

Communication and Sense-Making in Intensive Care: An Observation Study of Multi-Disciplinary Rounds to Design Computerized Supporting Tools

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Abstract

Multi-disciplinary rounds are a forum for communication and sense-making, and they play a critical role in intensive care to ensure care coordination across specialties and providers. Increased availability of clinical information through computers has made it possible to provide support during rounds. We conducted an observation study to determine ways in which computers may be used during rounds, when users are under time pressure in accessing and manipulating clinical data. A total of fifteen hours of rounds in a pediatric intensive care unit for 47 patients were observed. Factors influencing information transfer during rounds were characterized in three areas: physical, social and cognitive, and supporting artifacts. Based on these factors we developed a set of design guidelines for computerized supporting tools. An example guideline suggests digital capture of handwritten notes. These guidelines developed may help guide future systems development, thus leveraging the power of computing during the critical moments of multi-disciplinary rounds.

Introduction

Care activities in intensive care settings are collaborative and highly interdependent. Adverse events in such settings have frequently been attributed to errors related to communication among care providers.¹ Multi-disciplinary medical rounds are widely used to improve care coordination, to establish a common shared mental model of patient status, and to make decisions and plans collaboratively.² A number of obstacles exist that impede communication and sharing of information among care providers, such as lack of information tools supporting multiple users in noisy and interruption-prone work environments.² Medical rounds are further complicated by undesirable long duration³, frequent interruptions⁴, perceived “waste of time” and socio-political impacts on participation^{5,6}. Designing tools to support rounds may have a direct implication on patient safety by better supporting a shared mental model of patient status and goals, thus allowing care providers to adopt an “anticipative” mode of care management as opposed to a reactive mode due to lack of communication and corresponding lack of knowledge and decision-

making support⁷. Computerized and paper-based artifacts are widely used for communication and care coordination.^{8,9} Computerized handoff tools have been shown to be useful in reducing omissions and time spent in preparation for communication among care providers.¹⁰ Previous reports of computer use during rounds include medical knowledge reference via the “evidence cart”¹¹ and access to clinical information¹².

Despite the fact that increasing amount of data in healthcare is available in electronic medium, how computers may be used to improve communication during rounds remains poorly understood. Furthermore, information needs and transfer patterns during rounds are fluid and may be difficult if not impossible to pre-specify. Multi-disciplined participants such as attending physicians, medical trainees, surgeons, and primary care nurses may be under time pressure to exchange information and plan treatment goals at a rapid pace. One reason that computers have not been extensively used during rounds may be due to these unique requirements. With the rapid growth of mobile computing and increasingly availability of clinical information and decision support on computers, computing technology may be designed to better support joint social and cognitive activities during group sessions such as rounds.²

In this paper we report an observation study of multi-disciplinary rounds in a pediatric intensive care unit, with the objective of developing design guidelines for computerized systems to support communication and joint sense-making during multi-disciplinary rounds. We focused on physical arrangements and supporting artifacts used. In contrast to previous studies of rounds¹³, our study examined how verbal discourse was carried out in a physical environment with computer and paper-based artifacts to achieve communication and sense-making goals, such as disseminating patient status, providing teaching opportunity for medical trainees, and as a decision-making forum for formulating upcoming patient goals and treatment plans.

Methods

Setting: The study setting was a 10-bed pediatric intensive care unit (PICU) in a large metropolitan medical center. This unit consists of centrally located staff stations with several desktop computers for hospital information system access and all patient beds are within line-of-sight of the staff stations. Additionally, several computers on wheels (COW) allowed system access by staff in mobile group situations such as walking medical rounds.

Data collection: Two of the authors observed thirteen weekly cardiac rounds and morning multidisciplinary rounds over a three month period. A total of fifteen hours of field observation was conducted, on which 47 patients were rounded. Field notes and audio recording were collected during the rounds and transcribed for discovering thematic categories. We paid particular attention to tools used to support round discussions and physical, cognitive and social factors. We interviewed round participants, including three nurse practitioners, two attending physicians, and one medical resident to gather additional perspectives into the rounding process.

Data analysis: After each observation the observers met to discuss the themes emerged in relation to how supporting tools may be used and how they should be designed. Group meetings with clinicians were conducted to verify the observations. The themes were organized according to three areas: physical aspects of information exchange, social or cognitive issues, and artifacts used in rounds.

Results

We report findings along the three areas and then synthesize toward general design guidelines for a computerized platform to support information exchange in medical rounds.

Physical Features of Rounds

Several major features were observed, including the space constraints of the unit and its impact on mobility, the large grouping of participants, and evolving group configuration to optimize face-to-face and verbal communication. Medical rounds regularly consisted of very large groups of individuals: nurses, residents, nurse practitioners, fellows, attending physicians, and consulting physicians from multiple disciplines. During walking rounds, participants congregated at the bedside of the patient being rounded on. Weekly cardiac surgical rounds were especially congested, regularly attended by ten or more individuals. Despite the space limitations, participants were observed to self re-locate to optimize the line of sight between all individuals to afford eye-contact between

the presenter and participants. Quite often, the group configuration evolved into a circular pattern shortly after the start of each patient round (Figure 1). Also, individuals were observed to position themselves according to their level of involvement or contribution. For example, the presenting resident or nurse practitioner often stood in the center of the group or directly facing the center of the group “circle”. This arrangement allowed participants a shared view of physical information sources such as paper-based patient chart, computerized radiology report, or even cardiologist hand gestures to illustrate blood flow restriction through an artery. The circular arrangement afforded equal participation and optimal visibility by all members of the medical round.

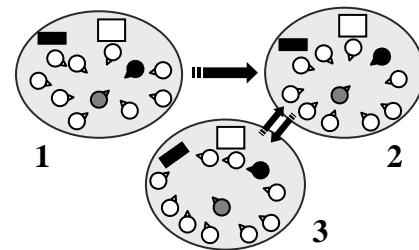


Figure 1: Three arrangements of participants during rounds. Black rectangle = computer on wheels (COW). White rectangle = patient bed. Grey icon = presenting resident. Black icon = attending physician. Note the tendency for a circular arrangement and the group directed attention towards the COW in arrangement 3.

Social and Cognitive Features

Medical rounds are held under significant time pressure because the level of resources allocated (i.e. clinical staff time) is so high. Our findings show a predominant use of verbal recite for group information transfer but also reveals its limitations for meeting individual information needs in a timely and accessible manner. Communication is further complicated by the vast array of information sources being accessed, from paper-based forms to rounding participants themselves. On average, a typical patient round took 15 to 20 minutes to complete. Each involved a combination of major processes identified as data presentation, discussions and teaching points, and negotiation of patient goals.

Each round began with data presentation. The resident or nurse practitioner assigned to the patient recited to the entire group raw data values they had collected prior to the round. The data values included physical exam details and data ordered by body systems, which the attending recorded into their official progress notes. Presentation was frequently supplemented by the computerized medical record to show

latest lab results, the patient bedside monitor, double-checking the fluids in and out at the patient bedside, or directing questions to clinical staff such as clarifying overnight issues with the primary care nurse. With the added time pressure of rounds, when an information source was difficult to query (e.g. a delay in loading up x-ray), the group immediately skipped to the next discussion and the relevant member would follow up later. Verbal recite also presented several challenges for information dissemination. If the presenter recited too quickly, the attending had to request clarification or repetition. If the resident was unfamiliar with the protocol of reciting data, the attending had to correct the resident (e.g. established practice for reciting medications is to list “everyday meds” followed by “as needed meds”). This amounted to “wasted or bad use of time” according to one attending. Also, another attending believed that the process of presenting data values is to promote “data synthesis” and decision-making on treatments by the rest of the group and the presenter, rather than tedious recital. One physician suggested that recital can become so monotonous that listeners become less vigilant and “ridiculous” data values such as “blood pressure 2000 over 100” can be missed, or worse, transcribed as is into their own records “without thought”. Such issues may be addressable by sharing visual data to the entire group.

Another observation during data presentation is that information needs vary by participants. One cardiac physician joked out loud “ok, I can space out for a bit now” when the attending asked the resident to present total parenteral nutrition (TPN) data. For the primary care nurse, their primary takeaway from a round was a clear plan of action for the patient for that day. Thus, a spectrum of information needs was observed by the many participants of the medical rounds.

The discussion and teaching phases of the round were primarily led by the attending and specialty physicians and also communicated verbally. In these phases, the use of external aids was much more flexible when compared to data presentation. Discussion and teaching aids included patient charts, online medical resources, hand drawings, hand gestures, and other references. This phase was conducted much more informally, with the goal to challenge the residents’ understanding of medical knowledge and clarify everyone’s perspective of the patient status. From this discussion, rationale was developed to serve the final phase of the round, discussion and negotiation of the daily goals for the patient. Observations of social and cognitive attributes of rounds suggest simultaneous visual presentation of information items based on the following three ideas. First, such a vis-

ual presentation can greatly support information transfer and dissemination within a multidisciplinary group. Secondly, providing a visual reference can facilitate sharing of information and multiple perspectives. Third, visual presentation of the topics already discussed and to be discussed can structure transient verbal exchanges.

Artifact Requirements

Despite the dominant mode of verbal communication, the importance of artifacts as contributors or recorders of information cannot be overlooked. In this context, we defined artifacts to be tangible devices or tools which supported the information exchange such as computers and paper-based tools (see Figure 2).



Figure 2: Multiple artifacts observed in rounds

For example, the dominant artifact for data presentation was the pre-round flowsheet which consolidated patient data from numerous information sources such as computerized lab results, patient bedside charts, vital signs, and medication administration record (MAR). This flowsheet reduced the need to look up patient data during the round and provided a central medium for storing preparatory work.

The key attributes of artifacts included preparation time, conciseness of presentation, “shareability” with other participants, and issues of data propagation. Each morning at 5:30, presenting residents copied patient data values into their consolidated pre-round flowsheet to prepare for the 8:30 morning rounds. Prior to start of rounds, residents or medical students were seen readying the computer on wheels in anticipation of presenting lab values and x-rays to the group. The flexibility of paper-based artifacts supported being written onto at any moment and in any context. On the other hand, computerized displays have the advantage to order data in relevant contexts and present concise and relevant information to the audience. For example, the most recent two-week trend graph of SPO2 was quickly loaded upon request by the physician, whereas pointing out an abnormal data value in the paper-based patient chart

was much more difficult to do in a group setting. We observed that data input or note-taking can be done easily with paper-based artifacts, while data output or sharing of data is potentially more flexible with computerized artifacts. The final observation of artifacts is their large role in propagating information into tangible artifacts for archive or later use. For example, while a resident recites patient data, the attending, nurse practitioner, and other on-call residents can be seen transcribing identical data (albeit in differing formats) into their personal artifacts.

Guidelines for Computerized Support

The following guidelines emerged to inform the design of a computerized platform to support medical rounds.

Physical Requirements

Viewing Angle and Visibility. All participants in the rounds should be able to see the on-screen information. This may be addressed by multiple and pivoting displays. The circular arrangement does not guarantee visibility from far distances, so computer tools to magnify on-screen elements may be useful.

Size and Spacing. The platform should be mobile and easily relocated to follow the rounding group, or ignored altogether if it is not being used. It should also be easily retrievable to display computerized data.

Attention Cues. The platform should facilitate presenters in directing the attention of participants to relevant data. This may be achieved by mouse-driven or remotely controlled “on-screen highlighter” to circle an area of interest on a chest x-ray, for example.

Social / Cognitive Requirements

Low Tolerance for Delays and “Glitches”. A computing platform must have user-friendly and quickly accessible screens and data to meet the high time pressure and social norms of rounds.

Show Salient and Relevant Data. Changes in patient values or abnormal clinical values may be highlighted, thus increasing visibility of noteworthy data to participants and facilitate the process of “data synthesis” and joint sense-making.

Multiple and Switchable Screens. Multiple and switchable screen content may facilitate the unique information needs of multi-disciplinary participants, allowing simultaneous broadcast of several information resources during data presentation, discussion and teaching points. For example, cardiovascular flowsheet data may be supplemented with chest x-ray and a medical reference diagram on ventricular septal defect.

General vs. Topic-Specific Data. Multiple displays can afford the coexistence of persistent high-level patient data (physical exam and diagnosis details) which everyone may be interested in and topic-specific data to support the immediate phase of information exchange (such as showing heart CAT scan during cardiovascular discussion).

Flexible Data Visualization. Computerization also has advantages of flexible navigation and data representation. Values may be plotted, graphed, compared side-by-side to other values on-the-fly, allowing quick perception of trends, changes, and relationships that may otherwise be missed.

Supporting Artifacts Requirements

Computerized Bundles. The observed behavior of creating personal information artifacts to assist work such as the preparation of the pre-round form is also known as “bundling”¹⁴. Our observations suggest a platform may be designed to support collections of individual artifacts for sharing during rounds and archive for later use.

Data Preparation. A computerized platform may reduce the time of preparatory activities with deeper integration of multiple online hospital databases and resources, thus reducing transcriptions of raw data into pre-round forms prior rounds.

Digital Capture and Distribution. The platform can enhance preparatory activities by digital capture of manually or automatically generated bundles and sharing it on the computer during rounds via shared displays or print-outs for participants.

Integration of Data and Visuals. The contribution of many digital bundles and deeper integration with hospital information systems may lead to more robust presentation techniques for summarizing patient data, thereby increasing the richness of case discussions. An example may be that “Screen 1” shows a magnified resident pre-round flowsheet, “Screen 2” shows online medical references related to patient diagnoses and treatments, “Screen 3” shows all ordered medications and procedures, and “Screen 4” shows yesterday’s daily goals alongside today’s daily goals.

Allow Dedicated Media Controller. The preparatory activities that take place on the computer on wheels may be redesigned to allow remote control of on-screen contents by the immediate presenter.

Discussion

Use of computers during rounds can potentially increase information awareness through clinical decision support and visualization of patient data.¹⁵ One report described the use of a video projector to display computerized patient medical records on a wall

during sit-down rounds for all to see the relevant patient information.¹⁶ Our field observation suggested a number of requirements that current designs do not fully support, thus limiting the potential of computerized supporting tools. A simple factor would be viewing sizes and ranges of existing computer displays, which may be remedied by having larger displays or multiple displays. A more fundamental challenge would be the lack of support for storing preparatory work. The concept of “bundles”¹⁴ captures this challenge well. Current designs do not allow “bundling” of the results from pre-rounding preparations. A related example would be to support the preparation of “visuals” to be used during round discussions, such as decision support¹¹ or visualization of patient data¹⁷. A seamless visual presentation management system would be needed to allow the exploitation of the prepared visuals.

Our field observations further suggest that computerized tools may enhance rounds by maintaining the interest of multi-disciplinary participants, (e.g. present different parts of the patient data, visualizing trajectory of patient stay and planning goals), and facilitate participant contribution through non-verbal means. Research efforts by computer supported cooperative work researchers in the study of collaborative knowledge sharing and editing may be expanded into medical rounds with the added context of time pressure.¹⁸ Our study provides some guidelines and possible future directions to explore ways to support critical communication and joint sense-making processes of multidisciplinary medical rounds. The current study was limited by its scope and future field and evaluation studies are needed to investigate other activities of rounds such as group or individual order entry and documentation tasks.

Acknowledgement

We wish to thank the PICU staff for their valuable contributions. This work was supported by the National Science Foundation (IIS-0325087 and 0534646). Opinions are those of the authors and do not necessarily reflect the official positions of the sponsor.

References

- Rothschild JM, Landrigan CP, et al. The Critical Care Safety Study: The incidence and nature of adverse events and serious medical errors in intensive care. *Crit Care Med* 2005 Aug;33(8):1694-700.
- Gurses AP, Xiao Y. A systematic review of the literature on multidisciplinary rounds to design information technology. *J Am Med Inform Assoc* 2006 May;13(3):267-76.
- Chung RS, Ahmed N. How surgical residents spend their training time: the effect of a goal-oriented work style on efficiency and work satisfaction. *Arch Surg* 2007 Mar;142(3):249-52.
- Alvarez G, Coiera E. Interruptive communication patterns in the intensive care unit ward round. *Int J Med Inform* 2005 Oct;74(10):791-6.
- Birtwistle L, Houghton JM, Rostill H. A review of a surgical ward round in a large paediatric hospital: does it achieve its aims? *Med Educ* 2000 May;34(5):398-403.
- Manias E, Street A. Nurse-doctor interactions during critical care ward rounds. *J Clin Nurs* 2001 Jul;10(4):442-50.
- Beuscart-Zephir MC, Pelayo S, Anceaux F, Maxwell D, Guerlinger S. Cognitive analysis of physicians and nurses cooperation in the medication ordering and administration process. *Int J Med Inform* 2006 Jul 5.
- Nemeth C, Nunnally M, O'connor MF, Cook RI. Creating Resilient IT: How the Sign-Out Sheet Shows Clinicians Make Healthcare Work. *AMIA Annu Symp Proc* 2006;584-8.
- Xiao Y. Artifacts and collaborative work in health-care: methodological, theoretical, and technological implications of the tangible. *J Biomed Inform* 2005 Feb;38(1):26-33.
- Van Eaton EG, Horvath KD, Lober WB, Rossini AJ, Pellegrini CA. A randomized, controlled trial evaluating the impact of a computerized rounding and sign-out system on continuity of care and resident work hours. *J Am Coll Surg* 2005 Apr;200(4):538-45.
- Sackett DL, Straus SE. Finding and applying evidence during clinical rounds: the "evidence cart". *JAMA* 1998 Oct 21;280(15):1336-8.
- Fiser D. Wireless technology empowers physicians. *Health Manag Technol* 2004 Dec;25(12):42-4.
- Reddy MC, Pratt W, Dourish P, Shabot M. Asking questions: information needs in a surgical intensive care unit. *Proc AMIA Symp* 2002;647-51.
- Gorman P, Ash J, et al. Bundles in the wild: Managing information to solve problems and maintain situation awareness. *Library Trends* 2000 2000;49(2):266-89.
- Fiser D. Wireless technology empowers physicians. *Health Management Technology* 2004;42-4.
- Baggaley M, Inglis G, Malizia A. The writing is on the wall: use of an lcd projector to aid communication at the ward round. *Psychiatric Bulletin* 2005;29:180-1.
- Goldschmidt AJW, Luz CJ, Giere W, Ludecke R, Jonas D. Multi-dimensional visualisation of laboratory findings and functional test results for analysing the clinical course of disease in medicine. *Methods of Information in Medicine* 1995;34(3):302-8.
- Pratt W, Reddy M, et al. Incorporating ideas from computer-supported cooperative work. *Journal of biomedical Informatics* 2004;37:128-37.