Usability of Reports Generated by a Computerised Dose Prediction Software

Melissa BAYSARI\textsuperscript{a,b,1}, Joanne CHAN\textsuperscript{c,d}, Jane CARLAND\textsuperscript{b,d}, Sophie STOCKER\textsuperscript{b,d}, Maria MORAN\textsuperscript{d} and Richard DAY\textsuperscript{b,d}

\textsuperscript{a}Centre for Health Systems & Safety Research, Australian Institute of Health Innovation, Macquarie University
\textsuperscript{b}St Vincent’s Clinical School, UNSW Sydney, Australia
\textsuperscript{c}School of Medical Science, UNSW Sydney, Australia
\textsuperscript{d}Department of Clinical Pharmacology & Toxicology, St Vincent’s Hospital, Sydney, Australia

Abstract. Computerised dose prediction software assist clinicians in undertaking therapeutic drug monitoring by providing individualised dosing recommendations, typically communicated to prescribers in the form of a report. These software are highly sophisticated and accurate in predicting individualised dosage regimens, but if the information contained in the report is not understood by prescribers, the benefits of the software are not achieved. In this study, we set out to assess the perceived usability of a report generated from a dose prediction system. Fifteen prescribers were presented with a mock report and asked a number of questions to elicit their views of the report’s content and design. Overall, we found that the mock report was effective in communicating the recommended dose of a drug, but this recommendation was presented alongside information that was not understood or was unlikely to be utilised by prescribers. In particular, the aspects of the report viewed negatively by end-users largely related to a lack of familiarity with the pharmacological terminology used in the report, which hindered understanding and caused confusion. Involving prescribers early on in the process of designing decision support systems is likely to result in systems and outputs that are more useful, usable and accessible to users.

Keywords. Decision support, dose prediction software, usability.

Introduction

Therapeutic drug monitoring (TDM) involves monitoring concentrations of a specific drug in the blood and adjusting doses accordingly in order to achieve the optimal effect of that drug [1]. TDM is most beneficial in patients with altered pharmacokinetic parameters, such as those with impaired renal function, those that are critically ill or who are obese [2,3]. Maintaining optimal drug concentrations is, however, a highly complex task. Computerised dose prediction software assist clinicians in this process. These systems comprise algorithms to enable the automated calculation of doses, while integrating relevant patient factors such as age, bodyweight, sex, renal function, and drug concentration results.
Dose prediction software generate reports that are then transmitted to doctors to guide their dosage decisions. These systems may be highly sophisticated and accurate in predicting individualised dosage regimens, but if the information contained in the report is not understood by decision makers, the benefits of the software are not achieved.

A number of studies have examined the features of guidelines desired by health professionals, or the features associated with greater uptake of guidelines, however, these documents typically comprise many pages, and so the features identified as valuable relate to minimising the time required for information retrieval (e.g., a contents page, a recommendation summary) [4]. To date, very limited work has focused on evaluating the usability of reports generated from dose prediction software. In one study, 12 dosing systems were assessed by a pharmacist and two clinical pharmacologists on a range of criteria, including the report generated for prescribers [5]. Raters assigned a score to each report based on the report’s readability, the inclusion of a relevant graph, the inclusion of a free text field, whether it displayed a user’s identity, whether it could be customised, and whether it could be converted to other formats (e.g., PDF). Overall, the quality and readability of reports varied considerably, with reports scoring on average between 1.0 – 4.3 out of a possible five [5]. Although this study is a very good starting point, it tells us little about how the reports are viewed by actual users, that is, by prescribers.

In this study, we aimed to assess the perceived usability of a report generated from a dose prediction system, in order to improve its content and design for optimal usability and accessibility.

1. Method

1.1. Study Site and Dosing Decision Support System

This study was undertaken at a 320-bed teaching hospital in Sydney, Australia. At the time of the study (July-August 2016), the hospital had in place electronic medication management, ordering and reporting of laboratory and imaging tests, paging, rostering, and clinical documentation. Patient progress notes were not electronic. The hospital had plans to implement the dosing software, DoseMe, following some additional testing and piloting. DoseMe is a computerised dose prediction software that uses the technique of Bayesian forecasting to provide individualised dosing recommendations (https://doseme.com.au).

1.2. Participants

Fifteen prescribers from a variety of wards were opportunistically recruited in-person or through the hospital’s paging system, to participate in a short interview (average 13 minutes). Recruitment was performed by a student researcher (JCh) with assistance from the hospital’s clinical pharmacology registrar. Participation in this study was voluntary and no remuneration was provided.

1.3. Procedure

Prescribers were presented with a mock DoseMe report (Figure 1), and asked a number of questions to elicit their views of the report (Table 1). Interviews were audio-recorded.
and transcribed verbatim. De-identified transcripts were then analysed independently by two researchers (JCh and MB) who extracted positive and negative perceptions of the report. The two researchers met periodically throughout data collection to compare themes. Any disagreements in themes were deliberated on until a consensus was reached. Ethics approval was obtained from the hospital’s Human Research Ethics Committee.

![Figure 1. DoseMe report presented to prescribers](image-url)
Table 1. Semi-structured interview questions posed to prescribers during interviews

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are your first impressions of this report?</td>
</tr>
<tr>
<td>What information do you find useful?</td>
</tr>
<tr>
<td>What information do you find not useful?</td>
</tr>
<tr>
<td>Is there anything here that you find confusing?</td>
</tr>
<tr>
<td>What other information do you think should be provided?</td>
</tr>
<tr>
<td>Which sections of the report (i.e. box, text, graph) would you like provided to you?</td>
</tr>
<tr>
<td>What improvements could be made to this report, in terms of both content and layout?</td>
</tr>
</tbody>
</table>

2. Results

2.1. Positive Perceptions of the Dosing Software Report: Summary Box and Drug Exposure Graph

Prescribers liked that the top text box provided a clear, straightforward recommendation. The red box was seen to be effective in drawing prescribers’ attention to the most important piece of information, that is, the recommended dose: “I like that, getting a big red box with what to do next in it.”

Some prescribers also found the drug exposure graph to be a useful way to visualise dosing, especially for patients on long-term courses of a drug. The graph was particularly liked by those who reported a preference for processing information visually. A registrar said: “I’m probably a more visual person so I think I like seeing this laid out more, in a more visual way.” It was also explained that when time pressured, visual information is more accessible than text-based information, making the graph very useful: “I think people could easily misinterpret it if they’re rushing through so I think the graph makes it a lot easier to see "oh, okay, we must increase to get to the target outcome".”

2.2. Negative Perceptions of the Dosing Software Report: Unfamiliar and Ambiguous Terminology, Unnecessary Information

Prescribers were unfamiliar with the term “AUC₁₂”, a key concept in the report. Some doctors also questioned the relevance of Area Under the Curve (AUC) to non-specialist doctors. A registrar said: “But I don’t know how many clinicians would be familiar with using it [AUC] other than I.D. [infectious disease] physicians or specific Microbiology/I.D. doctors... Because we don’t really use the area-under-the-curves in sort of practical, clinical sense on a regular basis.” A number of participants were confused by the concept of a single AUC target (the blue text), rather than a target range: “You’re aiming for 200... Is this the maximum you can go to? Is this the minimum you can go to?”

Although most prescribers saw value in including the drug exposure graph, it was also highlighted that the graph displays the same information as the text immediately above it, providing no additional content. This was thought to be potentially confusing for users. A registrar said: “I think it would also be useful just to see that, actually see that the graph has represented what’s written down. Because some people may think that they’re getting two amounts of information at first glance.”
2.3. Overall Perceptions of the Dose Prediction Software Report

Despite displaying some complex information, most prescribers viewed the report as useful, and they appreciated being shown data to support the recommendation that appeared in the red box: “It’s always good if the clinician can look at something and say that it sounds reasonable and not...that you’re completely relying on a computer-generated system to give you information in case there’s an error within it... I think it is nice to know on what basis that was done and that it gives you at least a feeling of justification”. However a number of prescribers anticipated that in the context of a fast-paced, time-poor clinical environment, the upper text box would likely be the only section of the report that is utilised. A resident said: “I'm in a hurry, I'm super busy, I'm already doing 14-hour days. I've got 25 patients and they're all really sick. I literally am racing through the bloods...I literally just want to know what to do next and how to do it as quickly as possible.”

3. Discussion

Discussions with prescribers revealed that a mock report produced from a dosing prediction system was effective in communicating the recommended dose of a drug, but this recommendation was presented alongside information that was not understood or was unlikely to be utilised by prescribers.

Comments from prescribers highlight the importance of clear presentation and expression of information, including the utilisation of colour and highlighting, and the value of supplementing textual information with visual information. Although these design principles are well known, [4, 6, 7] this study was the first to examine the design of reports generated by a dosing prediction software for prescribers.

The aspects of the report viewed negatively by end-users largely related to a lack of familiarity with the TDM terminology used in the report, which hindered understanding and caused confusion. “AUC_{12}” a key concept in the report, was unfamiliar to the prescribers we interviewed. This term is routinely used in the study of pharmacokinetics, and so is understood by infectious disease specialists and pharmacists. However, what this research has shown is that if specialised terms such as this are to be used in outputs for prescribers, implementation of the dosing system must be accompanied by appropriate training and the report should include clear definitions of these concepts (e.g. when hovered over with a mouse), as they will be novel to routine users.

Another key result from the study was that not all the information contained in the dosing software report is likely to be useful for all prescribers. To eliminate clutter and focus the reader’s attention on the principal recommendation of the system, all information outside the primary text box could be removed and made available via a hyperlink embedded in the form. This strategy, a well-known principle of good safety warning design, [8] reduces information overload while allowing those with a need or interest for more information to access this information easily.

Overall, this study has highlighted the value of seeking user input in the design of computerised decision support systems and their reports. While dosing prediction software are often designed with input from those with expertise in TDM (e.g. clinical pharmacologists and pharmacists), involving prescribers early on in the process is likely to result in systems and outputs that are more useful, usable and accessible to users. Our
findings and recommendations were communicated to the software vendor to inform future revisions of their report for prescribers.

References


