Feedback and Training to Improve Use of an Electronic Prescribing System: A Randomised Controlled Trial

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Abstract. Excessive presentation of alerts in electronic prescribing systems (ePS) results in ‘alert fatigue’ which reduces alert effectiveness and frustrates users. Previous research at our study site showed high rates of duplication alerts, some of which were the result of doctors not using available short-cut functions in the ePS. This study aimed to improve uptake of short-cut functions and so reduce alert fatigue by trialing two interventions: feedback and training. Fifty doctors were randomised to one of three groups: Control, Feedback or Training. The Feedback group received an individualised feedback report via email and the Training group received brief face-to-face refresher training. Participants partook in informal interviews to discuss the training and the ePS in use. The proportion of orders which triggered a duplication alert was our primary outcome measure. Neither intervention had a significant impact on duplication alert rate (Feedback: 80.8\% vs. 77.8\% of orders, Training: 77.5\% vs. 76.5\% of orders; all $p>0.05$). We identified a number of factors related to the intervention, ePS and prescribing environment that contributed to this result. Rather than focusing on changing prescribing behaviour, we suggest a more effective and appropriate approach is to redesign the ePS so that fewer and more meaningful alerts are presented.

Keywords. Electronic prescribing, alert fatigue, alerts, training, feedback

Introduction

Computerised alerts that trigger at the point of prescribing to warn doctors about possible risks in orders such as drug duplications and drug-drug interactions, are a common form of decision support in electronic prescribing systems (ePS) [1, 2]. Despite the potential benefits of alerts, users of ePS often suffer ‘alert fatigue’ which arises when an excessive number of alerts are presented [3]. Alert fatigue leads to user frustration [4, 5] and doctors overriding alerts, (i.e. clicking past alerts without performing the recommended action), minimising alert effectiveness. Alert override rates ranging from 49\% and 96\% have been reported in the literature [6-8].

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Our previous research at the study hospital showed that approximately one third of all medication orders initiated by doctors triggered one or more alerts [9]. During qualitative interviews, doctors reported receiving too many alerts and many were perceived to be irrelevant [10]. Therapeutic duplication alerts were most frequently encountered and were considered the least useful by prescribers, accounting for 61% of all alerts triggered. Interestingly, our research also showed that one third of the duplication alerts triggered were ‘technically preventable’, that is, were triggered because prescribers were not using particular ePS functions [9] [10].

In this study, two interventions were trialed to improve uptake of ePS functions and reduce technically preventable duplication alerts: refresher training and individualised feedback. The aims of this study were to determine: 1) whether providing doctors with refresher training would lead to more optimal ePS use and so fewer duplication alerts, 2) whether providing doctors with individualised feedback would lead to more optimal ePS use and so fewer duplication alerts, and 3) which strategy, training or feedback, was more effective in increasing uptake of underutilised ePS functions.

1. Methods

1.1. Setting and Electronic System

This study was conducted at a 320-bed teaching hospital in Sydney, Australia. At the time of the study, all departments of the hospital used an ePS except for the emergency department. The ePS electronically supports end-to-end medication management, including prescribing, medication review and administration. It includes a number of shortcut functions to minimise data entry time. These include for example, the ability to modify existing orders, instead of ceasing and re-prescribing medications, and ‘AND’, ‘THEN’, and ‘OR’ buttons which allow for similar concurrent, sequential or alternative orders to be placed without requiring multiple orders.

In the hospital’s ePS, duplication alerts trigger when a doctor prescribes a medication that was identical to (or a medication belonging to the same class) as a medication which is currently active on a patient’s chart, or was ceased within 24 hours. Failure to use some of the short-cut functions results in the generation of technically preventable duplication alerts. For example, if an order is ceased and immediately re-prescribed with a lower dose (instead of modified), this results in a duplication alert.

1.2. Design and Participants

The study utilised a randomised controlled design[11], with three study groups: Feedback, Training and Control. All doctors, regardless of level or specialty, who had prescribed more than 80 medications in a four month period, were randomised to one of the three study groups and invited to take part in the study. A sample size calculation determined that 20 doctors in each group, each with 100 orders, were needed to detect a 10% reduction in duplication alerts with 90% power for a two sided test at 5% significance. Doctors were excluded from the study if they left the hospital during the study period (n=10), served a term in the emergency department (where the ePS was not operational; n=10) or were seconded out to other networked hospitals (n=30).
Twenty doctors were recruited into the Control group, 19 in the Feedback group and 11 in the Training group.

1.3. Procedure

A sample of prescription data was extracted from the ePS four months prior to (2/2/2015–2/6/2015) and four months following (5/10/2015–5/2/16) the implementation of interventions. Doctors in the Control group did not receive any intervention over the course of the study. Doctors in the Feedback group were sent an email containing an individualised feedback report. This report contained information on the number of duplication alerts triggered by the doctor in the 4-month period, as well as information (written guide and screenshots) on how to use the ePS short-cut functions to avoid duplication alerts being triggered. In the report, doctors were also provided a contact email for any queries on ePS use or to provide feedback. Information on whether or not participants accessed the feedback document was not able to be collected. Doctors in the Training group participated in a 5-minute face-to-face refresher training session. During the session, delivered by a medical science honours student, the short-cut functions were demonstrated using a set of prescription scenarios and the doctors were provided with a summary sheet outlining the short-cut functions discussed. Training sessions were undertaken at a convenient time and location for participants (e.g. on the wards) using the ePS training environment. Following each training session, prescribers were given an opportunity to provide any feedback regarding the session and general ePS use either via a brief informal discussion or through email.

1.4. Outcome Measures

The primary outcome measure for the study was the proportion of medication orders which triggered at least one duplication alert (i.e. orders with a duplication alert/total medication orders prescribed). Our secondary outcome measure was the average number of duplication alerts per order (i.e. number of duplication alerts triggered/number of medication orders prescribed).

1.5. Data Analysis

All statistical analysis was performed using SPSS Version 22 for Windows (IBM Corp., Armonk, NY, USA). Descriptive statistics (mean±SD) were used to summarise the outcome measures. Two way ANOVAs were performed for both outcome measures and p-values of 0.05 or less were considered significant. Ethics approval was obtained from the hospital’s Human Research Ethics Committee prior to commencing the study.
2. Results

2.1. Impact of Interventions on Duplication Alerts

During the pre-intervention period, doctors included in the study prescribed on average 205 ± 92.6 orders (range: 80-444) and experienced on average 306 ± 160.7 duplication alerts (range 108-867). During the post-intervention period, doctors included in the study prescribed on average 161 ± 110.4 orders (range 11-461) and experienced on average 223 ± 150.5 duplication alerts (range 17-623). Order and duplication alert details for each group in each study period can be seen in Table 1.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of orders</th>
<th>Number of duplication alerts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Control</td>
<td>161</td>
<td>166</td>
</tr>
<tr>
<td>Feedback</td>
<td>238</td>
<td>144</td>
</tr>
<tr>
<td>Training</td>
<td>220</td>
<td>180</td>
</tr>
</tbody>
</table>

As shown in Figure 1, there was no statistically significant difference between groups (F(2,47)=0.548, p=0.582), between pre- and post-intervention time periods (F(1,47)=0.921, p=0.342), or between groups across the two time periods (F(2,47)=0.177, p=0.839) in the proportion of orders which triggered a duplication warning. Similarly, no statistically significant difference was found between groups (F(2,47)=1.158, p=0.323), between pre and post periods (F(1,47)=0.108, p=0.744) or between groups across the two time periods (F(2,47)=0.783, p=0.463) in the average number of duplication alerts triggered per order.

![Figure 1](image_url)
2.2. Feedback from Doctors

Brief discussions and email correspondence with prescribers following training revealed a number of potential reasons for training and feedback not impacting on duplication alert rate, as shown in Table 2.

Table 2. Potential reasons for the interventions not being effective in reducing duplication alert rate.

<table>
<thead>
<tr>
<th>Category</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>System related</td>
<td>The ‘modify’ short-cut function was sometimes intentionally being avoided due to its perceived inefficiency in certain prescribing scenarios</td>
</tr>
<tr>
<td>Institution related</td>
<td>Multiple doctors sometimes used a single doctor’s login which may result in prescribing data that does not accurately reflect an individual’s prescribing</td>
</tr>
<tr>
<td></td>
<td>Organisational structure of the study site meant high frequency prescribers were in different specialties during the pre and post periods</td>
</tr>
<tr>
<td>Intervention related</td>
<td>Refresher training sessions were only delivered once and were rushed as doctors did not consider them a priority</td>
</tr>
<tr>
<td></td>
<td>Training sessions were delivered by a research student</td>
</tr>
</tbody>
</table>

3. Discussion

The two interventions, refresher training and feedback were not effective in reducing the number of duplication alerts being triggered in the ePS. Despite this, the study offers some valuable insights into conducting studies in a hospital setting using real time prescription data.

As evident in Table 1, despite reviewing data across the same time period pre and post interventions (i.e. 4 months), there was considerable variation in prescription numbers and subsequent duplication alerts across the two time periods. This was a consequence of doctors working in different specialties during the two time periods. To accurately assess the impact of our interventions on prescribing, participating doctors should have worked in a single specialty for both the pre- and post-intervention periods. However, the organisational structure of the study site made this difficult. Junior doctors undergo up to five term rotations throughout a calendar year. Future studies trialing hospital-wide interventions over time should consider the movement of prescribers across specialties when determining data collection periods and appropriate outcome measures.

Discussions with doctors post-training revealed that during ward rounds in the ICU, a single login was used by an entire team to chart and cease medications. Additionally, some doctors left their login available throughout the day even when not physically present. This is an important consideration when prescription and alert data are used as outcome measures, as this data may not reflect an individual’s actual practice.

Furthermore, it was revealed that in certain circumstances, doctors intentionally avoided using some of the short-cut functions, as they were perceived to be less efficient than ceasing and reordering the medication, despite the triggering of a duplication alert. Workarounds such as these may have inflated the proportion of technically preventable alerts we observed, and may explain why our interventions were ineffective in changing prescribing behaviours. Our interventions targeted poor
awareness of the shortcut functions, not intentional avoidance of these functions. Workarounds are particularly pervasive in health information technology use and are suggestive of poor system or workflow design [12, 13]. Future work should focus on redesign of the ePS rather than behaviour change interventions to reduce alert numbers.

A number of characteristics of the interventions themselves may have also limited their effectiveness. Research has shown that feedback is most effective when it is provided systematically over multiple years from an authoritative, credible source [14, 15]. Similarly, research shows that for face-to-face feedback to be effective, the recipient must actively participate in its delivery [16, 17]. In this study, feedback was delivered only once via email, and it is possible that participants did not read the feedback report. In addition, most of the training sessions were brief due to doctors’ busy schedules and as a result the uptake of information may have been limited. Overall, this combination of factors likely limited the potential impact of our interventions.

4. Conclusion

Training and feedback were ineffective in improving the use of an ePS. Following discussions with prescribers, it is unlikely that behaviour change interventions will be effective in increasing uptake of ePS functions as the functions were intentionally being avoided. Instead, re-design of the system is recommended so that short-cuts are more efficient and align with prescriber workflow. This study highlights a number of difficulties associated with using data extracted from hospital systems to evaluate interventions, and provides important insights for researchers intending to utilise individual prescription data.

References


