

Critical decision method: A technique for eliciting concrete assessment indicators from the intuition of NICU nurses

Two studies supporting the use of the Critical Decision method (CDM) in eliciting knowledge from expert neonatal intensive care unit (NICU) nurses are presented. The first examines the utility of CDM in the nursing profession. In this study, significantly more information was elicited in CDM interviews than in non-CDM interviews. In the second study, cues, indicators, and exemplars were extracted from CDM incident accounts to form a guide to early sepsis assessment in the NICU that contains information not available in the current literature. All evaluators rated the guide as useful. Implications for future research, including generalizability to other areas of nursing, are discussed.

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ONE OF THE BASIC tenets of nursing practice is that a significant portion of nurses' clinical skill is acquired through day-to-day, hands-on experience. Benner¹ has argued compellingly that experience-based knowledge forms the basis for nurses' intuitive clinical judgments, allowing them to assess and respond to patients' needs accurately and immediately, often without reliance on standard assessment tools. The ability to make rapid, accurate assessments of patient status and needs, often under conditions of extreme time pressure, uncertain diagnostic information, and high risk, comprises an essential component of nursing expertise. This aspect of expertise, though rec-

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ognized as essential, is difficult to characterize or to communicate to others. Experience-based knowledge is typically difficult for the proficient performer to access or articulate. It involves skills so well learned and familiar that the expert may not be consciously aware of using them in the course of performing a task. For this reason, knowledge elicitation methods that focus on making such knowledge explicit can provide information on expertise that is typically unavailable by means of other methods.²

Klein Associates has developed a knowledge elicitation method—the Critical Decision method (CDM)—that has been successful in eliciting the intuitive, experienced-based knowledge of expert neonatal intensive care unit (NICU) nurses. CDM is a knowledge elicitation technique loosely based on Flanagan’s critical incident technique.³ The interviews are based on nonroutine events that have occurred in the expert’s work environment. 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. Solicited information includes goals that were considered during the incident; options that were generated, evaluated, and eventually chosen; cue utilization; contextual elements; and situation assessment factors specific to particular decisions. CDM protocols provide detailed records of the information gathering, judgments, interventions, and outcomes that surround problem solving and decision making in a particular task or domain.⁴ The method has been used in over 24 studies in a variety of domains including critical care nursing, corporate information

management, fireground command, and battle planning. (Space constraints preclude a full scale description of CDM or the empiric work surrounding its use. More detailed information can be obtained from the authors.)

In a project funded by the Center for Nursing Research,⁵ the utility of CDM for extracting key components of nurses’ clinical judgments was examined. In a follow-up study funded by the State of Ohio, Department of Development, a set of instructional materials designed to provide early indicators of sepsis in low birth weight (LBW) infants for less experienced NICU nurses was developed.⁶ (This guide can be obtained from the authors.)

STUDY 1

The goal of Study 1 was to develop a detailed, specific description of the cognitive processes that surround the assessment and care of critically ill infants.

Method

Study participants were 19 female registered nurses (RNs) working in the NICU of a 772-bed, urban regional referral center. The NICU is part of a Level III perinatal unit licensed for 25 critical beds and 10 step-down beds, with an average daily census of 100%. The participants had an average of 13 years of nursing experience (range = 5 to 25 years) and an average of 8.1 years of experience working with neonates (range = 5 to 18 years). Adaptation of incident selection procedures and CDM probes to the nursing domain was tested in pilot interviews with two NICU nurses. The study proper is based on interviews with 17 RNs.

CDM interview sessions lasted 1.5 to 2 hours and were conducted individually by two skilled interviewers. CDM is a semi-structured interview technique; it does not employ a standard set of interview queries that are presented in a set order to each interviewee. Rather, interviewers use active listening skills and a variety of probes to obtain desired information. Specifically, information was elicited regarding assessment parameters and salient cues surrounding critical incidents, as well as the cognitive factors specific to clinical judgments and patient evaluation. Participants were encouraged to focus on what they had actually seen, heard, and considered during the course of an incident.

Each participant was asked to select an incident in which she believed her presence made a difference to the patient's outcome. The interviewer suggested that this incident might be one where a gut feeling or hunch may have induced her to intervene. When the nurse recalled a relevant case, she was asked to "walk the interviewer through it." This approach provided an overview of the incident from the nurse's perspective. The initial account of the incident was then repeated back to the nurse so that she could identify any errors in the interviewer's comprehension. Interviewers then went over the incident again, this time probing exhaustively to elicit detailed information surrounding the cues, judgments, decisions, and actions contained in the nurse's initial account. When data collection for the first incident was completed, the interviewer requested a second case description, focusing on the interplay between human judgment and technologic supports. The nurse was asked for an incident in which her own clinical

judgment had pointed in a different direction from technologic indicators. When the nurse had selected a case to recount, the interview proceeded as before.

Results and discussion

The 17 interviews yielded a total of 33 incident accounts. (Mechanical failure of the tape recorder resulted in the loss of one case account in one interview.) The incidents range from immediate, life-threatening crises requiring assessment and intervention within minutes to emergent crises that might surface over a period of hours or even days. The accounts consisted of the following clinical events: sepsis ($n = 9$), pneumothorax ($n = 4$), respiratory or cardiac arrest, ($n = 3$), seizure activity ($n = 3$), pneumopericardium ($n = 2$), postsurgical complications ($n = 2$), impending death ($n = 2$), meconium aspiration ($n = 2$); heart murmur ($n = 1$), spina bifida ($n = 1$), hypoglycemia ($n = 1$), monitor malfunction ($n = 1$), poorly placed nasogastric tube ($n = 1$), and TE fistula ($n = 1$). The protocols were rich in information about many aspects of nursing and the critical care environment. However, the analyses focused on the portions of the protocols that were concerned with aspects of clinical assessment and judgment.

Interviews were recorded on audiotape and transcribed verbatim. Protocol analysis methods were employed to code the transcripts, with each incident account coded for the nature and extent of information yielded by the CDM interview. Coding was carried out separately for the initial accounts of the incident, which served as an index of what the nurses were able to articulate on their own, and for the probed portion of the

interview, which contained information that the nurses did not spontaneously articulate.

Each incident account was coded for the occupance of three categories of information:

1. the number and variety of discrete assessment categories attended to;
2. the type of assessment indicator (perceptual, diagnostic, telemetry, medical history, other); and
3. the type of judgment used in patient assessment: normative (comparison between similar cases), ipsative (comparison between the present and the previous status of the same patient), or cue discrepancy (apparent discrepancies among assessment indices).

In addition, each instance of use of an assessment indicator was coded for the specificity with which it was described. For example, one nurse might refer to "the look of the infant" (low specificity) while another might refer to the "underlying grey tinge of the infant's skin" (high specificity).

Clinical assessment information used

Table 1 contains the mean frequency and standard deviation for each coding category, presented separately for the initial account and the probed portions of the interview. In a typical incident, approximately half of the indicators mentioned were perceptual cues, a quarter were based on telemetry, and the remainder were split between the results of formal diagnostic procedures and information culled from the patient's medical history. CDM probes yielded additional information in nearly every category examined. Alpha levels of significance were computed within categories using a nondirectional t test for correlated groups. These figures ap-

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pear in Table 1. The increase in the total number of indicators reported in initial vs probed accounts was highly significant ($t = 14.18, p < .001$), as was the increase from initial to probed accounts in the number of perceptual cues reported ($t = 8.27, p < .001$). Reported use of diagnostic and telemetry information also increased, although the changes were not significant. Additional analyses indicated that the level of specificity nurses used to describe assessment indices increased as well. Substantial increases in elicited information can be seen as an indication of the utility of CDM.

Less information was obtained about how nurses evaluate patient information. Research on the nature of expertise suggests that exposure to numerous cases enables experts to accumulate knowledge that allows them to judge events in terms of a prototypical case.⁷ Thus, it was anticipated that the clinical assessments of experienced nurses would involve comparisons of the present case with other similar cases. However, nurses were much more likely to note discrepancies between the current and previous status of a given patient on specific assessment parameters. Assessments based on cue discrepancies were the least frequent, reported a total of only three times in the CDM accounts.

Table 1. Assessment parameters reported by experienced NICU nurses in accounts of challenging cases (n = 33)

Assessment category	Frequency of mention				Significance of difference between frequencies* (df = 32)	
	Initial account		Probed account		t	p
	Mean	SD	Mean	SD		
Total indicators	5.36	2.90	9.45	5.38	14.18	<.001
Perceptual cue	2.58	1.66	6.33	2.83	8.27	<.001
Diagnostic information	0.67	0.95	1.15	1.80	0.32	NS
Telemetry	1.27	1.42	1.45	1.23	0.91	NS
Medical history	0.64	0.65	0.36	0.55	-1.97	NS
Other	0.21	0.36	0.15	0.44	NS	NS
Domain knowledge	0.58	1.12	3.67	2.39	6.01	<.001
Basis for cue evaluation						
Normative comparison	0.12	0.33	0.76	0.95	3.53	<.01
Ipsative comparison	1.06	1.76	2.12	3.13	2.69	<.02
Cue discrepancy	0.12	0.33	0.15	0.44	0.44	NS

SD = standard deviation; df = degrees of freedoms; NS = not significant.

*Alpha levels of significance computed using nondirectional *t* tests.

Content of expert knowledge

Across the 33 incident accounts, the clinical event that nurses chose to discuss most frequently was that of sepsis, or systemic bacterial infection. These cases were used to examine the content of expert knowledge provided by the CDM interviews. This aspect of the study centered around the following issues:

- Does the information elicited using CDM represent a common core of experience-based knowledge regarding the assessment of particular clinical events? Or does the information represent idiosyncratic elements of personal experience or cognitive style? and
- How relevant is the information? Is it already thoroughly documented in the

medical or nursing literature, or does it provide fresh insights of importance to patient outcome and quality of care?

Medical texts, manuals, and periodicals directed toward NICU nurses were examined for descriptions of the assessment indices of sepsis in the NICU.⁸⁻¹⁰ The inclusive set of all indicators mentioned in these sources is shown in Table 2. The nine incident accounts of sepsis were then exhaustively reviewed for every assessment cue or indicator mentioned. The number of cases in which expert nurses looked for potential assessment indicators for sepsis is also presented in Table 2. Almost half of the indicators contained in the medical literature were never mentioned in experienced nurses' accounts of sepsis. Even more surprisingly, some indicators employed by experienced

nurses were apparently not available in the research or training literature.

One possible reason for the discrepancy illustrated in Table 2 is that experienced nurses are alert to signs and symptoms of sepsis that occur very early in the clinical course. Many of the literature-based indicators are symptoms of advanced sepsis (eg, seizures, purpura). In addition, many of the indicators absent from the literature but mentioned by expert nurses require perceptual judgments or alertness to shifts in the patient's state. This type of comparison is

especially difficult to represent in assessment guidelines.

What is not evident in Table 2 is the degree to which nurses were alert to the co-occurrence of particular symptoms (eg, poor color, lethargy, and increasing apnea or bradycardia). Also not apparent is the importance in tracking changes in assessment parameters over time. Thus, a nurse would describe a growing concern as the infant became increasingly limp and unresponsive and as the infant's color changed from pink to pale to dingy gray over the course of the

Table 2. Indicators of sepsis

Indicator	Identified in medical literature		No. of cases in which expert nurses checked for indicator
	Yes	No	
Unstable temperature	X		3
Hypothermia	X		2
Elevated temperature	X		
Feeding abnormality	X		4
Abdominal distention	X		5
Increased residual	X		2
Vomiting	X		
Lethargy	X		8
Irritability	X		
Color changes	X		9
Respiratory distress	X		4
Apnea	X		6
Cyanosis	X		2
Tachypnea	X		
Seizures	X		
Jaundice	X		
Purpura	X		
Bradycardia		X	7
Unresponsive		X	5
Poor muscle tone		X	5
Perfusion or mottling		X	2
Edema		X	2
"Sick" eyes		X	2
Clotting problems		X	2

shift. These findings offer strong support for the power of knowledge elicitation methods to identify meaningful, significant, and as yet undocumented components of nursing expertise.

STUDY 2

The analysis of sepsis indicators employed by experienced NICU nurses revealed assessment indices as yet undocumented in the nursing and medical literature. Study 2 focused on using information extracted using CDM to develop a guide for sepsis assessment in the NICU.

Method

Knowledge elicitation

Interviews were conducted with 5 experienced female NICU nurses with an average of 12.8 years of nursing experience (range = 7 to 23 years) and 9 years of experience in the NICU (range = 7 to 12 years). As in Study 1, nurses were interviewed individually by a pair of interviewers in 2-hour CDM sessions. Each nurse was asked to describe three types of incidents: an incident in which her skills led her to suspect correctly that an infant was becoming septic, an incident in which she incorrectly suspected that an infant was becoming septic, and an incident in which an infant became septic and it was not detected. The topics were introduced separately. After each topic was introduced, the interviews proceeded as in Study 1.

Guide development

Interviews with the 5 expert nurses in Study 2 yielded 15 incident accounts. These incidents were combined with the 9 sepsis

accounts in Study 1 to form a database of 24 sepsis-related incident accounts. Assessment cues, sepsis indicators, and exemplars were extracted from these incidents and were analyzed and combined to form a preliminary guide to early sepsis assessment in the NICU. The guide also included a detailed description of the pathophysiology of sepsis.

Results and discussion

The guide

The sepsis assessment guide⁶ created as a result of Study 2 contains four main sections: pathophysiology, assessment cues, sepsis indicators, and sepsis incident accounts. It also contains an introduction explaining the goals and the development of the guide. The pathophysiology section includes pathophysiologic changes in preterm infants with sepsis along with the signs and symptoms that commonly accompany these changes. The assessment cues section addresses the methods used for collecting the information, while the sepsis indicators section contains the sepsis assessment parameters consistently mentioned by experienced NICU nurses. Table 3 contains a list of these cues and descriptors associated with them.

Additional indicators were mentioned by some, but not all nurses. These indicators include poor perfusion, mottled skin, "sick" or glassy eyes, unstable temperature (specifically dropping temperature), and clotting difficulties. Also included in the sepsis indicators section was a discussion of the co-occurrence of particular symptoms and of the importance of tracking changes in assessment indices for a particular patient over time.

Table 3. Assessment parameters for sepsis consistently mentioned by expert NICU nurses

Cue	Descriptors
Color change	Pale, washed-out skin tones; underlying grey tinge to skin. Early on, paleness may be most noticeable in extremities; as infection grows, the grey skin tone becomes marked. Some nurses describe the color as green-grey, others as yellow-grey, but the grey descriptor is always present.
Apnea (A) or bradycardia (B)	More frequent episodes of A or B (or both); an accelerating pattern of As and Bs is especially noteworthy.
Lethargy	Patient is not alert, sleepy, listless; muscle tone is limp, floppy, flaccid.
Unresponsiveness	Decreased reactivity; signs that the infant is "shutting down."
Feeding abnormality	Abdominal distention, increased residuals.

The sepsis incident accounts section contains 10 exemplars. The first six accounts presented incidents in which the nurse correctly suspected that her patients had sepsis. Incidents number 7 and 9 contained accounts of infants that were thought to have sepsis but were actually well. Incidents number 8 and 10 were concerned with infants who were misdiagnosed by their nurses as having sepsis when they actually had other problems. These incident accounts were followed by the reasons why the nurses believed they may have been misled. The sepsis incident accounts section concluded with a summarization of important concepts contained in the accounts.

Evaluation

Six NICU nurse managers and 11 NICU staff nurses were recruited to review the guide. None had participated in the CDM interviews. The nurse managers had an average of 17 years of nursing experience (range = 10 to 29 years) and 15 years of experience in the NICU (range = 7.5 to 29 years). The staff nurses had an average of 16 years of nursing experience (range = 7 to 35

years) and 10 years of experience in the NICU (range = 5 to 24 years).

An open-ended evaluation questionnaire was developed for this phase of the study. Reviewers were asked to read the guide and to evaluate its utility and validity; the point in an NICU nurse's career that he or she would most benefit from its use (eg, during orientation or after 6 months on the unit); and misgivings or concerns about the guide's use. Reviewers were also asked to identify inaccurate or misleading information. Responses to all queries were open ended.

The guide was rated as useful by all evaluators. When asked to choose one or more instructional situations in which the guide would be most useful, 65% identified orientation, 41% identified 1 year, 18% identified refresher courses, and 18% replied between orientation and 1 year. Seventy-one percent of the evaluators stated that none of the information in the guide was misleading. The information that was cited as misleading was in the sepsis incident accounts section. Exemplars, by their nature, are highly susceptible to affective judgments when evaluated subjectively. Comments generally fo-

cused on only small portions of specific exemplars. No exemplar was singled out more than once. The majority of comments dealt with questions about why the nurse in a particular incident did or did not perform a particular procedure, rather than on information that was seen as confusing or misleading. The fact that no information was evaluated as misleading in the other sections of the guide indicates that the actual signs, symptoms, and cues presented were considered accurate by the evaluators.

All of the nurse managers surveyed stated that they would use the guide as a learning tool in their units. When asked to suggest possible improvements to the guide, nurse managers commented that including information such as the reasons behind changes in perceptual cues, common causes of sepsis, antibiotics used for sepsis treatment, and suggestions for the administration of these antibiotics and side effects would improve the utility of the guide as an instructional tool.

All staff nurses who evaluated the guide stated that they would use it during orientation for new NICU nurses. Forty-six percent of the staff nurses surveyed stated that they had gained new information about sepsis assessment from the guide. Half of those who reported that they had not gained new information from the guide still stated that it had reaffirmed for them the importance of primary nursing. Without exception, the staff nurses reported that they would have personally benefited from the guide when they were less experienced. One staff nurse commented that the guide would be very helpful in bringing new nurses up to speed in hospitals with high turnover rates. Another suggested that the guide would be especially beneficial to nurses in Level II and normal

nurseries. Because these nurses are not exposed to sepsis on a regular basis, incident accounts would make the early signs and symptoms more familiar to them.

CONCLUSIONS AND IMPLICATIONS

The overall goal of this pair of studies was to test the utility of CDM to identify and document key elements of nursing expertise. Analyses of experienced nurses' accounts of challenging incidents suggest that experienced nurses draw extensively on perceptual skills in assessment. In both studies, NICU nurses used a consistent set of assessment cues related to early detection of sepsis and other diseases in premature infants. These cues are subjective in nature and involve detection of subtle changes over time. These cues were difficult for nurses to articulate and were often reported in terms of highly generalized constellations of cues. CDM, however, allowed the nurses to describe aspects of their clinical judgment significantly better than did unstructured interviews, and in much more specific and elaborated terms.

Exemplars are frequently used in the nursing literature to describe expert knowledge. Benner writes that "any attempt to extract [exemplars'] 'essential features' and make them into guidelines is not likely to succeed."^{11(p177)} Yet she emphasizes that strategies must be developed to document the practical, experience-based knowledge of expert nurses. The findings reported here offer strong support for the value of cognitive task analysis for studying nursing expertise. CDM was highly successful in eliciting specific cues and assessment pa-

rameters from expert NICU nurses. The sepsis guide combines exemplars with a set of cues and assessment parameters in a way that both retains the qualities of exemplar-style presentation and presents information in a more rigorous, systematic way.

These knowledge elicitation and presentation techniques will generalize to many areas of nursing. Future research might focus on the development of guides for a variety of assessment problems both in the NICU and in other nursing environments. Often, technologic innovations (eg, the development of surfactant) bring new assessment

problems into the nursing environment (eg, the addition of a new patient population, such as very LBW infants). With the use of cognitive task analysis to extract knowledge concerning assessment and treatment techniques, nursing expertise can be passed along with new technologies, decreasing potential problems resulting from lack of expertise and enabling nurses in novel environments to provide a higher standard of nursing care. Nursing expertise can be recycled so that less experienced nurses can benefit from the skills and knowledge of their more experienced colleagues.

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