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Allergy transcription before and after the implementation of an inpatient electronic prescribing system in a tertiary referral hospital: a case study in two oncology wards

Harriet Launders[1*], Ann Jacklin[2] and Bryony Dean Franklin[3]

Abstract

Background: Patients with allergies can be protected from potentially life threatening harm by recording their allergen and reaction correctly. Electronic prescribing is being widely implemented with a view to improving patient safety; decision support functions can alert prescribers to the risk of prescribing an allergen. However the allergen must be correctly recorded to utilize this functionality. This study aimed to explore whether the introduction of an inpatient electronic prescribing system, in place of paper-based prescribing, has affected the accuracy of transfer of allergen data between hospital documentation systems.

Methods: Retrospective case note review of a random sample of 100 patients admitted to two oncology wards in a UK hospital before implementation of electronic prescribing, and 100 admitted afterwards. We compared accuracy of allergy information transcribed from admission documentation to the inpatient prescribing system and then to the separate electronic discharge summary for paper-based versus electronic inpatient prescribing. We analyzed data separately for patients with no known drug allergy and those with a recorded allergen.

Results: There was no difference between prescribing systems in the transfer of 'no known drug allergy' status from the admission documentation to the inpatient prescribing record. However transfer of 'no known drug allergy' status was better on electronic discharge summaries prepared from the separate electronic inpatient system (transferred correctly for 58 of 72 discharges, 81 %) when compared with paper inpatient prescriptions (26 of 68 patient discharges, 38 %) $p < 0.001$.
For patients with an allergy the correct transfer of allergens from admission documentation to the inpatient prescribing record was lower for the electronic prescribing system (10 of 28 patient admissions, 36 %) when compared with paper prescribing (21 of 32 patient admissions, 66 %) $p = 0.02$. However correct transfer of allergen information from the inpatient prescription to electronic discharge summary was better with electronic prescribing, being transferred correctly in 68 % (19 of 28) patients compared to 38 % (12of 32) with paper prescriptions $p = 0.02$.

Conclusion: Implementing inpatient electronic prescribing does not guarantee a safer system for patients with allergies. The usability of the user interface for allergen recording may be an important selection criterion when purchasing an inpatient electronic prescribing system.

Keywords: Allergy, Electronic prescriptions, Electronic prescribing, United Kingdom

* Correspondence: harriet@launders.net
[1]University Hospital Southampton NHS Foundation Trust, Southampton, UK
Full list of author information is available at the end of the article

Background

Giving someone a medicine to which they are known to have an allergy, sensitivity or intolerance is a potentially avoidable source of harm. Analysis of patient safety incidents reported to the National Reporting and Learning System in England and Wales between 2005 and 2013 identified 18,079 incidents involving drug allergy. These comprised 6 deaths, 19 'severe harms', 4,980 'other harms' and 13,071 'near misses'. The majority involved a drug that was prescribed, dispensed and/or administered to a patient with a previously known allergy to that drug or drug class and can thus be considered preventable [1].

The document 'Building a safer NHS for patients' recommended documenting the severity of any previous adverse drug reaction in order to differentiate between allergies and intolerances [2]. For example, if an intolerance to an antibiotic is recorded as an allergy, a patient may be prescribed antibiotics that are less effective or more toxic, have a broader spectrum, and/or are more expensive than the drug of choice for their condition [3].

Electronic prescribing (EP) can include drug-allergy decision support functionality; in the US, this has been shown to reduce prescribing of drugs to which a patient has a documented allergy [4]. Internationally, drug-allergy decision support is recommended for inclusion in newly implemented EP systems to improve patient safety [5, 6]. In order to trigger an alert at the prescribing stage, the prescribing system needs to have access to the patient's documented allergies in a coded way so they can be matched to the prescribing drug database [7]. This can be difficult to achieve due to the need to avoid classes of drugs rather than just a named allergen for many cases; for example all anti-bacterials with a beta lactam structure may need to be avoided in a patient who has had an allergic reaction to flucloxacillin. In order to be able to match the allergen with a prescribed medicine, EP systems with drug-allergy decision support typically provide an interface to select allergens from drug libraries, often in the form of drop-down lists.

It is not known how the introduction of inpatient EP affects the documentation of allergies during a hospital admission nor the transfer of this information between healthcare organizations after discharge.

Our aim was to assess whether the introduction of an inpatient EP system, in place of paper-based prescribing, affected the accuracy of transfer of allergen recording and thus patient safety. Our objectives were to compare the EP and paper systems in terms of accuracy of transfer of information on drug allergies between the admitting doctor's documentation, the inpatient drug chart or EP system, and the separate electronic discharge summary.

Method

Setting

This study was conducted in an English teaching hospital with 1,044 inpatient beds. A commercially available EP system (JAC Computer Services, Basildon, Essex) with drug allergy clinical decision support functionality had been implemented in 2012 to replace an inpatient paper prescribing system. The user interface for adding allergens was reported locally to be difficult to use. The system required allergy status to be completed before any medication orders could be added. The allergy status could be selected as 'No known drug allergy' (NKDA), or 'Allergy status undetermined', or a specific drug selected from a drop-down list of drugs comprising both individual drugs and drug classes. If a drug or drug class was chosen, details of the reaction experienced were required in a mandatory field, selected from a drop-down menu of five reactions plus an 'Other- see note' option. The EP system required the allergy status of an individual to be reconfirmed by the first prescriber when the patient was readmitted. There was no other validation system for this data. The paper prescription chart used previously had a prominent allergy documentation box on the front cover, prompting the user to record allergies and reactions or "NKDA" rather than leave the box blank.

The EP system was linked to a pre-existing separate electronic discharge summary system in which completion of the allergy field was not mandatory. The allergy information was transferred only when the medicines selected for discharge on the inpatient prescribing system were 'pulled through' to the discharge summary; this could also be by-passed by the user by entering medicines manually on the discharge summary.

Two oncology wards, with a total of 50 inpatients beds, were selected for this study. The medical teams comprised doctors with at least one year's post graduate experience. The implementation of EP on these wards did not coincide with any changes in the medical team. All prescribing users of the EP system completed an online training package, with a mandatory test that included recording of allergies, before their username and password were assigned.

Study design

A retrospective case note review study, with a before-and-after design, was carried out to compare allergy documentation in a random sample of 100 patients admitted to the two oncology wards in the paper inpatient prescribing period (November 2011 to August 2012) and 100 in the EP period (November 2012 to August 2013). This study was considered an audit and was approved locally as such.

Sample size

The sample size calculation was based on having power to detect a difference between the paper and EP systems in accuracy of allergen transcription from the inpatient prescribing system to the discharge summary for patients with one or more allergies. A pilot study showed the prevalence of recorded drug allergy on the oncology wards to be 16 of 49 inpatients across both wards (33 %), as identified using the EP system. We assumed that transcription of drug allergen information from the paper prescription to the discharge summary would be the weakest part of the system, with allergen accurately transcribed in 40 % of cases; and that the correct transcription of drug allergy from the EP system to the electronic discharge summary system would be 85 %. Alpha was set at 5 % and Beta at 20 %. The required sample size for each group was 28 patients. In order to be certain of achieving this number of patients with an allergy for each type of prescribing, 100 patients were sought for each group. Time series data collection was selected to limit possible bias due to clinician variation. Data were therefore collected by month; we studied ten patients each month for ten months of paper prescribing and then again for ten months of EP.

Data collection

Allergy information was collected from admission documentation, the paper or electronic inpatient prescribing system, and the discharge summary. Patients admitted to the two oncology wards were selected at each of ten separate time points, a randomly selected day each month, until two weeks before implementation of the EP system. The ten time points for the EP group started six weeks after EP implementation and were selected to be the corresponding week-days to the randomly selected dates of the paper based group.

At each time point, we randomly selected 20 patients and then included the first ten whose medical records were available for the selected admission. The following documentation was required for each patient: admission documentation, the inpatient prescribing chart (paper or electronic), and a discharge summary (unless they died during the admission). Patients could be included more than once if they had repeat admissions during the study period. Selected patients were excluded if their medical records were not available at the time of the data collection or if any of the required documentation was absent.

The data collected for each patient compared the allergy record on the admitting documentation with the allergy record on the inpatient prescribing system at the time of admission; for each patient these records were classified as the same or different. The allergy information on the discharge summary was then compared with the allergy information on the inpatient prescribing system at the time of discharge and again classified as the same or different. Each patient was classified as having NKDA if no allergies were recorded on any source documentation or as having an allergy if an allergy was reported on any of the source documentation.

The gender and grade of the admitting clinician were recorded, when available to the data collector, in order to assess comparability between EP and paper based prescribing groups.

Analysis

The patients were classified as having either NKDA or allergies in order to carry out statistical comparison separately for transfer of NKDA and allergen information between inpatient systems.

Statistical analysis was undertaken using IBM SPSS statistics software version 21.0. An independent samples t-test was used to make comparisons between normally distributed variables (age of patient, duration of hospital stay). Chi-square tests were used to compare categorical variables (gender of patient and admitting clinician, qualification of admitting clinician, allergy status and whether or not the patient died during the admission). Odds ratios were calculated where appropriate.

The hypotheses tested were: (1) there was no difference between the EP and paper systems in the accuracy of transcription of allergen data from the admission documentation to the inpatient prescribing system and (2) there was no difference between the EP and paper systems in the accuracy of transcription of allergen data from the inpatient prescribing system to the discharge summary.

Results

Characteristics of the study population

There were 100 patients in each of the paper prescribing and EP groups. Characteristics of each group were very similar with no statistically significant differences identified (Table 1). Sixty eight percent of patients in the paper prescribing group had NKDA; the corresponding figure was 72 % in the EP group ($p = 0.716$).

Accuracy of data transfer for patients with NKDA

The NKDA information on the admission documentation was the same as that on the inpatient prescribing system for 50 of 68 (74 %) patients in the paper prescribing group and 57 of 72 (79 %) in the EP group ($p = 0.43$). The omission of allergy status from both the admission documentation and the electronic prescribing record occurred in two patients with paper prescribing. For one patient in the EP group no allergy status was recorded on the admission documentation and 'Allergy status undetermined' was selected on the EP system.

Table 1 Summary of characteristics of subjects in each group ($N = 200$ patients in total)

Characteristic	Paper prescribing $n = 100$ patients (%)	Electronic Prescribing $n = 100$ patients (%)	p Value
Age of patient (years)			0.085 (t-test)
Mean ± Standard Deviation (SD)	59.0 ± 15.11	62.54 ± 13.75	
Median	61.0	64.5	
Range	26 to 89	24 to 85	
Duration of Hospital Stay (days)			0.488 (t-test)
Mean ± SD	6.9 ± 6.65	7.7 ± 9.39	
Median	5.0	5.0	
Range	0 to 42	0 to 62	
Gender of patient			1.00 (Chi-squared)
Male	64 (64)	64 (64)	
Female	36 (36)	36 (36)	
Allergy status			0.716 (Chi-squared)
Reported allergy	32 (32)	28 (28)	
No known drug allergy	68 (68)	72 (72)	
Subject died during admission			0.552 (Chi-squared)
Yes	5 (5)	7 (7)	
No	95 (95)	93 (93)	
Errors in transcription of allergy from admission documentation to inpatient system			(Chi-squared)
Incomplete entries ($N = 200$ patients)	4 of 100 (4 %)	9 of 100 (9 %)	0.152
Illegible (handwritten only) or incorrect entries (wrong drug selected) ($N = 200$ patients)	7 of 100 (7 %)	5 of 100 (5 %)	0.616
Profession/Grade of admitting clinician			0.676 (Chi-squared)
Nurse	1 (1)	1(1)	
Junior doctor, note all qualified more than one year.	79 (79)	74 (74)	
Registrar	24 (24)	20 (20)	
Not recorded in medical notes	0 (0)	1 (1)	
Gender of admitting clinician			0.517 (Chi-squared)
Male	51 (51)	43 (43)	
Female	46 (46)	53 (53)	
Not known to data collector	3 (3)	4 (4)	

The discrepancies in allergy status records for the sixteen paper prescribing patients and fourteen EP patients were due to no allergy record being made on the admission documentation but 'NKDA' being recorded on the inpatient prescribing record (twelve in each of the paper prescribing and EP groups) and 'NKDA' being recorded on the admission documentation but allergy status not being specified on the inpatient prescribing record (two in the paper prescribing group and one in the EP group). One patient in the EP group had 'NKDA' on the admission notes and 'Other Reaction: Other adverse reaction see note' in the EP system. This referred to a note left on a previous admission referring to gastro-oesophageal reflux with red wine and rosemary; this information was not immediately available to prescribers. The final discrepancy in allergy status records were two patients in the paper prescribing group who had non-drug allergies recorded on their admission notes and inpatient prescriptions, relating to cats and mushrooms, but no reference was made to allergies to medicines.

The transfer of NKDA information from the inpatient prescribing system to the discharge summary was more reliable in the EP group; we identified correct transfer for 58 of 72 of EP patients (81 %) compared to 26 of 68 patients (38 %) in the paper prescribing group ($p = <0.001$; odds ratio 6.69).

Accuracy of data transfer for patients with a reported allergy

The allergen information on the admission documentation matched that on the inpatient prescribing system for 21 of 32 (66 %) patients in the paper prescribing group but only 10 of 28 (36 %) of the EP group ($p = 0.02$). We identified five patients in each of the EP and paper prescribing groups who had a documented allergy on their prescribing records but nothing recorded in the admission notes. The remaining mismatches were where patients had allergies recorded on their admission documentation that were not transferred to their inpatient prescription. Prescribers recorded allergens on paper inpatient prescriptions more completely; this may be due to the users finding it difficult to find the relevant allergen from the drop down menu of the EP system.

The transfer of allergen information from the inpatient prescription chart to the discharge summary was more reliable in the EP group; we identified correct transfer in 19 of 28 of the EP cases (68 %) compared with correct transfer of allergen for 12 of 32 cases (38 %) in the paper prescribing group ($p = 0.02$; odds ratio 3.52).

Discussion

Key findings

The recording of allergy status on the inpatient prescribing record for patients with NKDA showed little improvement with EP when compared with paper prescriptions.

The standard of allergy recording for the paper prescriptions was higher than expected; Cantrill and Cottrell reported allergy documentation was present for 31 % ($n = 510$) of inpatient paper prescriptions in a one-day audit in a British hospital in 1997 [8]. The higher standard for paper prescriptions may be because recording allergy status of patients has been high on the safety agenda for NHS patients in England and Wales for over a decade [2], therefore the standard of practice was already relatively high for a paper system.

The transfer of allergy information to other healthcare providers is also important in maintaining patient safety [9, 10]. The link between the EP system and the discharge summary led to an improvement in NKDA documentation on discharge summaries: from 38 % with paper prescriptions to 81 % in EP patients, $p < 0.001$. This would be expected to rise to 100 % in organizations where the inpatient EP system is also used to provide the discharge summary without requiring any transcription or data transfer.

Patients with a reported allergy were studied separately and transfer of this information from the admission documentation to the inpatient prescribing system was significantly worse in EP, being correctly transferred in 36 % of patients, compared with 66 % of patients with paper inpatient prescribing. The data transfer relating to allergen and severity of reaction seemed to be worse in the EP group due to the limited number of reactions to allergens on the locally produced drop down list. As a result of this study the list of allergic reactions is to be increased locally. The transfer to the discharge summary of drug names to which a patient had an allergy was improved with EP when compared with paper prescribing.

Comparison with previous literature

Our work supports previous reports describing the challenges associated with allergen input into EP systems [11].

Implications for future research

We would recommend this work be replicated in other organizations and other EP systems, perhaps using a prospective method of patient selection focusing on those known to have allergies. The findings should be made available to suppliers of EP systems to aid in the development of safer systems. Purchasers of EP systems should assess the usability not just the specification of the software when comparing products.

This study has shown that the recording of NKDA was done relatively well and therefore the next study of the local system will be done prospectively identifying patients with a drug allergy at the time of admission and following them through when allergy is transcribed to the inpatient and discharge documentation systems. The study will be done after software upgrade and extension of the allergic reaction drop-down list.

Strengths and limitations

Strengths of this study include the time series method of data collection, minimizing possible influences on the clinician in relation to allergy documentation including their training, experience and familiarity with the EP system.

Limitations include the retrospective methodology which meant authenticity of documented allergies could not be confirmed with the patients themselves. This study was carried out on two wards in one teaching hospital before and shortly after implementation of a commercially available EP system. Therefore the generalizability of our findings may be limited. A further study is required to investigate the causes of inadequate allergen recording on the EP system and how this can be addressed, which may include changing the user interface to facilitate adding specific allergens and reactions to the patient's electronic record.

Conclusion

Implementing inpatient electronic prescribing does not guarantee a safer system for patients with allergies. The

usability of the interface for allergen recording may be an important selection criterion in relation to patient safety when selecting an inpatient electronic prescribing system.

Abbreviations
EP: Electronic prescribing; NKDA: No known drug allergy.

Competing interests
The authors declare that they have no competing interests.

Authors' contributions
HL carried out the data collection and analysis and drafted the manuscript. BDF and AJ participated in the design of the study, drafting and revising the manuscript. All authors read and approved the final manuscript.

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Author details
[1]University Hospital Southampton NHS Foundation Trust, Southampton, UK. [2]Department of Infectious Diseases, Imperial College London, London, UK. [3]Imperial College Healthcare NHS Trust and UCL School of Pharmacy, London, UK.

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