Modeling Clinical Workflow in Daily ICU Rounds to Support Task-based Patient Monitoring and Care

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Abstract
Of all the duties performed by the critical care team in a hospital intensive care unit (ICU), a primary duty is the morning attending rounds. During and following the rounds, the ICU team devises a 24-hour plan of action comprised of patient-centered tasks. The aim of this doctoral research is to: (1) design and evaluate a novel task management tool that addresses breakdowns in critical care workflow and (2) introduce a new task management notification tool that mitigates workflow breakdowns by identifying the nature and type of notification/alert sent to the clinical team.

Author Keywords
Task management, interruptions, critical care

ACM Classification Keywords
H.5.m. Information interfaces and presentation

Introduction
Hospitals intensive care units (ICUs) have the highest mortality rate of nearly 22% [1], accounting for 4% of annual healthcare spending in the United States [2]. ICU houses critically ill patients who require constant intervention and monitoring [3]. A critical care team in the hospital intensive care unit (ICU) may comprise of
multidisciplinary team members, such as, physicians, nurses, residents, specialists, pharmacists, and so on. Of all the duties performed by the critical care team in the ICU, the primary duty is the morning rounds [4,5] at patient bedside or within the corridors between the patient rooms (Figure 1). During/following the rounds, the team devise a plan of action comprising of tasks for the next 24-hours. The tasks include orders (such as completion of lab tests or administration of medicines), collection and summarization of patient physiological measures, follow-up on tasks that were devised during the past 24-hr period and so on. Thus, completion of all the tasks requires collaboration and coordination by the critical care team members to forward the patient’s condition towards recovery.

Previous studies [4] have identified the usage of paper-based task generation that is later transformed to a digital variant. There are, however, several drawbacks to this workflow model [4,5,6]. For example, Figure 2 depicts a common workflow model where ICU rounds management is executed during a two-day period. As several studies have outlined [4,5,6], in this common clinical scenario, there is often a lack of awareness, notification or updates on a common understanding of the patient’s condition with completion of tasks and their corresponding goals. Furthermore, there is a lack of clear and concise communication of all the goals and tasks between team members. This may lead to a breakdown in collaboration and coordination between the team members in administering patient care.

Research Questions
To overcome these drawbacks, critical care team members can collaborate through a task management application and receive notifications or alerts that require their attention at appropriate times. The process of effective and efficient management of tasks through its life cycle can serve as the foundation for efficient workflow in the ICU.

There is a lack of adequate research with respect to post-rounds task management (in the ICU environment) that identifies the appropriate time and type of notification/alert (visual, auditory, or tactile) to be sent to the clinical team. Although task creation and management was modeled in the MeDo approach [5], there is a lack of a notification system that can further optimize ICU teamwork. While the inclusion of a notification system can prove to be potentially disruptive/interruptive to ongoing tasks, it is imperative to understand both the timing and nature of interrupting notifications and its direct impact on clinician attention and overall workflow.

This dissertation research will address the following research questions:

RQ1. How are tasks managed in the notification system?

RQ2. How is goal-accomplishment updated and coordinated in the existing system?

RQ3. How is information transmitted to all team members as each member (and the team as a whole) advance towards the completion of individual tasks?

Dissertation Status
The dissertation was proposed and accepted by the research committee. IRB approval has been obtained to conduct the study. This doctoral dissertation research will include the following stages:
1. **Semi-structured interviews and surveys.** ICU clinicians from Methodist Hospital (Indianapolis, IN) will be interviewed to understand task management during the daily post-rounds period. Initial workflow task models and sketches for the task management application will be generated based on the knowledge gained.

2. **Participatory focus groups.** Informal focus groups (same participants/location) will help modify/enhance the initial model and the generated sketches. A low-fidelity prototype of a task management application will result from this method.

3. **Iterative rapid prototyping.** Evaluation of the low-fidelity prototypes (same participants/location) based on framed clinical scenarios in addition to participants’ perceptions of design, ease of learning and use of tool will be used to create a dynamic prototype of the task management application. The high-fidelity prototype will again be evaluated in a similar manner to obtain additional interaction design and usability feedback.

This dissertation research is currently at stage 1.

**Expected Contributions**

This doctoral dissertation represents two key contributions. First, novel design features that support task management between the critical care team members, while providing patient care, will be created and tested. Previous research [7] has identified the need to focus on complex social systems that constitute collaborative performance and team workflow while understanding clinical cognition. The majority of intensivists engaged in collaborative teamwork in the ICU, improved: (1) their shared understanding of the patient’s condition and (2) communication speed and reliability by 92%, coordination by 88%, reduced staff frustration by 75%, and (3) patient care by making it faster by 90% and safer by 75% [8]. Communication and decision-making among critical care team members is more than face-to-face. Often times, nurses or other team members are not present during daily rounds thereby inferring decisions made, their goals, and the patient’s condition. Hence, a task management tool that synchronizes and aids ICU teams to be informed of the patient’s status is of vital importance and thereby a novel contribution.

Second, there is lack of research on identifying the appropriate time and type of notification/alert (visual or auditory or tactile) to be sent to the clinicians. Notifications/alerts can be an interruption to a clinician’s concurrent task load. In addition to modeling and developing a task management tool, this research will also study the timing and nature of notifications/alerts sent to the critical care team members.

**Statement of expected benefits**

The ICU is an intensely complex environment where multidisciplinary team-members communicate and collaborate to administer patient care. Although the patient information exchange process is structured, ICU clinicians unintentionally become siloed as to their specific domain of expertise. Further, the exchange of clinical information is often under emphasized as to its importance while devising a plan of action for the next 24 hrs. Hence, breakdowns occur in communication, which in turn can impact the execution of a successful plan.
While each ICU multidisciplinary team member may have different concerns, work, and motivations, they must collaborate and coordinate their activities to accomplish a common goal of providing safe, effective and efficient patient care. One key element to success lies in the team’s ability to work collectively to seek and synthesize information effectively. I hope to discuss the complexities related to ICU communication, where clinicians should collaboratively seek medical information that can optimize their work to devise a daily patient-by-patient action plan comprised of meaningful tasks.

In summary, an application with a built-in notification system can aid in task management, while mitigating unnecessary interruptions to ongoing task activities. Hence, it is imperative to understand both the temporal and intrinsic aspects of notifications that regularly interrupt ICU clinical workflow overall and the clinician’s attention specifically. I hope to discuss this and get valuable feedback at the Doctoral Consortium.

Participation in this CSCW Doctoral Consortium will provide me with an opportunity to interact with other doctoral students from around the world with varying research interests. This will also allow me to expand my knowledge on what others are doing in human factors and computing systems. Being a HCI student, I will be able to understand and apply my existing knowledge in critiquing other students’ work and provide them with valuable feedback. Further, by sharing and discussing my research interests with a distinguished panel of seasoned researchers, I can make changes to my current research direction if necessary. Thus, I believe participation in this consortium will significantly support my research as well as my fellow student researchers.

**Selected Literature Cited**


