened’. So she needs teaching because we do know why this happens and we are starting her on some new medications so tomorrow, if I have her tomorrow, we will do some stroke education.” (9321c)

**Looking ahead: Anticipating discharge**

As in the think aloud from the beginning of shift and the initial patient interaction, anticipating discharge was a focus of nurses’ think aloud. In most cases, the think aloud related to discharge planning was focused on an impending discharge plans and care (including communication of care needs) related to discharge. In three cases, discharge plans were determined during the course of the shift observed. In one case, the participant was aware at the beginning of the shift that discharge would occur on the following day.

• “...has been okayed by safety and teaching (OT and PT) was in there so she’s safe to go home and she will be leaving this afternoon.” (2901c)
• “And social worker has been working with her and she’ll probably be dismissed on Tuesday of next week.” (9321c)
• “I found out he could possibly go out yet today and so I had to do RN 1-6 because that wasn’t started. Back to the nursing home but I heard it was just a possibility and I haven’t had time to talk to social workers, so, I don’t think it is going to happen now today since it’s after two p.m., but probably in the morning...PT and OT were both notified so their notes are getting up to date in the dismissal summary.

In cases when the discharge plan was not clear, the nurses gave their opinion regarding discharge planning but in those instances deferred further decision making about discharge disposition to occupational and physical therapy providers.

• “So, as far as discharge plan goes, when we are ready to let him go I think he can go home with his wife and still be safe. PT and OT will do the final evaluation but from a nursing standpoint I’m not too worried about it.” (2911c).
• “And in my own mind I think it would be nice if Rehab could take her, I think she’d get good rehab here. But they’re going to have to be the ones to decide that.” (3011c).

Looking ahead: Communicating needs

While think aloud at the beginning of the shift included information the nurse desired but was not available, at the end of shift as nurses’ thinking represented the desire for communication of patient needs to the next caregiver. Because the think aloud occurred near the end of the shift but separate from change of shift report, the nurse participants often framed these thoughts in terms of what they intended to communicate to the oncoming shift.

• “…and let them know that she is refusing Tylenol and that Ultram seems to be adequate for controlling her pain.” (2891c)
• “Now what I am probably going to report off to people is that she seems to be, her saturations are dropping as the evening goes on. Now whether that is a lot of times normal for older people that get tired and are ready to sleep…so I will have them monitor that.” (3031c)

Summary

Findings of ten nurse participants’ think aloud at three different times (beginning of shift, initial interaction, and end of shift) as they provided care to stroke patients suggest that the cues gained from change of shift report, observation of the patient, and provision of care to the patient were used to create a mental image of the patient that was used to form an impression of the patient’s status. This impression was derived in large part through comparison of patient data derived from observation (assessment) throughout the shift with the mental image of the patient generated at the beginning of the shift. There is evidence suggesting that the mental image was revised as additional data was gained. This allowed the nurses to look ahead and make plans for patient care.
Looking ahead included plans to acquire missing data, carry out nursing interventions, and plan for eventual discharge. The cognitive processes varied by time in the shift. These differences are summarized in Table 11.

Table 11
Comparison of Cognitive Activities Across Shift

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<td>Observing the patient</td>
<td>Looking back</td>
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<td>Looking ahead</td>
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<td>Seeking information</td>
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<td>Communicating needs</td>
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These findings will be further discussed in the following chapter. Limitations of the study and direction for further research will also be presented.
CHAPTER FIVE
DISCUSSION

Introduction

The purpose of this study was to explore the nursing intervention of surveillance from an information processing framework. Nurses caring for stroke patients were asked to think aloud at three points during the delivery of care in order to answer the research questions:

1. How is the nursing intervention known as surveillance expressed during nurses’ think aloud in the course of nursing care?
2. How do the data (cues) identified by the nurse influence the nurse’s decision about the focus of care for a stroke patient?

This chapter will discuss the research findings presented in the previous chapter. Implications of the study findings for nursing practice, education, and research will be presented. Limitations of the current study and opportunities for ongoing study and future research will be presented.

Research Question One

The first research question asked how surveillance was expressed by nurses taking care of stroke patients. Surveillance is a nursing intervention defined as “purposeful and ongoing acquisition, interpretation, and synthesis of patient data for clinical decision making” (Dochterman & Bulecheck, 2004, p. 687). The goal of surveillance is early identification, and as a result, prevention of potential complications or problems. Previous research (Titler, 1992) led to the definition of ten surveillance...
interventions and their associated nursing activities. These interventions are: invasive hemodynamic monitoring; ICP (intracranial pressure monitoring); neurologic monitoring; shock prevention; vital signs monitoring; fluid monitoring; surveillance; electrolyte monitoring; risk identification; and acid base monitoring. Nurse participants in this study consistently performed a neurological assessment at the beginning of the shift and related the need to monitor neurological status in order to easily identify changes in patient status. Other physiologic measures were either not available to nurses in this study because they were not working on a critical care unit (e.g. invasive hemodynamic monitoring and ICP monitoring) or were not expressed by nurses in the course of caregiving (e.g. acid-base monitoring, shock prevention, electrolyte monitoring).

The nurses in this study did, however, express their use of the activities associated with the intervention label surveillance. These activities include, but are not limited to monitoring of elimination patterns; monitoring neurologic status; monitoring nutritional status; skin surveillance; interpretation of laboratory data; and monitoring patient's ability to do self care activities. Participants also carried out the surveillance activities described under the intervention label risk identification (Titler, 1992). Activities expressed by participants include, but are not limited to, identifying patients with continuing care needs and determining past and current levels of functioning.

The cognitive component of surveillance has been described as "studying, interpreting, analyzing, and evaluating data to indicate a range of possibilities and to isolate those factors influencing a situation" (Dougherty, 1999; Schoneman, 2002). It was the patient's fit with the mental image generated by the nurse during the handoff
(shift report) at the beginning of the shift that informed the nurses’ surveillance activities, in particular the cognitive component of surveillance. The prominent cognitive activity of the ten nurse participants in this study was the evaluation of patient status in relation to the nurse’s expectations. These expectations were gained through both the nurse’s knowledge of stroke patients and knowledge of the individual patient. Nurses in this study formed and used a mental image of the patient which was revised as care continued throughout the shift.

The generation and use of the mental image to guide decision making is consistent with the information processing theory as it represents definition of the problem space. That is, scope and boundaries of the problem to be solved. In this case, the problem was conceptualized as the focus of nursing care. Nurses’ formation of the mental image of the patient helped them to identify areas in which further information was required in order to solve the problem.

Nurses’ creation of a mental image of the patient in this study is consistent with the concept of schema as a structure for organizing data (Marshall, 1995). Marshall identifies four types of knowledge used by individuals. One of the knowledge types described by Marshall is elaboration knowledge which includes specific examples of one’s experience in addition to more global abstractions from a number of experiences. The key characteristic of elaboration knowledge is that it enables a person to create a mental model of the problem. This creation of a mental model is similarly evident in Newell and Simon’s (1972) information processing theory. Nurses in this study created
mental images or models of the patient from change of shift report and through ongoing
assessment of the patient.

The philosophical foundations of Schema theory arise from Plato, Aristotle, and
Kant according to Marshall (1995). The ancient Greeks used schema primarily as a
means to describe objects while Kant advanced the idea that schema reflect an
individual's application of knowledge stored in memory to make sense of experiences or
events (Marshall, 1995). The work of Thomas Kuhn (1995) concerning paradigms is also
salient in discussion of schema. While Kuhn uses paradigms to describe the advancement
of science or scientific revolution, some of his concepts are relevant to an individual's
cognitive processing as well. A paradigm, according to Kuhn, refers to the scientific
achievements acknowledged by a scientific community as the foundation for its practice.
A paradigm is an accepted model or pattern and "what mainly prepares the student for
membership in the particular scientific community in which he will later practice"
(Kuhn, 1995, p. 11). Kuhn notes that in the absence of a paradigm all facts that could
possibly inform a given problem would be viewed as equally relevant. This function of
paradigms is particularly relevant to the findings of this study. First, the secondary
finding that the "assessment" of the patient was viewed as a documentation requirement
rather than an important source of information perhaps reflects the nurses' paradigm or
worldview that there were other more important sources of information on which to focus
care. One function of a paradigm is that it sets the problem to be framed. Again, nurses in
this study used their mental image of the patient to determine the focus of care and to
evaluate the patient in relation to that image. Like the development of schema through
experience, paradigms can be further articulated as more information is gained that adds to the scope and precision of the paradigm and the situations in which the paradigm is applied. Second, with the call for all healthcare providers, including nurses, to reexamine and change the ways in which patient data such as current status is communicated in order to achieve a shared vision of the patient, a paradigm is challenged in order to advance science. According to Kuhn, one function a paradigm serves is exploration of a specific aspect of some idea or activity. Kuhn further asserts that rules arise from paradigms.

Kuhn's (1995) idea of paradigms as the foundation of scientific revolution is inherent in the present exploration of nurses' cognitive work in early identification of problems through activities of surveillance in order to prevent the phenomena known as failure to rescue. Understanding the cues used by nurses to determine the focus of care and identify potential complications is key to what Kuhn describes a scientific revolution. Findings of this study relative to the worldviews and paradigms of the experienced nurses in this study suggest a community perspective that deems change of shift data as a key cue in the development of a mental image of the patient and guides the nurses' expectations in terms of focusing and evaluating care.

Schemata are mental representations that demonstrate links between concepts. Schemata are defined as organized knowledge structures that represent knowledge of a specific concept (Fiske & Taylor, 1984; Walsh, 1995). In this study, nurses developed and accessed schema or paradigms that represented knowledge about the particular patient in the context of experience and knowledge of stroke patients in general. These
schemas provided the knowledge to discriminate between similar and dissimilar data and information and resulted in an evaluation of the patient’s status, for example, “a typical stroke patient” or “pretty good for a stroke patient”. Interestingly, the change of shift report was identified by nurse participants as the means to develop the mental representation or schema for each patient. Nurses described the importance of having a ‘mental picture’ of what the patient would look like in order to know if there was improvement or not. In the cases where the nurse was familiar with the patient from a prior shift, the nurses’ recollection of the patient’s status as opposed to the change of shift information was used to inform the mental picture and subsequent evaluation of the patient’s status. Think aloud and observation data in this study suggest that the nurse’s paradigm led to a clear distinction and valuation of data. The nurses’ preference for data from their own experience with a patient on a prior shift over the data available from change of shift report or the medical record provides evidence for the mental image of the individual patient as the paradigm that guides care decisions.

The most striking finding concerning surveillance is the lack of emphasis on physiologic parameters as indicators of potential complications. Nurses in this study performed focused neurological assessments to inform their impressions of the patient, including whether or not the patient was improving. However, functional status served as a more prominent feature of surveillance. In particular, last bowel movement, mobility, and swallow were key cues nurses in this study used to focus care of their stroke patients.

While neurological assessment was a key activity performed by nurses in this study, mental status changes were surprisingly absent from the cues identified as
important. This could be the result of several factors. First, it is possible that the nurses included mental status changes in their definition of neurological assessment and viewed mental status as a component of the other functional abilities they observed. Second, because only two of the patients in this study had altered mental status in the form of confusion (in one patient dementia was a preexisting condition) mental status change was not present so was not commented on by nurses. Third, it is possible the nurses had incorporated mental status alterations in their vision of the patient and, as a result, mental status change was not a critical cue when planning care. Mental status change as a cue in the care of stroke patients is a topic for further study.

The limited reliance on physiologic monitoring data can potentially result from several factors. First, the patients in this study were cared for on a medical neurology unit and in the first three days of hospital admission following stroke. According to the Clinical Nurse Specialist on the unit, it is possible that these patients had a greater medical stability or were simply not as ill because they did not require or had only a brief critical care unit stay. As a result it is possible the focus of care had shifted away from physiologic monitoring to rehabilitation care. Second, because the interventions known as surveillance were initially developed through consensus of expert critical care nurses, the interventions of surveillance heretofore defined have less relevance to general medical patient populations. This presents an opportunity for further research related to the concept of surveillance as a nursing intervention, particularly in relation to the care of patients in general care units. According to Titler (1992) surveillance as a nursing intervention label is still at an abstract level of concept development. As a result more
types of monitoring interventions are needed to enhance understanding and communication about this phenomenon.

In summary, surveillance, defined as “purposeful and ongoing acquisition, interpretation, and synthesis of patient data for clinical decision making” (Dochterman & Bulecheck, 2004, p. 687) was expressed by nurses caring for stroke patients primarily as a comparison between the nurse’s mental image of the patient and the patient’s observed state. This was informed by ongoing data acquisition during the provision of care to the client. This supports the model proposed in Figure 1. While the surveillance interventions first defined by Titler (1992) are represented primarily by the monitoring of neurological status carried out by the nurses, there is evidence that the Nursing Interventions Classification (NIC) (Dochterman & Bulecheck, 2004) surveillance activities related to monitoring of nutritional status and elimination patterns did occur and then served as key cues in focusing nursing care for these stroke patients.

**Research Question Two**

The second research question asked how cues identified by nurses influenced the focus of their care. Cues were generated from change of shift report, observation of the patient, and reflection on the care provided. An interesting finding was that at change of shift nurses identified many unmet information needs. This could be a reflection of the change of shift being received in written format via the electronic medical record rather than face to face verbal exchange. In addition, the template used to structure change of shift report could influence the nature of the information provided via change of shift report. Observation of the nurses as they received change of shift report suggests that
despite the report being part of the medical record system, nurses seldom looked elsewhere in the medical record for the desired information. Nurses also had the opportunity to gain information through verbal ‘updates’ from the offgoing nurse, yet, oftentimes, these updates referred only to ‘any changes or updates?’ This was especially true if the nurse had cared for the patient during a previous shift.

Nurses’ use of patient observation in the form of assessment resulted in a significant decline in the amount of missing data at both the conclusion of the initial interaction and the end of shift think aloud. The missing data at change of shift and the initial interaction with the patient tended to reflect functional status data such as swallowing ability, mobility, and intervention by other healthcare providers.

Findings of this study related to cue use are consistent with previously reported work about the cognitive processes of clinical judgment. In particular, knowing the patient has been a consistent theme in studies of decision making. Both Ebright et al. (2003) and Thomas and Fothergill-Bourbonnais (2005) found that nurses were concerned with knowing the typical patient, knowing the individual patient, and knowing the practice in which care was delivered. Peden-McAlpine (2000) similarly described the use of universal versus particular knowledge and knowing the patient over time. Findings of this study demonstrated that knowledge about the patient did expand over time as evidenced by the diminished amount of missing information. This is consistent with the representation of data acquisition presented in Figure 1. In this case, it is difficult to determine what information was discarded as irrelevant, but nurses in this study did
identify missing data and by the end of the shift talked aloud about "what we found out" or "now we know...."

Nurses' observation of patients served as important cues in deciding whether or not a problem existed. This was coupled with the nurses' mental image of the patient. This use of cues is also consistent with findings from previous work. Perceptual awareness through the use of the senses served as a key cue for nurses in making the decision whether or not to suction a patient (Thomas & Fothergill-Bourbonnais, 2005). Minick and Harvey (2003) described nurses knowing that something was not as expected in examining nurses' recognition of a problem.

Secondary Findings

Nurses in this study expressed reticence to describe their initial interaction with the patient as the initial assessment. This was especially interesting as all of the participants did perform an assessment of his/her patient at the initial interaction with the patient. This finding could be idiosyncratic to the practice setting. The documentation standards in this setting require documentation of complete physical assessment for patients on general care (not critical care or progressive care) units a minimum of twice a day. Despite the fact that every nurse participant completed at least a neurological assessment, those working day shift described the assessment as "done by the night shift". This suggests that nurses viewed the complete assessment, not as a source of data about the patient, but rather as a task to be completed. The use of focused assessments, including neurological assessment, to gather data about the patient suggests that these experienced nurses assigned different value to particular assessment components.
Implications

Implications for Nursing Practice

Nurses' cognitive work has been identified as a key influence in the early recognition of complications. Handoff of patient care including handoff at change of shift has been described as an important vehicle for the communication of relevant information (Patterson et al., 2004). Costs of miscommunication previously identified include lack of awareness of significant data, ill preparation to manage effects of previous actions, inability to anticipate future events, failure to follow through on plans in progress, or shifts in goals, priorities, and plans (Patterson et al., 2004). In this study these miscommunications were represented as an ill fit between the mental image generated by change of shift report and findings from his/her assessment of the patient. Most notable in this sample was nurses' evaluation of the patient as better than anticipated from report. How this impacted nurses' care is not clear. However, as noted earlier, evaluation of patient status involved comparison of the patient with the mental image. It is possible that cues indicating changing status from a patient who is already better than anticipated may be missed as the nurse has developed a mental image, goals, and plan based on a lower level of function. Thus, if the patient is better than anticipated, has already surpassed the expectations, goals, and plans identified by the nurse following communication of change of shift report.

Change of shift report as a communication vehicle has sparked renewed interest as a factor in maintaining patient safety. This study not only supports the idea that change of shift report is important in communicating patient data but also in providing the
baseline for ongoing evaluation of patient status. Practice implications of this finding include the identification and provision of salient cues into change of shift report in order to help both expert and novice nurses generate an accurate mental image of the patient.

Findings from this study suggest that patient’s problems or conditions, including medical history and neurological status informed the mental image nurses formed of their patients. However, during change of shift report nurses identified information that was missing from the picture. Most often, these missing pieces of information pertained to functional abilities such as how the patient moved, ate, and toileted. In addition, the multidisciplinary character of stroke care emerged. In terms of information exchange, missing information often included queries about the care provided by other healthcare team members, in particular, occupational and physical therapists and social workers. Findings from this study suggest that strengthening communication among the multidisciplinary stroke team could decrease miscommunication, and therefore, errors. Supporting the nurses’ ability to search documentation in order to retrieve information about the plan of care and interventions of other disciplines could also enhance the nurses’ surveillance activities through generation of a more complete mental image of the patient.

The implications for errors in the early recognition of potential complications are inherent in the nurses’ identification of missing information. That nurses did not look for nor use data that was available in the medical record to provide the missing data is concerning. This, coupled with the nurses’ view of the “assessment” as a documentation requirement rather than a source of data, provides opportunities for practice focused on
use of available data. The risk here is that the nurse, relying only on information contained in change of shift report, observed him/herself, or received verbally from another nurse could result in an or inadequate representation of the patient’s state.

Implications for Nursing Education

Surveillance in this small sample focused on comparisons drawn between the nurse’s schema about stroke patients in general with the schema created at change of shift report representing the patient at hand. Findings from this study suggest that educational initiatives, both academic and staff development, aimed at development and use of communication skills to convey an accurate picture of the patient may be helpful. Opportunities for multidisciplinary education concerning this shared vision may are also suggested.

With the expanding use of patient simulators to aid nursing and medical education, it may be possible to educate and support nurses’ and other healthcare providers’ evaluation and communication of patient status. In addition, because knowledge of individual patients in addition to knowledge about the typical patient with a particular disease, diagnosis or problem is a consistent theme in studies of nurse’s decision making, the use of simulators and innovative teaching strategies may allow educators to teach and support the use of individual patient information in decision making. Because simulation based education can enhance multidisciplinary learning, this may be one way to teach and support communication about patient status and plans and goals for ongoing care.
An important factor in maintaining patient safety is the communication during handoffs (Haig et al., 2006; Leonard et al., 2004; Streitenberger et al., 2006). One outcome of effective handoff communication is the creation of a shared mental model of the patient’s condition (Haig et al., 2006; Leonard et al., 2004; Streitenberger et al., 2006). A number of approaches to this have been described. Most recently it has been recognized that a standardized approach to handoff communication that includes an opportunity for the participants to ask and/or respond to questions. One model that has been used is the SBAR model. The SBAR provides a structure for communication that reflects the situation, background, assessment, and recommendation (Haig et al., 2006; Leonard et al., 2004; Streitenberger et al., 2006). Based on findings of nurse to nurse handoff in this study, teaching a standardized format for patient handoff may decrease the amount of missing information, thus contributing to a more accurate mental image of the patient. As noted, formation of a mental image of the patient was a key aspect of the cognitive processes of nurses.

Prior research (Lamond & Farnell, 1998; C. Taylor, 1997) has demonstrated that less experienced nurses have greater difficulty extracting salient cues from change of shift report or other information. Findings of this study suggest that the ability to identify and later communicate such cues is an important aspect in the care of stroke patients. Simulation and clinical experiences that emphasize these abilities may improve nurses’ ability to develop an accurate mental picture of the patient and ultimately improve patient outcomes by allowing the nurse an accurate baseline for surveillance and the ability to focus care.
The skills required to identify and locate required information are also important considerations in the education and orientation of nurses. In this study, nurses were reluctant to use the electronic medical record as a source of information; however, in most instances, the desired information was available in the electronic medical record. This suggests a need for additional emphasis and skill in finding desired information. Another implication related to obtaining desired information is the communication of information once it has been obtained. Because the nurses' handoff at the end of shift was not observed, it is unknown how much of the information “found out” was conveyed to the following nurse via change of shift report. This has impact for the time and cognitive resources used for nurses to continually search for required data or cues.

Implications for Nursing Research

This study demonstrates that the conduct of research using think aloud as a data collection method is feasible in the clinical setting. Patients and their families readily participated in the study. Nurses, similarly, were willing to participate. Nurses who were not study participants did express interest and questions about the study procedures, particularly audio recording. Once assured that only data from consenting nurse participants was of interest, questions about method turned to interest in the study itself.

Methodological implications concern the verbal protocol analysis as a means to uncover the thinking processes of nurses. While verbal protocol analysis is the method most often employed in the analysis of data generated through think aloud, verbal protocol analysis proved ineffective in this study. The most likely reason for this is that verbal protocol analysis has been most often used to analyze data from case studies in
which the participant is solving a problem. In this study, the problem participants were faced with was determining the focus of care for one shift. Because think aloud represented ten unique patients with unique problems, the first stage of verbal protocol analysis resulted in long lists of concepts that were insufficient to capture the context and focus of the nurses’ care. As a result, content analysis was used for analysis in order to better describe the nurses’ information processing. Another difficulty in using verbal protocol analysis as planned concerned the language of the participants. The segments identified in this study compared to those offered in the extant nursing literature using verbal protocol analysis differ. The principle differences are reflected in the language of the participants. Participants in this study, especially at change of shift and initial interaction think aloud did not speak in the more formal sentence structures expressed in prior studies. Instead, they tended to speak in phrases and fragments. Thus, some of the procedures of verbal protocol analysis such as identification of noun phrases were difficult.

Findings from this study lead to new research questions. Examples of questions that could further inform the findings from this study include: What cues aid the nurse in “painting the picture” of what to expect when they begin caring for a patient. What is the information required to help the nurse paint the picture. Additional questions could focus on particular aspects of patient care, for example, discharge planning as the focus of care. Regarding the nursing intervention of surveillance; Is the nursing intervention of surveillance expressed differently in different practice settings (e.g. critical care nurses caring for stroke patients as compared to medical-surgical nurses caring for stroke
patients)? An additional question arising from this study is how the cognitive activities expressed during think aloud while caring for stroke (or other) patients can be mapped to the activities of surveillance. Finally, does the use of a standardized handoff such as SBAR reduce the amount of missing data identified by the healthcare team?

Conclusion

The cognitive work of nurses, as described by the IOM (Committee on the Work Environment for Nurses and Patient Safety Board on Health Care Services, 2004) includes activities related to assessing a patient’s health, monitoring for changes that require nursing intervention(s), and coordinating and providing for an individual patient’s health care needs in collaboration with a variety of health care providers to create a plan of care. These activities reflect the registered nurse’s knowledge work. Data and findings from this study support these cognitive activities. Nurses assessed stroke patient’s health through focused assessment and observation. Creating a vision of the patient laid the foundation for identifying changes in the patient’s status that required nursing intervention. Nurses’ collaboration with health care providers from a variety of disciplines was evident. In particular, social workers and rehabilitation professionals were frequent collaborators in the care of the stroke patients in this study. Findings from this study suggest that nurses are in constant evaluation of a patient’s status by making comparisons between the patient’s observed status with the nurses’ mental image of the patient.
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Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Dear Colleague,

I am a nurse here at Mayo and also a doctoral student at Loyola University Chicago. My dissertation research involves how nurses think about and plan patient care. Specifically, I am interested in nurses’ decision making and planning for the care needs of patients. I invite you to participate in a study of nurses’ decision making and care planning for stroke patients.

If you agree to participate in this study you will be asked to wear a portable audio recorder and think out loud at three points in your care of your patient. The first time will be immediately after receiving report from the previous shift. The second time will be during your initial assessment of the patient. The third and final time will be at the end of the shift. In addition, you will be asked to provide demographic information about yourself.

Your anonymity and confidentiality will be protected in the following ways. The transcripts of the audio tapes will be identified only by a code number—you name will not be used in any way. The audio tapes resulting from the study will be kept in a locked cabinet accessible only to the researcher. If any direct quotes from you are used in presentations or publications to explain the study findings your name will not be given or associated in any with the quote. If a name is required, aliases will be used.

There is no direct benefit to you by participating in the study but your participation may add to our knowledge about nurses’ decision making. Your decision to participate or not to participate is up to you and will have no effect on your current or future employment at Mayo Clinic or your healthcare at Mayo Clinic. You may stop participating in the study at any time by informing the investigator. Thank you for considering participating in this study. If you have any questions you can contact me at [redacted] or my dissertation director, Dr. Ida Androwich, at [redacted]

Sincerely,

Lori M. Rhudy, MS, RN
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<th>Cost per unit</th>
<th>Units</th>
<th>Total Cost</th>
<th>Funding Source</th>
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APPENDIX D:

NARRATIVE CONSENT SCRIPT FOR PATIENT CONSENT
Sample Narrative Consent Script for Patient Consent

We are conducting a study at the Mayo Clinic to assess what information nurses use when taking care of stroke patients. If you agree to participate in this study, you will receive the same care you would receive if you were not in this study. However, at some times while taking care of you, your nurse will talk out loud into a microphone that is connected to a tape recorder. In addition, I will be present to observe your nurse and remind him or her to talk out loud. There is a chance your voice will be recorded too. Anything you say during this study will not have your name or any other information that will identify you. In addition, information from your medical record will be used in the study. You will be asked to sign a release form to allow me to access your medical information.

Taking part in this research study is your decision. You may decide to stop at any time. You should tell the researcher if you decide to stop. We will be conducting this study with 5-25 patients and nurses over the next six months. You do not have to be in this study to receive or continue to receive medical care from Mayo Clinic. This study will not make your health better. While you will not benefit directly from this study, other patients with stroke are expected to benefit in the future. Information you share with us will be kept confidential. You will not be identified in any way. Information you provide will be used by us for improving our educational process and reporting the research results in professional meetings and journals.

You may talk to Ms. Lori Rhudy at any time about any questions or concerns you have on this study. You may contact Ms. Rhudy (or an associate) by calling the Mayo operator at telephone [redacted]. You can get more information about Mayo policies, the conduct of this study, or the rights of research participants from Administrator of the Mayo Foundation Office for Human Research Protection, telephone [redacted].
APPENDIX E: HIPAA AUTHORIZATION
Authorization to Use and Disclose Protected Health Information

<table>
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<td>Surveillance as a nursing intervention in the care of stroke patients: Nurses' information processing</td>
<td>06-002503</td>
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<th>RESEARCHER</th>
<th>PROTOCOL LAST APPROVED BY IRB</th>
<th>THIS FORM APPROVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ms. L. M. Rhudy and colleagues</td>
<td>March 21, 2006</td>
<td>March 21, 2006</td>
</tr>
</tbody>
</table>

Your privacy is important to us, and we want to protect it as much as possible. By signing this form, you authorize Mayo Clinic Rochester and the investigators to use and disclose any information created or collected in the course of your participation in this research protocol. This information might be shared in different places, including your original medical record, but we will only disclose information that is related to this research protocol for the purposes listed below.

This information will be given out for the proper monitoring of the study, checking the accuracy of study data, analyzing the study data, and other purposes necessary for the proper conduct and reporting of this study. If some of the information is reported in published medical journals or scientific discussions, it will be done in a way that does not directly identify you.

This information may be given to other researchers in this study (including those at other institutions), representatives of the company sponsoring the study (including representatives in the U.S. or other countries), or private, state or federal government parties or regulatory authorities (U.S. and other countries) responsible for overseeing this research. These may include the Food and Drug Administration, the Office for Human Research Protections, or other offices within the Department of Health and Human Services, and the Mayo Foundation Office for Human Research Protections or other Mayo groups involved in protecting research subjects.

If this information is given out to anyone outside of Mayo, the information may no longer be protected by federal privacy regulations and may be given out by the person or entity that receives the information. However, Mayo will take steps to help other parties understand the need to keep this information confidential.

This authorization lasts until the end of the study.

You may stop this authorization at any time by writing to the following address:

Mayo Foundation
Office for Human Research Protection
ATTN: Notice of Revocation of Authorization
200 1st Street SW
Rochester, MN 55905

If you stop authorization, Mayo may continue to use your information already collected as part of this study, but will not collect any new information.

If you do not sign this authorization, or later stop authorization, you may not be able to receive study treatment.

I have had an opportunity to have my questions answered. I have been given a copy of this form and understand that a copy will be placed in my medical record.

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<th>Printed Name of Participant</th>
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<th>Signature of Participant</th>
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<th>Printed Name of Representative Signing for Participant (if applicable)</th>
<th>Representative's Relationship to Participant (if applicable)</th>
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<table>
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APPENDIX F:

PATIENT DEMOGRAPHIC DATA
Patient Demographic Data

Clinic Number: ________________________________

Date: ____________________

Date of Admission: ________________________

Age: ______________________

Gender: □ Male □ Female

Diagnosis: ______________________________________

Co morbidities: ____________________________________________
APPENDIX G:

NURSE PARTICIPANT CONSENT NARRATIVE
Nurse Participant Consent Narrative

Good morning. My name is Lori Rhudy. You previously received information about a research study about nurses’ decision making I am conducting. Your patient, Mr./Mrs. _______ has agreed to participate. If you are willing, you will wear a microphone that is connected to a small tape recorder. While you get report, when you first assess this patient, and at the end of your shift I will ask you to say out loud whatever you are saying to yourself. I will accompany and observe you while you think aloud and will remind you to think aloud. At the end of the study you will also complete a form about yourself. Your participation is voluntary; you may choose to stop at any time. Anything you say or do will be kept confidential. The tape and transcript will be identified with only a code. If quotes are used, your name will not be included. Are you willing to participate in the study today?
APPENDIX H: EQUIPMENT SPECIFICATIONS
Sony ICD-P210 Digital Voice Recorder (http://www.sonystyle.com)

Weight: 2.1 oz (60 g) incl. batteries

Dimensions: 1.18" x 4.40" x 0.63" (30.0 x 103.5 x 16mm)

Recording Media --- Flash Memory 32MB

Recording Format --- HQ: 3 Hrs 35 Min; SP: 9 Hrs 40 Min; LP: 15 Hrs 45 Min

Input(s) --- External Mic Jack

Output(s) --- Earphone Mini Jack

Power Requirements --- DC 3V with "AAA" x 2 Battery

Battery Life (Approx.) --- Rec: HQ: 6 Hrs; SP: 15 Hrs; LP: 15 Hrs

Sony ECM-C510 Microphone (http://www.cdwg.com)

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<tr>
<td>Height</td>
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<tr>
<td>Weight</td>
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<tr>
<td>Width</td>
<td>1.6 in</td>
</tr>
<tr>
<td>Connectivity Technology</td>
<td>Wired</td>
</tr>
<tr>
<td>Microphone Form Factor</td>
<td>Lavalier</td>
</tr>
<tr>
<td>Microphone Operation Mode</td>
<td>Omni-directional, Stereo</td>
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<tr>
<td>Microphone Technology</td>
<td>Electret condenser</td>
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<tr>
<td>Noise Level</td>
<td>38 dB</td>
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<tr>
<td>Response Bandwidth</td>
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<tr>
<td>Sensitivity</td>
<td>-40 dB</td>
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APPENDIX I:

PROBES
Probes

Say out loud whatever you are saying to yourself
Keep talking
Say more
Say what you are thinking
Go on
What are you thinking?
Say your thoughts
Think out loud
Tell me more
Is there anything else?
Nurse Participant Demographics

Please answer the following questions about yourself.

1. **What is your Basic Nursing Education?**
   - □ Associate Degree in nursing
   - □ Baccalaureate Degree in nursing
   - □ Diploma
   - □ Other (please describe) __________________

2. **What is your highest degree?**
   - □ Associate Degree
   - □ Diploma
   - □ Baccalaureate Degree (nursing)
   - □ Baccalaureate Degree (not in nursing)
   - □ Masters Degree (nursing)
   - □ Masters Degree (not in nursing)
   - □ Doctorate
   - □ Other (please describe)_______________________

3. **Are you certified in a specialty?**  □ No  □ Yes
   
   If yes, please list certification(s): ______________________________

4. **What is your age?** ________________

5. **What is your race?** ________________

6. **Are you:**  □ female  □ male

7. **How long have you worked on this unit?** ________________

8. **How long have you worked for this hospital?** ________________

9. **How long have you been a nurse?** _________________________

10. **How long have you cared for stroke patients?**

11. **Please list any additional education in the care of stroke patients you have had.**
APPENDIX K:

SUMMARY OF STUDY PROCEDURES
<table>
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<th>Activities</th>
<th>Notes</th>
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<tr>
<td><strong>A. Preliminary Activities</strong></td>
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<tr>
<td>1. Investigator meets with unit leadership (CPF) team</td>
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<tr>
<td>2. Investigator attends team day or staff meeting</td>
<td></td>
</tr>
<tr>
<td>• Explain study</td>
<td></td>
</tr>
<tr>
<td>• Gain informed consent</td>
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<tr>
<td><strong>B. Participant Selection and Recruitment</strong></td>
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<tr>
<td>1. Charge nurse identifies nurses assigned stroke patient(s) and informs investigator</td>
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<tr>
<td>2. Investigator gains patient consent</td>
<td>Verbal consent narrative</td>
</tr>
<tr>
<td>• Document in patient’s medical record</td>
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<tr>
<td>HIPAA Authorization</td>
<td>File in patient’s medical record</td>
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<tr>
<td>3. Investigator verifies nurse’s willingness to participate in study</td>
<td>Use consent narrative</td>
</tr>
<tr>
<td>• Document in study record</td>
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<tr>
<td><strong>C. Data Collection 1 (after change of shift report received)</strong></td>
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<tr>
<td>1. Investigator fits nurse participant with audio device and instructs in use</td>
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<tr>
<td>2. Nurse participant receives report</td>
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<td>3. Investigator prompts nurse to think aloud</td>
<td>Investigator ensures audio recorder functioning</td>
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<td>Field notes: time from report to think aloud</td>
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### D. Data Collection 2 (initial assessment)

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<th>Task Description</th>
<th>Notes</th>
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<tr>
<td>1.</td>
<td>Nurse informs investigator ready to perform initial assessment</td>
<td>Field notes: approximate time from report to initial assessment</td>
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<td>2.</td>
<td>Investigator prompts nurse to think aloud during assessment</td>
<td>Ensure audio recorder functioning</td>
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### E. Data Collection 3 (30-60 minutes prior to end of shift)

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<th>Notes</th>
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<tr>
<td>1.</td>
<td>Investigator prompts participant to think aloud</td>
<td>Offer private location&lt;br&gt;Ensure audio recorder functioning</td>
</tr>
<tr>
<td>2.</td>
<td>Participant completes demographic data</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Investigator thanks participant</td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


VITA

The author, Lori Rhudy, was born in Wells, Minnesota. In 1985 she received a Bachelor of Science in nursing from Winona State University. In 1991 she received a Master of Science in nursing from the University of Wisconsin-Madison with an emphasis in the Clinical Nurse Specialist role. Ms. Rhudy received a Doctor of Philosophy in nursing from Loyola University Chicago in 2007. Ms. Rhudy is certified as an advanced practice nurse and has specialty certification in neuroscience and rehabilitation nursing. Ms. Rhudy has experience as a staff nurse, Clinical Nurse Specialist, Nursing Research Specialist, and Nurse Educator with experience in both clinical and academic settings. Throughout the author’s career, nurses’ decision making has been an important context for practice and education and sparked the desire to further understand this phenomenon.
DISSERTATION APPROVAL SHEET

The dissertation submitted by Lori M. Rhudy has been read and approved by the following committee:

Ida Androwich, Ph.D., R.N., F.A.A.N.
Professor and Director Health Systems Management
Niehoff School of Nursing
Loyola University Chicago

Sheila Haas, Ph.D., R.N., F.A.A.N.
Professor and Dean
Niehoff School of Nursing
Loyola University Chicago

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