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Refereed paper

Are we setting about improving the safety of computerised prescribing in the right way? A workshop report

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ABSTRACT

Background Prescribing errors are common and costly. Technology should enable safer prescribing. The two main current methods of doing so are computer initiated clinical support software (CDSS) and the user initiated information retrieval (IR) systems. However, despite the near universal availability of computerised prescribing support in the UK, errors continue.

Objective To evaluate the experience of UK primary health care professionals using CDSS and to consolidate current technical opinion and literature in this area with the aim of creating useful hypotheses for guiding future academic investigation and industrial development.

Study design The study was a synthesis, drawing together a literature review and views from experts in the field to explore from a qualitative perspective where and how CDSS and IR could be used to improve prescribing safety in primary care. We conducted a literature review, held a workshop to explore issues in practice and had a follow-up expert panel meeting to confirm the findings. The workshop was recorded, transcribed verbatim and analysed thematically.

Participants and setting The study involved primary care practitioners, system developers, information suppliers and academics.

Outcomes Although CDSS is incorporated into primary care electronic patient record systems there does not appear to be an associated marked reduction in prescribing errors. Clinicians are frustrated with current systems, and are concerned these may have a negative impact on patients. There is an unhelpful signal–noise ratio with too many clinically irrelevant alerts and insufficient recognition of the potential downsides of over alerting – possibly making compliance less likely, having a negative impact on the doctor–patient relationship and overloading clinicians. A preferred way forward would be alerts based on quantitative risk assessment of interaction at the level of the preparations being prescribed, rather than theoretical possibilities of interactions between classes of drugs.

Conclusion Prescribing errors remain a major source of unnecessary morbidity and mortality and current systems do not appear to have significantly reduced this problem; nor has the extensive literature about how to reduce unnecessary alerts been taken into account. We need a new and more rational basis for the selection and presentation of alerts that would help, not hinder, the clinician's performance.

Keywords: information technology, prescribing alerts, prescribing errors

Introduction

Medical errors occurring at the hands of clinicians unfortunately come about regularly and are costly in both financial terms and in terms of patients' health.[1] At a fundamental level, practising medicine with incomplete information regarding the patient or relevant to the management of the patient is thought to be a major contributory factor in the aetiology of these errors.[1] A retrospective analysis[2] of clinical records in the UK revealed that 10.8% of patients had experienced an adverse event on medication. Half of these were thought to be preventable by ordinary standards of care. One third of the events resulted in moderate to severe disability or death. In a separate study, 72.6% of iatrogenic adverse drug reactions were found to be due to a fundamental lack of knowledge regarding the drug therapy, the nomenclature, or patient factors affecting the use of the therapy.[3] The aim of prescribing support software or e-prescribing software including CDSS and IR is to facilitate the provision of this information at the point of care for the patient[4] (see Box 1 for definitions of these key terms). There is international evidence that some applications of e-prescribing software have successfully improved patient safety through this mechanism.[5–9] However, despite this optimism the range of areas where benefit has been realised are limited and prescribing safety problems remain a substantial issue.[10]

Primary care in the UK, along with many other countries that run personal registration systems, is almost universally computerised.[11] One of the few areas where computer use saves time is in prescribing.[12,13] Primary care electronic patient record (EPR) systems enable electronic prescribing to be linked to CDSS and IR. The most widespread prescribing support software in UK primary care practices is the prescribing alert system, warning of potential drug interactions and of a previous record of allergy.[14] These systems are included as a standard part of primary care EPR systems. Although rolled out relatively slowly, the most common use of CDSS is to support anticoagulation prescribing in primary care, usually in nurse run clinics.[15]

We carried out this study to evaluate the experience of UK primary healthcare professionals using CDSS and to consolidate current technical opinion and literature in this area, with the aim of creating useful hypotheses to guide future academic investigation and industrial development.

Method

We carried out a literature review to gain an understanding of the key terms, concepts and recent developments in using computers to improve prescribing safety. This included a Medline database search of the terms 'e-prescribing', 'clinical decision support system' and 'information retrieval'. The internet search engine 'Google'[18] was also used to find links to NHS websites on e-prescribing software. We included only findings which might be applicable in primary care.

A workshop was organised by SdeL, RTJ, IS and EC and held on behalf of the Primary Health Care Specialist Group of the British Computer Society as part of the HC2008 healthcare computing conference. Over 30 delegates attended the workshop. The primary aim was to describe current best practice, and to explore the role of and best practice in the use of prescribing support software. The attendants included a range of informaticians, academic clinicians, pharmacists, clinicians with an IT (information technology) interest, human factor/user experience consultants and medical and non-medical commercial IT vendors, as well as members of the National Health Service (NHS) national programme for IT development team.

The workshop was a series of four talks given by academics and industry leaders in the subject, followed by a discussion. The talks given outlined the scale of the safety problem with prescribing and the

Box 1 Key definitions

Prescribing support software/e-prescribing: The utilisation of electronic systems to facilitate and enhance the communication of a prescription, aiding the choice, administration or supply of a medicine through decision support and providing a robust audit trail for the entire medicines use process.[16] This includes IR and CDSS.

Clinical decision support software (CDSS): 'active knowledge systems which use two or more items of patient data to generate case-specific advice.'[16]

Information retrieval (IR): 'Information retrieval is concerned with enabling people to locate useful information in large, relatively unstructured, computer-accessible archives. In this respect, anyone who has ever used a web search engine will have had some practical experience of IR, as the web represents perhaps the largest and most diverse of all computer-accessible archives.'[17]

rationale for the development of IT solutions. Some of the methods for developing software to improve prescribing safety were mentioned, as well as the characteristics that such software should include to make it optimally functional. An anticoagulation clinical decision support programme was used as a worked example. The discussion that followed was semi-structured. The delegates were asked the question 'Are we addressing the right issues to improve prescribing safety?', and consequent ideas and themes were developed during the discussion. SdeL acted as chair to ensure that all delegate views were represented.

The workshop was tape recorded, and transcribed verbatim. Delegates used a hand-held microphone and the panel desk microphones. The transcript was produced by an experienced transcriber and was subsequently checked and annotated. The tapes were listened to for any additional context which might further explain meaning. The transcript data was subsequently analysed and interpreted with the assistance of the computer program NVivo 2.0. The transcribed data was disintegrated into segments and reintegrated into themes in the analysis.

The analysis results and conclusions were subsequently fed back to SdeL, EC, IS, RTJ (who are expert panellists in the CDSS and prescribing alert fields) and discussed. The major themes were developed and a consensus-building process was conducted through communications over the following several months, until conclusions were reached.

Results

Our findings from the literature were that preventable prescribing errors are common and that these often result in patient harm. However, although there may be improved reporting with electronic prescribing there still appears to be an ongoing high rate of avoidable patient harm due to prescribing errors.

End-users (principally general practitioners (GPs)) at the workshop reported that prescribing alerts were more often a source of frustration more than of help. This topic took up most of the discussion. Delegates also reported concerns about the current prescribing support prompts, primarily the low specificity of the pop-ups, which were too numerous, often unhelpful and therefore ignored. Low specificity prompts may frustrate a clinician:

> '.....if in my practice system I have an elderly person who might be on a diuretic, I give them a tiny bit of one half percent steroid cream, my system throws up this warning that says ''Steroids may result in fluid retention'', and it's terribly undermining of confidence with the patient.' (Academic GP)

There was agreement that excessive numbers of low specificity pop-ups result in low utility:

> 'Alerts that pop up all the time that annoy people, which has been alluded to several times. I mean, if an alert comes up once in a while people notice it, if they come up all the time they don't.' (Software developer)

Clinicians want high specificity information that will help them provide the best care in the practical clinical scenario:

> 'I only want to know what's relevant at that point of the process.' (GP)

Clinicians felt that the dual prescribing alert system was unwelcome. The disruption caused by needing to read excessive and non-contextual prompts impinged on the work flow within the consultation. The current practice of having the vendor's prescribing alert systems as well as additional alerts mandated by the National Patient Safety Agency (NPSA) may add to the information overload. This may not be a practical model for continued development.

> 'It's alright when there's one or two or three, on methotrexate we've had some bad events so we've got to do this, then we've had some bad events with this so we've got to do that, and that, and that, and that, and that, and that ... And I'm afraid – and I don't know if there's anybody here from NPSA ... that really the approach is not a hammer to crack a nut I suppose. That'll work for the first one, two, three or four, but it won't work for 200.' (GP)

Alerts may suggest that the clinician has made an error and may provoke patient anxiety, compromising adherence to treatment.

Some clinicians felt that their authority with the patient was undermined by the visual (e.g. the red exclamatory error – see Figure 1) and auditory disruption caused by prescribing alerts. GPs felt that patients might perceive that an alert from the computer system informing the doctor of an error was being ignored. It was thought that this might create unfounded worries for patients and might impact on the adherence of the patient to the medication.

GPs also felt undermined with patients by these systems:

> '....anti-rheumatoid drugs ... And you've got a patient that you're encouraging to take, you know, horrible medicine, ''You really, really want to take them,'' and then you've got this, ''donk'', for methotrexate or, you know, that comes up that you've actually physically got to cancel. My computer goes ''donk'' when it does it' (GP)

Prescribing alerts may also cause worry for patients:

> '...it is unhelpful and creates a false worry. Because my day to day practice is I see an awful lot of false worries and cancel a lot of them very quickly because of the impact on patients.' (GP)

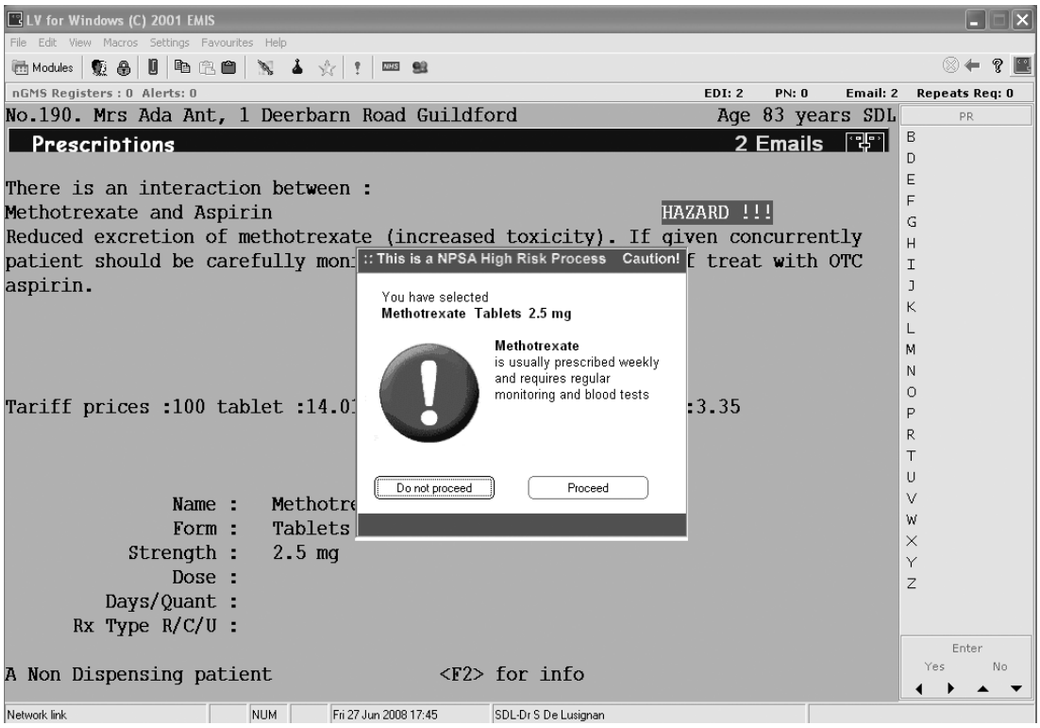

Figure 1 Example of prescribing pop-up alert

> '.....because I do sit there and the patient's sort of doubts ... "You mean it's terribly dangerous, doctor?"' (GP)

Information overload may have a negative impact on cognitive performance. Some workshop participants were concerned that the information overload from low specificity alerts combined with a cumbersome user interface could lead to the clinician being distracted and pressurised. This could compromise his or her cognitive performance and therefore jeopardise the quality of care provided and potentially increase the risk to the patient.

> 'I think if they've got to jump through so many hoops putting their prescription into the system, they're not focusing on the task or they're not focusing on the patient and the medicine they're trying to prescribe for the patient's condition, they're focusing on the screen. And they're trying to think, well do I have to type that in, do I have to pick that drop-down, do I have to move my mouse over there?' (Software developer)

Proposed methods of resolving problems with CDSS

A proposed solution to the problem of low specificity alerts was to make a change in the process that generates the alerts. The use of substantive quantitative methods using hazard and likelihood criteria from adverse drug events would allow an evidence-based calculation of the risk associated with each drug to be made. Current sources of quantitative data on adverse drug reactions include the Medicines and Healthcare Products Regulatory Agency's Yellow Card scheme[19] and the results of data analysis from drug trials. The potential benefit of a prescribing alert to this risk could then be balanced against the potential 'costs' of each alert. The costs include the detrimental effects of information overload on clinical performance, patient anxiety and medication compliance, for which evidence should also be collected.

The NHS should require risk-based assessment of prescribing alerts, so they flag real rather than hypothesised risk:

> 'One of the things the NHS should move towards is risk-based assessment, because obviously you could have something that was highly specific and highly sensitive but actually it going wrong was of no consequence or of such minimal consequence that it wasn't important' (Academic GP)

There was support for the use of quantitative methods to be implemented to perform risk assessments:

> '...industrial strength risk management with lots of quantitative methods' (Informatician)

However, some were more cautious, as there was not as yet any evidence base for this approach. Prescribing software needs to be validated like any other part of clinical care:

> '...like any other part of clinical care that you're doing ... it needs to be validated' (Clinician)

There was an interest in developing the more advanced forms of decision support by increasing the complexity of clinical coding behind the software. Advanced decision support is capable of picking up a broader range of safety hazards and could further improve prescribing safety. The linking of the prescribing support software to the patient's demographic details and diagnostic codes might be needed to substantially improve specificity and sensitivity. Diagnostic coding quality has been much improved as a consequence of the change to a financially incentivised quality based contract and the widespread use of computer links with laboratories. Advanced CDSS applied in this way could also improve specificity or context relevancy of alerts as only advice relevant to the patient would be included. The software would, however, have to be quite intelligent in order to discern which of the many coded clinical factors are relevant at that specific point of the care plan.

> 'An extension of prescribing support to include linkage to key Read codes or SNOMED codes within GP systems to make it more intelligent, because that coding is there and linkage to certain specific recodes would make warning more specific.' (Informatics consultant)

Discussion

Principal findings

There was dissonance between the literature, which reported that prescribing errors were common, and the delegates' irritation with current systems. Some reported positive effects from the use of prescribing support applications, but many reported end users are highly critical of the prescribing alerts used. The conclusion of the workshop was that the current system of prescribing alerts is experienced as problematic by some end users, it is often unhelpful and it disrupts some clinical consultations (Figure 2). However, attendees appeared unaware of the evidence base and the range of approaches used in other health systems for reducing low-yield prompts.

Implications for practice

Despite the shared will for decision support software to progress in order to improve prescribing safety, the implications of these findings are different for clinicians, software developers, academics and accrediting organisations.

General practitioners working in the front lines of medical practice feel they should have more involvement in software development. There needs to be a wider use of technologies which can better describe where difficulties lie and can enable developers, academics and accrediting bodies to gain a clearer understanding

What is known on this topic	What this paper adds
1 Prescribing errors are a major source of unnecessary morbidity and mortality	1 Clinicians still report being frustrated by numerous unnecessary alerts and these are frequently cancelled before being read
2 Prescribing alerts have the potential to improve the quality and safety of clinical practice	2 Prescribing alerts may displace other important information clinicians are processing during a consultation
3 The literature has persistently reported that many alerts are frequently cancelled and ignored	3 The benefit–harm ratio of alerts needs further investigation
4 Methods of identifying prompts which are of low value have been identified, but not widely implemented	4 Quantitative clinical risk assessment could provide a better method of balancing possible degree of harm and its likelihood. This could help select which alerts are most likely to improve quality and safety (greatest benefit) and should be displayed

Figure 2 What this study adds

in order to take corrective measures. Counts of alert override rates may be a pragmatic first step in providing feedback. *In vivo* observation of real consultations is needed, perhaps starting with simple counts of the number of times that the alerts are overridden, possibly followed by use of techniques such as the multichannel video to provide a greater understanding of where these alerts improve safety.[20]

Software designers should continue to work closely with users and modify software to suit the practical requirements of healthcare professionals during the clinical consultation. The 'costs' of the prescribing alerts, including the effect on the clinician's cognitive performance, should be taken into account during the design process.

There is scope to improve communication between software developers and end users. However, this relationship also needs to include knowledge developers and address any liability concerns.[21,22]

Comparisons with literature

The low specificity and low utility of the prescribing alert systems being used in primary care practice is a widely reported and long-standing problem. Payne *et al* reported that 11% of medical prescription resulted in alerts for drug–drug, drug–allergy or other hazards and that clinicians prescribed the medicine and ignored the advice for 88% of even 'critical' drug–drug interaction warnings; though work by Paterno *et al*, suggests tiering of alerts is needed to improve compliance.[23,24] Subsequent reports have shown little difference: clinicians felt that eight out of nine of all prescribing alerts are unhelpful,[25] and a review of 17 reports on prescribing alerts in 2006 found that between 49% to 96% of all prescribing alerts are overridden by clinicians.[26] The same review found multiple reasons for this, including low specificity, low sensitivity, unclear information content, unnecessary workflow disruptions and unsafe and inefficient handling. A recent study has shown that important and serious alerts are being ignored in the wake of unhelpful ones.[24] 'Miller's magical number' is a psychological concept that was first described in the 1950s; the number 7 (+/–2) is hypothesised to be the number of concepts or items that an individual can retain in their short term memory.[27] Miller demonstrated that most people can only retain this number of items and that if you add an additional item something else has to be dropped. There is a risk that an important item of information might be displaced by an unnecessary alert.

Alternative approaches to improving the specificity of prescribing alert systems have included the use of clinician's opinions to analyse the alerts produced in their system. Data on how specific interactions and other medical issues actually harmed patients were synthesised and clinical opinion was used to develop a set of alerts identified as low yield. The alerts were then removed from the system. This process improved the number of 'accepted' alerts to over 67%.[28] Other approaches to improving alert compliance also include the tiered presentation of alerts according to drug–drug interaction severity. In one recent study tiered presentation received a compliance rate of 29%, compared with non-tiered presentation at 10%.[25]

Other safety critical industries have powerful inspectorates who carefully analyse fatal and non-fatal errors. Perhaps the closest medical model is the confidential enquiry into maternal and child health.[29] Inspectorates in the air transport[30] and railway transport industries[31] raised safety standards on the basis of actual errors. In all these industries detailed retrospective analysis is conducted after a critical incident and corrective and preventative measures are introduced. The National Patient Safety Agency has only recently applied this model to prescribing errors made in primary care with methotrexate. Following analysis, a mandatory requirement was made of primary care computer systems to include a specific alert when methotrexate is prescribed.[32]

Adherence or concordance with prescribed therapy is a major issue in health care. Only a minority of patients take their medicine as prescribed. Whilst patients should be fully informed, they may have their confidence unnecessarily undermined by low specificity alerts which may not apply in their individual context. Unnecessary alerts can also distract the doctor and result in the patient feeling unattended to. This perception has been reported to have a negative impact on patient compliance with medication.

Limitations of the method

This research may be subject to bias, even though its findings are unexpected. Participants were conference delegates and inevitably self selected; they also represented only a tiny fraction of practising GPs. The workshop subject selection, the presentations and facilitation were all done by the co-authors, who share a strong interest in informatics. We originally set out to elicit where CDSS might be used most effectively in primary care, and might have prepared differently had we set out to investigate the negative effects of prescribing alerts.

Calls for further research

Further research is needed to see if the problems reported with drug alerts are experienced more widely among GPs, both in the UK and internationally.

This research should include assessing the potential harm of prescribing alert systems, including:
1 measuring the influence of additional prescribing alerts on clinician's behaviour and decision making;
2 recording how prescribing alerts influence patients both at the time of the consultation and later on in terms of treatment compliance.

Research is also needed to enable better evaluation of the effectiveness of the alerts that are presented, and to better designate which alerts are important and which are not, as well as to develop a greater understanding of why known approaches are not being adopted.[33]

Conclusion

Prescribing errors are a major source of unnecessary morbidity and mortality and prescribing alerts have the potential to improve the quality and safety of clinical practice. However, the literature has persistently reported that many alerts are frequently cancelled and ignored. Clinicians are frustrated by what they feel are unnecessary alerts that may displace other important information they may be processing at the time. They also find the alerts disruptive to the consultation and often cancel them before reading them. We conclude that the benefit–harm ratio of alerts needs further investigation. We believe quantitative clinical risk assessment could provide an accurate method of deciding which alerts are most likely to improve quality and safety, i.e. would have the greatest benefit. This would allow the selective presentation of alerts that would help and not hinder the clinician's performance.

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CONFLICTS OF INTEREST

None.

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