International Journal of Medical Informatics 87 (2016) 15–26

Contents lists available at ScienceDirect

International Journal of Medical Informatics

journal homepage: www.ijmijournal.com

Optimizing the user interface of a data entry module for an electronic patient record for cardiac rehabilitation: A mixed method usability approach

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ARTICLE INFO

Article history:
Received 11 May 2015
Received in revised form 7 December 2015
Accepted 11 December 2015

Keywords:
Usability evaluation
Electronic health records
CCDS
Cardiac rehabilitation

ABSTRACT

Introduction: Cumbersome electronic patient record (EPR) interfaces may complicate data-entry in clinical practice. Completeness of data entered in the EPR determines, among other things, the value of computerized clinical decision support (CCDS). Quantitative usability evaluations can provide insight into mismatches between the system design model of data entry and users' data entry behavior, but not into the underlying causes for these mismatches. Mixed method usability evaluation studies may provide these insights, and thus support generating redesign recommendations for improving an EPR system's data entry interface.

Aim: To improve the usability of the data entry interface of an EPR system with CCDS in the field of cardiac rehabilitation (CR), and additionally, to assess the value of a mixed method usability approach in this context.

Methods: Seven CR professionals performed a think-aloud usability evaluation both before (beta-version) and after the redesign of the system. Observed usability problems from both evaluations were analyzed and categorized using Zhang et al.'s heuristic principles of good interface design. We combined the think-aloud usability evaluation of the system's beta-version with the measurement of a new usability construct: users' deviations in action sequence from the system's predefined data entry order sequence. Recommendations for redesign were implemented. We assessed whether the redesign improved CR professionals' (1) task efficacy (with respect to the completeness of data they collected), and (2) task efficiency (with respect to the average number of mouse clicks they needed to complete data entry subtasks).

Results: With the system's beta version, 40% of health care professionals' navigation actions through the system deviated from the predefined next system action. The causes for these deviations as revealed by the think-aloud method mostly concerned mismatches between the system design model for data entry action sequences and users expectations of these action sequences, based on their paper-based daily routines. This caused non completion of data entry tasks (31% of main tasks completed), and more navigation actions than minimally required (146% of the minimum required). In the redesigned system the data entry navigational structure was organized in a flexible way around an overview screen to better mimic users' paper-based daily routines of collecting patient data. This redesign resulted in an increased number of completed main tasks (70%) and a decrease in navigation actions (133% of the minimum required). The think-aloud usability evaluation of the redesigned system showed that remaining problems concerned flexibility (e.g., lack of customization options) and consistency (mainly with layout and position of items on the screen).

Conclusion: The mixed method usability evaluation was supportive in revealing the magnitude and causes of mismatches between the system design model of data-entry with users' data entry behavior. However, as both task efficacy and efficiency were still not optimal with the redesigned EPR,

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http://dx.doi.org/10.1016/j.ijmedinf.2015.12.007

we advise to perform a cognitive analysis on end users' mental processes and behavior patterns in daily work processes specifically during the requirements analysis phase of development of interactive healthcare information systems.

1. Introduction

The primary aim of recording data in electronic patient records (EPRs) is to support the delivery of good care, clinical decision-making, communication between healthcare workers and continuity of care. Additionally, EPRs are a valuable source of quality assurance of medical practice and scientific research [1]. In achieving these aims, effective use of EPRs requires structured data entry; which may be a challenge for physicians when design and implementation of an EPR do not align with their cognitive and workflow requirements and preferences [1–3]. Poorly designed and cumbersome data entry interfaces can complicate structured EPR data entry during clinical practice, resulting in poor data quality and data incompleteness [4,5]. This may consequently lead to suboptimal functioning of health information technology systems integrated in the EPR, e.g., reminder systems, computerized physician order entry and computerized clinical decision support (CCDS).

Of those systems, CCDS is one of the most effective strategies to improve clinical decision making [4,6]. CCDS uses characteristics of individual patients to generate patient-specific recommendations (based on national guidelines, evidence analysis or expert opinion) at the time and place clinical decisions are made [7]. To do so, CCDS systems often require availability of a large number of patient data (demographic data, data on complaints, symptoms, previous history, physical examination, laboratory, and other tests). Clinicians, health care staff, or patients can manually enter the data into the system; in addition, the EPR can be queried for retrieval of patient data [6]. Despite their goal to improve the quality of care, systematic reviews of CCDS studies reported only an improvement in professional performance for somewhat more than half of the included studies [8,9] and attempts to identify critical success factors for CCDS systems have provided inconsistent results [8]. CCDS systems that derive their data form EPRs may provide inadequate advices as a result from incompleteness of EPR data needed to generate that advice [10].

Users of computerized systems are known to acquire knowledge about the system design models through experience that form the basis for the construction of reasonable action sequences. To stimulate complete data collection, an EPR systems' design model of data entry ("the way the designer represents the system's data entry functionality to the user, including screen presentations, interaction structure, and object relationships") should match the users' data entry behavior ("the way that users have internalized how the data entry should proceed based on their experiences from daily practice") [11]. Consequently, evaluation of the usability of the data entry interface in EPR systems is an essential step in human-centered design to optimize the match between the systems' design model and user's behavior of data entry. Several quantitative methods exist (e.g., sequential pattern analysis, keystroke models and log file analysis) to analyze or model navigation patterns and action sequences from system users [12,13]. These measures can provide insight into mismatches between the user's behavior and systems' design model, but not into the underlying system design aspects causing these mismatches. Mixed method usability evaluation studies may provide this insight, resulting in concrete redesign recommendations and finally in improved usability of a system's data entry interface [14,15].

An EPR system with CCDS functionalities, called MediScore CARDSS, was developed to stimulate guideline implementation on cardiac rehabilitation (CR) throughout the Netherlands [16,17]. To guarantee complete data collection of the patient's overall condition, a beta and a redesigned version of the system were both assessed by a mixed method usability evaluation with end-users (CR professionals). The results of the usability evaluation of the beta system version were handed over to the developers to improve the design of the system. The aim of this study was to improve the usability of the data entry interface of this first system version. Additionally we assessed the value of a mixed method usability approach (measuring fit between the systems' design model of data entry and users' data entry behavior both from a quantitative and qualitative perspective) in this context.

2. Background

2.1. Clinical setting: cardiac rehabilitation in the Netherlands

CR is a multidisciplinary therapy to support recovery from a cardiac incident or intervention, with the aim to improve a patient's physical and psychological condition [18]. CR is recommended for all patients who have been hospitalized for an acute coronary syndrome (ACS) and for those who have undergone a cardiac intervention [19]. A meta-analysis shows consistent evidence of the effectiveness of exercise-based and multimodal (e.g., psychosocial and stress management) CR interventions with regard to mortality and prevention of future cardiac events (relative-risk reduction 21–47%) [20]. The therapy is offered by multidisciplinary teams, which generally include cardiologists, specialist nurses (of whom one acts as the rehabilitation coordinator), physical therapists, psychologists, dieticians and social workers, and is supported by a medical secretarial office.

Consistent with international guidelines, the Dutch guidelines for CR state that patients should be offered an individualized rehabilitation program based on their medical, physical, and psychosocial needs [21]. Traditionally this program is formulated during a 30–60 min clinical patient interview, usually performed by a specialized nurse, physiotherapist or social worker. To structure the interview the guidelines include a paper-based clinical algorithm defining an extensive needs assessment procedure (NAP) [22]. This algorithm was designed in collaboration with CR professionals and is used in practice by multidisciplinary CR teams throughout the Netherlands [23]. It consists of fifteen numbered flowcharts across five domains, each describing how to select rehabilitation goals and therapies based on 155–175 patient data items (including both general questions and eight standardized questionnaires). During the daily routine with the paper-based NAP patient interview, professionals can adapt the order of data collection to their own preferences and as such data collection is flexible. A structured NAP to base therapy decisions on is a commonly used strategy within disease management of chronic patients [24]. It is needed to reduce inter-practice variation in the offered health care and is in line with recommendations from the Chronic Care Model. This model is widely used to improve quality of care for chronic patients [24].