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Application of contextual design methods to inform targeted clinical decision support interventions in sub-specialty care environments

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ABSTRACT

Background & Objectives: In healthcare, the routine use of evidence-based specialty care management plans is mixed. Targeted computerized clinical decision support (CCDS) interventions can improve physician adherence, but adoption depends on CCDS' 'fit' within clinical work. We analyzed clinical work in outpatient and inpatient settings as a basis for developing guidelines for optimizing CCDS design.

Methods: The contextual design approach guided data collection, collation and analysis. Forty (40) consenting physicians were observed and interviewed in general internal medicine inpatient units and gastroenterology (GI) outpatient clinics at two academic medical centers. Data were collated using interpretive debriefing, and consolidated using thematic analysis and three work modeling approaches (communication flow, sequence and artifact models).

Results: Twenty-six consenting physicians were observed at Site A and 14 at Site B. Observations included attending (33%) and resident physicians. During research team debriefings, 220 of 341 unique topics were categorized into 5 CCDS-relevant themes. Resident physicians relied on patient assessment & planning processes to support their roles as communication and coordination hubs within the medical team. Artifact analysis further elucidated the evolution of assessment and planning over work shifts.

Conclusions: The usefulness of CCDS tools may be enhanced in clinical care if the design: 1) accounts for clinical work that is distributed across people, space, and time; 2) targets communication and coordination hubs (specific roles) that can amplify the usefulness of CCDS interventions; 3) integrates CCDS with early clinical assessment & planning processes; and 4) provides CCDS in both electronic & hardcopy formats. These requirements provide a research agenda for future research in clinician-CCDS integration.

1. Introduction

Recent studies suggest that gaps and discontinuities from omitted or inappropriate patient care are common, and can result in increased costs due to higher readmission rates, and increased disease-related morbidities. This has been widely studied in reference to patients with coronary artery disease and heart failure [1], and more recently in studies related to other high-cost conditions such as decompensated

Abbreviations: CCDS, computerized clinical decision support; EHR, electronic health record; UI, user interface; VA, Veterans' Affairs; CPRS, Computerized Patient Record System; HFE, human factors engineering; IT, information technology; GI, gastrointestinal (gastroenterology); CPOE, computerized physician order entry; PC, primary care; WOW, workstation on wheels; IPCT, integrated primary care team

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cirrhosis [2–4] and inflammatory bowel disease [5,6]. Thus, enhancing the comprehensiveness and continuity of care for patients with specialized and/or uncommon conditions may have significant effects on patients' quality of life and the cost of care.

Computerized clinical decision support (CCDS) interventions that are integrated into electronic health records (EHRs) may reduce discontinuities by presenting evidence-based guidelines at the point-of-care [7]. However, CCDS systems have not fully demonstrated their value in terms of improved care quality or safety. A commonly reported failing is CCDS' 'poor fit' to clinicians' work and decision needs. For example, Russ et al. [8] describe processes used to bypass inappropriate order checking CCDS, and Lesselroth et al. [9] describe misalignments between surgical care patterns and CCDS recommendations that did not support adaptive and patient-responsiveness. Despite implementation into EHRs, poor integration into clinical work has been attributed to CCDS' under-utilization [10–13], workarounds [14], and unintended consequences [15,16]. The purposes of this study were to better understand physicians' inpatient and outpatient work and decision needs, and to translate these into user interface (UI) design guidelines.

1.1. UI design guidelines for CCDS in clinical work

Clinicians work in complex information environments that include diverse sets of related clinical concepts and information objects (e.g., datum, visual displays, action options, CCDS tools, and other aids including paper-based tools) [13]. Designing CCDS in ways that support clinicians' ability to rapidly and accurately comprehend and translate meaning into plans and action in this environment is challenging [17–19].

General guidelines for information presentation and UI design are well-established [20–23]. However, most guidelines were developed for non-medical consumer software [20,23], complex engineering environments [24], or medical devices [25], and rarely include specific guidelines for CCDS. The CCDS guidelines that do exist are limited in scope [26–28] or focus largely on whether or how to use CCDS from a technical or operations perspective [29]; advice about clinician-CCDS integration is generally absent. Indeed, few studies have been published that define the essential characteristics of interactions between clinicians, CCDS, and the clinical context. Human centered and human factors methods and approaches can help elucidate principles that guide clinician-CCDS interaction design [20,26,30–32].

Based on principles, human factors engineering (HFE) approaches start with a detailed understanding of relevant 'systems of work' that, in health care, include patients, clinicians, processes, technologies and the physical environment [30–36]. This is then translated into explicit user needs, design goals and UI interaction requirements. Our ultimate goal is to integrate a CCDS into clinical work in ways that optimize the management of patients with specialized and/or uncommon conditions such as cirrhosis. There clearly is a need for further research that focuses on clinician-CDSS integration with a focus of real world human performance. This paper describes the qualitative groundwork undertaken to extend existing and create additional CCDS user interface design guidelines.

Our key research questions were: What role, within a complex clinical information environment, should a specialist CCDS serve? Where, within the clinical environment, should a CCDS be placed? What form should the CCDS assume?

2. Method

2.1. Contextual design

Contextual design is a formative HFE and human-centered systems design approach that differs from other design frameworks primarily in its assumptions about human work [32–35]. Formative approaches specify the ways work 'could be done' based on the relationships between information environment elements in a work system [34,35]. Formative approaches are best used when designing or introducing new technologies. In contrast, normative approaches specify the ways that work 'should be done' and assume that such standard work patterns exist. Contextual design proceeds from the assumption that clinical work is information work that involves cognitive processes (e.g., judging, planning, problem solving) aimed at achieving and maintaining situation awareness, often by means of social processes such as communication and collaboration [36].

2.2. Participants

Following Veterans' Affairs (VA) Institutional Review Board approval, 40 consenting physicians (26 from the western United States (US), VA Site A and 14 from the southeastern US, VA Site B) agreed to be observed and interviewed in inpatient and outpatient settings. Observation sites included general medical wards, clinics and specialist (gastroenterology) consulting services that were chosen based on where cirrhosis care was known to occur. Thirty-three percent [14] of participants were attending physicians; the balance were residents. Some patients and clinicians were observed coincidentally after they were informed about the research and gave assent. Only data gathered from consenting participants were captured.

Medical team composition and roles at both VA sites were typical of healthcare teams. For inpatient and outpatient settings, residents are physicians in training and have completed medical school but have not yet completed specialty training in their specific discipline. Each resident had 2–7 years of specialty training, and they were responsible for implementing patient care under fellow and attendings' supervision. Fellows are physicians in training, but have completed a primary specialty training, most commonly Internal Medicine, and had further elective, sub-specialty training.Attendings, the most senior physicians, had completed all residency with or without sub-specialty training and operating as independent licensed practitioners who were responsible for monitoring and directing patient care decisions. In both settings, junior physicians (medical students, interns, residents) worked as a team reporting to fellows and attendings for final approval on medical care plan.

2.3. Procedures

Contextual design methods included: Contextual interviews and observations for data collection [32,33]; Interpretive debriefing sessions for data collation [32]; Data consolidation using thematic analysis [37] and three work modeling approaches (i.e., communication flow, sequence, and artifact models) [33]. The detailed methods appear in **Appendix A** but are summarized briefly below.

Two clinicians and three HFE researchers partnered to conduct 2–4 h inpatient and outpatient observations as well as contextual interviews that focused on the goals that drive clinicians' decisions and action, the structure of their information environment, and the roles of players in the decision process. Inpatient observations included pre-rounding, rounds, and post-rounds work. Clarifying questions were asked during observations as appropriate. Researchers noted information content and flow between clinical roles and also collected and annotated de-identified artifacts (e.g., printed forms, whiteboard photographs, and screen shots).

The resulting data were collated using interpretive debriefing [32]. These sessions began with a researcher talking through his/her notes to promote group discussion. Others interrupted to explore similarities and differences between the leader's observations and their own. Comments and opinions required evidence from that researcher's own notes. These discussions were documented. The resulting transcripts were segmented into coherent topics and then consolidated in sequential order in a spreadsheet for thematic analysis. Themes were developed by inductive aggregation and thematic convergence