Towards an Ontology for Interdisciplinary Handoff Communication in Intensive Care: Implications for Tool Resiliency and Patient Safety

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Handoffs are considered a vulnerable point in the clinical workflow. A recent report by The Joint Commission (TJC) found that nearly 80% of communication errors occur during care transitions. While there has been significant research on handoff tools and their use, it can be argued that there is variability among the handoff tools used in current practice. We conducted a multi-year, longitudinal evaluation on the nature of content and structure of handoffs among residents and nurses in a medical intensive care unit (MICU). In this paper, we report on our top-level findings regarding the use of a body-systems based formatted tool that supported standardized, interactive and effective communication for both medical and nursing practice. We discuss the theoretical and practical implications of our results for the design and development of future handoff tools.

INTRODUCTION

Patient handoffs involve the transfer of care responsibility and control between care providers (Abraham, Kannampallil, & Patel, 2012; Riesenberg, Leitzsch, & Little, 2009; Riesenberg, Leitzsch, Massucci, et al., 2009). The importance of handoffs is reflected by the attention it has received from a number of regulatory and research organizations including the Institute of Medicine (Institute of Medicine (IOM), 2000), The Joint Commission (TJC) (Commission, 2008), World Health Organization (WHO), and the World Alliance for Patient Safety (WHO, 2007). However, a recent report by TJC found that nearly half of communication errors occurred during care transitions (JCAHO, 2012), and identified handoffs as a vulnerable point in the clinical workflow. To promote safety in handoffs, TJC recommended standardization in the communication activities during care transitions, supported by the opportunity to ask and respond to questions. One well-recognized approach to standardization adopted by most hospitals was the use of tools to streamline information transfer during handoffs. Handoff tools have primarily been developed for physicians to support end-of-service handoffs and end-of-shift sign-outs (Basu, 2011; Ferran et al., 2008; Ram et al., 1992), and for nurses for their shift reports (Chung et al., 2011; E. Clark et al., 2009; Nelson et al., 2010). These tools are designed mostly to support several functions including information processing (Flanagan et al., 2009; Rabinovitch et al., 2009), distributed cognition (Joy et al., 2011), accountability (Salerno et al., 2009; Van Eaton et al., 2005), cultural norms (Wohlauer et al., 2012) and social interactions (Wentworth et al., 2012).

Based on the literature, handoff tools can be classified into three main types: paper-based (e.g., (Chung et al., 2011)), electronic standalone tools (e.g., (Cheah et al., 2005; Rabinovitch et al., 2009)), and EMR-integrated (e.g., (Anderson et al., 2010; Flanagan et al., 2009)). As expected the EMR-integrated handoff tools were the most preferred type, due to its distinguishing features for automated download of handoff information with minimal manual entry, interface into other ancillary clinical information systems, automatic population information, alerting capabilities and support for clinical handoff workflow including pre-turnover, handoff, and post-turnover phases (e.g., (Palma et al., 2011; Wentworth et al., 2012)). Despite the significant progress over the last decade on the design and development of handoff tools, evidence is mounting on their limited use in daily practice (Abraham, Kannampallil, & Patel, 2014; Harvey et al., 2007).
To investigate this issue further, we conducted an empirical examination of the use of handoff tools by physicians and nurses in a hospital setting focusing on how the use a body systems based format for handoffs supported the content, structure and quality of handoff communication.

**BACKGROUND**

Prior research studies on handoff tools have shown that there is significant variability in the implementation, adoption and use of these tools, even within a specific unit or department (Abraham, Kannampallil, Almoosa, et al., 2014; Harvey et al., 2007). We believe these variations can be attributed to five specific factors.

*First,* there is limited support for pre-turnover coordination tasks and post-turnover patient care and management activities. In other words, patient care information documented on communication tools was often used exclusively for the purposes of information processing and transfer between outgoing and oncoming clinicians during handoffs. The lack of persistence in such tools (i.e., the content from these tools not being saved for future use) was a significant drawback (e.g., (Abraham, Kannampallil, & Patel, 2012)). For instance, the handoff documentation of the outgoing nurses have been reported to be solely used during shift reports, but not retained anywhere in the system because of the limited functionality and integration into the nursing workflow.

*Second,* different units require handoff tools that are aligned with the specific functions (e.g., type of practice) and needs of a unit (Staggers et al., 2009), making them context-dependent. For instance, a tool designed to support handoffs in the emergency department may not be useable and transferrable to support intensive care unit handoffs because of the varying patient care goals and requirements.

*Third,* there are various content structures and organization that underlie handoff tools. Three main classes of handoff content structures were identified: patient-problem, situation briefing and body-system. The patient-problem based tool is defined by a structure where handoff information is arranged based on key patient problems, listed in either the order in which they were identified or prioritized (e.g., SOAP or Subjective, Objective, Assessment and Plan). The situation-briefing based tool organizes handoff information based on patient conditions and situation that requires clinician’s immediate attention and action (e.g., SBAR or Situation, Background, Assessment and Recommendation). Body-system based tools have for handoff information arranged based on a medical model in which illnesses are represented in relation to the functional systems of the body (e.g., the nervous, cardiology, gastrointestinal, and renal systems).

*Fourth,* varying hospital organizational policies on handoff tool adoption by clinicians create significant challenges for handoff use. While a few hospitals enforced strict policies and mandated the use of hospital-based handoff tools (Basu, 2011; E. Clark et al., 2009), others have made it voluntary, leaving the choice of type and use of the handoff tool up to the clinicians (Anderson et al., 2010; Bernstein et al., 2010; Frank et al., 2005).

*Fifth,* limited or lack of training of handoff tools has resulted in the lack of consistency in their use among clinicians, who have found different ways to use handoff tool. For instance, at times, clinicians used the handoff tool for purposes they were not intended for (Vawdrey et al., 2013).

Taken together, these factors have resulted in wide variability in the adoption and use of the handoff tools in healthcare settings, potentially leading to fragmentation of information during care during transitions. In this paper, we report on two empirical studies that evaluated the use of tools during clinician handoffs: the first study focused on a resident handoffs; the second study examined nurse shift reports. The common theme across both these studies was the use of a body-systems based handoff tool by clinicians in this setting. We report on our evaluation of the nature of clinical content that was exchanged, the structure of communication and the effectiveness of the communication during handoffs. We highlight our top-level findings regarding the use of the body-systems based format that supported seamless, interactive and effective communication for both medical and nursing practice.

**METHOD**

This study was part of a larger study involving the evaluation of handoffs in critical care settings [detailed descriptions can be found in (Abraham, Kannampallil, Almoosa, et al., 2014; Abraham, Kannampallil, & Patel, 2012)]. In this section, we describe the study setting, handoff tools, data collection, coding and analysis.

**Study Setting**

The study was conducted in a 16-bed, “closed” MICU of an urban academic hospital in Texas with approximately 55,000 emergency department visits per year. Patients in this unit stayed for an average of 4 days; hence care continuity was maintained through multiple clinician handoffs.
Resident Handoffs in MICU

The resident and intern on-call team were responsible for sixteen patients in the unit during a single shift. As there was no formal resident “sign-out” procedure at the study site, morning rounds were used for handoffs between resident teams. During these group handoffs, an outgoing team (resident and/or intern) presented patient care-related information by verbalizing the written content on a handoff tool to an oncoming team (attending, fellow, resident and intern). Patient nurses, pharmacists and respiratory therapists also attended these sessions. The attending physician moderated the discussion, which often involved follow-up questions on the information presented. The rest of the oncoming team played a “passive” role, by interjecting into the discussion when necessary to provide supporting information or clarification (Abraham, Kannampallil, & Patel, 2012).

Resident Handoff Tool: To support the information exchanges during handoffs, the residents used a handoff tool that followed a body-system-based format (See Figure 1) (Abraham, Kannampallil, & Patel, 2012; Abraham et al., 2011). The resident handoff tool was structured based on the body system model that mirrors the medical school training curriculum (Varon et al., 2010) in supporting standardization of content (Braun, 2012).

The order of the body system information is based on importance and relevance to critical care workflow: pulmonary, cardiovascular, infectious disease, renal/genitourinary, gastro-intestinal/liver/nutrition, neurology, endocrinology and hematology. The fundamental content categories are organized in a checklist format that includes physical exam/labs, medications, problem list, assessment and plan and system diagnosis for each body system.

Nurse Handoffs in the MICU

Nurses were responsible for two patients per shift. Handoffs occurred at shift changes twice a day. Similar to other institutions, nurse handoffs occurred between the outgoing nurse and oncoming nurse of the patient.

Nurse Handoff tool: To support the communication during nurse shift reports, they used a very similar body system-based tool that contained a patient-case narrative and organ-based information in a narrative format (See Figure 2).

We investigated resident and nurse handoffs using a body-systems based, head-to-toe assessment template in a Medical Intensive Care Unit (MICU). The purpose of these evaluation studies was to investigate the effectiveness of body-systems format in fostering effective communication during care transitions. For both studies, institutional review board of the University and the hospital provided approval, and written consents were obtained from all participants.

Participants

Resident Handoffs: Four (n=4) interns and four (n=4) residents participated in this study over a period of two months. During this period, data on the use of system-based tool on 41 patients (n=41) was collected. The
handoffs at this setting followed a group handoff model – where the outgoing team (resident, intern) presented attending and the oncoming team of resident/intern. These handoffs sessions were part of the morning rounds and were attended by nurses, pharmacists and respiratory therapists (as required).

Nurse Handoffs: Sixteen (n=16) nurses participated in this study over a 2-month period. During this period, data on the use of head-to-toe assessment format on 15 patients (n=15) was collected.

Data Collection

We used a handoff-centered approach where the emphasis was on collecting data on the information exchanges during handoffs. This methodological approach was supported by multiple methods such as observations and shadowing of clinicians (resident handoffs: 120 hours; nurse handoffs: 30 hours), audio recording of handoff communication between clinicians (residents: 41 patient handoffs; nurses: 15 patient handoffs) and semi-structured interviews with clinicians (residents: 4; nurses: 7).

Observations and Clinician Shadowing: General observations were conducted to obtain first hand information on the work practices and processes including the sequence of steps in the handoff process, the roles of the patient care team during care transitions, tools and artifacts used to support the handoff process, handoff methods and strategies. Shadowing, unlike general observations, involve a researcher closely following and focusing on a single participant (and their activities) over an extended period of time. The purpose of the shadowing sessions was to focus on clinicians’ tasks and activities, both before and after handoffs.

Audio-recording of Handoffs: The data collection for this study followed a handoff-centered approach (Abraham, Kannampallil, & Patel, 2012), which has been extensively used to study handoff communication (Kowalsky et al., 2004; Philibert, 2009; Smith et al., 2008). The handoff-centered approach affords a detailed examination of the content and structure of the information exchanges during resident and nurse handoffs. Resident and nurse handoffs were recorded on the days when shadowing data was collected.

Clinician Interviews: Interviews with the residents and nurses were useful to obtain their perspectives on the handoff process including pre-turnover and post-turnover activities. The interviews provided us an opportunity to obtain participants’ insights on the rationale behind their specific tasks and activities including preparation for handoff and completion of shift tasks.

Data Analysis

The data was first transcribed verbatim. The observation, shadowing and interview data for both resident and nurse handoffs were analyzed using an open coding method to understand the overall handoff process including the information seeking and organization, and the nature of communication activities.

The audio-recorded data was examined using a structured coding method. The audio-recorded data of resident communication was coded using a handoff communication framework where the unit of analysis was communication events (Abraham, Kannampallil, & Patel, 2012). Specifically, we tracked the evolution and progression of the “process” of handoff communication activity and accounts for the nature and distribution of the communicative events (i.e., the passing of messages through a channel for a particular purpose), that unfold during the conversation, the communication breakdowns (i.e., gaps or failures in conveying a message by the sender (or team) to the receiver. Four types of communication breakdowns included incomplete information, inaccurate and conflicting information, irrelevant information (from the sender) and incomplete, inaccurate, or irrelevant information from the team) during these interactions, and the roles played by the different participants (i.e., attending physician, oncoming and outgoing resident/intern, fellow).

The audio-recorded data of nurse handoffs were analyzed using conversational analysis methods – verbal content was broken down into utterances (i.e., psychological analogs of a single unit of experience (Apker et al., 2010; Morrow et al., 1993)) and categorized along multiple dimensions: structure (i.e., conversational moves, modified from (H. H. Clark et al., 1987)), content (adapted from (Berkenstadt et al., 2008), and included a comprehensive list of specific clinical elements relevant to critical care patients), and breakdowns in communication (i.e., doubtful information, missing information, incorrect/conflicting information, repetitive information or misinterpreted information). All the data codes related to both resident and nurse handoffs were then transferred to a Microsoft Excel workbook for further analysis.

RESULTS

We highlight three key findings from this evaluation of tools used by residents and nurses in a critical care environment. This evaluation is based on the TJC recommendation of standardization of communication
content and interactivity. Our analysis of the communication content supports the standardization features of handoff tools, while the communication structure supports interactivity of handoff tools. In addition, the preliminary examination of communication breakdowns provides a basis for the evaluation of the nature of communication supported by these tools.

**Handoff Communication Content:** As previously described, the resident handoff communication content followed a body system-based approach. The organ-based information of the patient was organized into categories such as physical exams, labs, medications, problem list, assessment and plan and system-related diagnosis. This structure reflects the medical knowledge epistemological framework by Evans and Gadd used in medical school training (Evans et al., 1989). Similar to residents, nurse handoff communication content also followed a body system-based approach. The organ-based information of the patient was organized into categories such as problem list, assessment and system-related diagnosis, medications and lines, events and orders. This structure was found to foster critical thinking and reasoning skills required by ICU nurses. Although communication content was distributed across information related to system-based evaluation and diagnosis, we found that resident handoff content was predominantly related to assessment/plan and diagnosis; while nurse handoff content was predominantly related to lines/medications and order reviews.

**Handoff Communication Structure:** Based on our analysis of the distribution and transition of communication events, we identified the four prominent communication events during resident handoffs were present information (18.6%); accept information (10.9%), request information (25.8%); response information (21.1%). The analysis of nurse handoff communication demonstrated a similar pattern of distribution and transition of conversational moves – present information (69.7%); accept information (16.3%) and seek information (8.1%). Irrespective of the handoff type, we found that a body system-based tool led to significant interactivity during conversations with limited monologues, which can potentially help achieve symmetry in dialogue and common ground between the outgoing and oncoming clinicians.

**Handoff Communication Breakdowns:** Approximately 1% (N=33) of the resident communication events were characterized by communication breakdowns. Based on a deeper analysis of the nature of these breakdowns, we identified that they were either caused by incomplete information (78.8%) or inaccurate information (21.2%). Approximately 3% (N=58) of the nurse conversational moves were characterized by communication breakdowns.

Based on a similar analysis of the nature of these breakdowns, we identified that the root contributors of nurse handoff breakdowns included doubtful information (37.9%), missing information (37.9%), incorrect/conflicting information (6.9%), repetitive information (15.5%) and misinterpretation of information (1.7%).

**DISCUSSION**

Our findings provide preliminary evidence that a body system-based structure can not only promote content standardization and interactivity in conversations, but also aid in identifying inconsistencies in communication content. In other words, a communication content model supported by a body system-based structure was found to serve as an effective “coordination of care artifact” for information transfer as well as conversations during formal handoffs. Information transfer was facilitated through its systematic and logical organization of standardized communication content, while conversational interactivity was promoted through a “common information space.” Such an information space afforded an interactive medium for the receiver to ask the right questions and the sender to respond in an appropriate manner.

We believe that the effectiveness of a body system-based communication content structure during handoffs can be attributed to three factors associated with the ICU care delivery system. These factors were derived from our observations and follow up interviews with both residents and nurses.

First, the body system-based information structure supported coordination of activities of teams at various levels of the organization. For example, the unit we studied was a “closed” ICU – where all care activities were under the direct supervision on an intensivist physician (Brilli et al., 2001). The effective management of a closed unit depends on coordination of interdisciplinary patient care team consisting of attending physicians, residents, nurses, pharmacists, respiratory therapists and also, coordination of multi-professional care teams between units such as consulting physicians from cardiology, neurology services. The organizational structure in a system-based format afforded clinicians irrespective of their profession or discipline to attend to relevant pieces of information pertinent to their role. One consulting resident from the cardiology service stated in his interviews that this particular structure allowed him to gather pertinent
patient care information related to the CV body system from the handoff tool and therefore saved him a lot of time and effort spent on waiting from the on-call resident in the unit.

Second, the critical care management process was supported by the system-based information organization structure. In other words, the management of ICU patients is based on organ systems and therefore it is effective to use a handoff tool with similar format that can easily be integrated into the inherent care management workflow of the unit.

Third, and most importantly, we found that the body system-based content model supported clinicians in their clinical workflow activities (not just the communication activity during handoffs) and the management of interdependencies in the critical care trajectory. For example, this structure provided support for the overall handoff process including the coordination activities in the pre-turnover phase such as information seeking, documentation and organization (Abraham, Kannampallil, Patel, et al., 2012) and also the patient-care tasks in the post-turnover phase.

Given that our studies were exploratory in nature, a more focused and systematic exploration of the effectiveness of the system-based format is required. This would involve evaluation of potential clinical outcomes as a result of the use of this structuring format.

Based on our studies, we believe that an interdisciplinary handoff ontology based on the body system-based information structure can have significant potential benefits for effective care coordination and care continuity. This is because the format provides support for enhanced common ground and mutual understanding, improved situation awareness and better resource use and management. Such a common ontology can also help in identifying and creating appropriate levels of granularity and arrangements for information standardization for specific disciplines and practices. This can potentially result in limited variability in tool selection and implementation by hospitals, which can then improve the sustainability of the tool use.

CONCLUSION

The relevance of handoffs in the modern academic critical care environment is magnified by the reduced resident work hours, increased patient volume and the complexities of a socio-technical environment. However, several reviews on handoff research have shown that the current state of the art of handoff tools is limited in scope – both in terms of the breadth and depth of empirical evaluation studies and in terms of effective design interventions. We described the aggregate results from two longitudinal studies on resident and nurse handoffs on an often-argued and well-acknowledged challenge of handoffs – communication. Our findings point to the need for a systems-based medical ontology for ICU handoffs given the similarities and overlap in the patient care information that is presented between physician and nurse handoffs. Collins et al. (Collins et al., 2011) highlighted the importance of content overlap between physicians and nurses as a key aspect of handoff documentation. A handoff ontology would allow us to capitalize on the content overlap in verbal communication among the various disciplines for developing task-specific tools that can be easily integrated into the electronic medical record system of the hospital. The standardization of the content and structure of handoffs across medical and nursing practice supported by the handoff ontology can potentially improve handoff use, its sustainability and its resilience to errors.

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