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A COGNITIVE TASK ANALYSIS OF NICU NURSES' PATIENT ASSESSMENT SKILLS

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A study is presented utilizing cognitive task analysis (CTA) methods to elicit knowledge from Neonatal Intensive Care Unit (NICU) nurses regarding the assessment of infants at risk for Necrotizing Enterocolitis (NEC). Researchers were successful in eliciting knowledge not available in current nursing texts. Knowledge elicited includes a framework for considering NEC and problem-solving strategies used by experienced nurses. Implications for nurse instruction and potential applications of this information for decision support are discussed.

INTRODUCTION

Necrotizing Enterocolitis (NEC) is one of many life-threatening disorders prevalent among low birth weight infants. This disease is characterized by an infection of the bowel which results in the necrosis of a portion of the bowel often leading to perforation. The incidence of NEC in the United States ranges from 1 to 3 cases per 1000 live births and 1 - 7.7% of neonatal intensive care unit (NICU) admissions. The mortality rate has been calculated at 13.1 deaths per 100,000 live births or 20 - 40% of all cases (Kosloske, 1994). In the case of NEC, early detection is critical to infant survival. The early signs, however, may be very subtle and easily mistaken for an underdeveloped digestive system, or missed altogether. The nurse must be vigilant for subtle changes in the infant's condition, alert to cues which may have little significance occurring in isolation but suggest potential problems when occurring together, and know what to expect if NEC is in fact developing.

Unfortunately, many of the skills needed to distinguish the early signs of NEC are only available as passed from one health care provider to another, or learned via experience. NEC is a mysterious disease in that there are a number of

different ways in which it may present. Expert nurses are aware that any of a number of seemingly small changes in an infant's condition may indicate the beginnings of NEC. The difficulty is that all of these early signs are likely to appear at some point during an infant's stay in the NICU. Experienced nurses develop problem-solving strategies and critical thinking skills which allow them to recognize the significance of subtle cues and track them over time, noting clusters and patterns which may emerge.

The instructional nursing literature does little to guide new nurses in developing these critical thinking skills. In order to begin to recognize patterns of cues which may indicate NEC and to predict what may happen next if NEC is in fact developing, nurses must learn to combine textual knowledge with their own experiences in the NICU.

The goal of this study was to establish the feasibility of our methods for extracting the knowledge of expert nurses regarding the assessment of NEC risk. We used cognitive task analysis (CTA) methods to extract and document elements of nursing expertise relevant to NEC that are not currently captured in the nursing literature. Documenting this expertise will provide the building blocks for enhanced nurse instruction.

METHOD

Setting

Participants in this study included both highly experienced and less-experienced NICU nurses from three different hospitals. The highly experienced group ($N = 14$) included nurses who had at least five years of experience in the NICU and who were nominated by their Nurse Managers as experts in patient assessment. This group had an average of 14 years of experience in nursing (range = 7 to 30 years) and an average of 10 years of experience in the NICU (range = 6 to 16 years). The less-experienced group ($N = 5$) was made up of nurses with one to three years of experience in the NICU. Those nurses had an average of four years of experience in nursing (range = 2 to 8 years) and an average of two years of experience in the NICU (range = 1 to 3 years).

Procedures

The knowledge elicitation portion of the CTA utilized the Critical Decision method (CDM) (Klein, Calderwood, & MacGregor, (1989). CDM is a knowledge-engineering strategy based on Flanagan's critical incident technique (Flanagan, 1954). Using recollection of a specific incident as its starting point, CDM employs a semi-structured interview with specific, focused probes designed to elicit particular types of information from the interviewee.

For this study, interviews were conducted individually and sessions lasted 1-1/2 to 2 hours. A standard introduction was read to each nurse explaining the focus of the interview, asking permission to record the session, and assuring the interviewee of the confidentiality of her/his responses. Demographic information regarding education and nursing experience was obtained. Nurses were asked to think of "an incident in which you suspected the baby was developing NEC, and your guess turned out to be correct." A timeline was constructed of the incident in

order to clarify the sequence of events. The timeline was then used as an aid in probing the nurse's thoughts, suspicions, and judgments at different points during the incident. Once the nurse and the interviewers were satisfied that the incident had been explored fully, the nurse was asked for additional incidents: "an incident in which you suspected a baby was developing NEC, and your hunch was incorrect," and "an incident in which a baby developed NEC and you thought there was some other problem, or missed the early signs."

DATA ANALYSIS

All interviews were transcribed to facilitate data analysis. The goal of the analysis was to extract information surrounding the assessment of NEC from each incident so that comparisons could be made across incidents, hospitals, experience level, and over time. The coding and sorting procedures are described below.

Coding

The incidents were divided into situation assessment (SA) shifts representing shifts in the nurse's assessment of the situation. These SA shifts were derived from the timeline constructed during the interview sessions. As the nurse related an incident, each change in her/his assessment of the situation was noted on the timeline. The incidents were thus divided using these natural breaks. The total number of SA shifts across incidents was 117. The average number of SA shifts per incident was 3.8 (range 1 to 11).

Four coding categories were created: cues present or sought, nurse concern level, suspecting NEC, and nurse actions. Two raters independently coded a randomly selected sample of 24 SA shifts (20% of the SA shifts). The raters achieved excellent agreement beyond chance for the coding categories Cues and Concern Level, $\kappa = .808$ and $\kappa = .815$, respectively. The raters achieved fair to good

agreement beyond chance for Suspecting NEC and Nurse actions, $\kappa = .739$ and $\kappa = .495$, respectively. Interrater agreement having been achieved, one coder then completed the coding.

Data Sort. The coded data were entered into a spreadsheet in order to manipulate the

data, get frequency counts, and look for patterns and trends. Within each concern level, the occurrence of each cue was tallied. A pattern of cues within each concern level emerged and is represented as a framework for early detection in the following section (see Table 1).

Table 1. Most Frequently Mentioned Cues Per Nurses' Concern Level

Cue	Concern Level 1 (n=28 SA shifts)		Concern Level 2 (n=20 SA shifts)		Concern Level 3 (n=43 SA shifts)		Concern Level 4 (n=26 SA shifts)	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Early gastrointestinal cues								
Girth increase	8	29	9	45	19	44	5	19
Aspirates	7	25	10	50	12	28	6	23
Guaiac positive stool	3	11	8	40	8	19	3	12
Loops			3	15				
Infection cues								
Color change	6	22	3	15	11	26	4	15
Change in activity level			4	20	11	26	4	15
Increase in apneas/ bradycardias			7	35	25	58	11	42
Look of the infant			3	15	6	14	3	12
Irritability			4	20				
Late gastrointestinal cues								
Discolored abdomen					5	12	3	12
No bowel sounds			3	15				
Abdomen is hard					5	12		
Frank blood in stool					6	14	4	15

SA = situation assessment.

FINDINGS

Assessment Strategies

We found that experienced nurses have a much more sophisticated view of NEC than is found in the instructional nursing literature. Often, nursing texts present a list of NEC cues with no differentiation between early and late cues (Beachy & Deacon, 1993; Kenner, Brueggemeyer, & Gunderson, 1993; Korones, Bada-Ellzey, 1993; Willett, Patterson, &

Steinbock, 1986.) In most cases, the emphasis is on abdominal and gastrointestinal cues, with little attention given to what may be happening to the rest of the infant. While these texts do include the common signs of NEC, they do little to guide the nurse. The nurses we spoke with had developed strategies for sorting out the many ambiguous indicators of NEC.

The first strategy we will address is that the experienced nurses had learned to look at these signs in the context of a specific baby. Any cue that appears to be out of range will

prompt an experienced nurse to search the patient's chart for possible explanations, and indications that this indeed is a sign of potential problems. A second strategy concerns the development of expectations. While nearly all of the cues on the list above can be explained away when they occur in isolation, experienced nurses know what patterns of cues to look for if NEC is developing.

Expert/novice differences. We were surprised to find few differences between the highly experienced and novice nurses in terms of NEC assessment strategies. It may be that our novice category was not inexperienced enough. Although we solicited nurses with 1-3 years of experience, all of our participants in the novice category had at least two years of nursing

experience. Perhaps two years is sufficient time to develop effective NEC assessment strategies.

Framework for early detection. From the interview data we were able to construct a framework based upon the strategies nurses use in assessing NEC. Although we are aware that a number of laboratory values and diagnostic tests provide cues for the nurse as they assess NEC risk, we have included only the clinical assessment cues in this framework. Our focus has been on the clinical assessment, where the nurse's perceptual abilities and monitoring skills are most critical. A future study including the interpretation of laboratory and diagnostic data might expand this framework. NEC cues are divided into three categories as shown in Table 2.

Table 2. Framework For Early Detection

Early Gastrointestinal Cues	Infection Cues	Late Gastrointestinal Cues
Girth increase	Poor perfusion	Dramatic change in any of the
Aspirates	Color change	early gastrointestinal cues
Guaiaac positive stool	Change in activity level	Discolored abdomen
Loops	Increase in apneas/bradycardias	No bowel sounds
Emesis	Change in O ₂ requirement	Abdomen is hard
	Temperature instability	Abdomen is tender
	Look of the baby	Frank blood in stool

Categorizing the indicators of NEC in this way allows nurses to assess NEC risk more effectively. It is important that this frame include both early and late indicators of NEC. Because the early cues are so ambiguous, it is critical that the nurse know what to expect if NEC is in fact developing. Below are three generalities which were pulled from the interview data. These, together with the categories listed above, represent a valuable framework for sorting out the many possible indicators of NEC.

- When one or two of the early gastrointestinal cues occur, an experienced nurse will begin to suspect NEC. At this point, there is

still much ambiguity and the concern level is low, but the nurse will begin to look for increasing signs of gastrointestinal trouble and signs of infection.

- If two or more of the early gastrointestinal cues are present in combination with signs of infection, the nurse will in most cases notify a doctor or charge nurse so that feeds may be held and a doctor may do a further assessment to determine whether medical management for NEC is needed at that point.
- If any of the late gastrointestinal cues are present, the nurse knows that the

patient is in need of immediate attention. S/he will notify the doctor immediately so that appropriate actions may be initiated.

DISCUSSION

These findings have valuable implications for both nurse instruction and patient information management. In terms of instruction for nurses new to the NICU, our findings provide a frame within which to present information regarding NEC. This frame will allow new nurses to better integrate their experiences on the NICU as they are exposed to a variety of patients during the orientation period. In addition, the strategies documented here provide access to experienced nurses' problem-solving skills. Exposure to this information will aid new nurses as they begin to develop the specialized critical thinking skills needed to work in the NICU.

The advent of electronic charting has opened possibilities for much more flexible ways of storing, organizing, and presenting patient information. We would suggest that electronic charting systems should take into account the human's thought processes and thus serve as a decision support. In this case it makes sense to set up the interface so that information is organized and presented in a manner that is compatible with the nurse's problem-solving strategies. Changes in the patient's condition over time should be made obvious through the use of graphics. Specific values that fall outside of the expected range (such as an increase in girth) should be highlighted in order to call these cues to the attention of the health care team.

Expanded use of CTA methods shows much promise for nursing research. These methods allow access to much of the expert knowledge of experienced nurses that is difficult to document and disseminate to novice nurses.

Access to expert strategies and decision-making processes will provide a framework for new nurses as they develop critical thinking skills specific to nursing.

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