Reducing prescribing errors: can a well designed electronic system help?

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ABSTRACT

In this study, the aim was to investigate if an electronic prescribing system designed specifically to reduce errors would lead to fewer errors in prescribing medicines in a secondary care setting.

The electronic system was compared with paper prescription charts on 16 intensive care patients to assess any change in the number of prescribing errors. The overall level of compliance with nationally accepted standards was significantly higher with the electronic system (91.67%) compared to the paper system (46.73%). Electronically generated prescriptions were found to contain significantly fewer deviations (28 in 329 prescriptions, 8.5%) than the written prescriptions (208 in 408 prescriptions, 51%).

BACKGROUND

Electronic prescribing has been identified as a tool to improve patient safety [1, 2]. Findings suggest that it is essential when creating a system to improve safety that the solution involves clinicians during the development and is designed to minimise the risk of human error [2, 3]. An interdisciplinary team that was involved from the beginning of a 3 year period created the system in this study, suggesting and reviewing the design as it evolved into the final implementation.

Intensive care is a high risk setting where patients are in a critical condition and are frequently prescribed multiple medicines, often in complicated combinations. This complexity increases the risk of medication errors [4], which may have catastrophic consequences [5]. The nature of the intensive care environment makes it an ideal test bed for evaluating the extent of error reduction. If successful in such an environment, we could expect that potential for error reduction throughout secondary care and the health care setting.

There has been some evidence of the effects of electronic prescribing in UK hospitals [6-13]. Although in the UK intensive care setting, electronic prescribing is not commonly adopted [14].

A study in a UK intensive care unit (ICU) [13], which compared a commercial electronic prescribing system (referred to as a Computerised Physician Order Entry system CPOE) to hand written prescription charts, found that the overall rate of errors was reduced with electronic prescribing. However, the only three major errors that were identified occurred with the CPOE system. This illustrates the importance of the design of an electronic system supporting prescribing error reduction.

Another UK ICU which implemented electronic prescribing [8] found that, although the electronic system provided 100% legibility and completeness of prescriptions, it increased prescription errors. More broadly, international studies examining the types of errors have found that new errors emerge with the introduction of an electronic

prescribing system [15-18], which could have been caused by the design and interface with the users of such systems.

Electronic prescribing does not necessarily reduce prescribing errors. This paper explores the extent to which a system designed with interdisciplinary involvement throughout can lead to a reduction in prescribing error.

INTRODUCTION

In a collaborative project, a team consisting of a group from the School of Computing, University of Dundee, and clinicians made up of consultants in anaesthesia and intensive care, intensive care fellows, pharmacists and nurses from Ninewells Teaching Hospital & Medical School, Dundee, developed a prototype of an electronic prescribing tool based on practices widely adopted by clinicians in the ICU. The aim of the system was to create an electronic prescribing and administration tool, which actively minimised errors prevalent in the ICU [19] and was also highly usable.

In this study, by identifying errors and their particular nature, we set out to determine whether the use of electronic instead of paper prescribing did actually lead to a reduction in errors.

METHOD

Setting

The electronic prescribing system was introduced into a 10-bed ICU. Paper and electronic prescription charts were run in parallel on the ward over a 5 month period (14th January – 5th June 2008), during which 16 patients were involved.

Study Design

To measure the effect of the electronic prescribing system, errors made in the prescribing process were compared using the two different systems; the electronic prescription and administration system and the paper prescription chart. A retrospective review was conducted where both types of chart were checked against 15 standards for prescription compliance, derived from the Safe and Secure Handling of Medicines Policy [20].

Photocopies of the patient's existing paper prescription chart and a printout of the electronic prescription and medication chart were taken after the electronic system had been used on the patient.

The principal author, who is external to the clinical setting, compared all the prescriptions and identified which met standards and which did not comply. The pharmacist for the clinical area then verified the results. Chi squared tests were used to compare both the prescription error frequencies and the overall levels of compliance between the two systems.

Semi-structured interviews were conducted with a sample of clinicians who used the electronic prescribing system to evaluate the usability of the system. Feedback about the system was also obtained during the evaluation period by observation, informal discussions with the users and through use of a logbook positioned beside the electronic system.

Classification

On confirming the errors the individual prescriptions were assigned a specific error category adapted from Potts et al [21] and Taylor et al [22] shown in Table 1. Some prescriptions were assigned more than one category where appropriate.

RESULTS

The electronic prescribing and administration system was evaluated on 16 different patients over a five month period; 15 paper charts and 16 electronic charts were viewed and assessed. Paper charts were assessed for a sample of the patients (n=10) viewed.

The system was used at one bed for 76% of the time (n=109 days) by 15 doctors, 46 nurses and the critical care pharmacist. During this time 329 prescriptions were created on the electronic prescribing and administration system, which led to the recording of 1916 drug administrations, 147 syringe changes and 68 bolus dose administrations. A higher number of prescriptions were created on the paper prescription charts (n=408) due to prescribers not being trained on the electronic prescribing system. Feedback from the staff during the evaluation period resulted in 14 updates being made to the software.

Table 2 shows the percentage of specific deviations that occurred in the reviewed paper and electronic charts.

The overall level of compliance of the electronic system (91.67%) was significantly higher compared to that of the paper system (46.73%), (P<0.001). Of the individual prescriptions viewed, the electronically generated prescriptions contained significantly fewer deviations (28 in 329 prescriptions, 8.5%) than with the written prescriptions (208 in 408 prescriptions, 51%), (P<0.001).

Further examination of the prescriptions with errors assigned to the error categories defined in Table 1 concluded that on the paper charts 208 prescriptions contained a total of 219 errors (63 omissions, 123 rule violations, 33 incomplete directions) and on the electronic charts, 28 prescriptions contained a total of 27 errors (0 omissions, 17 rule violations, 10 incomplete directions). Rule violations were the most common error category (Figure 1). If a single prescription contained multiple occurrences within an error category (e.g. rule violations) this was recorded only once.

DISCUSSION

The study was designed to investigate the impact of taking an interdisciplinary team approach to designing a system to both reduce identified prescribing errors [19] and fit easily into the clinician's everyday practice. The overall level of compliance was significantly higher with the electronic prescribing system and resulted in a significant reduction in identified prescribing errors.

However, there was a decrease in the level of compliance with infusions created on the electronic system where both the rate and concentration of the medication was not always stated. This was due to a flaw with the design of creating a new infusion prescription and as a result of the population of the drug database used. Evaluating the system in parallel with the paper chart allowed the flaw to be identified without affecting the level of patient care.

Ideally the electronic prescribing system would have access to an online drug dictionary database that is regularly updated and has the facility to be amended. However, as the system was in prototype form, the facility for making changes to the database was not available. This meant that the drug dictionary was not updated throughout the trial. Doctors inputted the required medication by free text if it was not displayed on the system, which was subsequently added to the drug database for future reference. The pharmacist felt that if they had access to the drug database and were able to update it, the level of compliance for the infusion rates and concentration would have been higher as would the level of generic medication prescribing as doctors would be provided with all of the required information to select rather than having to enter free text with the opportunity of omitting important information or entering the brand name.

Running the system in parallel did mean that the clinicians had to record information twice, once on the paper and once on the electronic system. However, this did not seem to cause a problem or give rise to negative perceptions, as the system was viewed as a tool which could contribute to the work of clinicians and improve the effectiveness and efficiency of prescribing within ICU in the longer term.

CONCLUSION

Forming an interdisciplinary team to work on the creation of a system specifically designed to be user friendly and minimise the risk of error has resulted in a favoured system that reduces errors. The results conclude that the reduction in prescribing errors with the electronic system is significant.

Initially identifying the prescribing errors which occurred in the ICU allowed the system to be designed to deliberately reduce these inaccuracies. Involving clinicians from doctor, nursing and pharmacist backgrounds throughout the design and development of the system resulted in a solution that supported the users with their work and did not interfere with it.

Previous studies have shown that inappropriate designs can lead to the introduction of errors or to systems which are not viewed positively by the users. This study confirms the importance of involving clinicians in the design and development of an electronic system to produce a solution that is not only accepted and easily adopted by users but which also reduces the numbers of errors made.

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Table 1 Error Categories

Omissions	Missing route, interval, signature, dosage form, dose, time of administration, date medication is to be started on, discontinuation signature and date where applicable
Incomplete directions	Both infusion rate and concentration of continuous medication not stated, as required medication lacking required directions such as dosing frequency, indication or maximum daily dose
Rule violations	Abbreviations such as prn, bd, 1º The generic name of the medication not used where appropriate Inappropriate dosage units such as trailing zeros (e.g., 1.0mg or 0.1mg) or abbreviations of micrograms (e.g., mcg, µg) Multiple routes

Table 2 Results from the live parallel trial

Standards Required	% Charts		Examples of non compliance
	Paper	Electronic	
Patient details stated	100	100	
Allergies documented	80	100	
Prescriptions signed for by the prescriber	87	100	
Dose stated	80	100	
Each entry must be dated	60	100	No year entered or date missing
Dosage form documented	67	100	No form entered
Infusions –rate and concentration should be stated	67	62.5	Missing rate or concentration
Time of administration indicated	60	100	Once off medication with no time of administration documented
Discontinued medicines procedure followed	27	100	No discontinuation date or signature or both
No abbreviations	20	100	Latin abbreviation “prn” used instead of “as required” “1º” used instead of “hourly”
Legible	27	100	
‘As required’ doses should have a dosing frequency, indication and maximum daily dose stated	13	87.5	Missing required information
State route of administration correctly	13	100	Multiple routes stated or route missing
Appropriate units stated e.g. 250 micrograms	0	81	“mcg” stated instead of “micrograms” “iu” or “u” stated instead of “units”
Where appropriate generic name used for medication	0	44	“Fragmin” stated instead of “dalteparin”, “Augmentin” instead of “co-amoxiclav”

Figure 1 Percent of prescriptions assigned to each error category