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A Design Thinking Approach to Developing a Clinical Decision Support System for Breathlessness in Primary Care

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Abstract

Clinical decision support systems (CDSS) have the potential to support guideline implementation and bridge the research translation chasm. However, clinician barriers to uptake remain strongly reported in previous studies. This study aims to utilise a design thinking approach to develop a CDSS for breathlessness in primary care. A low fidelity mockup was developed based on an exploratory focus group to elucidate clinician needs and assess responses to key features. The low fidelity prototype was then developed and tested through two rounds of Think-Aloud testing. Post each Think-Aloud, changes were made and split-run (A/B) testing conducted in the second round in response to user interface concerns raised in the first round. Overall, GPs find the CDSS to be a useful addition to their breathlessness assessment and are open to its use. This study showed that utilising a design thinking and practice-oriented approach with rapid usability testing, it was possible to gain crucial insight in a more rapid and cost effective way.

Keywords:
decision support systems, clinical; primary health care; dyspnea.

Introduction

Continuous innovation and translation of medical research into clinical practice is important to improve patient outcomes. However, a chasm remains between translating research into practice, with the seminal Institute of Medicine report stating it takes an average of 17 years for research translation and more recent National Institutes of Health plan estimating it to be 14 years.[1]

Clinical guidelines contributes to narrowing this gap and effective implementation of clinical guidelines in practice have been demonstrated to improve clinical outcomes in patients.[2; 3] Even so, guidelines are frequently not applied in practice resulting in unnecessary diagnostics and inadequate or potentially harmful treatments being prescribed.[4]

A recent systematic review conducted by the American Heart Association on strategies for implementing clinical practice guidelines have reported that the use of an electronic guidelines system where guidelines are embedded into practice computers was found to be a facilitating factor to guideline implementation. Leveraging innovative research methods and study designs utilising electronic health records was recommended to improve implementation.[5]

While electronic clinical decision support systems (CDSS) have great potential to improve care especially in primary care where most patients are managed, previous qualitative studies with clinicians[6; 7] have reported barriers to their use in practice, including lack of flexibility, interruptive alerts, cluttered presentation of materials and complexity in navigation. This was supported by the result of a systematic review on CDSS for asthma that reported CDSSs are unlikely to improve patient outcomes as they are rarely used and the advice provided is not followed.[8]

A design thinking approach that is human centered by incorporating needs and feedback from users (clinicians) throughout the CDSS development process is one way to reduce this barrier in uptake.[9] This study aims to present the results of utilizing a design thinking approach in the early stages of developing a CDSS for breathlessness in primary care. Specifically, we will share the mockups developed based on a previous exploratory focus group and results of a think aloud study on low fidelity prototypes with task scenarios based on real world practice.

Methods

Our design and development process relates to the five iterative main stages of the design thinking process – "empathize, define the problem, ideate, prototype and test".[10] We had previously conducted a focus group with practicing clinicians to ascertain the first 3 stages.[7] The features proposed by the focus group had then informed the development of a low fidelity prototype using a wireframing software (Balsamiq). The prototypes were then tested using the Think Aloud method further explained below. After each Think Aloud iteration, the team discussed and made changes to the prototype based on the participants' input.

Study Participants

General practitioners (GPs) were recruited from varying local health districts. A balance of both early-mid career and more senior GPs were sought. For each version of the prototype, we aimed to have between 3 to 5 participants perform usability testing before reiterating. This number was selected based on a previous study which showed that best results come from testing with smaller numbers more often.[11] Ethical approval for the study was granted by the University of New South Wales Human Research Ethics Committee. Informed consent forms were sent to participants prior to the think aloud testing.

Think Aloud testing

Think Aloud testing was conducted on the prototypes based on three scenarios with a real-world context (Table 1). These scenarios were developed based on input from medical experts and provided a mix of common as well as less common causes of breathlessness in practice.

Table 1 - Task scenarios for think aloud testing

Task Scenario 1
A 65-year-old female presents with breathlessness. She's mildly obese with cardiac risk factors.
Perform the consult using the breathlessness CDSS to look into guideline recommended therapy for this patient.
Task Scenario 2
The 65-year-old female presents again with breathlessness.
Perform the consult using the breathlessness CDSS to make her a referral for the most appropriate diagnostic test.
Task Scenario 3
A 30-year-old female presents with breathlessness and notes its worse with stress.
She has a history of childhood wheeze. No spirometry.
Perform the consult using the breathlessness CDSS, checking the patient's PHQ4 and Nijmegen score, then record the result in your EHR.

The Think Aloud tests were conducted virtually through a videoconferencing platform. Prior to the test, participants were provided an explanation and non-related example. We emphasised that it is the platform and not their knowledge that is being tested to promote greater openness to provide feedback. Facilitators provided participants remote access to their screen allowing participants the freedom to explore the available features. Facilitators were also instructed to provide minimal help to participants during testing.

Following Think Aloud testing, participants were invited to share their overall views, features they like and dislike, propose design and feature adjustments to improve their experience, and were asked whether they would be open to implementing such a CDSS when available. Hotspot image testing was also conducted where screenshots were provided, and participants were asked to choose whether they like or dislike a specific feature. A system usability survey was also conducted following these questions The result of the SUS was presented as a single continuous score ranging from 0 to 100. SUS scores were also mapped into categories based on previous literature[12] with >51 as okay, 71 as good, 86 as excellent and 91 as best achievable. The survey was conducted using Qualtrics XM.

Data Analysis

Screen and audio recordings as well as field notes of the think aloud testing were analysed. Qualitative analysis was performed using NVivo 12 through a thematic approach as described by Terry et al.[13] Direct quotations from participants were reported between single quotes. Quantitative results were analysed using Stata 16.

Results

Previous to this study, an exploratory focus group to understand GPs needs was conducted to inform development of the prototype and has been reported elsewhere.[7] In brief, GPs reported ascertaining diagnosis to be the main challenge with an additional focus on supporting patient education. They described the various current CDSSs in use and requested one that is short and intuitive for breathlessness. Other requested features include electronic health record (EHR) integration and incorporation into clinical notes.

A total of two rounds of think aloud testing were conducted. Their results and mockups are separately described below. Changes were made between both testing sessions to incorporate the feedback received from test one and to test the various forms of user interface.

Think Aloud Testing round 1

Five GPs participated in the first round of testing. Their years in practice ranged from 6 to 42 years, and they practice for an average of 3 days per week. They reported encountering patients with breathlessness at a prevalence of about 1% to 10%. All reported they were confident in using technology in clinical practice.

In general, GPs had a positive view regarding the mockup. One GP reported 'I enjoyed it. Simple to use. Clear quantitative information.' with another stating 'It seems useful and quite intuitive'. Even so, one of them mentioned that it provided limited differentials based on a limited patient history, another emphasized the importance of using the CDSS in conjunction with clinical reasoning. Early-to-mid-career GPs seemed to find it more helpful than those with more experience.

The main feature that all GPs liked was the CDSS's potential to remind them of a diagnosis they have not considered before. Others include the provision of quantitative information (probabilities), quick links to validated questionnaires and education material. Similar to our exploratory group, having the CDSS as part of the EHR was also a liked feature that half of the GPs believed was necessary to increase uptake. There were varying responses with regards to providing prompts for history taking and physical examination, some found it too extensive while others not comprehensive enough.

On the other hand, it was interesting to hear from one GP that there is no need for an integrated information display of past history as they can easily find it themselves from the EHR. Another GP also shared how previous experience showed that 'some of these tools that "sit alongside" our EHR become "clunky" and also slow down our system', something we found crucial to consider as we progress. The description below the graphical differential diagnosis likelihood representation (Figure 1B; "Based on XX matched patients in the BREATHE dataset") reporting the evidence basis of the likelihoods was also a feature disliked by most GPs.

Navigational issues were reported by some participants to access the CDSS and find items within it. All participants were unable to find the CDSS button (top right corner) on their own without some prompting. In general, they preferred a more streamlined approach than the current 'wizard' style system. Other user interface suggestions included simplifying the graphical presentation of likelihood of diagnoses (Figure 1B), addition of back buttons and adjusting the typeface to ensure some important items stand out. Our hotspot image findings were consistent with these responses. The result of the system usability survey found an average score of 55 among participants which qualitatively falls under the "okay" category.

Following the first round, several changes were made in response to the feedback, including adding the option to view a greater number of differentials, and added history and physical examination suggestions (Figure 2A, B). While no major changes to the features were made, substantial changes were done to provide four options of user interface to test (wizard style, lazy loading on a single page, side tabs with text and side

tabs with icons). Split-run (A/B) testing was also conducted on the CDSS launch module (top right versus mid screen reminder box), the likelihood representation (graphical [Figure 1B] versus text based [Figure 2B]), addition of back buttons and more info buttons (Figure 2A, B). The text below the graphical likelihood representation was also removed.

Think Aloud Testing round 2

The second round of testing recruited four GPs. Their years in practice were longer compared to round one ranging from 33 to 45 years, although they also practice for more days with an average of 4 days per week. They reported encountering patients with breathlessness at a prevalence of about 5% to 10%. Three of four reported they were confident in using technology in clinical practice.

Similar to round one, all GPs reported the CDSS to be 'useful' and that it could help ensure a detailed history is taken. Their ability to quantify probabilities was also the main feature they liked. Seamless integration into EHR also elicited a positive response. A proposed feature was to allow the ability to save progress made in the CDSS and return back to it after, for example browsing other parts of the EHR.

Even so, some issues arose including non-familiarity with the system and the difference in its process to their current clinical reasoning. One GP noted that 'It would be more tempting to use for patients where there were diagnostic dilemmas (not all breathlessness patients)'. Medicolegal implications of not following recommendations and of too many tools being already available were also brought forward. Two of the GPs also suggested the need to see a more interactive version before being able to provide further feedback.

Hotspot image testing found a preference for more non-intrusive reminders (top right rather than mid-screen reminder box), tabs with icons interface (Figure 2A, B) and an equal vote for both graphical versus text-based likelihood probabilities representation. GPs mentioned the lack of need for an integrated prescription module and reducing the number of entries needed to utilize the system also remained a comment from GPs. There was an increase in the average system usability survey score to 59 although qualitatively it remains categorised as "okay".

Discussion

It is estimated that 30%-40% of patients receive non-evidence based treatment and 20-25% receive unnecessary or potentially harmful treatments.[14] This is often put down to poor guideline implementation in practice. However, poor clinical assessment resulting in difficulty reaching an accurate diagnosis may contribute, leading to suboptimal management. In the primary care setting, a study of patients referred for breathlessness, reported that less than 30% had a fully concordant referral diagnosis with the final diagnosis.[15] This finding was supported in another study where less than 40% of breathlessness patients referred to secondary care with heart failure were confirmed to suffer from heart failure.[16]

Another study in over 130 primary care physicians reported that physicians only asked 59% of essential history items and missed a large number of items affecting treatment plans. This study recommended the use of questionnaires or other approaches to ensure more complete and accurate history taking.[17] Hence, in line with the results of our exploratory focus group, we aimed to prototype and test a CDSS with an emphasis on diagnosis. We therefore particularly focus on supporting clinical reasoning, not only basing the CDSS on diagnostic tests but also on high-yield history and physical examination which are the main armamentariums of a general practitioner.

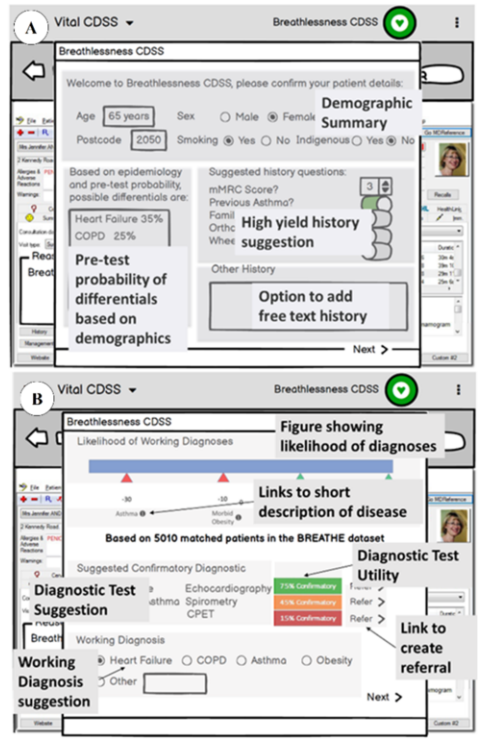

Figure 1– Sample CDSS mockups tested in round 1

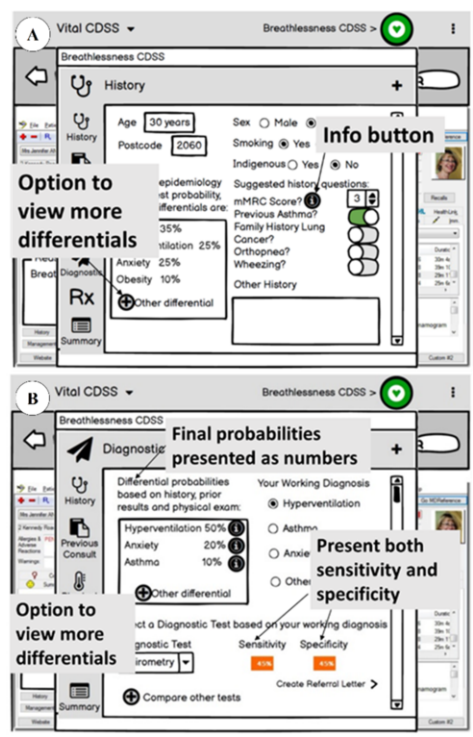

Figure 2 – Sample CDSS mockups tested in round 2

A design thinking approach was chosen to mitigate negative physician perceptions and biases which are one of the main barriers to effective use of diagnostic decision support systems in the wider CDSS ecosystem.[18] We also tested features such as using toggles for input, integrating with the EHR while also providing free text entry and the ability to automatically create structured notes to copy into the medical records. This should address poor system integration that was also identified as a barrier in Sutton's recent review.[18]

The varied responses to the user interface design during A/B testing introduces the possibility of including a setting that allows users to tweak the presentation format. Furthermore, it was interesting to find GPs mentioning the lack of need for an integrated prescription module which might stem from their familiarity with their current EHR. System usability scores improved between tests but remain qualitatively in the "okay" category which might stem from this being a low fidelity prototype.

It is worth noting that the use of low fidelity prototypes imposed limitations on what we could test. Even so, a previous study comparing high and low fidelity prototypes in game design did not support a difference in the number of usability issues identified between prototype fidelities, and recommended the use of lower fidelity prototypes to allow more rapid iteration and to keep costs comparatively low.[19]

Conclusions

This study has showed that while GPs find the CDSS to be a useful addition to their breathlessness assessment and are open to its use, selective use for only dilemmatic cases is anticipated in practice. GPs were found to be uninterested in having the underlying data for the CDSS presented but prefer a succinct presentation of practice-oriented recommendations.

Contrary to prior studies, GPs did not report requiring extensive integration of the CDSS with the EHR as they were familiar with where to obtain results in their own EHR and already have their own clinical workflow. Providing options to personalise some of the interface features to individual clinician workflow can improve usability, promote uptake and use in practice. Further mixed methods studies and iteration remains required until a CDSS solution with high usability that meet GPs' need is developed.

The results of this study also showed that utilising a design thinking and practice-oriented approach with rapid usability testing, it was possible to gain crucial insight in a more rapid and cost effective way. It also showed the viable use of virtual methods to conduct rigorous Think Aloud testing which is especially relevant in the current shift to virtual studies.

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