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Presenter Information

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Do Novice and Expert Users of Clinical Decision Support Tools Need Different Explanations?

Emergent Research Forum (ERF)

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Abstract

A key requirement for the successful adoption of clinical decision support systems (CDSS) is their ability to provide users with reliable explanations for any given recommendation which can be challenging for some tasks such as wound management decisions. Despite the abundance of decision guidelines, wound non-expert (novice hereafter) clinicians who usually provide most of the treatments still have decision uncertainties. Our goal is to evaluate the use of a Wound CDSS smartphone App that provides explanations for recommendations it produces. The App utilizes wound images taken by the novice clinician using smartphone camera. This study experiments with two proposed variations of rule-tracing explanations called verbose-based and gist-based. Deriving upon theories of decision making, and unlike prior literature that says rule-tracing explanations are only preferred by novices, we hypothesize that, rule-tracing explanations are preferred by both clinicians but in different forms: novices prefer verbose-based rule-tracing and experts prefer gist-based rule-tracing.

Keywords

Clinical decision support systems, decision making, decision explanations, wound care, fuzzy-trace theory

Introduction

Clinical decision support systems (CDSS) have been widely used to support consistent clinical decision making (Curcin et al. 2017). A key requirement for the successful adoption of such systems is that users (e.g. physicians, nurses, other clinicians) must have confidence in recommendations these tools provide (Nunes et al. 2017). To achieve this, several studies explored explanation facilities as a means of establishing trust in these tools (Nunes et al. 2017) in several areas such as CDSS advising on patients suffering from bronchiolitis (Doyle et al. 2006) and patient's cardiac rehabilitation trajectory (Goud et al. 2008). However, providing reliable explanations to the user is challenging as it can cause self-reliance or over-reliance issues if explanations are not efficient (Bussone et al. 2015) especially in areas where prior use of CDSS is limited such as chronic wound management (Schaarup et al. 2018).

Chronic wounds affect 6.5 million Americans (Fife et al. 2012), have complex management (Han and Ceilley 2017) and cost \$28-\$32 billion annually (Nussbaum et al. 2018). Yet, majority of the chronic wound patients receive their treatments from novice clinicians (Benskin 2013). This lack of expertise results in

uncertainty during wound care judgement and decision-making (JDM) causing delayed wound healing, amputations (Jeffcoate and van Houtum 2004), limited quality of life and even death (Järbrink et al. 2017). Although narrative wound care guidelines exist to support these clinicians (Kottner et al. 2019), adherence to these guidelines is low. Thus, there is a pressing need for decision tools that provide evidence based wound care guidance and reliable explanations that are tailored to the current knowledge and expertise of the novice clinicians.

Our goal is to evaluate two proposed explanation variations to be used for one such tool for wound management. The CDSS tool is a smartphone App called SMARTWAnDS that provides decision recommendations based on predictions produced by a machine learning (ML) algorithm that utilizes wound photos taken by the novice clinician at the point of care (POC) using smartphone camera. The SMARTWAnDS App is equipped with an explanation facility that uses features extracted from standard wound care guidelines. In this paper we propose an experimental study to understand how different types of explanations provided in CDSS impact novice and expert users' (1) trust in and acceptance of the CDSS and (2) wound care JDM behavior.

Literature review

CDSS tools for wound management have gained so much popularity since clinicians can easily keep track of wound healing process. Wound CDSS are considered as advanced technological applications that can be effective for wound management in supporting, guiding and informing clinicians (Kim et al. 2013). For instance, CDSS can support novice clinicians to set order entries (Battle-Wherry 2016), diagnose a condition or receive recommendations for it (Alvey et al. 2012), efficiently document patients' information (Alvey et al. 2012), and receive wound education (Beitz et al. 2012). However, research on the topic of JDM for novice and expert clinicians with respect to nature and type of explanations they prefer is limited.

The need for explanation

Due to the recent calls encouraging explainable decision tools for healthcare JDM (Ahmad et al. 2018), Wound CDSS tools must build users' trust by clearly explaining why these tools are recommending a specific decision (He et al. 2019). Explanations in information systems (IS) are intended for any recommendation agent (RA) or expert system that is designed to provide users decision support in a certain context. For example, based on cognitive fit theory one study (Giboney et al. 2015) explained why fit is important for user acceptance of knowledge-based systems (KBS) evaluations and how the fit between KBS explanations and users' internal explanations influences acceptance of KBS recommendations.

There are four types of explanations (Gregor and Benbasat 1999b): (1) definition explanations that supply descriptive or terminological information, (2) justifications which rationalize part of a reasoning process by linking it to the deep knowledge from which it was derived, (3) strategic explanations which explain the system's control behavior and problem solving approach, and (4) rule-tracing explanations which explain why certain decisions were or were not made by reference to the data and rules used in a particular case. In this study, our focus is on the rule-tracing explanations in the context of chronic wounds JDM. We refer to JDM concept contextually and as a process that involves wound clinicians (novice or expert) to assess and take reasoned or unplanned actions towards a wound or its underlying condition. Wound JDM is expected after a recommendation is generated for a wound with respect to presence of one or more conditions (e.g. necrosis, granulation, bony prominence, etc.). The transparency of generated recommendation allows the novice clinicians to trace back the path of the predicted decision and see which wound condition was emphasized by the Wound CDSS App. For example, through displaying the trace of rules (IF-THEN), rule-trace explanations enable clinicians to find out why and how a certain decision (Darlington 2011) is recommended for a particular wound.

Current literature regarding novice and expert users of decision support tools is mostly concerned with the influence that high-level explanations (i.e. definition, rule-trace, judgement, or strategic) have on the users and fail to explain whether variations of these explanation types especially rule-tracing explanations have different effects on the users.

Propositions

Several theories support the concept of explanations in the context of use and adoption of technology in JDM tasks such as technology acceptance model (Davis et al. 1989), technology transition model (Briggs et al. 1998) and technology dominance model (Jensen et al. 2010b). In this study, we draw upon technology dominance model (TDM) (Jensen et al. 2010b) to satisfy task-related constructs. To provide support for proposed variations of explanations, we derive upon fuzzy-trace theory (FTT). We will also consider task complexity, task expertise, explanation types and JDM quality, as proven relevant by prior literature, in building the theoretical foundation for this research.

Task expertise is a construct that plays an important role in our context of complex wound JDM which is the amount of experience gained and degree of strategies formed by a decision maker when it comes to completing a given decision task (Jensen et al. 2010b). Additionally, consistent with TDM, we predict that wound expert clinicians will be initially reluctant to rely on the Wound CDSS aid. As hypothesized by TDM, when confronted by a CDSS, experts that have high knowledge about the task will attempt to understand how the decision tool arrives at its recommendation to see if the recommendation is acceptable (Jensen et al. 2010b). It is suggested that professionals seek explanations whenever they need to verify the performance of the decision tool. *Proposition 1:* The type of explanation that a user of a chronic Wound CDSS requests is partly determined by the user's level of expertise with chronic wound management.

FTT describes mental representation as a continuum from verbatim to gist (Reyna and Brainerd 2011). Gist representations capture the bottom-line meaning of the problem or situation. In contrast to verbatim representations, which are precise (and quantitative, if they involve numbers), gist representations are vague and qualitative (Reyna and Brainerd 2011). FTT explain why people can get the facts right, and still not derive the proper meaning, which is key to informed JDM (Reyna 2008). However, according to the FTT getting the gist is not enough and retrieval of health-related values and processing interference brought on by thinking about nested or overlapping classes of numbers and ratios such as chance of healing for chronic wounds, are also important (Reyna, 2008). In the context of wound JDM, we see gist-based representations as explanations that are more focused on the main conditions and are vague to the novice clinicians (e.g., this wound was recently debrided and offloaded from the pressure). Wound verbose representations however, as we argue, are more detailed explanations that novice clinicians seek whenever they have uncertainty due to lack of expertise (e.g., if chronic wounds are located on plantar foot and there is no necrotic tissue present and the size of the wound is not very small they must be offloaded). In line with FTT, we predict that verbose and gist rule-tracing explanations are needed for decision tools where users can be novices as well as experts. *Proposition 2-a:* Rule-tracing explanations are sought by wound clinicians regardless of their level of expertise (novice/expert). *Proposition 2-b:* Novice clinicians would be more likely to prefer more detailed rule-tracing (i.e., verbose-based) explanations, whereas expert clinicians would be more likely to prefer less detailed rule-tracing (i.e., gist-based).

We also include from literature that suggests task complexity to be a reliable construct in the context of CDSS (Jensen et al. 2010b). Task complexity within wound context is relevant to wound assessment tasks that require more detailed analysis or external data rather than relying on experts' own expertise and experience such as JDM with respect to the sensitive location of the wounds. Therefore, we predict that in the context of wound assessment, the location of the wound does affect the quantity of novice and expert explanation requests similarly. *Proposition 3:* The number of requests from either novice or expert users is proportionate to the complexity of the tasks for which the support of the system is sought. *Proposition 4:* Low complexity tasks are not likely to change the type of explanations that novice and expert request.

Proposed Methodology

The SMARTWAnDS App will be based on a decision framework (a pathway to recommended decisions within the App <https://doi.org/10.6084/m9.figshare.12194994>) proposed for a specific wound management scenario where novice or expert wound clinicians encounter patients with a lower extremity (LE) chronic wounds. The clinicians will use the App to take wound images using the phone camera and receive wound care decision recommendations that are explained to them based on their expertise level. These care decisions are: (1) continue with the current treatment, (2) request non-urgent change in treatment from a wound specialist, or (3) refer patient to a wound specialist.

Experimental design

An experiment will be conducted in a clinical setting. The main purpose of this experiment is to test the usability of the proposed decision framework that will be used for the SMARTWAnDS App. We will test our hypotheses, developed based on the theories of JDM from literature, to understand how different types of explanation envisioned for a Wound CDSS impact wound care decisions of the novice and expert users. We plan to implement a 2x3 within-subject design.

Based on an alpha of 0.05, a power of 0.80, and a large effect size ($f = 0.40$) using G*Power tool for a 2x3 design (Faul et al. 2013) the desired sample size was calculated as 21 participants. Thus, we will recruit at least 30 participants from two groups of clinicians: registered or visiting nurses with no or limited experience in chronic wound management (novices) and wound nurse practitioners (experts). The participants will be asked to make wound care decisions after viewing wound images of anonymous patients and reviewing the explanation descriptions provided to them. We will randomly assign the participants to one of the three explanation groups: (1) definition explanation, (2) verbose rule-tracing explanations and (3) gist rule-tracing explanations. For definition explanations participants will use the selected excerpts and descriptions from standard wound care guidelines in a narrative form and will be shown a wound image on a printed sheet that includes EHR notes (patient history, description of the wound condition, wound size, etc.). For verbose rule-tracing explanations participants will use detailed wound features extracted from text-based guidelines summarized in the form of intuitive IF-THEN rules. Gist rule-tracing explanations will be provided in a less detailed fashion than verbose-based and only focus on the important conditions of the wound. To control for high and low task complexity participants will receive mixed sets of images in each explanation group. We will sample this mixture of wound images from our ongoing data collection protocol at a local hospital using the help of our wound experts. After each session participant will be asked to take a post-experience survey that ask how much they find the type of explanation helpful and whether they have any suggestion about the presentation format of the explanation to them. To measure task complexity we will use measures suggested by Jensen et al. (2010a). We also use extents of use (frequency of access and duration of use) to measure the use of explanations (Gregor and Benbasat 1999a).

Discussion and Future Work

As part of a larger project, this phase of the research provides several contributions. First, prior research regarding development of chronic wounds CDSS did not experiment with explanation facilities. Second, we propose two new variations of rule-tracing explanations. We will investigate how these variations will affect the JDM of novice and experts in the context of wound management. Results from testing our hypotheses will inform our design of the SMARTWAnDS App that will be used in a pilot study on a clinical site.

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