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Nurses As Knowledge Workers: Is There Evidence of Knowledge in Patient Handoffs?

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Abstract

Patient care handoffs are critical to ensuring continuity of care and patient safety. Current definitions of handoffs focus on information, but preventing errors and improving quality require knowledge. The objective of this study was to determine whether knowledge and wisdom were exchanged during medical and surgical patient care handoffs and to discover how these were expressed. The study was a directed content analysis of 93 handoffs using the data/information/knowledge/wisdom framework. Results indicated knowledge was present in all handoffs, comprising 41% of the phrases across the two types of units. No wisdom was coded. The percentage and types of knowledge phrases differed between medical and surgical units. Handoffs could be more knowledge based by linking handoff content to patient problems and goals. Future handoffs could be computationally derived, context-specific, and linked to problem-focused care plans and patient summaries. Improved data visualization and cognitive support are needed.

Keywords

content analysis, knowledge, nursing informatics, patient handoff

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Patient care handoffs are a critical component of ensuring consistent care and patient safety. Current definitions of handoffs predominantly focus on information, but preventing errors and improving care quality require knowledge and critical thinking. Little research is available about the knowledge component of nursing handoffs. The objective of this study is, therefore, to determine whether knowledge and wisdom are exchanged during patient care handoffs on medical and surgical units in acute care settings and if present, to discover how these are expressed.

Patient care handoffs, or change of shift reports, are defined as the exchange of patient information between health care professionals, accompanying either a transfer of control or responsibility (Cohen & Hilligoss, 2009). Also known as handovers, sign-off, and intershift reports, handoffs occur when nurses provide pertinent information about their patients to facilitate care continuity. This information is a synthesis of facts gathered during care, received from the previous shift and gathered from other sources such as health records. Thus, handoff activity is a critical component of ensuring consistent care and patient safety (Croteau, 2005; Ebright, Urden, Patterson, & Chalko, 2004; Pezzolesi et al., 2010).

Current definitions for and stated functions of handoffs focus on information transfer and do not yet include the concept of knowledge; however, nurses are considered knowledge workers (Antrobus, 1997). Knowledge work involves analyzing information and applying critical thinking to solve problems and educate others (McDermott, 1995; Sorrells-Jones & Weaver, 1999). From an experiential point of view, we contend that handoffs likely contain knowledge as well as information, but little is known about the extent to which knowledge is a component of nursing handoffs. This is a gap in the current literature and perhaps in thinking among handoff researchers, given the current emphasis on its information content. If handoffs do not portray knowledge, methods are needed to improve handoffs to be consistent with the concept of nurses being knowledge workers. If handoffs already contain knowledge aspects, we need to understand what knowledge is exchanged and how it is exchanged. In either case, the results have implications for computerizing the handoff process and how this exchange might support nurses in their role as knowledge workers.

Enhancing or including knowledge in handoffs could leverage nurses' abilities as knowledge workers and assist them in analyzing information by using critical thinking to care for the patient's problems and facilitate goal progression (Antrobus, 1997). This is important to nursing as a whole because knowledge is used to influence evidence. Evidence-based practice (EBP), a current focus for nurses' clinical care, is "the conscientious, explicit and judicious use of current best evidence in making decisions about the care of the individual patient" (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996, p. 71). Thus, EBP involves knowledge rather than merely information.

Prior Research on Handoffs and Intro to the Data–Information–Knowledge–Wisdom (DIKW) Framework

The impetus for this research came from the increased attention on handoffs by regulatory agencies and recommendations on the use of technology to support the activity. In 2007, the World Health Organization (WHO) and The Joint Commission in the United States created a combined document outlining best practices for handoffs. They acknowledged research in Australia and Great Britain on defining patient safety issues for handoffs. Suggested actions to alleviate existing types of patient safety issues included (a) implementing a standardized approach to handoffs, (b) implementing systems to ensure the next shift received pertinent information, (c) incorporating training about handoffs into educational programs, and d) encouraging communication between organizations caring for a patient (WHO, 2007).

In 2006, The Joint Commission launched a National Patient Safety goal calling for hospitals to implement a standardized approach to handoffs. This was initiated because failures in communication between health care workers are known threats to patient safety as indicated by studies on critical incidents caused by incomplete or omission of information (Croteau, 2005; Hinami, Farnan, Meltzer, & Arora, 2009; Pezzolesi et al., 2010; Pothier, Monteiro, Mooktiar, & Shaw, 2005).

Despite the calls for standardized approaches, no common standards, no common format, and limited tools exist for nursing handoff communication (Klee, Latta, Davis-Kirsch, & Pecchia, 2012; Nelson & Massey, 2010; Randell, Wilson, & Woodward, 2011). Acceptance of one data set or tool has not yet occurred, although some countries are standardizing content and developing tools. For example, Kaiser Permanente developed a handover checklist using the SBAR (situation–background–assessment–recommendation) checklist suggested by The Joint Commission, prompting information in the four categories (Haig, Sutton, & Whittington, 2006). Although providing some structure for handoffs, this general checklist was developed for cross-discipline communication; its use in handoffs requires tailoring and the inclusion of more specific information. Clinicians in Australia revised SBAR into a tool called the iSoBAR (identify–situation–observations–background–agreed plan–read back; Porteous, Stewart-Wynne, Connolly, & Crommelin, 2009). Last, Johnson, Jeffries, and Nicholls (2012) developed a minimum data set for electronic nursing handovers. While these tools represent progress toward standardization, research is not yet available to assess their implementation and resulting patient outcomes.

The WHO and others suggested increased technology support as a solution for improving handoffs (Strople & Ottani, 2006; WHO, 2007), but efforts to standardize nursing handoffs using computerization have had mixed results. Nelson and Massey (2010) implemented a standardized electronic template in a surgical oncology unit. They reported perceptions of improved information and a decrease of 38 min average for shift report times. Unfortunately, this template was not integrated with the existing electronic health record (EHR), which may limit its longer term use. Staggers, Clark, Blaz, and Kapsandoy (2011) found that a computerized patient summary report was often incomplete, inflexible, and did not offer the information tailored to the patient to provide the cognitive support needed by the nurses. Laxmisan, McCoy, Wright, and Sittig (2012) evaluated the presentation of computationally created patient summaries of 12 different EHR systems. They found large variation in the capabilities of the systems to summarize content and recommended improvement in the summary screen functionality.

This study used the DIKW framework to analyze handoff content. The framework is widely accepted nationally and internationally in nursing informatics (American Nurses Association [ANA], 2008; Schleyer & Beaudry, 2009). The ANA's (2008) definition of nursing informatics emphasizes on DIKW. The International Medical Informatics Association Nursing Informatics Working Group's definition of nursing informatics states, "Nursing Informatics (NI) . . . integrates nursing, its information and knowledge and their management with information . . . to promote the health of people . . . world wide" (International Medical Informatics Association Special Interest Group on Nursing Informatics, 2009).

Graves and Corcoran (1989) published a foundational article outlining data, information, and knowledge as the basis for nursing informatics. It was not until the 2008 edition of the ANA scope and standards of practice for nursing informatics that wisdom was added to the formal definition of nursing informatics. The current ANA definition of nursing informatics emphasizes the continuum of DIKW (ANA, 2008; Schleyer & Beaudry, 2009). The components of the DIKW framework are described below.

Data have little meaning. They are symbols that represent properties of objects, events, and their environments. Data are discrete facts described objectively without context or interpretation (Graves & Corcoran, 1989). For example, the number "120" has little meaning in isolation.

When data are put into a context and combined within a structure, information emerges (Tuomi, 1999). Information is derived computationally by manipulating the symbols, or data, using procedures in an organized or structured way, such as gathering the observations for a specific patient and organizing them by date.

Knowledge is information that is synthesized so that relationships are identified and formalized. These relationships leverage the nurse's ability to apply inferences to information and to make a judgment to determine patient progress toward expected outcomes, or to identify nursing problems, and interventions appropriate for the problem. A set of vital signs with patient demographics, or a trend of vital signs, is information. The interpretation of that trend as abnormal, however, indicates knowledge.

Wisdom is knowing *why* things should or should not be done. Wisdom builds on knowledge and expertise; it involves understanding the individual patient, and applying knowledge with empathy and compassion (ANA, 2008; Matney, Brewster, Sward, Cloyes, & Staggers, 2011). Because no research is available at the intersection of handoffs and DIKW, the aim of this study was to determine whether knowledge and wisdom were exchanged during patient care handoffs and if so, to discover how they are expressed. Understanding how knowledge is represented in handoffs by applying the DIKW framework could help define electronic templates or shift summaries.

Method

This study is a secondary data analysis of 93 patient care handoffs using deductively driven, directed content analysis. Directed content analysis was chosen because the DIKW framework is already developed, and it was conceptually extended for this study within the context of nursing handoffs. We first describe the original study and then the secondary data analysis.

Original Study

The original study was conducted to understand current practices and computerized processes for handoffs on medical and surgical units (Staggers & Blaz, 2013; Staggers et al., 2011; Staggers, Clark, Blaz, & Kapsandoy, 2012). The study was approved by the facility's Institutional Review Board.

Sample and setting. The initial research used a purposive sampling technique across levels of expertise, shifts, length of shifts, patient care units, type of nurse (permanent staff, agency, and per diem), and experience levels. Nurses were recruited through email, nomination from the nurse manager, and face-to-face interviews (Staggers et al., 2011, 2012). Nurses with less than 6 months of work experience were excluded. The sample included 23 female and 3 male nurses with an average age of 37. Most held a bachelor's degree. Experience ranged from 6 months to 20 years with various levels of experience and employment. The nurses worked in different shifts and different medical surgical units. The sample included 25 different nurses giving report on five different medical and surgical units. Nurses giving (vs. receiving) a handoff report needed to synthesize material across various patients and tools to prepare and communicate handoffs. The cognitive tasks of nurses giving and receiving a handoff are distinct; therefore, the researchers focused only on nurses giving a handoff. Nurses worked in 8- and 12-hr shifts; data were collected equally across nurse expertise, units, and shift changes at 07:00, 15:00, 19:00, and 23:00 hr.

The settings were a tertiary care (425 beds) and an oncology specialty (50 beds) hospital in the same health system in the Western United States. Three surgical and two medical units were sampled, representing the total population of available medical and surgical units.

Both institutions shared an EHR from a worldwide vendor. EHR functions included a computerized handoff form. The form pulled data from modules, including computerized provider order entry, an electronic medication administration record, results retrieval, and nursing documentation. Previous findings showed reduced adoption of the computerized handoff form and continued reliance on paper (Staggers et al., 2011).

Data collection. The original study used multiple data collection methods, including direct observation, field notes, artifact collection, and semistructured interviews about the handoff process, and was carried out between October and November 2009. The 25 nurses gave an average of 4 handoffs each. The 93 resulting handoffs were audio-recorded and transcribed verbatim by a professional transcription firm. Transcripts were checked for accuracy against the audio-recordings. Completed transcripts were stored on a secure server at the university and de-identified.

The Secondary Data Analysis for DIKW

The data analysis for the present study followed the three steps recommended by Bernard and Ryan (2010): (a) the first cycle provisional coding to establish boundaries among the DIKW components, (b) the second cycle coding of all of the transcripts, and (c) the third cycle consolidation of categories to examine the data for themes. The three steps were followed using the qualitative software Atlas.ti.

The first cycle coding involved developing DIKW category definitions, determining subcategories, and conducting joint coding of three transcripts to establish boundaries among the DIKW components. Using the literature describing the DIKW framework, definitions were carefully developed to differentiate the DIKW concepts within the context of coding patient care handoffs. At the end of the first cycle coding, the codebook included definitions and examples for each DIKW category and subcategory.

The codebook acted as a living document that reflected our iterative discussions, analysis, and code development through first and second coding cycles. After the subcategories were determined, utterance selection criteria were established. Based on their subcategory alignment, utterances were coded as entries in Atlas.ti. Entries could be any word length as long as the utterances were supported by the selection category definition; thus, the unit of analysis used for the content analysis was each coded entry.

For second cycle coding, the remaining 90 handoffs were evenly divided between the researchers (S.A.M. and L.J.M.) for individual coding. Using the codebook, the researchers read and coded each transcript using a deductively driven, directed content analysis coding technique (Bernard & Ryan, 2010; Hsieh & Shannon, 2005).

Third cycle coding resulted in a refined subcategory list. It involved combining the coding for all transcripts for evaluation of coding consistency, examining each category for blurred boundaries between the two coders, and discovering additional subcategories. Subcategories were combined where the content was similar and categories with large numbers and differing content were separated into subcategories. After examining and revising the subcategories, all 93 handoffs were reevaluated to ensure coding consistency.

Validity and reliability. The concepts used in this study, DIKW, are foundational to the field of nursing informatics and as such are valid concepts for study. The subcategories in this study such as allergies, activity, medications, and vital signs are well known to nurses and embedded in the delivery of health care services to hospitalized patients.

Repeated dialogues and comparative coding between coders were used to maintain intercoder reliability throughout the coding process. As part of the third cycle coding, three individually coded transcripts were used to measure intercoder reliability. They included 224 coded entries across 38 subcategories that resulted in a Cohen's kappa of 60.6. This represents the minimal amount of the required level of agreement and led us to conduct additional coding described above. (Bernard & Ryan, 2010). Reliability was recalculated using 163 coded entries for information and (Staggers & Jennings, 2009) knowledge across the final subcategories resulting in a Cohen's kappa of 87.0. The researchers concluded that the 93 handoff transcripts were reliably coded and satisfactory for frequency analysis and making inferences (Bernard & Ryan, 2010; Krippendorf, 2004).

Results

The codebook included definitions and examples for each DIKW category tailored to handoffs. The authors primarily referenced Graves and Corcoran (1989) to develop the definitions of data, information, and knowledge. The definitions were not as straightforward as expected. Instead, the iterative coding process included extensive dialogue to distinguish boundaries among the DIKW concepts. After much discussion, we adopted Graves and Corcoran's position that information is data with context. The statements in handoffs are embedded within context, for example, organizational culture of a specific unit, and the handoff for a specific patient on a specific date and shift. Therefore, we concluded that handoff communication begins at the information level because the activity occurs within a context.

For this study, the concept of information was defined as observations reported without a nursing judgment. Examples of information in the handoff transcripts included basic name/value pair observations such as "The patient is a female," "Age is 63," and "Past history of diabetes."

The concept of knowledge was coded when nursing judgment or critical thinking was articulated (an utterance). Critical thinking is the ability to take a large amount of information, think in a systematic or logical manner to deduce a conclusion, and apply it to a problem or goal (Gambrill, 2006). Within handoffs, judgment was apparent when an inference was given about the stated information (International Organization for Standardization, 2009). For example, in the subcategory of Pain, a judgment is exemplified by a nurse who stated, "His pain med is holding his pain level down nicely." Although a consensus definition for wisdom is not available in the nursing literature, the concept was defined as "the ability to add experience and intuition to a situation and apply knowledge with empathy and compassion" (ANA, 2008; Gluck, 2010).

Knowledge in Nursing Handoffs

The first research question asked whether evidence of knowledge was apparent in nursing handoffs. For the 93 handoffs, a total of 1,718 codes were assigned. Only the concepts of information and knowledge were represented in the transcripts; no entries were coded as data or wisdom. The handoffs included 59% (n = 1,010) phrases (utterances) coded as information and 41% (n = 708) as knowledge. Each one of the 93 handoffs included some form of knowledge.

The contrast between the concepts of information and knowledge is clear. Information was the simple statement "regular diet," whereas knowledge in the same subcategory was "I was worried about her blood sugar so I had her drink a whole thing of orange juice. She wasn't eating, so I needed to at least get something down her." Information might be "he walked down the hall × 2 today," while knowledge was "ambulation is a big deal." From these results, knowledge is evident in this sample of 93 nursing handoffs.

A total of 15 subcategories were developed. Table 1 displays the subcategory frequencies and examples of information and knowledge. The most frequent information phrases coded were Current Illness & History (n = 166) and Procedures & Treatments (n = 127). The fewest codes were for Risk (n = 0). Whereas, the most frequent knowledge phrases coded were for Physiologic Signs & Symptoms (n = 185) and the fewest number of knowledge codes assigned was for Allergies (n = 0).

The percentage of information and knowledge entries was also evaluated by type of nursing unit because handoffs occur within specific and unique contexts (see Figure 1). For medical units (n = 562), information and knowledge were almost evenly split—information (51%, n = 288) and knowledge (49%, n = 274). For the surgical units, the total number of entries was higher at n = 1,156. These were coded as information at 59% (n = 722) and knowledge at 41% (n = 434).

Details about subcategory entries, including information and knowledge by type of unit, are available in Figure 2. Nurses on surgical units had double the volume of information entries and approximately one third more knowledge entries than did nurses on medical units. The highest percentage on the surgical unit was for the subcategory Procedure and Treatment, while the highest percentage on the medical unit was for the subcategory Assessment and Physiology (Figure 2). All information subcategories except Assessment and Physiology were communicated more frequently by the surgical units. The lowest percentage on both units was the subcategory Laboratory.

How Knowledge Is Expressed in Handoffs

The second research question was "If knowledge is exchanged, how is it expressed in handoffs?" Knowledge was present in every handoff although the distribution of information versus knowledge phrases (utterances) differed between the medical and surgical units as noted above. Nurses on medical units communicated Psychosocial, Labs, and Medications (including Pain Medication) categories at a greater frequency than surgical nurses (Figure 3). One nurse made the following statement pertaining to Labs and Medications:

Table 1. Subcategory Codes With Exemplars.

Subcategory	Information example	Number of coded phrases	Knowledge example	Number of coded phrases
Activity	She went for a walk today.	76	Walking ambulation was a big deal. She was holding her breath a lot just for pain because she was so tight.	12
Allergies	Allergic to penicillin.	50	None coded.	0
Current Illness & History	This guy was diagnosed with squamous cell carcinoma . . . where they've done three removals.	166	None coded.	0
Input & Output	She voids.	71	You do a flush of 75 of normal saline (NS). And I've been doing like 120 because he's a little bit low on his urine output.	65
IV Status	He has an 18 gauge in his left forearm.	94	When you do a little flushing with it, it's tender. But it free flows nicely.	24
Labs	His coags came back down to normal.	24	. . . the stool is a large amount, and that's probably why her mag is low at 1.3.	54
Medications	I just gave her Percocet.	76	It's basically for rheumatoid arthritis or a basic chemo drug. However, what they're giving it for is—because he's in rejection . . .	113
Nutrition	Regular diet.	57	I was worried about her blood sugar so I had her drink a whole thing of orange juice. She wasn't eating, so I needed to at least get something down her.	22

(continued)

Table 1. (continued)

Subcategory	Information example	Number of coded phrases	Knowledge example	Number of coded phrases
Pain	No pain.	42	His pain is at about one or two on his back and his hip but he is comfortable with his pain. Just a little soreness and a little discomfort but he's fine.	27
Pain Medications	. . . all ready to go with some IV morphine.	64	So she's actually trying to hold off on that to help get her bowels moving.	45
Physiologic Signs & Symptoms	Color is pink.	82	He's still on a couple of liters of oxygen. I've got to convince him that he's needing to do his incentive spirometry (IS) . . .	185
Procedures & Treatments	They did an electrocardiogram (EKG).	127	And they did x-ray her and all that, for when she did fall. There's no fractures from the falls, which is amazing because you saw that she does have some osteoporosis probably, from reading the history.	65
Psychosocial	She's not in a happy mood.	49	Well, not flat, but just a little depressed. Maybe it's just lonely; I don't know.	23
Vital Signs	Vital wise, she was very stable at 113 over 61.	32	His blood pressure down a little bit here, because he was a little drowsy, and we went and redid it, and he's still—I mean he just dipped down barely.	70
Risk	No risk information was coded within the transcripts.	0	I was worried—because it was gonna be right under the sterile dressing, and I was afraid that it wouldn't quite be sterile.	3
Total		1,010		708

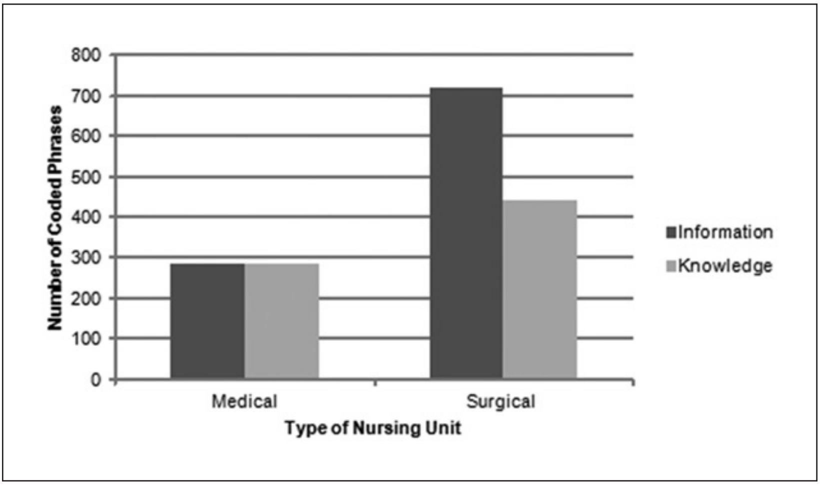

Figure 1. Total coded entries by type of nursing unit.

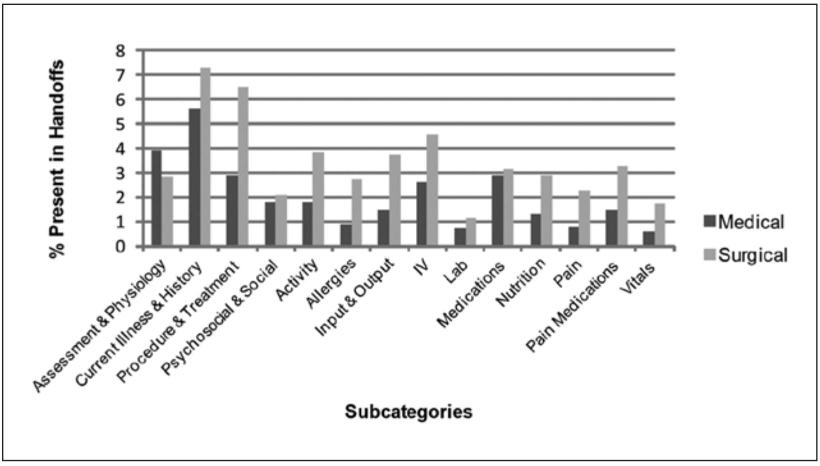

Figure 2. Coded information entries.

> And his blood sugar was still high. He's been in the 200s all day. So I went in and educated him about his body's need for—his insulin needs are gonna be greater now with injury to his body, his body trying to fight stuff going on. So I wrote it on his board, and what the order is, it's one unit bolus per every 20 over 120.

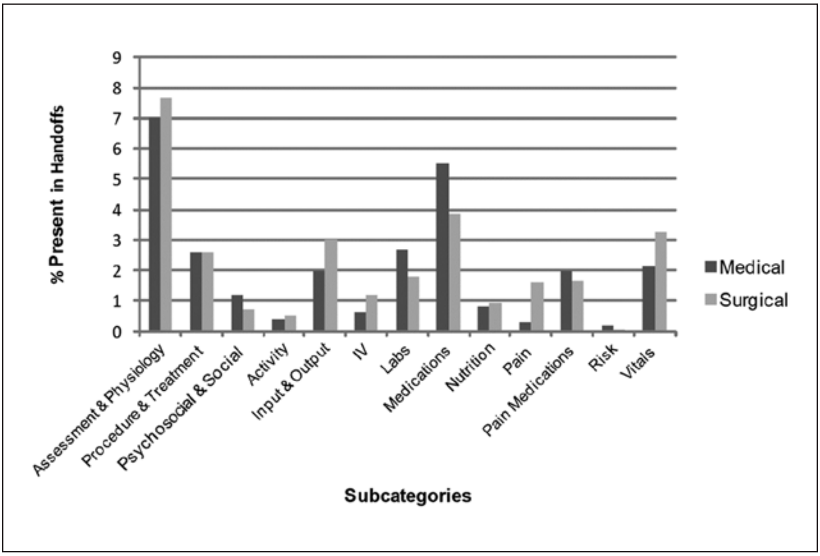

Figure 3. Coded knowledge entries.

Types of knowledge entries used in the surgical unit include postoperative indicators such as Assessment and Physiology, Activity, Input & Output, IV Status, Pain Symptoms, and Vitals.

Following is an example of a knowledge statement concerning Pain Symptoms:

> He's still like loopy as loopy. So I put the PCA [patient controlled analgesia pump] in there, but I have not hooked it up, haven't told him it's available; he has no pain, so I haven't initiated it yet. But it's in there.

We calculated information to knowledge ratios to determine how knowledge is communicated by each nurse. Each of the 25 nurses communicated knowledge, but the amount varied widely. The majority of the 25 nurses reported information more than knowledge, but 9 nurses reported more knowledge than information (Figure 4). Interestingly, 6 nurses were from the medical units and only 3 from the surgical units ($n = 15$). The sample size was too small to make any conclusions about information/knowledge ratios by specific nurse characteristics such as the highest degree obtained, experience, staff type, gender, age, or primary shift worked.

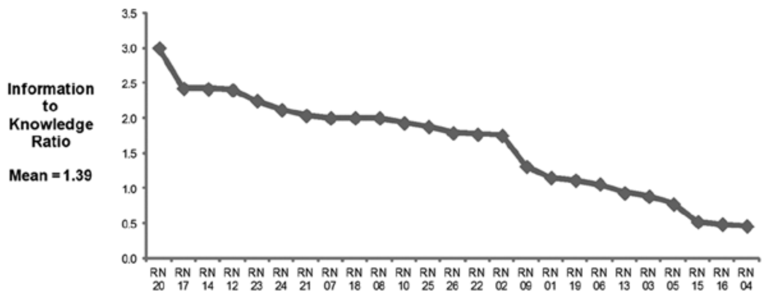

Figure 4. Information to knowledge ratio by nurse during change of shift report.

Discussion

To our knowledge, this is the first analysis of handoffs using the DIKW framework and to determine the extent of knowledge contained in nursing handoffs. Of the four categories, only information and knowledge were represented. No wisdom was coded in the transcripts. This may reflect particular activity, handoffs, and the researchers' adopted definition of wisdom as applying knowledge with empathy and compassion. Empathy and compassion may be associated more with the direct delivery of health care services rather than communications during handoffs. Still, the researchers expected at least one example of wisdom would be coded during the 93 handoffs.

This sample of handoffs did not include knowledge utterances about plans of care, nursing diagnoses, multidisciplinary goals, and patient problems. Instead, these were implied. Nurses only explicitly mentioned risk (e.g., risk for falls) 3 times in more than 1,700 coded phrases. Nursing-derived patient care goals and patient education content were also missing. Based on the literature and our clinical experience, goal setting is part of the nursing process and should be included in patient handoffs. Nurses pride themselves on being patient educators, although this content was not seen in these patient care handoffs.

Several reasons may help explain the lack of goal content in handoffs. First, the EHR in use in these sites did not include a care planning module, although one was planned for the future. Multidisciplinary plans of care were, however, available on paper. These two types of media may not have allowed for easy integration and inclusion in handoffs. Another reason may be the type of units observed. For example, the surgical units were fast paced with patient stays averaging only 2 to 3 days. Many of the patients had routine recoveries so the plans of care may have been routine as well. Plans of care for these two types of units and their variety of patients may be more difficult to effect consistently.

Patient education may not have been mentioned during these handoffs because it was not part of the handoff routine, and the paper or EHR handoff forms did not have a category listing patient education. Moreover, because patient care goals were not included in handoffs, perhaps nurses did not make the link between patient care goals and needed education. Unfortunately, the lack of education content in handoffs is consistent with previous research on handoffs (Staggers & Jennings, 2009).

An obvious implication is that handoff content can be improved, by including patient care goals, risks, and education whether the content is computerized or not. This would increase the knowledge-based content, which occurs when critical thinking and judgment are used. Basing handoffs on the plan of care and/or the nursing process could provide fundamental structure that could increase the level of knowledge in handoffs. Then, knowledge could be linked to explicit rather than implicit nursing diagnoses and patient problems. Likewise, interventions would be more likely to be linked to problems or goals. The outcome might be more efficient care, better care coordination, and even perhaps decreased lengths of stay and improved patient safety. In addition, this approach would have implications for informatics to assure that the design of handoff content was rooted in the plans of care and the nursing process. Knowledge levels such as goals, nursing diagnosis, and risks could be integrated with and included in standardized, electronic forms.

With higher levels of knowledge-based handoffs, nurses could improve their practice. One of the main functions of a registered nurse is to be strategic versus tactical. Ideally, nurses would be evaluating the larger picture with the patients' outcomes and goals in mind, including the link to patient education.

Each nurse communicated some knowledge, although the amounts varied highly across nurses. This variability indicates an opportunity to increase knowledge (vs. information) communication through training on necessary handoff content, especially for nurses who rely primarily on information transfer. In this way, handoffs have the potential to be knowledge transfers versus information transfers in the future.

This study does give beginning support to the claim that nurses are knowledge workers even though the variability across nurses is high. Knowledge was evident in handoffs when patients' progress was not normal or their progress was linked to projected outcomes, nursing problem status, and needed interventions. Still, the majority of utterances reflected information because the number of knowledge utterances was less than half the total content.

The ratio of information to knowledge was greater for nurses on surgical versus medical units. The reasons for the higher ratio of knowledge versus information on medical units may be attributed to several reasons. One might assume that medical conditions are more complex and require longer lengths of stay, allowing registered nurses an opportunity for increased critical thinking and the increased knowledge exchange in handoffs. Patient courses of care may be more routine on surgical units and not require as much knowledge exchange. Moreover, medical patients may have more comorbidities, be older, and more prone to nonroutine recoveries, elements that could trigger knowledge-level exchanges. Last, the differing information and knowledge content could be expected given the different types of patients and work design. This is exemplified by nurses on surgical units communicating most frequently about procedures and IVs, whereas nurses on medical units communicated about assessments, procedures, and medications.

The differing amounts of information and knowledge on the two types of units have implications for informatics. One unified format and structure for the patient summary used in handoffs will not be acceptable, although EHR vendors often combine the format for these types of units. Moreover, patient goals and problems are highly contextualized and different between units and patients, indicating the need for tailored e-designs. If these notions are implemented, informatics can better support patient-centered, context-specific problem-focused care plans, patient summaries, and data visualization. This difference also implies that handoff content may be more easily standardized on surgical units than medical, and that computerization of content may be more easily accomplished for surgical patient handoffs.

Nurses often conveyed information that was freely available via the EHR or paper handoff form, such as age or medical orders. The rationale to restate this obvious information was not apparent. Perhaps this information is part of the ritual of nursing handoffs or it may be that the off-going nurses need to state this simple information to anchor themselves or to introduce more critical content.

The action of nurses giving and receiving information during shift report requires them to process information into knowledge. This processing can be interpreted using information processing theory and schema theory (Fang & Holsapple, 2011; Plant & Stanton, 2013). Deriving knowledge from data and information is cognitively accomplished through pattern recognition within the human brain or using a computer. These patterns for patient care can be considered a type of schema. Therefore, data and information are used to recognize appropriate patterns and schema for a specific patient during a handoff. In this manner, abnormalities and deviations from the schema can be detected. EHRs can assist in this process. For example, time series and graphical representations of data such as vital signs, lab values, and activity levels, and links between these separate modules (such as medications and vital signs) can support recognition of deviations, assist with patient assessments beyond one shift, and potentially beyond a current hospitalization. Electronic documentation also can be used to graph pertinent results, such as vital signs or lab values. These could be customized to represent longer time periods creating a "bigger picture" of the patient beyond the 8 to 12 hr nurses who currently worked on a shift.

Decision support rules can be created that examine atypical data for information. For example, if an adult patient has an oxygen saturation of 82% and a respiratory rate of 40 breaths per minute, an alert could be written to trigger the possible problem of impaired gas exchange. More subtle patterns than this obvious one could be programmed. More complex decision support rules have been used for processes such as ventilator weaning using physiological measurements such as blood gasses (Morris, Hirshberg, & Sward, 2009; Thomas, Hoffman, Handrahan, Crapo, & Snow, 2009).

The results of this study have implications for EBP in nursing handoffs because EBP requires knowledge. If handoffs are to be consistent with EBP, they likely need to comprise more knowledge than is evident in current handoffs.

This study raises questions for future exploration, especially to understand the implications of the differing information and knowledge ratios on medical and surgical units. Future researchers could study the role that patient complexity plays in the amount of knowledge exchanged. Comparison of manual processes and electronic handoff designs to increase the knowledge levels in handoffs could be evaluated. Reasons for the lack of discussions about risk could be explored. In addition, researchers could identify the types of information and knowledge coded by nurses' characteristics such as years of experience or educational levels.

Knowledge discovery is another area for future nursing research. Transforming information to knowledge is complex, but knowledge discovery should be carried out to assist and support critical thinking (Bakken, Stone, & Larson, 2008). Knowledge in databases requires domain expertise as well as informatics expertise to mine patient data stored in database and identify relationships (knowledge) within the data.

There are limitations in this study. First, the care plan module within the available EHR was not yet implemented and may have affected the results even though it was available in paper format. Second, shared, up-to-date problem lists were unavailable in the EHR except in narrative format in nursing and progress notes. Finally, this research was performed in multiple not-for-profit institutions in one state and may not be generalizable to all health care systems.

In this analysis, we demonstrated that nursing knowledge was present in patient handoffs on medical and surgical units. Knowledge was evidenced when patient problems and interventions were discussed during handoffs. EHRs designed to support process and knowledge needs of diverse nursing units may be used to support an increased use of knowledge in handoffs. Increased knowledge in patient handoffs could facilitate critical strategic work of registered nurses and contribute to the patient's experience and outcomes.

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