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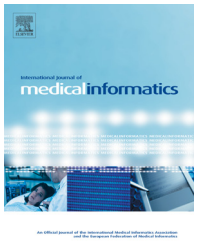

Review

Design of decision support interventions for medication prescribing

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ABSTRACT

Objective: Describe optimal design attributes of clinical decision support (CDS) interventions for medication prescribing, emphasizing perceptual, cognitive and functional characteristics that improve human–computer interaction (HCI) and patient safety.

Methods: Findings from published reports on success, failures and lessons learned during implementation of CDS systems were reviewed and interpreted with regard to HCI and software usability principles. We then formulated design recommendations for CDS alerts that would reduce unnecessary workflow interruptions and allow clinicians to make informed decisions quickly, accurately and without extraneous cognitive and interactive effort.

Results: Excessive alerting that tends to distract clinicians rather than provide effective CDS can be reduced by designing only high severity alerts as interruptive dialog boxes and less severe warnings without explicit response requirement, by curating system knowledge bases to suppress warnings with low clinical utility and by integrating contextual patient data into the decision logic. Recommended design principles include parsimonious and consistent use of color and language, minimalist approach to the layout of information and controls, the use of font attributes to convey hierarchy and visual prominence of important data over supporting information, the inclusion of relevant patient data in the context of the alert and allowing clinicians to respond with one or two clicks.

Conclusion: Although HCI and usability principles are well established and robust, CDS and EHR system interfaces rarely conform to the best known design conventions and are seldom conceived and designed well enough to be truly versatile and dependable tools. These relatively novel interventions still require careful monitoring, research and analysis of its track record to mature. Clarity and specificity of alert content and optimal perceptual and cognitive attributes, for example, are essential for providing effective decision support to clinicians.

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Contents

1. Introduction

Clinical decision support (CDS) systems can safely and effectively support medication prescribing when they deliver relevant, unambiguous and actionable advice well integrated into patient care [1–3]. Many contemporary installations, however, have poor interface design, use verbose or unclear language, non-standard terminology, alerts may be temporally misalignment with corresponding clinical tasks and their important human–computer interaction (HCI) attributes may be inadequate, making the receiving and responding to decision support interventions difficult.

There is a recognized and pressing need for high-performing CDS. Aside from an array of successes at specific sites in individual domains, few systems have substantially delivered on the promise to improve healthcare processes and outcomes [4]. The challenges of designing effective but potentially work-disruptive alerts and notifications are manifold and often require the reconciliation of contradictory goals, such as the need for succinctness with the need to adequately support complex medical decisions.

Designers and developers of health information technology (HIT) need a cohesive, widely accepted and reliable set of industry standards, recommendations and best practices to substantially increase the usability, effectiveness and safety of electronic health records (EHRs) and CDS systems. Such guidelines must be rooted in empirical evidence from biomedical informatics and HCI research, follow recognized usability principles and be informed by decades of software design and evaluation experience from other safety-critical domains.

This report describes design recommendations for CDS interventions that are activated during medication prescribing, such as alerts to drug and allergy interactions. We reviewed published reports on the successes, failures and lessons learned from CDS implementation in large hospitals and small clinics and interpreted the findings with regard to HCI principles and software usability. Emerging themes and specific suggestions were then formulated into a set of design recommendations for CDS interventions that would improve their effectiveness, safety and human interaction by, for example, reducing unnecessary workflow interruptions or allowing clinicians to make informed decisions quickly, accurately and without extraneous cognitive and interactive effort. A related methodological review of design approaches that are applicable to a wider range of decision support and EHR systems can be found in a recent JBI article [5].

This targeted review was focused on articles containing references to design features of CDS and therefore was not exhaustive. The recommendations, however, are not limited to specific CDS and EHR systems as they are partially derived from and reconciled with existing general usability principles. They are organized in the following sections according to specific design goals, with high-level principles and examples of their specific application.

2. Background

There is somewhat scant but increasingly more reported evidence of medical errors, adverse drug events, near misses and other patient safety problems that can be at least in part attributed to failures in human interaction with poorly designed EHR and CDS interfaces. Published reports include descriptions of decreased cognitive performance [6], medication prescribing errors [7–12], unsafe workarounds [13,14] and poor handling of safety alerts [15].

A common unintended consequence of CDS is frequent and disruptive alerting to minimal risks that may be irrelevant in a given clinical context or for the current task [2,16]. Excessive and repetitive interruptions are distractive, add to cognitive effort and rather than contributing to safety may in fact lead to the almost automatic dismissal of most alerts, including those that are safety-critical [17–20]. Poor specificity of warnings significantly lowers the perceived signal-to-noise ratio and limits the ability to differentiate between significant, relevant alerts (true positive, or "signal") and inconsequential, irrelevant ones (false positive, or "noise"), according to the signal detection theory [21,22]. This learned behavior not only