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Conducting an efficient proactive risk assessment prior to CPOE implementation in an intensive care unit

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ABSTRACT

Purpose: To develop, conduct, and evaluate a proactive risk assessment (PRA) of the design and implementation of CPOE in an ICU.
Methods: We developed a PRA method based on issues identified from documented experience with conventional PRA methods and the constraints of an organization about to implement CPOE in an intensive care unit. The PRA method consists of three phases: planning (three months), team (one five-hour meeting), and evaluation (short- and long-term).
Results: Sixteen unique relevant vulnerabilities were identified as a result of the PRA team's efforts. Negative consequences resulting from the vulnerabilities included potential patient safety and quality of care issues, non-compliance with regulatory requirements, increases in cognitive burden on CPOE users, and/or worker inconvenience or distress. Actions taken to address the vulnerabilities included redesign of the technology, process (workflow) redesign, user training, and/or ongoing monitoring. Verbal and written evaluation by the team members indicated that the PRA method was useful and that participants were willing to participate in future PRAs. Long-term evaluation was accomplished by monitoring an ongoing "issues list" of CPOE problems identified by or reported to IT staff. Vulnerabilities identified by the team were either resolved prior to CPOE implementation ($n = 7$) or shortly thereafter ($n = 9$). No other issues were identified beside those identified by the team.
Conclusions: Generally positive results from the various evaluations including a long-term evaluation demonstrate the value of developing an efficient PRA method that meets organizational and contextual requirements and constraints.

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1. Introduction

There are known vulnerabilities associated with implementation of computerized provider order entry (CPOE) [1–4]. Many of these vulnerabilities occur by not considering the work system in which the technology is implemented and are related to the design of the technology and its impact on workflows and processes [5]. The human factors engineering discipline offers a range of approaches and methods for anticipating some of the vulnerabilities which can be addressed before technology implementation [6–9]. In this paper, we describe the development and use of a proactive risk assessment (PRA) method to identify and address known and potential vulnerabilities related to CPOE implementation in a particularly error-prone process, i.e., a transition in care within a hospital [10–13].

PRA methods have been used to identify potential vulnerabilities associated with changes in processes [9] and technology implementation, including those related to the implementation of Smart infusion pump technology [14] and to identify strategies for dealing with vulnerabilities associated with IT-mediated medication management [15]. To our knowledge, there is only one published study on the use of PRA in the context of CPOE implementation [16]. Bonnabry et al. [16] used a specific PRA method – failure mode and effects analysis (FMEA) – to evaluate the medication prescription process before and after CPOE. While this application of FMEA identified a number of vulnerabilities in CPOE implementation, there was no information provided on the long-term effectiveness of the PRA.

The use of efficient PRA methods before health IT implementation will increase if we can demonstrate their long-term safety benefits. However, few PRA studies have attempted to assess the long-term impact of the method or its results. Our own research has described significant vulnerabilities identified through an FMEA method used prior to implementation of Smart infusion pump technology [14]. After implementation we assessed the various vulnerabilities related to the Smart infusion pump's performance and determined which ones the FMEA team identified as well as which ones had not been anticipated. We demonstrated that the FMEA method identified many but not all vulnerabilities. A significant vulnerability related to the Smart infusion pump technology was identified only after implementation [17].

Another barrier to the use of PRA methods before health IT implementation is the significant investment of resources and time necessary. Conventional PRA methods such as FMEA have demonstrated shortcomings due to the excessive resources required [18] and expectations placed on participants [19]. By following the method prescriptively, FMEA teams generally spend a significant amount of time attempting to fully understand the problem and current process(es), to generate extensive issue and problem lists, and to identify possible solutions. Likewise, organizational constraints (e.g., staff availability, implementation timelines) are not always taken into account when initiating PRAs. When implementing health information technology (IT) such as CPOE in a complex healthcare environment, it is even more critical to ensure that the PRA method is conducted in an efficient manner. Research on PRA has produced a set of guidelines to use when preparing for the team portion of a PRA [9,20,21].

In this study we developed, implemented, and evaluated a PRA method that identifies vulnerabilities in CPOE design and implementation.

2. Methods

The PRA was part of a larger study evaluating the impact of a computerized provider order entry (CPOE) implementation in intensive care units (ICUs) (http://cqpi.engr.wisc.edu/cpoe_home). The PRA was conducted jointly by human factors engineering (HFE) researchers at the University of Wisconsin-Madison and staff from the various departments that would be affected by or were involved in the CPOE implementation at Geisinger Medical Center (GMC), in Danville, PA.

2.1. *Organizational setting*

GMC, a flagship quaternary hospital, has 403 beds and four intensive care units (ICUs): a 24-bed semi-closed adult ICU (medical/surgical shock and trauma), an 18-bed open cardiac ICU (cardiac medical/surgical, transplants, adult ICU overflow), an 11-bed semi-closed pediatric ICU (all pediatric medical/surgical patients excluding neonates), and a 38-bed closed neonatal ICU (critically and seriously ill newborns). Electronic health record (EHR) technology was first implemented in 1996 in the ambulatory setting.

In conjunction with EHR implementation, workflow redesign efforts have aimed at improving the quality and efficiency of the care provided [22]. Through the PRA we describe here, hospital leaders and IT management further demonstrated support for identifying critical issues associated with CPOE by obtaining input from multiple individuals representing various clinical stakeholders. Hospital leaders were especially interested in assessing a process that: (1) was complex in the paper world and would be equally challenging to transform to an electronic format, (2) required numerous transitions in care, and (3) was currently error-prone.

Because there were limitations on staff availability and a tight development and implementation timeline, management believed the amount of group meeting time required by many conventional PRA methods [9,18] would be problematic. The organization was committed to conducting a PRA, however, and was willing to pay staff overtime to participate. Including benefits, this cost the organization approximately $2500. The participating stakeholders demonstrated their commitment to the PRA by the fact that each of them worked an 8-h shift immediately prior to convening for the PRA team meeting. All necessary Institutional Review Board approval was obtained before proceeding with the PRA.

Given these constraints, we determined that the PRA would be divided into three phases (Fig. 1): a *planning phase* requiring considerable up-front effort by a limited number of content and methodological experts; a *team phase* that would capture the unique experience and expertise of the stakeholders related to the process selected; and an *evaluation phase* that would include collecting feedback related to the PRA team