Developing Medication Safety Training Applications with Software Patients for Human Teams

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1. Introduction

The cost and consequences of medication errors are a huge concern for healthcare systems around the world, and are often attributed to breakdowns in processes involved in medication prescription, delivery, and administration. Medication administration errors are associated with violations of one (or more) of the six rights of medication administration: right drug, dose, patient, route, time, and documentation. Medication administration errors are the second most frequent type of error and may account for up to a third or more of all preventable events (Bates et al., 1995).

2. Practice Innovation

While healthcare providers are trained in the six rights of medication administration (typically via lecture or some form of didactic teaching), errors may still occur especially when there are breakdowns in communication and team coordination. This paper outlines a powerful method for training healthcare providers to help recognize and prevent potential breakdowns in medication delivery coordination. Providers are trained through interaction with a software-based medication safety training simulation tool. In this paper, we highlight human factors engineering challenges discovered during the design and development stages of this tool.

3. Simulation Description

Healthcare professionals use a variety of “medical simulation” scenarios for education and training purposes ranging from expensive high-fidelity medical simulations (e.g., life-sized synthetic mannequins) to portable low-fidelity medical simulations (e.g., playing a card game to simulate variability in potential outcomes for patients). The authors’ research aim is to design a mid-fidelity simulation that incorporates some of the complexity and validity of a high-fidelity simulation, with the portability and economic advantages of a low-fidelity simulation.

The typical perception of a “simulation” in healthcare differs substantially from the Industrial Engineering (IE) concept of software-based behavior analysis of system dynamics. This application integrates techniques from an IE perspective (an agent-based Monte Carlo simulation) into a team-based medical simulation of patient care in a hospital unit. Each participant is assigned a mobile device and a role in the simulation (e.g., nurse, pharmacist). The simulation runs over the course of a set period of time; system events are dependent upon the other role players’ actions, increasing team-level integration and simulation validity. Examples of real patient data were used to simulate patients traveling through the system, further increasing ecological validity. The simulation requires human-human interaction as well as human-computer interaction (with the mobile device) for the participants to perform at a high level. This simulation can also provide real-time feedback via a training performance dashboard, using a tablet-based mobile application that simulates a hospital environment.

4. Findings

Throughout the development of this simulation tool, the team has uncovered a number of human factors challenges, addressing interface design, usability, situation awareness (SA) and cognitive aspects of variable simulation time scales in the simulation. The goal of the simulation tool is not to develop software skills, but to develop team coordination and situation awareness. Thus it is essential that the simulation interface facilitate a transfer of clinical skills from the clinician’s experience, software usability must support those skills. During a cognitive walkthrough of an early prototype, the team also uncovered mismatches
between participants' mental models and the simulation output, such as a lack of feedback concerning patient status.

Effective individual and shared SA requires individual team members to have an understanding of the current state / goal of the system, team processes, and overlap between tasks (Cuevas et al., 2007). The team's cognitive walkthrough analysis identified a lack of SA-supporting features, such as a list of tasks that needed to be completed (e.g., patient needs medication picked up from the pharmacy) or distributed collaboration and clinical handoffs (indications that someone else on the patient care team was completing the task). These factors continue to be addressed with a new “back-end” software development team and additional prototype and user testing.

5. Discussion

The design of this unique software-based medication safety training simulation tool has integrated human factors engineering and user-centered design goals throughout the software and user testing / development process. Results from heuristic evaluations and cognitive walkthroughs have been essential to improving the design of the tool to support medication safety process skill development. Future work for the simulation tool involves further user testing and dissemination of the tool in educational settings to improve medication administration safety training for pharmacists, nurses and other healthcare professionals.

References
