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Evaluating clinical decision support tools for medication administration safety in a simulated environment

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ABSTRACT

Objectives: The specific aims of this study were to develop a methodology and tools for the design of clinical decision support systems to decrease the incidence of medication administration errors.

Methods: A mixed-methods design was utilized in this study. First, observations of medication administration practice were used to inform the design of a simulated information system with a variety of decision support tools. Then, nurses were observed administering medications in a simulated environment using the simulated system. Finally, the nurses participated in focus groups to provide input into system tools design. Observations of nurses' use of the decision support tools as well as semi-structured focus groups were used to evaluate nurses' use and perceptions of the utility of the system decision support tools.

Results: Nurses' evaluation of the medication administration decision support tools as well as their actual performance revealed a tendency to underestimate their need for support. Their preferences were for decision support that was short, color coded, and easily accessed. Observations of medication administration showed that nurses exhibit a variety of work processes to prepare and administer medications to patients and access system decision support tools at a variety of points in this process. System design should allow flexibility of multiple points and types of information delivery to accommodate variations in workflow to minimize the tendency for system workarounds.

Conclusions: This study was performed in one hospital and results may not generalize beyond this setting. However, this method used to design and test decision support could be transferred to other settings. Using simulation in this study provided a method for testing new information system design, related to a potentially dangerous procedure, in a manner that eliminated the hazards of potential unintended consequences for patients.

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1. Introduction

Medication administration errors have been shown to be frequent and serious. It is estimated that approximately 40 adverse drug events (ADE) occur each day in a hospital of 300 beds [1]. Computer-based Provider Order Entry (CPOE) systems with decision support can reduce incorrect orders, but do not directly influence those errors made during medication administration. Errors in medication administration can occur at multiple points along the process of preparing, administering, or monitoring medications. The aims of this study were to develop a methodology and tools for the design of clinical decision support (CDS) systems to decrease the incidence of medication administration errors. We focused on providing decision support for nurses who administer IV medications, since these medications are known to be high risk and a frequent source of serious adverse events [2]. To improve the CDS design process, we developed a simulated system that includes the relevant and realistic elements of the actual clinical environment and used teams of nurses from five intensive care units to test its applicability to real-world settings.

2. Background

2.1. Medication administration errors in intensive care

Error is particularly prevalent in highly technical specialties such as critical care, vascular surgery, cardiac surgery, and neurosurgery where the rate of adverse events is significantly higher than in other areas of acute care [3]. Intensive care units may be one of the most dangerous places in acute care settings with respect to medication errors. The rate of preventable ADEs in intensive care can be twice as much as in non-intensive care units [4]. Errors in medication administration in intensive care settings also have the potential to be more deadly than those on other hospital units due to the large amount of intravenous medications given [2,4,5]. Adverse events related to IV medication administration occur when nurses administer intravenous medications at the wrong rate, through a vascular access catheter of an inappropriate gauge for the medication, through IV lines that carry incompatible drugs, prepare medications with the wrong diluents, and fail to recognize commonly occurring side effects or drug interactions [6].

The Institute for Safe Medication Practices and the Agency for Healthcare Research Quality (AHRQ) [7] has recommended the use of three technologies to reduce ADEs at the point of medication administration: unit dose dispensing, BCMA and smart infusion pumps. These combined strategies can reduce the incidence of medication errors related to the administration of drugs to the wrong patient, wrong drug, the wrong drug amount, and the wrong administration time [8–10]. Unit dose dispensing, BCMA, and smart infusion pumps do not address, however, the ADEs that can occur because of lack of knowledge of the drug on the part of the administering nurse or those errors that result from information that the nurse knows, but has forgotten or does not use during the actual patient care situation [11]. In a description of errors by stage of medication process, Kopp et al. [12] report that lack of drug knowledge was the cause of 10% of error and slips, and memory lapses were responsible for 40% of errors at the administration stage.

It is not surprising that some medication administration errors are attributable to slips and memory lapses as healthcare work occurs within an interrupt-driven environment where workers are carrying on more than one communication task simultaneously [13–15]. Such disruptions can cause memory lapses, even when only 10 s separate the intention from the interruption [16]. In a study of near misses, nurses cited interruptions as the major reason for medication error near misses [17]. While nurses who have long experience in a setting might be expected to prevent many errors because of familiarity with the drugs, dosages, and patient population, older and more experienced nurses are leaving the workforce and hospitals increasingly rely on novice nurses, transfers among settings, and the use of agency nurses to staff units. Traditional educational interventions alone are insufficient to decrease the errors committed during medication administration; new drugs become available, some drugs are infrequently given, and interruptions, fatigue and overwork are prevalent in current practice environments [7].

2.2. Clinical decision support design

CDS systems are computer-based systems designed to assist clinicians with clinical decision making [18]. CDS systems include systems to assist with diagnosis as well as therapy, although most research on medication CDS has focused on therapeutic decision making and integrating decision support capabilities with CPOE systems. These CDS systems can provide alerts related to medication orders (drug–drug, drug–allergy interactions) [19] or can critique orders or remind clinicians about procedures or tests that should be ordered (e.g. prophylactic antibiotics prior to surgery for a given patient). In their 2007 white paper on decision support, Osheroff et al. describe decision support tools as including: “computerized alerts and reminders, clinical guidelines, order sets, patient data reports and dashboards, documentation templates, diagnostic support, and clinical workflow tools” [20].

Relatively little research has been conducted on the use of CDS to aid decision making in acute care nursing practice, however, this is beginning to change. Recent studies in nursing CDS have shown the benefit of systems to provide decision support for regulating potassium [21] and insulin therapy [22,23]. Clinical alerts and reports have been found to be an effective mechanism for prompting nurses to remember clinical routines [24,25], or to provide information regarding a patient’s progress on a care pathway [26]. Embedding information into nursing documentation and medication administration components of clinical information systems may be an effective strategy in delivering decision support to nurses in the acute care environment.

Rapid prototyping and assessment of user input into system design is an accepted strategy for software development [27,28], but because CDS is a new and evolving function in nursing clinical systems, there are few clear models for their assessment and for obtaining the input of users. Prototyping and testing systems through simulation and observation can