Chapter 18
Cognitive Disconnect and Information Overload: Electronic Health Record Use for Rounding and Handover Communications in a Pediatric Intensive Care Unit

R. Stanley Hum

18.1 Introduction

Bedside working rounds can be one of the most cognitively complex situations in clinical medicine. Team members develop a mental model of the patient synthesizing electronic health record (EHR) information and information that is verbally transmitted during shift-to-shift communication. Each provider must synthesize and filter a large amount of information, which can be error prone. Rounds are also prone to interruptions. Despite interruptions, because the EHR allows for each individual provider to interact with the patient chart and there is an expectation that each team member fulfills a different role for the same patient, the team should develop a shared mental model to enable optimal workflow and provide optimal care. In this case study describing the bedside working rounds in a pediatric intensive care unit (PICU), we will explore each of these issues in depth.

18.2 Case Background

When you think about critical care medicine, you think about a team of healthcare providers frantically performing cardiopulmonary resuscitation on a patient whose heart has stopped. While these situations happen, the more common situation is a critical care team participating in a discussion about a complex patient. In medicine, these discussions are called "rounds". What a description of patient cases during rounds may fail to convey is the time pressure imposed on providers. In a typical unit with 14 patients, completing rounds within a 3-h period is not uncommon.

R. S. Hum (✉)
Columbia University, New York, NY, USA
e-mail: rsh2117@cumc.columbia.edu

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Hence, a patient presentation from start to finish needs to be in the order of 10–15 min. During this time, the team discusses a single patient, but interruptions are inevitable. Other patients may be deteriorating, new patients may be coming in, and stable patients may need to be discharged to maintain patient flow. This time constraint leaves little time for reflection and contemplation even in the absence of interruptions.

18.3 Case Presentation

Fourteen patients ranging from 2 months through 18 years of age are admitted in a 16-bed PICU. Around 9 AM, the healthcare team is starting to see patients. Standing and gathered in front of the patient's room is the PICU attending physician ("the attending"); the PICU fellow physician ("the fellow"); four resident physicians ("residents"); and the bedside PICU nurse. The patient can easily be seen from the outside and the patient's parents have come out of the room to listen and participate in the discussion.

The attending, working on a workstation on wheels (WOW), is logged into the patient's electronic health record (EHR). The others are waiting for the attending to finish opening a new physician note for this patient. Using a combination of copying and pasting from yesterday's attending note, acronym expansion and direct data substitution, the attending is finally ready to hear the presentation.

There are three residents on the team today. Each of them is carrying a stack of stapled paper printouts and each is standing in front of a WOW. These printouts were created just before the shift-to-shift communication ("handover") at 7 AM and are summaries of their respective assigned patients including the medication orders, last 24-h of laboratory results and fluid status summaries. They received handover from the overnight resident at 7 AM who has left the unit. Each printout also included handwritten notes including "To Do" reminders, corrections and events which the overnight resident did not enter in the handover document. Each resident also carries a mobile internal phone so that they can be contacted individually.

The resident assigned to this patient ("the presenting resident") starts to report the patient's summary and major events of the last 24 h. Simultaneously, the attending is typing the pertinent information into the interval history section of the patient's EHR note. The attending interrupts the resident as some of presented patient events were reported on the previous day. The resident realizes that some of the handover document events had not been updated. Upon completion of the 24-h events, the attending adds an additional event, which the resident was unaware. After the interval events are described, the bedside nurse ("the nurse") starts their report.

The nurse is standing next to the bedside computer with the patient flowsheet. The nurse has a paper-based written handover aid sheet. The sheet has been updated by the overnight nurse. To ensure consistency, the nurse follows the protocol of reading through the handover sheet in the following order: major 24-h events, neurologic status including sedation, analgesic and muscle relaxant infusions and

boluses; cardiovascular status including vasoactive infusions; respiratory status including respiratory rate ranges, ventilator settings and the most recent arterial blood gas as it is written on a sheet by the bedside; fluid balance status; and other systems including skin. Some of the information on the sheet is incorrect, and the nurse reports the correct information. There is also some missing data that has not been updated. Some of the information reported contradicts the resident presentation of the events. The attending asks the team to try to clarify the events. There is no one present with firsthand knowledge of the event in question. Using the bedside computer, the nurse checks the flowsheet data or a nursing note in the EHR but there is no further explanation. The resident checks the handover document interface on the patient's record, but no further information is available.

Simultaneously, while the resident and nurse are presenting, several events happen. First, a nurse pulls the fellow aside because of a deteriorating patient. The fellow returns after the completion of the nurse report, and continues to listen. The fellow has their own sheets on all the patients in the unit. The fellow also received handover at 7 am from the overnight fellow.

Second, one of the other residents' internal phone rings. It is another patient's nurse. That patient's medication is due to be given and the nurse would like clarification about the order. The resident steps aside and looks up information on their handover sheets. The nurse asks the resident to update the order. The resident changes to the appropriate patient, enters the order and returns to the discussion.

Once the nurse report is completed, the presenting resident continues by describing their findings on physical examination, followed by the laboratory results. The presenting resident's phone rings. The presenting resident passes the phone to a third resident who answers the phone and steps away. It is one of the consulting services regarding another patient. The third resident takes a message and returns to rounds.

Meanwhile, to save time, another resident has pulled up the patient's chest X-ray (CXR) of this morning along with yesterday's CXR while the presenting resident continues. The attending asks about the CXR and all eyes move to the display which has been turned so the entire team can see the CXR. The endotracheal tube (ETT) is in a little high. The resident measures the exact distance that the ETT needs to be pushed inwards. The attending confirms that the ETT should be advanced inwards by that distance. Both the presenting resident and the nurse take note as this procedure will need to be performed after the rounds.

The presenting resident the discusses their impression and plan of care. Intermittently, as the resident is corrected by the attending, the presenting resident writes down "To Do" reminders on their handover printout. Since there is minimal time, the handover screen will need to be updated later in the day. One of the other residents starts to enter orders on the patient. As part of the order entry system, there is an alert to notify if the resident is accessing the correct patient's chart which forces a brief period of waiting. Fortunately, the resident notices that the wrong patient's chart has been accessed. In fact, it was the patient that the resident was asked for a medication clarification. The order is cancelled, and the resident switches to the patient being discussed, and the order is re-entered. After waiting, the system allows the order to be finalized.

The other resident continues to enter orders as they are being presented. Another resident is modifying a portion of the handover screen in the EHR. This portion of the handover screen is reserved for the daily checklist. The checklist for the previous day's goals are removed and current goals are entered. The parents are asked if they have any questions. They do not, and the team moves to the next patient of the day.

18.4 Analysis of the Case and Discussion

This case illustrates a typical process preparing for and participating in patient rounds. Upon examination of the case, we will discuss a couple of themes: first, the development of a shared mental model including the effect of technology and use of artefacts to overcome constraints imposed by time and the nature of EHRs, and second, the occurrence of interruptions.

18.4.1 Shared Mental Models

In a recent systematic review, there is a significant body of evidence supporting teamwork in the intensive care unit to provide high-quality care (Donovan et al. 2018). In this example, the work during rounds is distributed across multiple providers with each provider having a different role. Lane et al. (2013) concluded that a successful communication strategy during patient care rounds included standardized rounding structures and processes with explicit roles for healthcare providers. Ideally, each of the providers should maintain a shared mental model of the patient and the goals of care (Page et al. 2016; Weller et al. 2014; Westli et al. 2010; Reader et al. 2009; Haig et al. 2006; Mathieu et al. 2000). In our example, each of the providers receive their initial patient mental model individually from their overnight counterparts who are not present during rounds. The process of rounding serves to synchronize and reconcile conflicting understanding about the patient amongst the providers as well as to make explicit the goals for the day (Lane et al. 2013). Ideally, the entire team, overnight and daytime, would gather on rounds to handover but these have become increasingly difficult because of duty hour restrictions (Philibert and Amis 2011; ACGME 2017).

With the implementation of reduced duty hours and the increased importance of the healthcare team, handovers to provide continuity of care has become essential (Arora et al. 2014). Handovers have become an increasing important topic of study and handover tools have become more common (Hoskote et al. 2017; Cochran 2018; Mardis et al. 2016, 2017; Keebler et al. 2016; Davis et al. 2015; Abraham et al. 2014). During these handovers, the goal is not only to communicate information but a mental model of the patient in question (Reader et al. 2009; Jiang et al. 2017). Discrepancies between a provider's firsthand knowledge and that which is documented in EHR should be reconciled (Davis et al. 2015).

Sources of error in the EHR can lead to discrepancies in the provider's mental models (Collins et al. 2011; Embi et al. 2004). These sources include incorrect original documentation, incorrect interpretation of an event, copy and pasted information which no longer is accurate and missing information. Based on a provider's expertise and familiarity with the patient, these errors can be accommodated. Unfortunately, in the case of electronic handover tools, which can be a combination of summarized prose by providers and automated summaries extracted from observations documented in the EHR, these errors can lead to incorrect summaries, and can create serious misunderstandings in the mental model developed by inexperienced providers or providers that have never cared for the patient (Davis et al. 2015).

Beyond errors, the amount of information stored in the EHR is immense and can lead to information overload (Farri et al. 2012). Inexperienced providers do not necessarily understand which information is significant and which can safely be ignored and as a result they tend to convey all the information which can impede a succinct description of the patient. Rarely are EHR summaries context-aware as to filter out unneeded information. While advances in EHR summarization is being investigated (Pivovarov and Elhadad 2015), mostly, the summaries are aggregators and it is up to the provider to interpret the summary (National Academy of Sciences 2009). In fact, Varpio et al. (Varpio et al. 2015) found showed differences between paper and EHR data summarizations and cognitive loads with EHR data summarization being detrimental to clinical reasoning.

Despite the promise of EHRs, many providers still use personal (usually paper) artefacts, such as handover sheets to make up for the deficiencies in the electronic reporting (Kelley et al. 2013; Blaz et al. 2016; Collins et al. 2012; Rosenbluth et al. 2015). In the dynamic environment of the intensive care unit, information about a single patient varies from provider to provider leading to diverging mental models throughout the workday (Mamykina et al. 2014). Some of the unintended consequences of healthcare technology include workarounds such as deferred data entry by first documenting on personal artefacts and then subsequently transcribed into the EHR if time permits which can negatively impact documentation quality (Kelley et al. 2013; Blaz et al. 2016; Zheng et al. 2016).

In the previous section, we discussed the discrepancies of information content that needs to be effectively reconciled to develop a shared mental model and how these discrepancies can cause incomplete shared mental models which may lead to suboptimal care. In our case, each of the healthcare providers is situated behind a computer so there is potential for a physical divide between team members. The lack of face-to-face communication and physical barriers is thought to negatively impact rounding effectiveness (Lane et al. 2013; Gharaveis et al. 2018; Morrison et al. 2008). Additionally, each provider is interacting with the computer and thus, their attention is divided between the EHR interface and the group discussion.

While each provider has the overarching goal to provide the best care for the patient, each provider has their own set of priorities (Donovan et al. 2018). Effectively, each handover (nursing, resident, fellow, attending) concentrates on specific sets of information and not all are overlapping (Jiang et al. 2017; Collins et al. 2011; Mamykina et al. 2014). There is a distributive nature of the division of

work in rounds. Each provider must have a similar understanding about the patient to be able to most effectively perform interrelated tasks (Page et al. 2016; Weller et al. 2014; Westli et al. 2010; Mathieu et al. 2000). Information from each of the providers must be taken into context, information must be evaluated in terms of being most representative of what occurred. Discrepancies must be reconciled so that a shared mental model can be established. Despite this shared mental model, each provider must augment that mental model to suit the needs and requirements of their own priorities.

18.4.2 Interruptions

Smartphones or rather instant access communications (voice or text) are increasingly common in the clinical workplace (Tran et al. 2014; Wu et al. 2010) and have been shown to improve communication efficiency (Ighani et al. 2010). The ability to immediately contact a remote provider is clearly important and helpful but it can also be a source of increased interruptions and potential interprofessional conflicts (Aungst and Belliveau 2015; Wu et al. 2013a, b; Vaisman and Wu 2017; Quan et al. 2013). If there are differing interpretations of the significance of a clinical event, then the provider who is being interrupted can become frustrated or experience increased stress (Weigl et al. 2014). With a paging system, it is the provider being interrupted who controls the timing of the communication, whereas, with personal mobile communications, a phone call or text message is generally returned immediately (Lo et al. 2012). In addition to increased interruptions, text paging and smartphones can have negative effects on decreased communication quality compared to face-to-face interactions and potentially leading to weakened interprofessional relationships (Wu et al. 2011, 2012, 2014).

These interruptions can be a source of increased cognitive load due to task switching (Li et al. 2012; Skaugset et al. 2016). Interruptions can lead to gaps information flow (Laxmisan et al. 2007). In our case, the face-to-face interruption and the phone call interruptions require task switching. Providers involved in the interruption must change their focus to another patient and they may miss important information that contribute to shared understanding. These external interruptions are a potential source of rounding efficiency (Anderson et al. 2015) and detrimental to team understanding (Laxmisan et al. 2007). However, Rivera-Rodriguez et al. (Rivera-Rodriguez and Karsh 2010) suggests that not all interruptions are should be considered detrimental. For example, when a presenting member is interrupted by others to clarify information then the mental model remains focused on the same patient and discrepancies can be reconciled and contributing to better shared mental models.

In addition to the effect on information flow, interruptions can be a cause of medical errors (Skaugset et al. 2016). In our case, an interruption was the potential

cause of a near-miss with ordering. Several authors have suggested the importance of interruption management such as using physical cues or conscious times to delay or reject interruptions to mitigate errors (Ratwani et al. 2017; Coiera 2015) as well as the importance of error recovery (Patel et al. 2015). Unfortunately, a systematic review of interventions to reduce interruptions showed that the evidence that these interventions reduced errors was equivocal and that further study was needed (Raban and Westbrook 2014).

18.5 Conclusions

The time of the individual provider delivering care is past and teamwork is essential to delivering optimal healthcare. Effectively developing a shared mental model is important in teamwork. Rounding in the intensive care unit is a cognitively complex task involving multiple members of the healthcare team. Participation in rounding serves to distribute work and cognitive load as well as to help solidify shared mental models. The development of shared mental models is affected by the handover process, by handover tools including those that involve EHR systems, by discrepancies in the experiences of individual team members, and by errors in the EHR systems. In addition, the demands of using EHR systems at the point of rounding can change the physical environment so that team dynamics are sub-optimal for shared mental model creation. Rounding is also affected by interruptions. Technology can also mediate provider-to-provider communication and be a source of interruptions. Personal communication devices have been shown to make care more efficient but the technology can also lead to increased interruptions and potentially interprofessional conflicts. These interruptions can be a source of medical error. Recovery from these errors and interruptions is an important process.

18.6 Recommendations

Current processes and workflows, particularly involving handover and rounding, need to be re-evaluated in the light of the distributive nature of work and cognition in the intensive care unit. Processes need to optimize development of shared mental models and support effective teamwork. Implementation of technology needs to be reviewed in this context as it can both be a benefit and a hinderance (for example, smartphones can improve unit efficiency but can also contribute to increased external interruptions or EHR use on rounds can be a cause of distraction and worsening shared mental model development).

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