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Human factors engineering approaches to patient identification armband design

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ABSTRACT

The task of patient identification is performed many times each day by nurses and other members of the care team. Armbands are used for both direct verification and barcode scanning during patient identification. Armbands and information layout are critical to reducing patient identification errors and dangerous workarounds. We report the effort at two large, integrated healthcare systems that employed human factors engineering approaches to the information layout design of new patient identification armbands. The different methods used illustrate potential pathways to obtain standardized armbands across healthcare systems that incorporate human factors principles. By extension, how the designs have been adopted provides examples of how to incorporate human factors engineering into key clinical processes.

1. Introduction

1.1. Patient identification

The task of patient identification is performed frequently by nurses and other members of the care team each day and is essential for patient safety. Patient misidentification and associated preventable patient harm occurs daily nationwide with potentially fatal consequences (Gray et al., 2006; Schulmeister, 2008). Errors in the identification process can occur in a myriad of care encounters, such as blood transfusion, medication administration and specimen collection (Mannos, 2003; Pagliara and Rubella, 2006; Valenstein et al., 2006). In response to risks of misidentification, the Joint Commission established as one of its National Patient Safety Goals (NPSGs) the "use of at least two patient identifiers (e.g., patient name and date of birth) when administering medications, blood, or blood components; when collecting blood samples and other specimens for clinical testing; and when providing treatments or procedures. The patient's room number or physical location is not used as an identifier" (Joint Commission, 2014).

Identification armbands have been used for ensuring compliance to NPSGs. Organizations have modified armbands to contain key "patient identifiers" in order to support the "two identifiers" requirement by NPSGs (Joint Commission, 2014). To further enhance safety, organizations have paired patient armbands with scanning technology, such as barcode medication administration (BCMA), to reduce medication errors (Akiyama et al., 2010). Barcode medication administration requires a clinician to electronically verify that the correct patient is being given the right dose of the prescribed medication at the accurate time by scanning both the patient identification armband and each medication being administered.

1.2. Patient armband design

The optimal design of data elements and their layout on patient armbands is essential for patient identification (Dhatt et al., 2011). Previous studies have identified several potential sources of error with armband use, such as the omission of key information or the display of unreadable information (Burrows et al., 2009; Linden, 1998; Lumadue et al., 1997). Poor design, such as suboptimal barcode orientation (Snyder et al., 2010), has been linked to medication errors (Bauer and Guerlain, 2011; Orser et al., 2001). Optimizing barcode width and layout in addition to implementing process changes and specific staff training has been shown to reduce patient identification errors (Colard, 2005), improve efficiency, and allow staff to focus more on direct patient care activities (Keohane et al., 2008).

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One feature of well-designed armbands is their ability to be scanned quickly and accurately. Specific scanning technology used in BCMA necessitates re-engineering the space, layout and content on the armband. The inability to successfully scan barcodes frustrates users, reduces efficiency and can delay the administration of essential medications to patients (Johnson et al., 2002). In one instance, unsuccessful attempts to scan certain Large Volume Parenteral (LVP) bags for product identification were traced back to problematic barcode placement (Raman et al., 2011). Furthermore, if patient armbands do not scan in as few as one or two attempts, nurses will resort to workarounds such as attaching a patient's identification barcode to something other than the patient to make it easier to access (DiConsiglio, 2008; Koppel et al., 2008; Miller et al., 2011).

One challenge in the re-engineering of armband layout for enhanced barcode scanning is that these changes can compromise the readability of armbands. In some cases, enhancing barcode scanning might actually decrease human readability, such as when barcodes take up so much space on the armband that font is too small to be easily read by staff. Reports of implementation efforts of BCMA systems indicated that successful implementation relies upon usable, easy to read patient identification armbands (Miller et al., 2011). Note that human reading of armbands is required for direct patient identification and as a backup method when BCMA is not working, such as during system downtimes.

1.3. Usability testing during the design process

Despite the importance of optimal armband design to patient safety, there are no published guidelines or testing processes for a safe, usable patient armband design. User testing is advocated to identify usability issues (ISO 9241-11, 1998; Patterson et al., 2006) and should be integrated into design processes (Preece et al., 2007), but with the exception of one report of simulation-based usability testing comparing commercial barcode technology systems for transfusion (Anders et al., 2011), healthcare systems have few examples to follow when attempting to design, test and implement patient identification armbands.

In this article we report efforts at two independent, multi-facility healthcare systems utilizing different human factors engineering approaches to develop new processes for patient identification armband design. We outline the human factors principles involved in design and the practical barriers in implementation. At both healthcare systems (referred to as Sites 1 and 2), the goal was to achieve a single, system-wide armband design using human factors guidelines and recommendations when feasible. A standardized armband design was considered more cost effective and less complex to maintain, with the intended benefit of consistency for staff that may work at different facilities within a system.

Site 1 was a nonprofit integrated health care delivery system consisting of 12 acute care hospitals. Site 2 was a nonprofit healthcare delivery system consisting of 12 hospitals. Both sites independently formed multidisciplinary teams to prototype and evaluate the design layout of new patient identification armbands. The two sites collaborated by sharing armband standards and requirements as well as de-identified prototypes for comparison purposes.

2. Case study: Site 1

2.1. Background

The design effort was triggered by the purchasing department's decision to consolidate all facilities to a single patient armband vendor. Previously, each facility designed and chose its own patient armbands. As the start of the effort, the corporate Office of Patient Safety was consulted and recommended that human factors experts be included. The multidisciplinary team consisted of human factors engineers, patient safety nurses, an informatics resource nurse, a software developer familiar with the armband configuration software, the director of supply chain management and an information systems manager. Key activities included: (a) comparing different armband layouts and data elements used at facilities to identify common elements, (b) interviewing and observing users to determine which data elements on armbands were actually used and (c) reviewing the literature and national standards to determine the core data elements to comply with NPSGs. An iterative design process was employed for the team to work within the constraints of the armband design software, while finding solutions to best include data elements required following human factors design principles.

2.2. Armband prototyping process

2.2.1. Assessment of current armband design and guideline development

The data elements in existing armbands varied across facilities (Fig. 1). For example, the admitting physician's name was included at one facility so that staff could easily clarify orders or discuss a patient's treatment with physicians. Staff were found to utilize different data elements when reviewing patient armbands. For example, laboratory staff used the patient's visit number, which is unique to a specific patient visit and account, instead of the medical record number for matching laboratory draw orders. Through usability inspection, we found issues pertaining to the readability/usability of the two patient identifiers, name and date of birth, such as variations in locations, difficult to find core data elements (e.g., non-bold, similar size font), reduced readability due to all uppercase letters and cluttered with too much information (e.g., area of care, name of admitting physician).

2.2.2. Prototype design process

We encountered major armband design software limitations in layout, formatting and spacing. Multiple iterations resulted in an 'ideal' prototype armband design (Fig. 2). To support ease of use, the ideal prototype improved the readability of the two key patient identifiers, name and date of birth, by placing them at the top of the armband and formatting them to promote key information retrieval (e.g., bold, larger font size). We capitalized only the patient's last name to enhance visual scanning for the core data elements. The prototype reduced clutter by stripping all non-essential elements for patient identification (e.g., area of care, admitting physician's name). Finally, the barcode was given a prominent, easy to scan location and made as large as possible.

2.3. Simulation-based usability test

The simulation-based usability test was conducted to compare a design in use at three facilities with the ideal prototype. It should be noted that the evaluation effort was Site 1's first attempt to incorporate simulation-based usability testing to inform design decisions.

2.3.1. Participants

The participants were 10 nurses (9 females and 1 male) recruited at a monthly system-wide health information technology (HIT) meeting. These nurses were specially trained in informatics and remain active in nursing practice (minimum of two patient care shifts per month to remain current on patient care practices and staff workflows). Informatics training included "super user"