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Mapping the Nursing Process

A New Approach for Understanding the Work of Nursing

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The work of nursing is nonlinear and involves complex reasoning and clinical decision making. The use of human factors engineering (HFE) as a sole means for analyzing the work of nursing is problematic. Combining HFE analysis with qualitative observation has created a new methodology for mapping the nursing process. A cognitive pathway offers a new perspective for understanding the work of nursing and analyzing how disruptions to the nursing process may contribute to errors in the acute care environment.

During the past decade, hospitals have attempted to address issues of patients' demands for high-quality, safe care along with payers' demands for lower costs. As a result, many hospitals have examined the work processes involved in patient care in an effort to streamline the processes, gain productivity, reduce costs, and maintain quality. Human factors engineering (HFE) techniques, drawn from the sciences of industrial engineering, ergonomics, and mathematics, have been used successfully to analyze clinical care processes and restructure patient care delivery. HFE has been used as a framework for constructive thinking to help healthcare teams perform patient safety analyses.[1] Use of HFE techniques often resulted in changes in patient care systems, such as medication delivery, supply access, or documentation.

Although HFE has enjoyed success in performance improvement, healthcare administrators must be aware that "traditional HFE or control-based engineering methods for improving performance are not successful in analyzing knowledge and service work such as nursing"[2] This lack of success results to a great extent from the nonlinearity of knowledge work such as nursing, which involves complex reasoning and decision making that are part of the nursing process.

The nursing process is aimed at identifying, diagnosing, and treating actual or potential human responses to health and illness.[3] The cognitive work of delivering nursing care is not easily observed and recorded using HFE methodology. Drawing conclusions and making process changes in the nursing care system based on HFE studies can be problematic. For example, system changes resulting from HFE analysis may benefit the environmental design on a patient care unit but not provide the solutions needed to change those processes that support a nurse's clinical reasoning. To date, few attempts have been made to analyze how the cognitive work of the nursing process is conducted in practice and how it is influenced by acute care working conditions.

This article describes an observational investigation of a single registered nurse (RN) and patient care technician (PCT) dyad, in which a new methodology for mapping the nursing process, described here as a cognitive pathway, was developed. The pathway offers a new perspective for understanding the work of nursing and provides an analytical tool for examining how disruptions to the nursing process may contribute to errors within the acute care environment.

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Human Factors Engineering

Human factors engineering (HFE) is the study of human beings and their interaction with products, environments, and equipment in performing tasks and activities. Within this domain the central focus of study is the human-machine system. HFE has been widely used in industry to improve the operation of complex systems, to reduce cognitive errors related to poor person–machine interface, and to increase the comfort level of workers by adapting the work environment to human anatomy and function.

The objectives of HFE are to maximize human and system efficiency and human well-being and quality of life.[4] HFE has been beneficial in improving healthcare processes such as laboratory specimen acquisition and delivery, medication preparation, and the patient admission process. HFE analysis is limited in its ability to understand work with organic characteristics—work that is nonlinear, requires discretion, and is self-paced and unpredictable.[2] Clinical reasoning is a component of professional nursing practice that enables nurses to analyze information relevant to patient care. Nurses engage in a recursive cognitive process that uses inductive and deductive cognitive skills.[5] Clinical reasoning enables a nurse to apply appropriate knowledge to a clinical situation based on a patient's changing status and thus to intervene in a timely and appropriate manner. In an ideal healthcare setting, an RN would attend to one patient's needs before attending to another. However, in today's acute care setting RNs typically care for multiple patients simultaneously.

A nurse will move in and out of multiple patient rooms to attend to the patients' clinical situations and make decisions about their care. Typically, a nurse begins a shift by conducting patient rounds, assessing a patient's condition, and identifying the pertinent problems and priorities for the day, only to then have to shift to other patient rooms before care can be implemented for that initial patient. This organizing and reorganizing or "stacking" of multiple priorities and interventions on the basis of ongoing clinical decisions is the nature of nursing practice.[6]

The nursing process involves covert cognitive behaviors as well as overt physical activities of care. Therefore, to fully capture the details of this process one must employ qualitative observation of staff nurses as a complement to HFE analysis. Shadowing an RN in practice allows a researcher to view assessment activities, question staff about patient problems and priorities, note the types of activities performed, and understand the cognitive intent of those activities. Qualitative data place into context the data gathered from HFE analysis. For example, an observation of a nurse assisting a patient to sit up in bed might be categorized through HFE analysis as a simple positioning activity. Qualitative analysis of the same activity would recognize the clinical context of the situation; the nurse positioning the client in preparation for assessment of lung sounds. A human factors engineer will track the number of times a medication is administered. Qualitative analysis can reveal the purpose of the medication administration, the RN's decision in administering the drug, and observation of the patient's response.

The application of HFE techniques and qualitative observation together provides a powerful tool for examining the clinical decision making involved in the nursing process. The resultant joint methodology enables researchers to better understand the conduct of the nursing process. It also provides an understanding of how the process becomes disrupted and the influence of this disruption on errors and delays in effectively caring for patients. A new visual graphic, described here as a cognitive pathway, offers a useful tool for identifying potential problems resulting from a disruption to the nursing process and potential solutions.

Method

A research team consisting of a human factors engineer, 2 registered nurses, a management engineer, social worker, and physician have been conducting an analysis of working conditions on acute care nursing units. This report focuses on the examination of an RN and PCT dyad that is part of that study. A human factors engineer and a nurse researcher jointly observed an experienced registered nurse (RN) during the first 10 hours of a routine 12-hour day shift. An additional human factors engineer observed the PCT assigned to the RN during the same time period. The RN and PCT were staff members of a general acute medicine unit that practiced total patient care as their delivery of care model. The RN had more than 20 years of experience, and the PCT had 6 years of experience. The RN cared for 6 patients; 2 were discharged and 2 additional patients were assigned 9 hours into the RN's shift. The PCT was assigned to the RN to assist in the care of the same 6 patients, as directed by the RN.

The focus of HFE analysis was to identify the activities performed by the RN and PCT during the work shift. Data collection included a listing of ac-

tivities, time duration, and physical interactions with the environment and equipment as patient care activities were performed. The human factors engineers recorded each activity performed by the RN and PCT, recording the time in 1-minute intervals. A list of categories encompassing the most frequent patient care tasks was used to standardize observations for ease of analysis. RN and PCT movements were mapped according to sequence of activities and the environmental layout of the nursing unit. Environmental conditions were noted because they were observed to affect efficiencies in workflow.

The nurse researcher shadowed only the RN while HFE analysis was simultaneously conducted. The researcher observed the work of the RN within the context of the nursing process. Observations began during the change of shift report, allowing the nurse researcher to identify the patient care priorities communicated by the previous shift. The researcher accompanied the RN to each patient's room, observing the RN's activities, including any interaction between the RN and patient. As the RN left each patient's room, the nurse researcher asked the RN to identify the patient problems and care priorities for the shift.

The researcher shadowed the RN for the remainder of the observation period, attempting to record all activities performed, as well as the rationale for each activity. The intent was to observe how and to what extent the five steps of the nursing process (assessment, diagnosing or problem identification, planning, intervention, and evaluation) were completed. The qualitative data were paired with the HFE data, providing a complete picture of the RN's activity for the 10-hour observation period.

Data Analysis

HFE analysis for this study quantified the complex patient care process in the form of a task analysis. The task analysis recorded physical activities or tasks of patient care, including time measurements, information processes, communication activities, and motion patterns. The data reported included listing of every observed activity, start time, finish time, duration, and any observed subtasks. Next, every task was sorted to reveal general categories, such as medication preparation and patient communication. Finally, the percentage of time spent for each category was calculated.

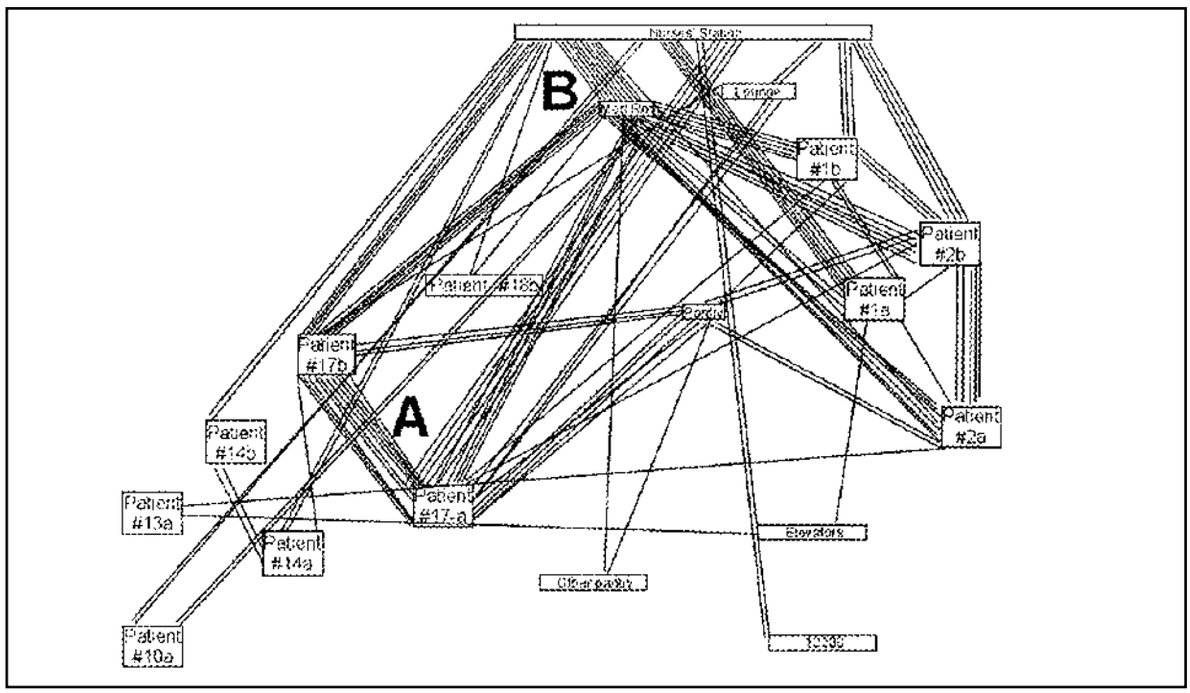

Figure 1. Link analysis: a representation of nurse's movement between patient rooms and key geographic areas on the nursing unit. **A** and **B** denote heaviest links. **A** represents links between rooms 17a and 17b; **B** represents links between medication room and nurses' station.

After analyzing the RN's motion patterns, the human factors engineer constructed a flow chart of the RN's tasks in the form of a link analysis (Figure 1). Task sequences were broken down into motion patterns revealing the repetitive trips or pathways taken by the nurse on the nursing unit. The total number of links (or motions) were summarized and grouped, and the number of activities that occurred for each link was counted. The link analysis provides a perspective to determine if RN movement may or may not indicate wasted motion. A time line was created for the 10-hour observation period to determine if tasks were conducted serially or in parallel and to identify when timing of a task was dictated by external events.

The qualitative analysis conducted by the RN researcher measured the cognitive components of the nursing care process. The researcher maintained extensive notes on the RN's patient care activities to track and categorize the activities of assessment, diagnosis, planning, intervention, and evaluation. Assessment activities included any inquiries made by the RN pertaining to the patients' initial and ongoing physical and psychological conditions and any physical observations and measurements. Nursing diagnosis data included the patient problems identified by the RN. Planning activities included the RN's identification of patient care priorities as well as any observed consultation and referral activities. Intervention activities included direct and indirect care measures, such as medication preparation, medication administration, symptom management, and charting. Evaluation activities included any inquiries the RN made or measurements conducted to determine the patient's response to an intervention.

Data pertaining to assessment, intervention, and evaluation were supplemented by observations of PCT activities because the PCT functioned as an extension of the RN. For example, the PCT and RN meeting to confer about a patient's blood glucose level was recorded as an assessment activity, and the insertion of a straight urinary catheter by the PCT was recorded as an intervention.

Combining HFE and qualitative data created a cognitive pathway (Figure 2). The cognitive pathway is a graphic of the sequence of the nursing process steps conducted by the RN for all 6 patients during the 10-hour observational period. The pathway reveals the RN's cognitive shifts, throughout the observation period, across steps of the nursing process for each of 6 patients.

Each number on the pathway represents a step of the nursing process: assessment (1), nursing diagnosis (2), planning (3), intervention (4), and evaluation (5). A horizontal hatch mark between each step of the process depicts the flow from one step to another. The top horizontal line shows the time intervals for observed activities. The bottom horizontal line of arrows and designated times shows the occurrence of interruptions. Interruptions were defined as actions on the part of other staff or occurrences from the environment that disrupted the RN's performance of a nursing process activity. Vertical lines moving up or down from 1 patient to another depict the cognitive shift from a step of the nursing process for 1 patient to a different patient. The vertical lines do not necessarily represent physical movement on the part of a nurse. For example, the graphic shows that at 0835 the nurse shifted from planning for Patient 01B to planning for Patient 01A. The nurse did not physically move to Patient 01A's bedside. Instead, the nurse consulted at the doorway with a physical therapist about Patient 01A's plan of care.

The merging of HFE and qualitative data produced a method to quantify the interruptions that occurred during the observational period. Qualitative notes were used to categorize the interruptions and record their incidence in relation to when steps of the nursing process were performed (Table 1). The tabulation of data offers an approach to examine if an association can be made between interruptions to the nursing process and any delays in treatment and omissions or commissions in care.

Comparing when the RN completed an intervention and when the intervention was scheduled for completion based upon established nursing standards defined a delay. For example, nursing care standards require routinely ordered medications to be administered 30 minutes before or after the scheduled time. Any medication administered outside that time frame was recorded as a delay.

Omissions were recorded when a planned activity identified by the RN was not implemented. Commissions were recorded when a step in a procedure or process was observed to be deleted. Additional analysis of the association between interruptions and the incidence of delays, omissions, and commissions will be addressed in a future article.

Results

The link analysis graphically displays the flow of activities across the 6 patients cared for by the RN. A "link" is simply the sequence or connection between two elements of a task, such as walking to

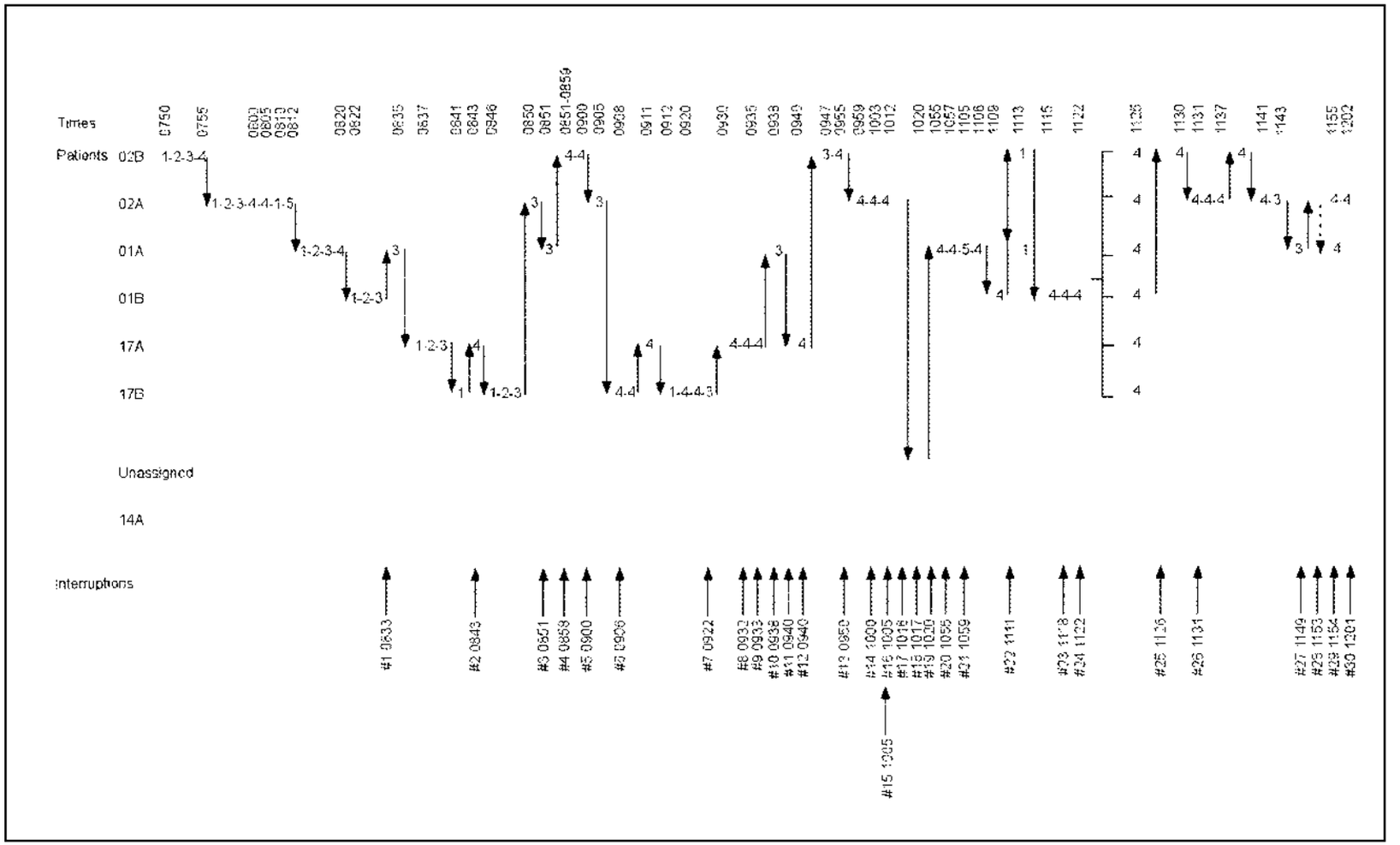

Figure 2. Portion of RN cognitive pathway. Horizontal entries at top record times of observations; horizontal entries at bottom (*with arrows*) record interruptions; vertical arrows across time span demonstrate cognitive shifts between patients as nurse performs nursing care process.

Table 1. Interruptions by Type and Step of Nursing Process Affected

Interruption	Time	Occurrence	Location	Type	Nursing Process Step
1	8:33	Telephone call	Nurses' desk	Delay	NA
2	8:43	Telephone call to PT	PT room	Disrupt direct	Assessment
3	8:50	RN accesses Pyxis medication storage (Cardinal Health, Dublin, OH)	Med room	Delay	NA
4	8:58	Unit clerk query	Med room	Disrupt indirect	Intervention
5	9:00	Water unavailable	PT room	Disrupt direct	Intervention
6	9:09	RN inquiry	Med room	Delay	NA
7	9:22	MD rounds	PT room	Disrupt direct	Intervention
8	9:32	MD inquiry	Med room	Disrupt indirect	Intervention
9	9:33	Unit clerk query	Med room	Disrupt indirect	Intervention
10	9:38	Equipment unavailable	PT room	Disrupt direct	Intervention
11	9:40	Cups unavailable	PT room	Disrupt direct	Intervention
12	9:41	RN informs re: leaving floor	Hallway	Delay	NA
13	9:50	Count narcotics	Med room	Delay	NA
14	10:00	Inquiry	Med room	Disrupt indirect	Intervention
15	10:05	Cups unavailable	PT room	Disrupt indirect	Intervention
16	10:05	RN inquiry	PT room	Disrupt direct	Intervention
17	10:16	RN inquiry	Med room	Delay	NA
18	10:17	Family inquiry	Med room	Disrupt indirect	Intervention
19	10:20–10:53	Bone marrow biopsy	PT room	Delay	NA
20	10:55	MD inquiry	Med room	Disrupt indirect	Intervention
21	10:59	PT report	PT room	Disrupt direct	Intervention
22	11:10	MD inquiry	Med room	Disrupt indirect	Intervention
23	11:18	Flush solution unavailable	PT room	Disrupt direct	Intervention
24	11:22	PT telephone rings	PT room	Disrupt direct	Intervention
25	11:26	Unit clerk informs	Nurses station	Disrupt indirect	Intervention
26	11:31	Unit clerk informs	Med room	Disrupt indirect	Intervention
27	11:49	Dietary informs	Hallway	Delay	NA
28	11:53	Answer telephone	Nurses' station	Delay	NA
29	11:54	RN inquiry	Hallway	Delay	NA
30	12:01	PT requires assist	PT room	Disrupt direct	Intervention
31	12:03	Asked to assist RN	Nurses' station	Delay	NA
32	12:12	Nursing office query	Nurses' station	Delay	NA
33	12:16	Dietitian informs	Nurses' station	Disrupt indirect	Intervention
34	12:20	Linen unavailable	PT room	Disrupt direct	Assessment
35	12:21	Kitchen not stocked	Pantry	Disrupt direct	Intervention
36	13:50	Family inquiry	Hallway	Delay	NA
37	13:53	Gloves unavailable	PT room	Disrupt direct	Intervention
38	15:31	RN inquiry	Nurses' station	Disrupt indirect	Planning
39	15:35	Staff conflict	Nurses' station	Disrupt indirect	Intervention
40	15:38	Locate staff	Hallway	Disrupt indirect	Planning
41	15:44	Telephone call	Nurses' station	Disrupt indirect	Planning
42	16:23	Find armband	PT room	Disrupt direct	Assessment
43	16:26	Staff inquiry	PT room	Disrupt direct	Assessment

NA = not applicable; PT = patient; RN = registered nurse; med = medication; MD = physician.

the supply room to obtain equipment. A link occurs in Figure 1 when the RN exits room 17b and enters the medication room. During the 10-hour observation, 128 links were recorded. Ultimately in HFE, a link analysis allows researchers to weight connections by "costs of time" distance, frequency, resource consumption, or priority importance. Such was not the purpose of this study. However, the link analysis created from the HFE data showed that the RN assumed an active work activity pattern, moving frequently between patient rooms, as well as key locations such as the nurses' station. These data were useful in tracking the RN's physical movement while conducting nursing process activities.

The cognitive pathway for the RN and PCT dyad (Figure 2) reveals that the nurse began the shift of care by systematically conducting patient rounds on all 6 assigned patients. The steps of the nursing process initially were conducted sequentially, with the nurse assessing the patients' condi-

tion, identifying problems and priorities of care, and then in some cases (such as Patients 01A, 02A, and 17A) moving directly to interventions. The nurse frequently moved back and forth across steps of the nursing process. For example, in the case of Patient 02A, the nurse completed assessment, diagnosis, planning, and intervention but then conducted additional assessment of the patient's pain and evaluated the patient's response to discontinuation of a Foley catheter, which had been inserted during the night shift. It was not until the RN completed rounds on Patient 01B that frequent shifts in the steps of the nursing process begin to occur back and forth between patients.

The cognitive pathway shows that the work of nursing is nonlinear. In the example between the time frames of 0837 and 0850, the RN moves back and forth between Patients 17A and 17B 4 times in 13 minutes. After identifying priorities for Patient 17A, the nurse shifts to Patient 17B to begin assessment. Then as a result of an interruption, the RN moves back to Patient 17A to perform an intervention. Finally, the RN returns to Patient 17B to complete the assessment, diagnosis, and planning steps. This movement between patients occurs frequently throughout the shift.

Once the RN begins to perform interventions, significant movement can be seen in the conduct of the nursing process across all patients. During the course of the 10-hour observation there were 71 cognitive shifts across steps of the nursing process as the RN attended to the assigned 6 patients. Maintaining focus on the priorities and needs of multiple patients requires organizational and short-term memory skills.[7] Simmons and colleagues[5] warn that there is a limit to the information that can be stored in short-term memory.

The cognitive pathway is useful for showing how an RN organizes care activities. Between 0850 and 1125, the RN dedicated considerable time to medication administration. Although there were interruptions and planning activities also taking place, the RN clearly focused time on medication administration. The deliberate approach to preparing medications, 1 patient at a time, allowed this nurse to focus on the purpose and precautions necessary in medication therapy. Although there were delays in administering all medications in a timely basis, there were no administration errors made by this RN. The data from HFE analysis helped to show how the RN conserved time by working with patients in the same room before moving to a different geographic area. This can be seen from 1055 to 1122, when the RN works primarily with 2 patients for a period of time.

RNs provide multiple types of interventions. The cognitive pathway is a useful tool for revealing an RN's organizational skills and ability to deliver multiple interventions to a subset of patients during a specified time. On 4 occasions the nurse engaged in a step of the nursing process simultaneously for the entire group of patients. For example, at 1125 the nurse completed patient classification and at 1224 charted for all patients.

The pathway shows that the RN was inconsistent in evaluating patients. Although there is no standard for a 10-hour time frame for how frequently evaluation should be performed, there are standards for the conduct of evaluation after select types of interventions. The RN did not consistently evaluate patients for pain relief after analgesic administration. In addition, there was no evaluation of patient education activities. The RN did consistently evaluate 2 patients with developing clinical problems; 1 patient experiencing urinary retention after Foley catheter removal (Patient 01A) and a second patient experiencing esophageal regurgitation and vomiting (Patient 17A).

Once the RN completed rounds on the first 4 patients, interruptions began to occur. The RN observed was a senior RN, who was perceived as a leader on the nursing unit. Many of the interruptions were the result of other staff seeking her assistance and direction with procedures. One example occurred between 1020 and 1053, when the RN was called into an unassigned patient's room as a physician prepared to perform an invasive procedure requiring conscious sedation of the patient. The RN interceded when she discovered the procedure was about to begin with insufficient monitoring. The RN remained at the bedside to set up necessary monitoring equipment and to assist other staff in conducting ongoing patient assessment. In this case, the RN prevented a potential error from occurring.

Table 1 summarizes the type and timing of interruptions in relation to steps of the nursing process. The RN experienced 43 different interruptions during the 10-hour observation period. Interruptions were classified as delays in starting (occurred while RN not engaged in a step of the nursing process), direct disruption (occurred while RN provided direct care activities), or indirect disruption (occurred while the RN provided indirect care activities).

Among the 30 disruptions, 3 occurred during assessment, 3 occurred during planning, and 24 occurred while the nurse was engaged in interventions. A total of 13 delays in starting occurred. No omissions or commissions were identified as associated with interruptions. The 3 most common types of interruptions involved staff inquiries (seeking information from RN), staff communications (sharing unit management information), and equipment or resource access.

The RN was reasonably successful in completing the identified priorities of care. Of the 18 priorities identified for the 6 patients, 8 were met, 2 were managed but not evaluated for an effect, and 8 were unmet. Two of the unmet priorities were not completed because of an unavoidable test delay. Three additional priorities were unmet because the patients failed to experience response to therapy. For example, the priority for discharging Patient 01A was unmet because the patient experienced no response to measures to relieve urinary retention and was forced to remain hospitalized. One priority, referral for foot care, was unmet as a result of a patient's early discharge. Finally, only 2 patient priorities were omitted by the RN, a failure to provide interventions to promote a patient's bowel elimination and to increase another patient's activity. Whether the omissions were attributable to a conscious decision by the RN to delay intervention or failure of the RN to recall the priorities was not determined.

Discussion

The merging of HFE techniques and qualitative observation provides a rich source of data for analyzing a nurse's practice within the acute care setting. Compared with HFE analysis alone, the combined methods offer a clearer and more detailed view of the nature of nursing care and when environmental factors are most likely to create potential for error. The cognitive pathway visually demonstrates the dynamic nature of nursing care across time and shows the importance of the cognitive work of nursing, particularly with respect to the ongoing decision making that occurs in the care of multiple patients.

The cognitive pathway is a valuable tool for tracking how well nurses are able to attend to priorities of care and the conditions within a clinical setting that support or interfere. The nonlinearity of nursing care coupled with interruptions in the work setting creates situations in which the nurse can easily lose cognitive focus on a given patient's priorities. For example, after the interruption during assessment of Patient 17B, the RN returned to complete a problem-focused assessment. The assessment was based on patient priorities and was reasonably complete; however, data were missing. The RN rated the patient as 14 on the Braden pressure ulcer risk scale without physically examining the condition of the client's skin. A question to raise in this situation is whether the interruption and the cognitive shift between two patients contributed to the assessment omission or was it a practice oversight? The interruption conceivably prevented the RN from thoroughly inspecting the client's skin. A cognitive pathway has the potential for revealing the threat interruptions create when cognitive shifts occur within and between patients. This has significant implications for understanding the true nature of errors and what type of interventions might prove useful in their prevention.

The cognitive pathway provides a clear perspective of how and when an RN conducts activities of the nursing process and the type of interruptions within the work setting that create barriers. In the case studied, the RN was inconsistent in performing evaluation. The fifth step of the nursing process typically follows intervention to determine patient progress and subsequent outcomes. Interestingly, among the 30 direct care disruptions observed, 24 occurred during intervention. Are there safety implications when a nurse is unable to follow through with evaluation once an intervention is completed? Use of a pathway can reveal the frequency with which critical steps of the nursing process are not conducted and whether such omissions might be related to environmental interruptions or practice patterns.

The ability of a nurse to focus and attend to multiple patient needs is clearly a challenge and one that, if disrupted, can lead to error. Physical and operational structures within a healthcare setting affect RN decision making and result in multiple potential paths to failure, including increased stacking of incomplete tasks, increased opportunity for interruptions, and complicated access to care resources.[5] Understanding how patient care is delivered within the context of clinical decision making is crucial. Capturing the nonlinear character of nursing practice, in contrast to linear analysis of nursing tasks or activities, poses very different implications for identifying the type of solutions needed to minimize error. For example, being able to study how nurses conduct nursing rounds or the success nurses have in meeting standards for assess-

ment and evaluation may prove useful in defining new delivery of care strategies for promoting decision making.

Traditionally, hospitals have made changes to the work environment as a result of HFE analysis alone. These changes have brought efficiencies to linear procedures (eg, medication preparation and test ordering) that nurses perform. The combined analysis of HFE and qualitative observation offers a previously unavailable analytic perspective to the healthcare environment. The clinical decision making of the nursing process is crucial to the ongoing problem solving and intervention that nurses use in patient care. If clinical problem solving becomes disrupted or blocked, are there ways to prevent omissions or commissions in care from occurring? HFE and qualitative analysis offer a new and stronger methodology for examining this question and for recommending innovative ways to support clinical decision making in patient care. Additional development and investigation of this methodology is needed.

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