Identifying effective strategies to prevent drug-drug interactions in hospital: a user-centered approach

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Abstract

Background: Drug-drug interactions (DDIs) are an important and preventable cause of medication errors in hospitals. Research has shown that doctors and pharmacists are often unable to recognise potential DDIs, suggesting that a strategy to aid in DDI detection and prevention is needed. Recent developments in technology have seen new strategies emerge for preventing DDIs but these strategies are rarely evaluated and are typically implemented with little input from the individuals using them.

Aim: The aim of this study was to determine the opinions of both experts and users (doctors) on strategies available to assist in the identification and prevention of DDIs.

Method: Eight drug safety experts and 18 doctors took part in semi-structured interviews. Participants were asked about their confidence in identifying DDIs and their views on strategies to prevent DDIs.

Results: No doctors reported complete confidence in identifying dangerous DDIs, with junior doctors appearing less confident than senior doctors. Most doctors believed that computerised alerts would be the most effective strategy for preventing DDIs, while experts were more critical of alerts.

Conclusion: The lack of confidence displayed by doctors in their ability to identify DDIs suggests that a strategy that does not rely on individuals seeking out the information themselves would be most appropriate. While a large number of problems related to DDI alert implementation have been reported in the literature (e.g. alert overload), users appeared to be receptive to the idea of being alerted. By ensuring users are aware of the limitations of the system and involving them in DDI strategy design we expect greater use and satisfaction with the adopted strategy.
1. Introduction

Drug-drug interactions (DDIs) are a preventable cause of medication errors in community and hospital settings. They occur when two or more drugs are taken in combination that lead to a change in the activity of either or both drugs.\textsuperscript{1,2} DDIs can result in adverse effects; commonly these include low blood pressure, bleeding or kidney damage.\textsuperscript{3} Additionally DDIs can lead to therapeutic failure, where one or both of the drugs are unable to achieve their desired clinical effect.\textsuperscript{3} DDIs account for 2.4%-4.4% of hospital admissions in Australia.\textsuperscript{4,5} In a recent study examining the incidence of medication errors in two wards of a Sydney hospital, it was discovered that DDIs represented the fourth most frequent type of prescribing error, with up to one DDI error occurring per ten hospital admissions.\textsuperscript{6}

Research has shown that both doctors and pharmacists are often unable to recognise potential DDIs.\textsuperscript{7,8} Recent developments in technology have seen new strategies emerge to assist in DDI identification and prevention. In particular, alerts integrated into electronic medication management systems (eMMS) have frequently been adopted by hospitals in an attempt to minimise DDI occurrence.\textsuperscript{9,10} These alerts ‘pop-up’ during the prescribing process to warn doctors of potentially interacting medication combinations.\textsuperscript{7,11} Few studies have examined the effect of DDI alerts on medication errors, although one study reported a 50% reduction in the mean number of DDI prescribing errors following implementation of an eMMS with alerts.\textsuperscript{12}

Computerised DDI checking programs are also commonly discussed in the literature as a strategy to target DDI errors.\textsuperscript{13,14} Prescribers enter medication names into the computer program, which then checks medication combinations for potential DDIs. The main difference between this strategy and an alert system is that software programs are voluntarily used and so are non-interruptive. Evaluation of DDI checking software usually includes an assessment of its ability to identify DDIs, most often in the form of an analysis of sensitivity and specificity.\textsuperscript{11,15}

Given the complexity of the emerging field of health informatics, the focus is now shifting towards consulting users to develop more effective and efficient systems.\textsuperscript{16} Users’ views are important because users have a unique ability to pick up problems and suggest ideas for improvement that system developers sometimes overlook.\textsuperscript{16} Research has also shown that user involvement in system design can lead to greater system usage and satisfaction.\textsuperscript{17}

The aim of this study was to determine the opinions of both experts and users on strategies available to target DDI. Experts’ ideas about potential DDI strategies in Phase 1 were used in Phase 2 to ascertain what users perceived to be the best strategy to implement in hospital for preventing unwanted DDIs.

This study is unique in its approach to DDIs; most studies only assess user views post-implementation of a specific system.\textsuperscript{7,18} We hope seeking input from users before implementation will allow us to identify user needs and perceived system requirements, and to determine barriers and facilitators to successful uptake of a DDI intervention in hospital.

2. Methods

2.1 Setting
This study was conducted at a 326-bed teaching hospital in metropolitan Sydney. At the time of the study, all wards of the hospital used an electronic medication management system (eMMS: MedChart version 4.2.0) except the emergency department. When MedChart was implemented, a decision was made not to incorporate DDI alerts into the system because it was felt that having a large number of alerts would lead to doctors being over-alerted and so to alerts being ignored.

2.2 Recruitment

2.2.1 Phase 1

Purposive sampling was used to recruit participants for Phase 1. Members of clinical pharmacology or pharmacy with expertise in the area of medication safety were invited to participate in the study via telephone, email or face-to-face. Of the 11 participants contacted, eight agreed to take part in the study. Three were clinical pharmacologists and five were pharmacists.

2.2.2 Phase 2

Convenience sampling was used to recruit participants for Phase 2. Doctors working in a variety of specialities, and of differing levels of seniority were contacted via telephone, email, or face-to-face. Of the 35 participants contacted, 18 agreed to take part in the study (eight junior doctors and ten senior doctors).

2.3 Data Collection

Semi-structured interviews were carried out by a single investigator (OM) for both phases. During Phase 1, participants were asked to identify and discuss potential strategies to prevent DDIs. The responses from Phase 1 were used to shape the focus of the subsequent phase. In Phase 2, prescribers were asked about their confidence in identifying DDIs and about their views of the different strategies identified in Phase 1. Interviews in both phases continued until saturation of themes had been achieved and no new ideas were apparent.

2.4 Data analysis

Interviews were audio recorded and transcribed. Two investigators separately reviewed each of the transcripts to identify key themes. The investigators discussed the themes to ensure consistency in coding. Any discrepancies that emerged were resolved by reaching a consensus. Analysis of the transcripts in both phases was performed with no pre-conceived ideas about emergent themes. The software program, NVivo version 9.0.204.0 was used by the primary investigator to code themes and compare them between senior and junior doctors.

3. Results

3.1 Phase 1

3.1.1 What strategies could be useful in reducing DDIs?

When participants were asked for their opinion on what would be an effective strategy to reduce DDIs in hospital, many experts mentioned an alert system. Despite this, all felt strongly about a
number of problems that could arise following DDI alert implementation. The main concern was that having too many alerts would be disruptive and lead to ‘alert fatigue’. One participant emphasised the importance of ensuring that DDI alerts are “the right ones that really count” (Clinical Pharmacologist 1). Other participants noted the complicated nature of selecting specific DDI alerts to put in place and discussed the legal liability problems associated with this.

Participants also discussed the potential long-term effects of implementing DDI alerts. Experts felt that having an alert system in place might lead to doctors beginning to over-rely on the system to detect DDIs, resulting in fewer doctors remembering DDIs on their own.

“If you have an alert system people rely on the alert system......And they forget that if it doesn’t go “bing” in front of them, then it doesn’t mean that there’s no interaction, it just means that that particular database doesn’t think there’s an interaction” (Pharmacist 8)

Participants in Phase 1 also suggested a second, more novel strategy to target DDIs: that of a reference “look-up” tool integrated into the eMMS. This intervention differs from DDI checking software because it uses the patient’s current medication list available in the eMMS. With only one or two mouse-clicks, a doctor can perform a DDI check of all a patient’s medications. The main benefit of this strategy was said to be the absence of unnecessary alerts annoying prescribers. With this kind of a system in place, prescribers “...would only do [the DDI check] when they were interested enough to actually read the results.” (Clinical Pharmacologist 3).

Nearly all participants spoke briefly about education as a useful strategy to help reduce DDIs in hospitals, suggesting a variety of education settings, such as Grand Rounds, in clinical meetings, or as part of physician training.

3.2 Phase 2

3.2.1 What are prescribers’ thoughts on DDIs and the current prescribing process?

All prescribers described giving some level of thought to DDIs while prescribing, although the extent of this varied considerably. Less than half of those interviewed reported thinking about DDIs every time they wrote a prescription, while the remainder said it was often dependent on the specific drug being prescribed, and the condition of the patient.

No prescriber reported having complete confidence in their ability to recognise dangerous DDIs; less than half described having a moderate level of confidence. One participant said:

“I don’t think anyone can know absolutely every drug-drug interaction, particularly with the fact that more drugs are coming out every day” (Junior Doctor 6)

Most junior doctors reported not being confident in recognising dangerous DDIs.

3.2.1 What are prescribers’ ideas on an effective strategy for preventing DDIs?
All participants agreed that there needed to be some kind of strategy in place to prevent DDIs. When asked for their opinions on the two main ideas from Phase 1 – an alert system or a reference ‘look-up’ tool – the majority of doctors preferred an alert system.

The main advantage of an alert system was reported to be the fact that alerts occurred independently of a conscious decision by a prescriber to check an interaction. One prescriber said about the look-up tool:

“You have to be looking for interactions, so if you're not thinking about it then you probably won't look it up, where at least if there's an alert that prompts you... it's already done the work.” (Junior Doctor 7)

Participants also felt that doctors’ ability to recognise DDIs was compromised when they were busy or time-constrained, so a look-up tool would not be used. This was particularly a problem for junior doctors.

“When you're in a hurry, in an emergency things may not occur to you which the alert system would remind you of” (Junior Doctor 8)

Some participants recognised that with the addition of DDI alerts to the current alerts in their hospital eMMS prescribers may be exposed to too many alerts, to the point where they may begin to ignore and overlook them.

When asked about the features they would like to see in an ideal alert system, most doctors supported a system where DDIs were differentiated according to severity. In this way, clinicians could be alerted only about the more serious and most clinically significant interactions. Some participants thought that overriding DDI alerts should be allowed while other participants felt that some medication combinations should require the approval of a senior doctor, or pharmacist, before prescribing could be continued.

Participants who supported the idea of a look-up tool spoke about its convenience and its potential for learning:

“If you’re actually looking it up yourself, you’re more likely to remember and not rely on the alert system to pop up next time.” (Junior Doctor 7)

When asked whether they had any other ideas about DDI prevention in hospitals, nearly all doctors spoke about continuing and increasing education.

4. Discussion

This study used interviews to explore the perspectives of both drug-safety experts and doctors on effective DDI strategies in a hospital setting. We discovered that doctors did not always consider potential DDIs when prescribing, were not confident about knowing all DDIs and so supported introducing DDI alerts into the current alert set at their site.

When doctors were asked about their confidence in knowing the most dangerous DDIs, no prescriber reported having complete confidence. This finding is not surprising in light of research
that has shown that doctors are unable to classify more than half of all medication combinations that result in a DDI correctly.\textsuperscript{7} We found a difference between junior and senior doctors in terms of reported confidence, with junior doctors feeling far less confident in their ability to detect dangerous DDIs than senior doctors. This finding suggests that a strategy to prevent DDIs would be particularly useful for junior doctors.

The doctors in our sample were very receptive to the idea of introducing DDI alerts. This result was unexpected given that recent research at the study site revealed that alerts currently operational in the eMMS were not seen as helpful in guiding prescribing decisions and were largely ignored by doctors on ward-rounds.\textsuperscript{19} Previous research has also shown that a number of systemic factors consistently hamper the effectiveness of alert systems and of DDI alerts specifically. A recent review described ‘alert fatigue’ as the main problem associated with incorporating DDIs alerts into an eMMS; irrelevant and unnecessary alerts frequently interrupt doctors, causing them to ignore all alerts.\textsuperscript{10} Participants in our study were aware of the potential for alert fatigue following DDI alert introduction but still preferred alerts to the ‘look-up’ tool integrated into the eMMS. This was primarily because the ‘look-up’ tool is reliant on doctors actively searching for information. Doctors believed that the tool would not be used given the busy nature of hospitals and the lack of awareness and knowledge of DDIs among doctors.

A major barrier to the success of similar software programs in healthcare is doctors not using them\textsuperscript{20} and one of the most significant independent predictors of improved clinical outcomes with clinical decision support (CDS) is the automatic provision of decision support, instead of the requirement for doctors to seek out the advice on their own.\textsuperscript{21} If a look-up tool is implemented at the study hospital, there is a real and significant risk that doctors will not consult the source as often as they need to, particularly because doctors are not aware of many potentially harmful medication combinations.\textsuperscript{7,8,22}

In general, participants in Phase 1 were more critical of DDI alerts as a strategy, compared to the users interviewed in Phase 2. This was most likely because as experts, Phase 1 individuals were more aware of the intricacies and difficulties associated with DDI alert implementation. For example, participants in Phase 1 spoke of legal liability issues that might arise following the development of a site-specific DDI alert set but this was not mentioned by users in Phase 2. Although doctors expressed a preference for only being alerted about the more serious and clinically important interactions as a way of reducing the number of alerts experienced, experts in Phase 1 recognized the complexity and difficulty of identifying what constitutes a serious or important DDI. Multiple studies have been conducted in an attempt to generate a small set of contraindicated DDIs for incorporation into alert sets,\textsuperscript{23-25} but no consensus has yet been reached on which are the most critical and important DDIs to include. Further research is needed to amalgamate all this information and develop a conclusive DDI list.

Experts in Phase 1 also expressed a concern that DDI alerts might lead to an over-reliance on the system by prescribers. A consequence of this ‘automation bias’ is that users can miss important clinical errors because the system hasn’t warned them about them.\textsuperscript{26,27} This problem can be minimised by ensuring that users receive regular updates and training about the limitations of the alert system.
4.1. Study limitations

This study had several limitations. It was conducted at a single site so has limited generalizability, however the study’s aim was to determine a suitable site-specific DDI prevention strategy. Only a small number of participants were interviewed and the recruitment mechanism for Phase 2 – convenience sampling – may have resulted in a biased sample, although we ensured doctors from a range of specialties and levels of experience were interviewed.

5. Conclusion

Doctors, particularly junior doctors, were not confident in their ability to identify potential DDIs. This suggests that a strategy which is not reliant on individuals seeking out information for themselves would be most appropriate at this hospital. While a number of problems with the implementation of DDI alerts have been discussed in the literature, doctors in our sample felt that alerts would be the most effective strategy to introduce for preventing DDIs. When incorporating DDI alerts into an alert set, care must be taken to ensure that doctors are not being over-alerted, or becoming too reliant on alerts to identify all potential errors. These harms can be partly mitigated by ensuring that users are aware of the limitations of the system and by continuing to consult users during the implementation process. By involving users in DDI strategy design we expect greater adherence and satisfaction with the strategy implemented at this site.

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7. References

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