Theories and Methods for Context Sensitive Health Informatics

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Abstract. Context is a key issue when designing, implementing, and evaluating health information technology. Advanced and well-designed systems may not achieve desired outcomes because of complex contextual issues, and unintended consequences are often reported in the literature. The conference introduced in this article integrates sociotechnical and human factors based theories and methods for analysis and evaluation of complex health information technologies in diverse environments demanding high context sensitivity.

Keywords. Context, sociotechnical, human factors, health information technology

Introduction

In Greek mythology Procrustes was a rogue smith and innkeeper who lived in Attica. He invited passing strangers in for a pleasant meal and a night's sleep in his iron bed. He told his guests that his unique bed had a length that exactly matched whoever lay upon it. However, he did not reveal his methods to achieve this: if the guest was shorter than the bed he stretched him by hammering or racking the body to fit. If the guest was longer than the bed he would chop off the guest's legs to make him fit. This was a very brutal way of enforcing a "one size fits all" principle, which ended. Theseus, the hero, captured him and "fitted" him into his own bed.

The conference on context sensitive health informatics is not going to be the Theseus who can free the world from the "one size fits all" syndrome that we have experienced in health informatics, but rather a humble attempt to bring forward examples and experience on how we can analyze and solve some of the contextual problems we encounter in the design, implementation and use of health informatics systems.

The health care systems around the world are all in a transition state trying to adopt technologies in order to deal with the problems of an aging population, an increase in number of chronically ill citizens and a limited amount of resources. However, while individual countries have made advances in developing innovative health informatics systems in response to local contexts and healthcare needs, these innovative advances have not always been exported to other countries to enable adaptation to other systems of care. Important innovations are coming from both developed and developing nations and differing countries around the world are emerging as leaders in health informatics

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design. These leaders are challenging other countries to use health information systems in new contexts to address the challenges of providing healthcare. Despite our cultural and geographical differences we are all united by the desire to improve the safety, access and quality of healthcare delivery. Therefore it is essential that we learn from each other and use our collective experiences to support the design of innovative new health informatics systems.

Healthcare is taking place in many different locations and the information necessary to provide care must be present at these places. Many different professionals use this information to do their job, and as a relatively new phenomenon, patients and citizens have become important users of information regarding their own health. As a further contribution to this complexity, it is obvious that the many users use the information for different objectives. The papers in this volume all concern how health informatics systems are developed, implemented and evaluated in a complex environment of many places, many users, many uses and in many contexts. The papers can be grouped into four themes described below: (a) different users in different contexts, (b) evaluating for context through usability testing and ensuring patient safety, (c) organizational and social issues in different places, and (d) understanding different contexts using theory.

1. Different Users in Different Contexts

A number of papers in this issue look at users that work in differing contexts and how this affects user needs, requirements, adoption and satisfaction with the systems they use. Anderson et al. take a global perspective to this issue by directly examining the challenges, consequences and mitigation strategies in developing *Marketable eHealth Systems* that lead to an efficient research and development process, an integration of all stakeholder interests and facilitate design within the context of regulatory requirements [1]. Parv et al. [2] consider primary care physician users in office, clinic and in-patient settings (i.e. differing contexts) and their user needs where e-Prescribing is concerned. Here, the work describes the outcomes of a survey study that focuses on the national Estonian e-prescribing service and the medication management tools that might be used by primary care physicians. Griffith and colleagues' [3] work describes how physicians are pressured to order diagnostic imaging services for patients and how decision support systems could be used in the office or clinic context to facilitate discussion between patients and physicians about when to/when not to order diagnostic imaging tests. Monkman and Kushniruk [4] extend the focus on users beyond that of physicians to that of consumers who use differing types of health information systems. The authors describe how these technologies can be used by consumers to manage their own health. Here, the researchers purpose a model of consumer health information system adoption. The authors suggest that usability and usefulness influence consumers' adoption, value and successful use of consumer health information systems. Solvoll and colleagues [5] focus their work on alarms and how they influence nurses', patients' and other healthcare actors' communication patterns in in-patient contexts (i.e. hospital). They examine the use of alarms in healthcare settings and how they can be improved to help enhance communication among nurses, patients and other healthcare professionals. Cummings et al. [6] employ a country context approach when considering how nursing informatics is being taught in Australia, Canada and Denmark. The work looks at the historical influences and future directions and strategies towards incorporating nursing

informatics into undergraduate curricula in three comparable countries. Lastly, Borycki and others [7] examine nurse practitioner perspectives regarding the impacts of introducing electronic medical records into their work in primary care (e.g. clinic context). Here, the research describes the improvements that have arisen from introducing the technology to the nurse practitioner workplace as well as the challenges that still remain in customizing electronic medical records to fit nurse practitioner work.

2. Evaluating for Context through Usability Testing and Ensuring Patient Safety

There have been a number of advances in the development of methods for evaluating the impact of context on usability and safety of healthcare IT systems. In this issue Marcilly and colleagues [8] describe a trend towards the use of evidence about usability engineering in healthcare and discuss evidence based usability practices that accrue from gathering, comparing and synthesizing publication findings in this area. Lesselroth and colleagues [9] describe a methodological approach to evaluating a medication reconciliation and allergy review kiosk that applies and integrates clinical simulations with heuristic evaluation in the triangulation of usability findings and evidence. An area that has remained relatively unexplored in the published literature has been the development of evidence-based coding schemes for analyzing usability data in healthcare. Kushniruk and Borycki [10] in their paper provide a practical, theory-based coding scheme for analyzing video and audio recordings resulting from usability testing and clinical simulations. In a different methodological direction, Kaltoft et al [11] describe the dual use of a decision quality measure to explore impact of systems at both the level of higher-level feedback as well as impact at a personal level. Using the MyDecisionQuality instrument they show how individuals can in an online survey contribute feedback to providers as well as lead to personal benefit. At the level of workflow processes, Wawrzyniak and colleagues [12] describe their work in analyzing and improving medication review processes using human factors approaches, including interviews, shadowing and video recording. Closely related to the work being conducted in human factors analyses is research on improving the safety of healthcare systems and two papers in this issue directly address this area. Senathirajah [13] describes a new method for designing user interfaces for healthcare information systems where users themselves have control of the design by applying a modular composable approach. The implications of this approach to the safety of healthcare systems are explored by Senathirajah. Finally, in a paper by Liang and Gong [14] the application of a text classification system (using K-nearest Neighbor classifier) is explored as a way to analyze reports about patient safety events. Such automated approaches will become more important as the number of reported incidence of technology-induced error grows over time.

3. Organizational and Social issues in Different Places

While much of our system design efforts focus on the technology per se, there is also an increased realization that organizational and social issues are a key consideration in how we design and evaluate health information systems. In this issue Borim et al. propose an evaluative method that integrates evaluation approaches for software quality and approaches specific to the health domain [15]. Cornett and Kuziemsky look at is-

sues pertaining to implementation of team based workflow. Specifically, they highlight how information issues and contextual factors may be an underlying cause of implementation challenges for team based workflows [16]. Johansen and colleagues studied quality-assurance work conducted by medical transcriptionists in the production of medical records and how it impacts the design of an electronic patient record (EPR) system [17]. Their findings suggest that corrections and quality-assurance tasks done by medical transcriptionists need to be compensated for as part of EPR design. Kaufman et al. look at the problem of clinical workflow as a cause of usability problems and suggest how quantitative methods of analysis can yield critical insights in robust designs that better support clinical workflow [18]. Mather and Cummings look at the mobile learning paradox and how healthcare work redesign must include learning and teaching that supports professional identity formation of students during work integrated learning [19]. Petersen points out that while e-health research is often focused on development and implementation there is a need to consider IS maintenance and management [20]. She points out how the IT department is a central partner and can be both a catalyst and barrier to change. Villumsen and colleagues look at how log data can provide meaningful insights on practical use of eHealth systems [21]. They highlight that a large challenge is defining a common set of indicators for monitoring practical use of eHealth through in depth discussions of definitions of indicators and insight into the architecture and content of the national databases. Watbled et al. state the need for studies of impact of HIT to consider socio-technical characteristics of the work system in which the technology is implemented [22]. They identify hidden variables that can explain why inconsistency of impact of performance, quality and satisfaction occurs in studies of HIT.

4. Understanding Different Contexts Using Theory

Contextual factors are among the main issues when analyzing and explaining design and evaluation of health information systems and this section of papers focus on how different contexts can be understood through a theoretical approach. Botin [23] brings attention to the role of narratives in the construction of health information platforms and how different voices should have space for speech on these platforms. He argues that certain interactions and voices are absent from the construction of platforms, because they are regarded as outside of the text of computational and medical practice and expertise. Kuziemsky and colleagues [24] articulates the current state of patient safety research and health information technology from the perspective of three different International Medical Informatics Association (IMIA) working groups and integrates them into a model to support research, education and policy development. By the way of an example from a large-scale openEHR project in Norway Pedersen et al [25] consider how the contextualization of clinical templates is governed over multiple national boundaries, which exhibits complexity due to the dependency of clinical resources. They examine how local, regional, and national organizers maneuver to standardize within openEHR technology. In a different theoretical direction Kaltoft et al [26] analyze how 'symbolic violence' is experienced by individuals at any and all levels of general literacy because a particular form of functional decision literacy is not recognized. They propose a different response to exploit the alternative generic decision literacy used for many consumer services and products on comparative websites and magazines.

5. Conclusion

There is much to be learned from the myth of Procrustes. A "one size fits all" approach may limit country and/or local healthcare system innovation. Innovation is a key source of knowledge and advancement in health informatics. Research and development that stimulates health informatics innovation in developing and developed countries will lead to overall healthcare system advances as differing parts of the world learn from each other. As well, importing healthcare technologies and allowing for local, contextual changes may improve local adoption of the technology, and may also lead to unexpected innovations in already established technologies. A continual investment in research and a recognition that context has an important role stimulating such innovation will lead to further knowledge development and innovation. Such work is critical to ensuring the successful introduction and adaption of healthcare systems to new countries, contexts and health care settings.

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