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Does Involving Clinicians in Decision Support Development Facilitate System Use Over Time? A Systematic Review

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Abstract. Involving clinician users in the design and development of Clinical Decision Support (CDS) systems is touted to improve the fit between system and user needs. However, the impact of clinician involvement on CDS acceptance and use in practice has not been systematically studied. This review aimed to identify the approaches taken to involve clinicians in CDS development and understand the impact of these approaches on barriers and facilitators to acceptance and use in hospital settings over time. Twenty-three studies met full inclusion criteria. Clinician involvement was rarely described in depth and no comparative studies were identified. Despite frequently reporting perceived ease of use, included studies still reported barriers to acceptance and use shortly after CDS implementation and years later. Future studies should report clinician involvement in adequate detail to enable understanding of its impact on CDS acceptance and use over time. Additional recommendations for future research, including conducting comparative studies and maintaining clinician involvement beyond implementation, are described.

Keywords. clinical decision support, user involvement, clinician involvement, system use, user acceptance

1. Introduction

Clinical decision support (CDS) systems aim to assist clinicians in making informed decisions by presenting them with integrated patient-specific information and clinical knowledge at the point of care [1]. CDS has been increasingly implemented in hospital settings to improve patient safety, increase adherence to guidelines and enhance efficiency, however, these systems are often implemented with limited consideration of end users' needs [2]. Failure to align CDS with user needs has been demonstrated to hinder acceptance and use in practice and contribute to unintended consequences, such as alert fatigue, disrupted workflows, and new system-related errors, which can pose risks to patient safety [3].

Involving clinician users in CDS design and development is frequently proposed as a technique that can help to improve the fit between the system and user needs [2]. Approaches to user involvement such as user-centered design, co-design, and

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participatory design aim to incorporate user requirements into CDS prior to implementation, in turn enhancing system usability, usefulness and fit with existing workflows [4]. The level of users' participation in each of these approaches sits on a continuum, from users being involved as 'subjects' in user-centered design, to users being active decision makers in participatory design [4]. Although user involvement in CDS development is widely reported, it is currently not known how the use of these methods impacts clinicians' acceptance and use once CDS is implemented in live hospital environments. Additionally, while sustained use of CDS is required for implementation success, user involvement is often evaluated in the near-term, with long-term effects ignored [5]. Given the time and resources required to involve clinicians in CDS development [6], understanding its impact on early and long-term acceptance and use of CDS in practice is critical.

To address this, we conducted a systematic review of studies that involved clinicians in pre-implementation design and development of CDS and evaluated acceptance and use of CDS over time in hospital settings. By doing so, we aimed to understand the approaches taken to involve clinicians in CDS development and the impact of employing these approaches on barriers and facilitators to acceptance and use that arose over time.

2. Methods

The protocol for this review is registered in PROSPERO (CRD42022325469).

2.1. Search Strategy

We systematically searched Ovid MEDLINE, Embase, Web of Science, CINAHL, and PsycINFO databases to identify studies evaluating clinicians' acceptance and use of CDS. To ensure relevance to current CDS implementations, our search was limited to studies published between January 2007 to March 2022. Our search strategy used a combination of MeSH terms and text words related to CDS, acceptance, use, methods, and hospitals.

2.2. Inclusion and Exclusion Criteria

We included CDS targeting any health condition or patient group, implemented and being used in inpatient or outpatient hospital settings. Additionally, CDS had to be integrated with a clinical information system (CIS). Eligible studies reported clinician (e.g. doctors, nurses, pharmacists) end-users' perceptions or attitudes (acceptance), and/or self-reported or actual interactions (use) of CDS, and described involving clinicians in CDS development. Published, peer-reviewed original research and case studies that employed qualitative, quantitative or mixed-methods research were eligible for inclusion. To capture the point in time that factors relating to acceptance and use were observed, eligible studies needed to report the timeframe of data collection following CDS implementation with sufficient granularity.

2.3. Study Selection, Data Extraction and Analysis

Titles and abstracts of identified studies were screened for inclusion in Covidence by four authors (NN, AB, RF, MB), with two authors performing independent screening of

each result. A sample of full texts were independently screened by review pairs and remaining texts were screened by one reviewer each (either NN, AB, RF or MB). Data were extracted by five authors (NN, AB, RF, AT, MB), with two authors performing independent screening of each result. Details extracted included study identifiers, description of CDS, description of user involvement, timeframe of data collection following implementation, and barriers and facilitators to acceptance and use. In the case where a component of a study met inclusion criteria, but another component did not, only the component meeting inclusion criteria was extracted. Disagreements were resolved through discussion between the review pair and if required, discussion and consensus among four authors.

3. Results

Twenty-three studies met full inclusion criteria, after excluding 2,367 titles and abstracts and 573 full texts, during screening. Different forms of CDS were examined, including passive and interruptive alerts, recommendations, dashboards, and order sets, that targeted activities such as medication prescribing, prevention of adverse events and flagging of high-risk patients, across diverse clinical conditions. Studies described employing user-centered approaches to CDS development such as usability testing, cognitive task analysis and workflow observations, as well as more active methods of clinician involvement such as regular design meetings with multidisciplinary teams (Table 1). Five studies reported employing multiple approaches. Included studies were conducted between 1 month to 5+ years post CDS implementation, however most studies (16/23) were conducted at or before 12 months post implementation.

Table 1. Type and frequency of clinician involvement approaches reported in included studies, according to the timeframe that acceptance and/or use was evaluated following CDS implementation.

Clinician involvement approach used (pre-implementation)	**Number of studies**					
	0-6 months	6-12 months	12-18 months	18-24 months	2-5 years	5+ years
Clinician input (not specified)	3	2	1		2	
Multidisciplinary team	3	2	2	1		
User/usability testing	2	1	1			
User developed (not specified)			2			1
Focus groups	1					
Design walkthrough	1					
Interviews	1					
Expert group			2			
Human factors approach (not specified)		1				
Workflow analysis			1			

Clinician involvement was not reported consistently across studies, with few describing details on the depth and nature of involvement, i.e., who was involved (13/23), how often (4/23), and their role in development (6/23). Those that did, often did not describe post-implementation acceptance or use in detail. Clinicians reported to be involved in CDS development included physicians of various specialties, nurses, and pharmacists. In addition to clinicians, multidisciplinary development teams often included researchers, informaticians and engineers. Clinicians were involved in the design and development of system components, as well as the knowledge base and logic that underlay CDS.

The **impact of clinician involvement** on CDS acceptance and use was only reported in two studies. Pirnejad et al. [7] reported that user involvement improved clinicians' collective sense of ownership over the system, whereas Bersani et al. [8] described the need for earlier, more intensive and continuous approaches to engagement. No papers evaluated the impact of clinician involvement on acceptance or use of CDS (i.e., compared clinician involvement in CDS development to no involvement, or compared different approaches to involvement).

Perceived ease of system use was frequently cited as a **facilitator** to CDS acceptance and use (10/23), particularly among studies conducted within 12 months post implementation (8/10). Numerous **barriers** were reported across studies of differing timeframes, including challenges relating to system features and display, integration into workflow, and clinical relevance and usefulness of recommendations.

4. Discussion

We conducted a systematic review of existing literature to understand the approaches taken to involve clinicians in the design and development of CDS, and the impact of clinician involvement on early and long-term acceptance and use. Clinician involvement was generally not described well, with included studies often failing to report the frequency of involvement and the role clinicians played in development. The former being critical to determining the depth of involvement, and the latter being necessary to understand how involvement contributed to acceptance and use [9]. Existing work has reported similar inconsistencies in the reporting of design activities in health research [5,10], and suggested explanations such as the tendency to split reporting of projects across publications [9]. While reporting guidelines for healthcare design exist [10], more focused guidance may be necessary where post-implementation evaluation is the focus of a study. To understand the degree of clinician input into CDS development [4], and therefore enable comparisons regarding its impact on CDS acceptance and use over time, we recommend that future studies include at a minimum: the approach used to involve clinicians, the type of clinicians involved, the frequency of engagement and the role that clinicians play in design or development.

Studies rarely described findings relating to the impact of clinician involvement on acceptance and use. Further work is therefore needed to understand the benefits and challenges of employing different approaches to clinician involvement on acceptance and use following implementation. This could include comparing user involvement to no user involvement or comparing the use of different approaches.

Despite involving clinicians in CDS development, barriers to system acceptance and use were still observed in studies conducted shortly after implementation and those conducted years later. This emphasises the need for continued user involvement following CDS implementation to ensure the system meets ongoing user needs as they evolve over time. Notably, both studies describing the impact of clinician involvement stressed the need to continue engagement beyond CDS development. Pirnejad et al. [7] described how the presence of fast-paced cycles of iteration within the year following implementation contributed to ongoing acceptance, while Bersani et al. [8] highlighted that the absence of early and ongoing engagement within the 18 months post implementation hindered acceptance. Existing literature has described strategies to involve users in ongoing CDS optimisation, such as the continued consultation of multidisciplinary teams or committees, ongoing monitoring of CDS use, and creating

mechanisms for users to provide quick and easy feedback [7,11]. Thus, it is recommended that future research incorporate such strategies to mitigate barriers to use that arise over time.

5. Conclusion

Due to inconsistencies in the reporting of clinician involvement in CDS design and development, and the lack of evaluation of clinician involvement in included studies, its impact on acceptance and use could not be determined in the current review. We recommend that future research enhance reporting of clinician involvement and examine the impact of different approaches on clinicians' acceptance and use of CDS, for example through comparative studies, over time. Given the time and resources required for clinician involvement, we need evidence that these approaches meaningfully contribute to early and long-term acceptance and use of CDS in practice.

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