Cognitive ergonomics, socio-technical systems, and the impact of healthcare information technologies

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ABSTRACT

The United States healthcare system is transitioning from paper-based to computer-based systems. In this process, it is vitally important to focus on optimizing the role of human factors in systems design. This review examines a wide range of cognitive ergonomics and socio-technical systems issues that impact the successful implementation of healthcare information technologies (HIT). We review evidence on the impact of HIT on medication errors, electronic health records and clinical support, copying clinical exams and notes, computerized-provider order entry and clinical decision support system, and bar-code medication administration systems. We examine research on barriers to successful HIT implementation and also on user workarounds of systems' limitations. The review concludes by summarizing a series of important human factors design considerations that must be considered for successful systems implementation. This information is presented in a manner that should allow HIT system designers and implementers to readily incorporate these principles into their future developments.
Relevance to industry: Evidence from a comprehensive review of the impact of HIT on a wide variety of important healthcare issues is presented and a series of human factors design considerations that are critical to successful HIT systems design is summarized.

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1. Introduction

Most U.S. healthcare transactions still rely on paper-based systems, and many of these systems have remained unchanged since their inception in the 1950s. Paper-based systems are prone to errors in the transcription, storage and retrieval of health information; they transmit such information slowly between different healthcare providers; they do not readily follow with the patient when s/he moves location; and they are dumb and do not check for potential problems, such as errors in medication dosage or adverse drug interactions. A study of medication errors with a paper-based system in use at the University Medical Center, Groningen, Netherlands showed that over a 5 month period during which there were 592 hospital admissions and 7,286 medication orders (MOs), 60% of those MOs had at least 1 prescribing or transcribing error. These errors resulted in 103 adverse drug events that were preventable, resulting in 92 cases that experienced temporary harm, 8 cases that required prolonged hospital admission, 2 cases that were life-threatening and 1 fatality (van Doormaal et al., 2009).

Increasing the use of electronic information technology potentially could lead to reductions in cost and improvements in healthcare delivery. Effective design, implementation and use of healthcare information technology (HIT) is inextricably linked to the fundamentals of human factors ergonomics and user-centered design — building systems that reflect the physical, cognitive and social needs and goals of a person or team in the context of the technology, environment and culture with which they operate. Technology inherently transforms the way in which an individual provider performs work; how teams communicate and coordinate care practices; and the mode and geography in which information is transmitted. Effective HIT systems work synergistically with the norms, expectations, and mental models in existing care practices; other technological systems; and the environment in which it will be used. Understanding and optimizing these socio-technical components and interactions to the extent possible is critical to a fluid transition towards HIT (Wears & Berg, 2005; Carayon et al., 2007; Carayon et al., 2009). Realizing the projected benefits of HIT depends not only on the design of intuitive, user-friendly and supportive user-machine interfaces, but also on the design of its strategy for integrating with existing work processes from conception to implementation.

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