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Human Factors of Health Information Technology – Challenges and Opportunities

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Health information technologies are becoming ubiquitous. According to the DHHS Office of the National Coordinator for Health Information Technology, 96 percent of non-federal acute care hospitals had adopted certified EHR (Electronic Health Record) technology by 2015, up from 71.9 percent in 2011 (Henry, Pylypchuk et al. 2016). Adoption of basic EHR technology rose from 9.4 to 83.8 percent between 2008 and 2015 (Henry, Pylypchuk et al. 2016), and Personal Health Records (PHR) technology adoption will exceed 75% by 2020 (Ford, Hesse et al. 2016). Health information technologies are changing healthcare delivery, transforming relationships between patients, caregivers and clinicians, and offering unique opportunities to achieve the Quadruple Aim of individual care experience, population health, healthcare cost control and clinician quality of working life (Sikka, Morath et al. 2015). As health information technology becomes pervasive, issues of appropriate design and implementation have emerged as special challenges (Karsh 2004, Karsh, Weinger et al. 2010, Institute of Medicine 2012); this is an area of contribution for the concepts and methods of human factors engineering. This special issue presents state-of-the-art research on human factors of health IT with eight papers that identify and address various human factors aspects of health IT. These eight papers examine multiple technologies and user groups and describe how health IT can support care that is highly distributed over time, space and boundaries. The papers also make it clear that a systems approach to health IT design and implementation is critical for positive outcomes for all stakeholders. Finally, the eight papers show the impact of human-centered methods for the design and implementation of health IT.

1. New and varied technologies – New opportunities

According to the Office of the National Coordinator for Health IT, “The term “*health information technology*” (health IT) is a broad concept that encompasses an array of technologies to store, share, and analyze health information.” (<https://www.healthit.gov/patients-families/basics-health-it>). Health information technologies include electronic health records, personal health records (including patient portals), e-prescribing technologies, and health information exchange. Not only healthcare providers but also lay people, patients and their caregivers use health IT. In this special issue, research examines new forms of health IT used by clinicians and patients. For instance, on the clinician side, Asan et al. examined pediatric ICU nurses’ perception of a large customizable interactive monitor. Alyousef et al. described various health information technologies used by care managers and the challenges associated with these multiple technologies when coordinating care for chronically ill

patients. The papers by Doggett et al. and Ozok et al. assessed usability and other design characteristics of personal health records used by lay people, including college students. In this special issue, three papers address primarily clinicians (Asan et al.; Alyousef et al.; Hundt et al.), four papers address primarily patients (Doggett et al.; Ozok et al.; Valdez & Brennan; Srinivas et al.), and one paper examines the perspectives of both clinicians and patients (Martinez et al.). Future research needs to address the range of users (healthcare professionals and lay people) of health information technologies.

A recent study introduced the terminology of clinical, collaborative and consumer technologies (Valdez, Holden et al. 2015). Future research is critically needed to further understand patients as users of health IT especially in the context of collaborative and consumer technologies.

Several papers in this special issue examine various groups of patients, such as elderly patients with heart failure (Srinivas et al.). As technologies continue to develop in the form of, e.g., smart applications, wearables and sensors, we need to further develop human factors concepts and methods to ensure that these technologies fit user needs and are integrated with healthcare processes.

Health information technologies provide opportunities to not only enhance tasks and processes of individual user groups, but also to transform the relationship between healthcare providers and patients (Walker and Carayon 2009). The study by Asan et al. shows how a large customizable interactive monitor used in a pediatric ICU can facilitate clinician/family communication and support family-centered care and family engagement and empowerment. The study by Martinez et al. shows the benefit of a well-designed consumer health informatics application to enhance collaboration between patients and clinicians and, subsequently, improve blood pressure control. Future research should further explore how health IT can be used to support the collaborative work between clinicians and patients (Holden, Carayon et al. 2013).

Collaboration between clinicians and patients often implies care that is highly and variably distributed over time, space and organizational boundaries. This can create a range of challenges for health IT users, especially as patient-related information may not be easily accessible or available as demonstrated by Alyousef et al. Future research needs to develop concepts and methods for designing health IT that can support distributed care processes.

2. Need for systems approach in the design and implementation of health IT

Papers in this special issue clearly highlight the need for a systems approach in health IT design and implementation. Several studies use the original SEIPS (Systems Engineering Initiative for Patient Safety) model (Carayon, Hundt et al. 2006) or the SEIPS 2.0 model (Holden, Carayon et al. 2013). For instance, Alyousef et al. used the SEIPS model to describe and quantify health IT-related obstacles experienced by care managers. Martinez et al. applied the SEIPS 2.0 model to examine the range of system variables that influence the experience of patients and clinicians with a consumer health IT application for blood

pressure monitoring and management. Like a few other studies in the special issue (e.g., Doggett et al.), this study shows the importance of usability; but it also demonstrates that usability is not sufficient. Other system factors are critical to ensure that technologies support effective, efficient and safe care processes. Martinez et al. show that the sociotechnical system needs to support collaboration among patients and care team members.

Using a systems approach allows researchers to uncover issues of importance in the design and implementation of health IT. For instance, the studies by Martinez et al. and Srinivas et al. emphasize the critical role of health IT to support and enhance patient self-management. The study by Ozok et al. describes how personal health records should be designed to support personal health information management. Future research should further develop system-based methods for the design of health IT. It is not just about the technology; we need to pay attention to the entire system, i.e. the sociotechnical system, in which the technology is used. This poses methodological and practical challenges, especially when looking at technologies used in non-traditional work environments, e.g., home and community settings (Holden, McDougald Scott et al. 2014).

Understanding the person at the center of the sociotechnical system is key to good design and implementation of health IT that helps users and support tasks and processes. In this special issue, Valdez and Brennan help us to understand the cultural dimension of sociotechnical systems. Their research highlights the need to go beyond simplistic conceptualization of culture. Patients often describe their multiple, varied cultural identities; therefore, challenging the approach in which a technology is designed for a specific cultural group. In addition, Valdez and Brennan describe the various ways that culture influences users and their interaction with technology. This type of research provides important direction for human factors design of health IT that is culturally-informed. Future research should extend this line of research and better define how culture can be incorporated as part of the complex sociotechnical system.

3. Human-centered design can make a difference

The discipline of human factors needs to demonstrate not only that it can identify problems, but also that it provides value to design and implementation processes and that it can improve care processes and outcomes (Xie and Carayon 2015). Two papers in this special issue are particularly important as they demonstrate the value of human-centered design. Srinivas et al. describe a multi-phase approach for the design of consumer health IT for elderly patients with heart failure. The multi-phase approach incorporates multiple data collection methods, systematic usability evaluation, and user feedback. Hundt et al. describe the CUE (Collaborative Usability Evaluation) model and its implementation and sustainability in a healthcare delivery organization. Based on participatory ergonomics (Haims and Carayon 1998, Haines, Wilson et al. 2002), the CUE model describes a process for integrating systematic usability evaluation in health IT design and implementation processes of healthcare delivery organizations. Hundt et al. emphasize the importance of feedback and ongoing learning, and organizational leadership as key contributors to the successful implementation of the CUE model.

Human-centered design can make a difference, but it is hard work and it comes with challenges. See, for example, the paper by Srinivas et al. that describes various methodological and practical challenges. Future research should further develop human factors methods and approaches that can be adopted and adapted by designers and implementers of health information technologies. This remains an important research challenge (Ratwani, Fairbanks et al. 2015).

In conclusion, as information technologies become a critical tool in healthcare transformation, human factors engineering holds promise for supporting and identifying health IT users' needs for the optimal design of these technologies. Using multiple human factors methodologies, studies in this special issue describe complex interactions between various health information technologies and their users. As information technologies continue to develop, we need to further develop human factors concepts and methods to ensure that health information technologies are designed for humans, support user needs and are integrated with healthcare processes.

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