Chapter 13
Bridging Gaps in Handoff Communication: A Comparative Evaluation of Information Organization Tools

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Introduction

Handoffs permeate the healthcare system at all levels, from the individual to the organizational level. A recent study estimated that approximately 1.6 million handoffs occur per year in a typical teaching hospital [1]. This number is likely to increase given the current ACGME (Accreditation Council on Graduate Medical Education) restrictions on resident work hours [2].

Patient Safety in Handoffs

Several reports and research studies have highlighted that handoffs, or care transition points, are high-risk areas for patient safety. Furthermore, handoffs at the different levels and within each level of the organization are highly variable and

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potentially unreliable [3]. A number of initiatives have been launched for targeting error detection, error recovery and error prevention during care transitions, including the High 5's initiative proposed jointly by Commonwealth Fund, the WHO World Alliance for Patient Safety and the WHO Collaborating Center for patient safety [4] and the National Patient Safety Goals by the Joint Commission [5]. To support these initiatives, a number of safety solutions have been proposed that can minimize transition errors through standardization of communication. While standardization efforts have led to widespread development and implementation of handoff strategies and tools, they have had varying degrees of success in these environments [6].

Nature of Handoff Tools

Handoff tools are generally classified into two types: electronic and paper-based. Electronic tools can further be categorized into electronic medical record (EMR) integrated tools or standalone tools. The key difference between these two variants of electronic tools lies in the fact that EMR integrated tools have features that can support the automatic download and population of information fields and interface with other ancillary systems such as radiology and laboratory [7, 8]. Paper-based tools are generally in the form of a piece of paper with patient information organized into single-page [9] or tabular or checklist-based templates with basic patient information such as demographic data, reason for admission, medications, to-do lists [10], IV fluids, oxygen levels, tube feeds, and monitor settings [11, 12]. Based on a systematic review of handoff evaluation tools [13], we found that a large proportion of handoff tools are being developed for supporting physicians' handoffs [9–11, 14–27], and nursing handoffs [8, 12, 28–37], with few integrated tools to support both professions [7, 38–43].

Content and Structure of Handoff Tools

Handoff communication content in tools has been structured using one of three content models the *problem-oriented medical record* that characterizes key patient problems in a priority order (e.g., *SOAP* or *S*ubjective, *O*bjective, *A*ssessment and *P*lan) [44]; a *situation-briefing* model, that utilizes an easy-to-remember framework based on patient conditions (e.g., *SBAR* or *S*ituation, *B*ackground, *A*ssessment and *R*ecommendation) [45]; and (c) a *body-system or medical* model, where information is organized based on body-systems (e.g., cardiology, gastrointestinal, and renal systems) [46]. Our analysis from a previous systematic review has confirmed that the most common handoff content framework was the patient-problem model, followed by the situation-briefing and body-system models [13]. A detailed description of the different types of content frameworks can be found in [13].

Handoff Tool Evaluation Studies

These content models, especially the SOAP and SBAR have been adopted to structure the content for communication in a variety of clinical settings [47–50]. A majority of physician handoff tools utilize these content models as a mechanism for standardizing communication content and topics to be discussed (e.g., [18, 42]). However, their open-ended structure of topic content organization increases the potential risk for information loss and inconsistencies in communication [51]. It has been reported that SOAP-based tools decreased time needed to locate and organize information [28], improved documentation [20], reduced perceived likelihood of information omissions and missed tasks [10], and enhanced quality of information transfer [41].

Similarly, studies of SBAR-based tools have shown reliable information transfer without increasing handoff duration [8], improved patient-centered outcomes [31], and improved nurses' confidence in their communication skills [29]. Despite the support for comprehensive and systematic coverage of all body system related information, the system-based model has been used sparingly to standardize handoff communication [7].

Furthermore, the evaluation of these different content structures underlying the handoff tools have been predominantly measured using handoff-related outcomes such as information gaps [18, 20, 28], handover duration, number of patients handed off, interruptions [8], care quality, frequency of tool use [40], handoff efficiency, and length of shift-report [30].

Despite the early adoption and successes in handoff implementations [40], broader issues of handoff tool sustainability still linger. Based on our own handoff study and also other prior studies, we identified that there were two critical factors which potentially results in the ineffective use of these handoff tools in actual healthcare practice: (1) handoff tools have limited support for the completion of coordination activities such as information organization, documentation and reasoning in the preparatory phase (prior to handoff); (2) handoff tools lack a standardized structure and therefore tend to be characterized to exhibit either a very structured and rigid information organizational structure or ambiguous and flexible information structure [52]. On one hand, there is a push towards the incorporation of standardization of communication using structured methods such as templates, heuristics and communication mnemonics (e.g., SBAR). In contrast, experts have proposed guidelines for customization of communication using less-structured methods such as conveying updated patient information in summarized format. While there are tradeoffs in adopting these methods, very seldom is either one of them strictly followed in actual healthcare practice [53].

Theoretical Framings Underlying Handoff Tools

As described in Chap. 12, the seven theoretical frameworks for understanding handoff communication include information processing, stereotypical narratives, social interaction, resilience, accountability, distributed cognition, and cultural norms[54]. Most of these frameworks have been used by researchers to analyze and identify gaps in communication activity during care transitions [9, 10, 28, 30, 34, 40]. Our research analysis and that of others have confirmed [55], that information processing was the primary and most used theoretical framing [13] and the least studied theoretical perspective was resilience of tool.

Furthermore, in addition to these theoretical underpinnings that focus exclusively on the information transfer during handoffs, we identified that information organization and documentation in the preparatory phase is an important prerequisite for ensuring effective communication during handoffs [56]. There is significant evidence from other research studies by high-reliability organizations that confirms this finding [57–60]. Consequently, researchers and hospital officials have emphasized the need to develop and design tools to support clinicians in their handoff process using an evidence-based approach [61]. In other words, design of tools should focus on improving not only the standardization of the communication content but also the preparation activities such as information seeking, organization and documentation of clinical content are critical.

These factors taken together account for the limited fit of handoff tools within the social fabric of clinical workflows, consequently resulted in limited adoption and appropriation by clinicians. Towards the aim of designing a handoff intervention tool that will fit within the model of critical care practice, we designed a handoff tool and evaluated its use in a medical intensive care unit (MICU). The goals of this chapter are two-fold: first, to describe the design of the Handoff intervention tool (HAND-IT) and second, to determine the effectiveness of HAND-IT using a comparative pre-post evaluation study of handoff tools.

In this chapter, we describe the design, development and evaluation of a handoff tool to support information organization and documentation activities and its impact on the handoff workflow. We compared our body-system based handoff tool, HAND-IT (*HAND*off *I*ntervention *T*ool), with a problem-oriented, SOAP (Subject, Objective, Assessment and Plan) tool using a pre-post intervention study. The results showed the relative flexibility of HAND-IT in supporting clinical documentation and potentially preventing clinical and workflow errors.

Design of Handoff Intervention Tool

Informed by the findings from our prior study, a simple, paper-based handoff intervention tool was developed, referred to as HAND-IT. The design of the tool was based on the *spiral method* that included steps for requirement gathering, designing, building and testing of the tool.

Requirements gathering: Requirements were formulated to address the communication breakdowns and their root contributors in the overall handoff process. The two higher-level tool requirements were information organization in the preturnover phase and information transfer in handoff phase. The lower-level information-related requirements for our intervention tool were based on the evaluation of the information seeking and needs analysis of oncoming team.

Design: A design team for the handoff intervention tool was formed, which comprised of two senior attending physicians, a clinical fellow and the first author.

Informed by these higher- and lower-level requirements, the team collaboratively developed the basic structural format (i.e., body system-oriented and patient case-narrative) and content of HAND-IT.

Development: First, the attending physicians and the fellow individually created drafts of the tool content. The team then convened multiple times to discuss and iteratively develop a unified version of the tool including its information content and order. Through several group discussions and expert suggestions, the information elements were included/excluded based on their clinical relevance, especially to critical care.

Evaluation: The prototype was then evaluated in the MICU and based on clinician feedback through formal and informal discussions during the testing phase, the tool was modified to best fit the critical care workflow.

Theoretical Rationale for Design

The theoretical design rationale of HAND-IT was informed by our prior empirical work (described above) which found that handoff tools supporting the preparatory information organization and documentation activities prior to handoffs can result in effective communication during handoffs [56, 62]. Furthermore, handoff tools that adopt a hybrid information representation model combining features for supporting both structured and summarized information can minimize breakdowns in information and decision-making.

To address this, the design of HAND-IT was based on *content standardization* (using a body system-oriented format) and *content summarization* (using a problem-case narrative format) for standardizing information sharing during handoffs and also supporting information organization and documentation during the pre-turnover phase. Content standardization and summarization have been reported to minimize information breakdowns and support effective clinical decision-making [46, 63]. Additionally, based on the Society of Critical Care Medicine (SCCM) guidelines [64], we incorporated evidence-based concepts related to standard critical care management, which can improve patient outcomes including identification of delirium, sedation practices, prophylaxis and feeding information. Based on these functional requirements, the basic format and content of the tool were decided by the design team consisting of two ICU attending physicians (which include the MICU director and a quality officer), one MICU clinical fellow, and one researcher (first author) [See Fig. 13.1 for the final design of the HAND-IT and Table 13.1 for information categories in HAND-IT].

A *checklist-based* body system-oriented format was used to support content standardization. The patient care information within each body system was organized into fundamental categories including (a) diagnosis, (b) physical exam and labs, (c) medications, and (d) resident plan (for that particular body-system). In addition to content standardization, we incorporated a summarization feature through free-text fields to add care summaries related to (a) patient admission information, (b) problem list, (c) patient events over the last 24-h period and finally, (d) resident notes.

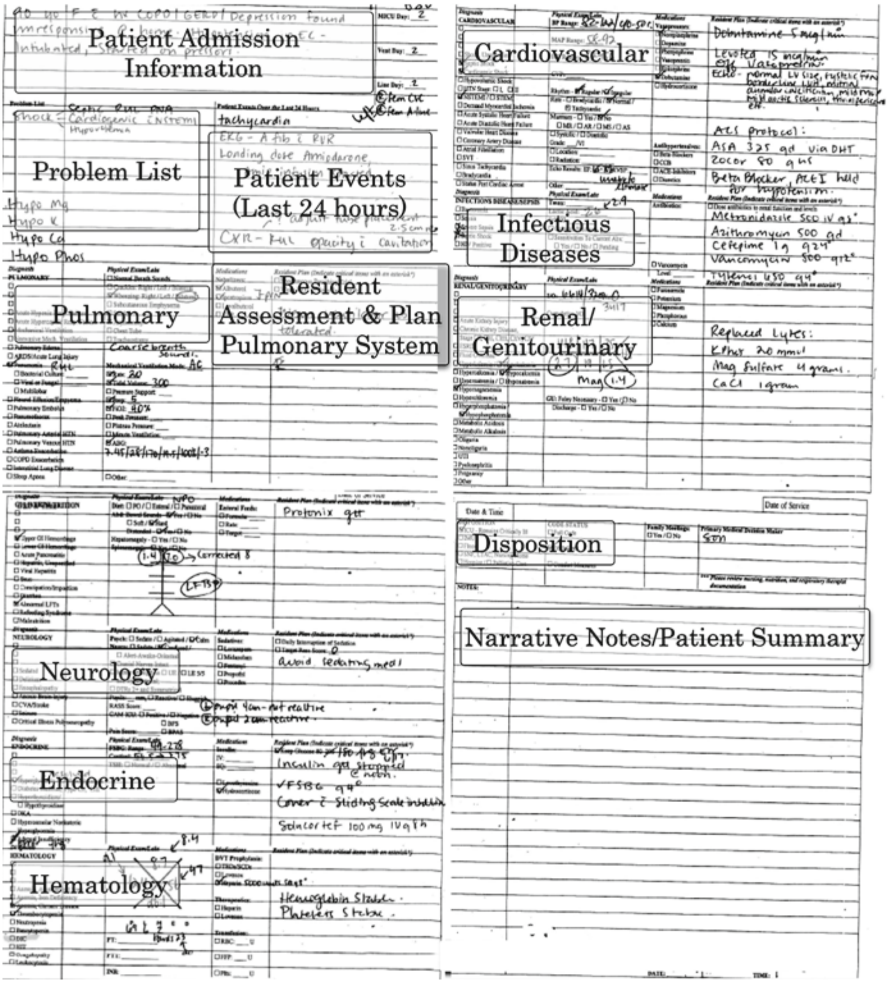

Fig. 13.1 Handoff Intervention Tool, HAND-IT (Adapted with permission from Abraham et al. [52])

Empirical Evaluation of Handoff Intervention Tool[1]

We conducted a comparative pre-post prospective intervention study to determine the effectiveness of the intervention tool for documentation. The study was based on the evaluation of two tools for supporting handoffs: SOAP note and HAND-IT,

[1] This section (including tables and figures) has been adapted from Abraham J, Kannampallil T, Patel B, Almoosa KF, Patel V L. 2012. Ensuring patient safety in care transitions: an empirical evaluation of a handoff intervention tool. Paper presented at the Proceedings of AMIA 2012, Chicago, IL.

Table 13.1 Information categories in HAND-IT

Information field	Description	Example
Date & time	The date and time stamp for the report being prepared.	10/20/11; 13:00 h
Admission information	The basic patient history and information related to patient's admissions/ transfer to the MICU.	81 year old female with HIV, CKD stage 2, HLD admitted with chest pain, shortness of breath found to be in pulmonary edema – TTE showed MR from ruptured chordae tendinae.
MICU day#, vent day#, line day#	MICU length of patient stay, Mechanical ventilation day #, day # for IVs and lines (central and peripheral).	MICU day# 3, vent day#0 and Line day#0.
Problem list	Patient problems including current and past conditions.	The patient has hypotension.
Events over the last 24 h	All noteworthy patient-related events that occurred over the last 24 h (during the last two clinician shifts).	A failed placement of a central line on a patient twice.
System diagnosis	Diagnosis information for body systems including CV, GI/GU, renal, infectious disease etc.	The data elements characterizing the CV system-oriented diagnosis include HTN stage 2, NSTEMI, valvular heart disease MR, and sinus tachycardia.
Physical exam/ labs	Information elements related to exam and labs of the patient corresponding to each organ system.	Physical exam/labs for CV system contains BP range: 90–51 and 179–75, MAP range: 61–101; HR range: 78–92; rhythm- regular, rate- normal; murmurs- Yes; MR; systolic; grade IV; echo results: EF: RVSP: 26.9 > 70 %.
Medications	Current, active medication orders such as name, dosage, route and interval can be entered/checked.	Medications for CV include aspirin 325, lipitor 40, plavix 75, lisinopril 10 mg, and metoprol 12.5 Q6 h.
Assessment	Plan for care and management information for each organ system.	Resident assessment and plan for the CV system for a patient case was "patient – hypotensive; NTG was weaned off; Now BP Stable; continue ACE –I, Beta blockers, aspirin, plavix for ACS protocol, continue heparin gtt, new MR – Transfer to CCU for possible MVR, TEE today to rule out endocratis."
Disposition	Disposition information for patient's continued stay in the ICU, or downgraded to an intermediate care unit (IMU) or floor service or physical transfer to an outside facility such as the skilled nursing facility (SNF) or Long-term Acute Care Hospital (LTACH) or will be under hospice/palliative care.	The patient is ready to be transferred to CCU (Cardiac Intensive Care Unit).

(continued)

Table 13.1 (continued)

Information field	Description	Example
Code status	Information on patient's code status. Three categories include full code (i.e. Full resuscitation with aggressive measures in the event of cardiac arrest), DNR/DNI (i.e., do not resuscitate or intubate) and comfort measures (eliminating sources of discomfort of a dying patient).	The patient is DNR/DNI.
Primary medical decision maker	Includes the name of relative primarily responsible for decision making for the patient.	Patient's son is the medical decision maker.
Family meetings	Includes information on whether meetings with family and care team have been held (or planned for) to explain the patient's condition and their current disposition to the family members.	
Other diagnosis and management plan	Includes any critical information that was included/not in the previous sections in a summary format in addition to a to-do and contingency list.	H and H Q12 h, Rocephin change to 1 g Q12 h, continue heparin for NSTEMI and hold diuretics.
Resident signature	Includes signature of the on-call resident primarily responsible caring for the patient and preparing the information on the tool.	
Date and time	Includes the date and time stamp of filling the information on the tool.	10/20/11; 13:30 h.

which were constructed based upon inherently different design rationales. The patient information in the SOAP note is structured upon a subjective component, an objective component, an assessment, and a plan of care. Therefore, this type of structuring follows a problem-based format, and is commonly used in a general medicine-surgery ward [65] (See Chap. 12).

In contrast to the SOAP note, the HAND-IT tool is grounded in our prior results, which show that content standardization using a body system-oriented format, and content summarization using a problem-case narrative format, would reduce the communication complexity and incidence of transition errors [56].

In the following sections, we describe the participants, design, data collection and analysis process, and evaluation measures. The setting is the same as in the previous chapter (Chap. 12), and the Institutional Review Boards (IRB) of the hospital and the university approved the study.

Participants

The study participants include the attending physician, clinical fellow, internal medicine residents, interns, respiratory therapist, pharmacist and nurses. The residents and interns were responsible for a total of 16 patients, and each were assigned up to 8 patients during a shift. The team handoffs occurred daily in the morning and took approximately 4 h to complete. At the MICU we studied, a set of three residents and three interns rotated for a period of 1 month, although their specific roles varied during different shifts (e.g., on-call, post-call or short-call). Thus there were a total of six residents and six interns during the 2-month period of the evaluation study.

Study Design

The SOAP note and HAND-IT tool were evaluated for their effectiveness as tools for supporting documentation for the handoff process. In our longitudinal pre-post prospective intervention study, two sets of residents and interns used SOAP and HAND-IT over a 2-month period (See Fig. 13.3 for the organization of the study). The effectiveness of documentation using both tools was measured during the multi-professional rounds conducted by the director of the MICU and the on-call care team (see details in the next section).

Data Collection: Multi-Professional Rounds

The multi-professional round (MPR) is a mechanism by which teams of clinical professionals perform joint evaluation. For example, such multi-professional teams often convene to evaluate quality and decision-making initiatives [66]. The director of the MICU in our study convened MPRs to evaluate the quality and completeness of the handoff note (either SOAP or HAND-IT). As they were not part of the typical MICU workflow, these MPRs (See Fig. 13.2) were conducted immediately after the morning rounds and were organized for research purposes only. Each collaborative session was attended by the MICU Director, an on-call attending physician, an on-call resident and intern, patients' nurses, a pharmacist, a respiratory therapist and the first author.

The specific patient handoff notes selected for evaluation during an MPR (in either the SOAP or HAND-IT condition) were decided upon after a brief discussion between the MICU director, the on-call attending physician and the first author of the paper. These decisions were made in a manner that ensured maximum selection variability across patient cases, patient status and patient condition complexity. Following patient cases selection, the MICU team (including each patient's nurse) convened to jointly evaluate the information documented (by the outgoing) on the tool with respect to the accuracy and completeness of patient-care information. During the MPR session, the handoff note (either SOAP or HAND-IT) was read aloud to the team. The on-call team members were then individually asked to identify any breakdowns in patient care information and patient care decisions. For instance, the patient's nurse was asked whether or not there were any identifiable omissions from a nursing standpoint for the

Fig. 13.2 Multi-Professional Rounds (MPR) in MICU

particular patient. Furthermore, the team members were asked if the handoff note was up-to-date and accurate. Based on their collective content analysis of the handoff note, the team characterized the breakdowns into omissions, inaccuracies, and modifications to the originally written plan of care, and missed problem lists of patients. During each MPR, the first author took meticulous notes on the analysis of the case by the team, in addition to audio-recording the sessions. Additionally, the de-identified photocopies of the evaluated SOAP and HAND-IT tools (with prior IRB approval) were collected for detailed analysis. Lastly, informal interviews with the participants (about the tool use and limitations) were conducted following each MPR.

Procedure

The experimental implementation was conducted over a 2-month period and consisted of multiple stages per month (See Fig. 13.3). During the first month, participants used the SOAP note for a period of 4 days as part of their training. This was followed by the experimental stage, during which participants used the SOAP note for 5 (High 5 s, #29) days. On the seventh, eighth, and ninth day (the last 3 days of experimental evaluation), MPRs were conducted after the morning rounds. Following

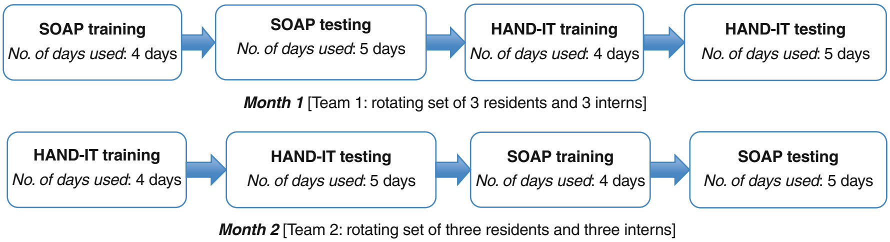

Fig. 13.3 Study Design and Procedure (Adapted with permission from Abraham et al. [52])

this period, participants were provided introductory training with the HAND-IT tool. They used HAND-IT for handoffs for the next 4 days, which helped to familiarize them with the different features with respect to content, function and format of the tool. In the last stage, we began the experimental evaluation of the use of HAND-IT for a period of 5 (High 5 s, #29) days. As with the SOAP condition, MPRs were conducted over the last 3 days of the experimental sessions. A total of five (High 5 s, #29) notes for each condition were evaluated during the MPRs: two each on days 1 and 2, and one each on day 3. The same procedure was repeated in the second month with a new MICU on-call team, but the order in which the participants used the two tools was counter-balanced with the previous month. In other words, the participants began with HAND-IT training for 4 days, followed by testing for 5 (High 5 s, #29) days. As in the previous month, a total of five (High 5 s, #29) notes from each condition were chosen for evaluation during the MPRs. As detailed in the previous section on MPRs, each handoff tool was evaluated for missed information, incorrect entries, missed problem list items and changes to plan of care.

Evaluation Measures

We employed three measures for evaluating the *effectiveness of handoff documentation* using each of the two tools: number of information breakdowns, number of decision-making breakdowns, and expertise of the clinicians. Each of these measures is described below.

Information Breakdowns: We characterized an information breakdown as a failure to appropriately gather the necessary information regarding a patient or a gap in information flow. Two variables were used in representing the information breakdowns on the handoff tool (either SOAP or HAND-IT): *number of missed information* and *number of incorrect information*.

Decision-Making Breakdowns: We characterized a decision-making breakdown as a modification (including additions/deletions) made by the attending physician to the decision-related information documented by the outgoing team (resident or intern) on the handoff tool during the MICU morning rounds. Two variables were used in representing the decision-making breakdowns: number of changes to plan of care and number of missed problem list items.

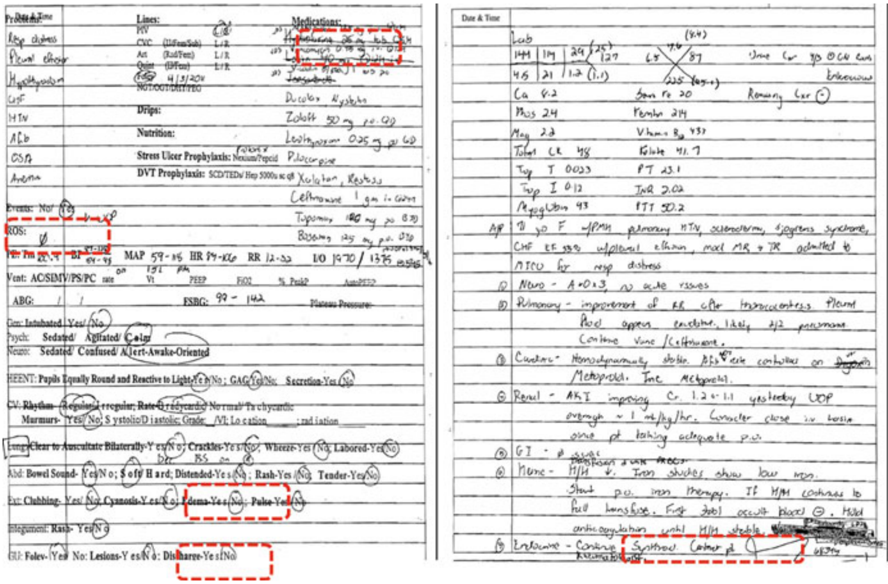

Fig. 13.4 Example of Analysis of Information and Decision Making Breakdowns using SOAP Tool

Expertise: Since patient care responsibility in the MICU was divided between an intern (a first year trainee resident) and a senior resident (third year trainee resident), we characterized the efficacy in the use of the handoff tools based on their year of residency training.

Data Analysis

For our dual-stage analysis, we used audio-recorded data, researcher notes from the MPR evaluation, and photocopies of the selected SOAP and HAND-IT tools. First, a qualitative analysis of the information on the tools was coded based on information breakdowns. Next, the frequencies of missed and incorrect information, missed problem list items, and changes to plan of care were tabulated based on the MPR recordings (See Figs. 13.4 and 13.5).

Data was organized according to *handoff tool type* (SOAP, HAND-IT) and *expertise* (resident, intern), after which a comparative analysis using student t-tests was performed. Next, the causal determinants of decision-making (i.e., number of missed problem list items and number of changes to plan of care) were evaluated while using the SOAP and HAND-IT tools. To achieve this, we developed the best-fit zero-inflated Poisson regression model with the following variables: *expertise differences* (resident, intern) and *information breakdowns* (number of missed

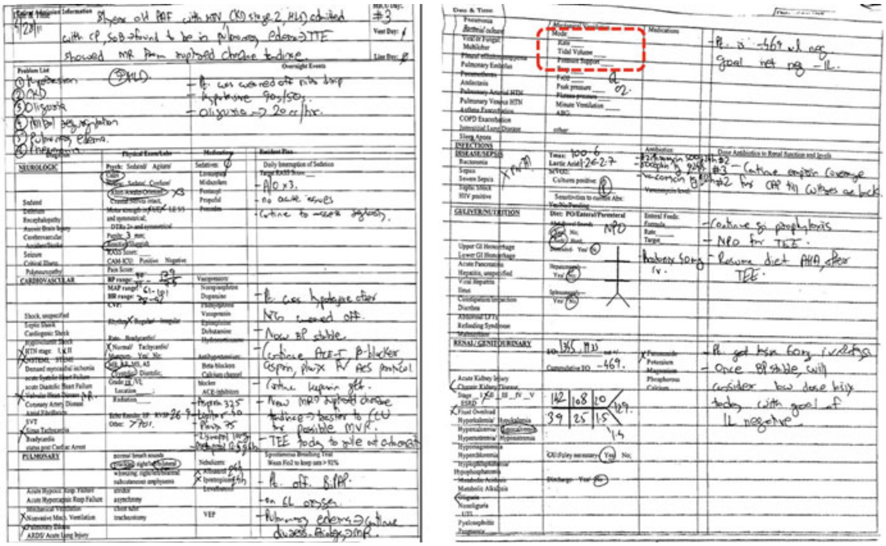

Fig. 13.5 Example of Analysis of Information and Decision Making Breakdowns using HAND-IT

information, number of incorrect information). These were the variables considered, because there was no association between expertise and information breakdowns based on Chi-square tests ($\chi^2 = 0.0899$, df $=1$, $p = 0.76$). For the analysis of information breakdowns, an aggregate value of the number of missed information and number of incorrect information was used. For expertise differences, we used the categorized notes created by the residents and interns.

Results and Discussion[2]

Information Breakdowns

When physicians used the HAND-IT tool, they missed significantly less information than when they used the SOAP note [$M_{HAND\text{-}IT} = 2.8$, $M_{SOAP} = 12.5$; $t(18) = 5.98$, $p < 0.0001$]. In addition, when they used the HAND-IT, they recorded less incorrect information than when they used the SOAP note [$M_{HAND\text{-}IT} = 0.9$, $M_{SOAP} = 1.8$, $(18) = 2.1$, $p < 0.05$]. They differences indicate that the HAND-IT intervention tool improved the way residents and interns seek information and organize activities during the pre-turnover phase of their shifts. By changing information seeking and

[2] This section has been adapted from Abraham J, Kannampallil T, Patel B, Almoosa KF, Patel VL. 2012. Ensuring patient safety in care transitions: an empirical evaluation of a handoff intervention tool. Paper presented at the Proceedings of AMIA 2012, Chicago, IL.

organizational activities, use of the HAND-IT intervention tool led to fewer occasions of missed and incorrect information.

Decision Making Breakdowns

We also assessed two features of decision making which can indicate breakdowns in information: the number of changes to a patient's plan of care, and the number of problem list items that were missed. We found that the different intervention tools were also associated with differences in the number of changes to the patient's plan of care: Attending physicians made fewer changes to plan of care when using HAND-IT than with the SOAP note [$M_{\text{HAND-IT}}=0.8$, $M_{SOAP}=4.0$; $t(18)=3.7$, $p<0.001$]. We found a trend for fewer problem list items missed with the HAND-IT than with the SOAP note [$M_{\text{HAND-IT}}=0.8$, $M_{SOAP}=2.1$; $t(18)=1.93$, $p=0.051$], although this difference did not reach significance.

Handoff Tool Resilience

We evaluated the resilience of the handoff tools by examining the decision-making effectiveness variables (number of missed problem lists and number of changes to plan of care) in terms of both information breakdowns and expertise of the participants (residents, interns) using a Poisson regression. Based on the analysis, we found evidence that the HAND-IT was associated with fewer missed problem list items, and fewer breakdowns as a result. Specifically, when participants used the HAND-IT, an increase of 11.92 breakdowns was required before a one-unit increase in the missed problem list. In contrast, for the SOAP note, the increase in the aggregate number of breakdowns was directly proportional to the number of missed problem list items. For each unit increase in the missed problem list, we observed a unit increase in the total number of breakdowns. The number of changes in plan of care was not statistically significant in models which described the effects. This pattern of results provides evidence that the HAND-IT was more resilient in the face of breakdowns and differences in expertise than the SOAP note.

Effect of Expertise

We also evaluated effectiveness of decision-making based on the expertise of the physicians who used both tools with the regression model. Residents and interns showed different patterns of missed problem list items based on the tool they used. Residents using the SOAP note made 0.32 *fewer* missed problem list items than interns, while Residents using the HAND-IT made 2.92 *more* missed problem list items than interns. We believe this is evidence that interns, with less experience and expertise than senior residents, benefited more from the information organizational capabilities of HAND-IT than residents.

Discussion

Our results show that the HAND-IT provides effective support for the information organization activities physicians perform to prepare for handoffs, and use of HAND-IT results in fewer information breakdowns and errors. The design of HAND-IT multiple support mechanisms including a standardized checklist, organization into body systems, extensive coverage for details for the body-systems and a structured, user-friendly display for reading and writing. Our results indicate the HAND-IT use resulted in fewer changes to the plan of care created by the outgoing medical team, and fewer omitted patient diagnoses (i.e., problem lists). This was potentially afforded by the juxtaposition of body systems in a checklist and narrative cuing the physician to consider or recall information that was relevant to making diagnostic and therapeutic decisions. This also allowed physicians to draw specific inferences relevant to patient problems because the assessment and corresponding plan are formulated for each of the different body systems, and c) provided cognitive support, affording physicians' reasoning process.

Tool resiliency was also apparent as the use of HAND-IT led to fewer missed problem list items, and significantly more breakdowns were required before a missed problem list item occurred when using the HAND-IT than the SOAP note. Error resilience is one of the most frequently described characteristics of a good handoff tool, so this finding is especially relevant [54, 67]. HAND-IT was designed to summarize and systematize content in a checklist format; while resilience to breakdowns was not an explicit goal, this serendipitous outcome was likely a result of our design goals. Features of the design provided (a) transparency for the clinician's thought process via the checklist format, which could help to identify and avoid errors, and (b) support for clinicians' process of crosschecking assumptions by using the narrative to achieve a fresh perspective.

We also observed improved performance by interns using HAND-IT. Their improvement may have been due to the layered display of information, which prompted interns to attend to information relevant and appropriate for their decision-making. As a result, the significant amount of information available could be approached with a focused perspective. Additionally, HAND-IT's organization may have helped the less-experienced interns whose schemas for medical knowledge are less developed [68]. Residents, who have more developed knowledge schemas, showed a contrasting response to the HAND-IT because using a new tool forced them to re-adjust their mental models. This may have led to a higher number of breakdowns. More detailed empirical evaluation is necessary to identify the causal factors behind the differences we observed between residents and interns. A detailed discussion of the results can be found in [52].

Implications for Practice

In the current study, HAND-IT supported error detection and recovery (i.e., avoiding breakdowns in information organization and decision-making), was resilient to breakdowns, and supported education and learning, all desirable characteristics of handoff tools [54, 69, 70]. In addition, by its very design, HAND-IT supported the coordination of information flow and decision-making. This coordination inherently helps to ensuring continuity of care, and emphasizes the importance of capturing an "uninterrupted and coordinated succession" of patient events to meet their care needs. In other words, mitigating information and decision-making breakdowns improves timeliness of care delivery, reduces work duplication, minimizes patient length of stay, and most importantly, enhances patient safety and quality. Development of HAND-IT is one example of an empirically driven and theoretically grounded clinician handoff workflow tool, which takes a fundamental step toward the Joint Commission's mandate to standardize handoff communication activity. Our HAND-IT intervention tool highlights the workflow elements central to the intensive care unit model of practice.

In the modern ICU, optimal delivery of care requires consistent coordination among multiple disciplines and services, including sub-specialty consultants and supportive healthcare personnel. For example, a septic patient with multi-organ failure will require a critical care team, plus consultations from infection disease specialists to help manage the infection, and nephrology specialists to help manage acute renal failure. In addition, other services including nutrition, physical therapy, and social work frequently contribute to the general plan of care for complex patient. Our MICU observations and informal interviews with nurses and consults revealed that the HAND-IT tool improved overall continuity of care both between clinicians during transitions, and also across clinicians from different services. The tool was viewed as a "coordination artifact" that helped to manage information and task interdependencies between multiple clinicians involved in a single-patient care process.

Future Work

The next phase of our work in this area will be to evaluate handoff communication by assessing the impact of information organization on verbal communication. The *first step* in this phase is to capture the types and characteristics of communication events and breakdowns; the *second step* will be to map the handoff tool documentation to verbal communication data for a set of common patients. This process would allow us to identify the impact of information organization and documentation practices on effective communication during care transitions. Our goal in the first phase will be geared toward comparing the effectiveness of a problem-based tool (SOAP) and a body system-based tool for supporting handoff communication by analyzing the content and structure of handoff communication. Our observations and audio-recorded data of 82 resident handoffs in the MICU form the basis for our investigation in the first step of future work. While prior evaluation studies on handoff tools have primarily used survey-based and self-reported measures [7, 10, 15, 30, 50], our approach will specifically evaluate the impact that a tool's standardized content and structure has on communication effectiveness and safety.

Discussion Questions

1. What are the potential advantages and disadvantages of using a medical training model (i.e., a body system based format)? Discuss the implications of using such a model with respect to the following aspects: (a) ability to have comprehensive information regarding a patient (b) effort, time and cognitive requirements, and (c) ability to support diagnostic decision making and patient management decisions.
2. Can the medical model serve as a standardized content model for structuring handoff communication in other settings during patient transfers within a hospital and across hospitals?
3. Can the medical model be considered as a framework to train and educate multiprofessional clinicians at varying levels of expertise and experience to perform better handoffs? If so, how?

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