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RESEARCH ARTICLE

Satisfaction predictors and attitudes towards electronic prescribing systems in three UK hospitals

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Abstract *Objective* Measuring satisfaction of technology users, along with satisfaction determinants, is important to enhance system utilisation and identify potential problems. The aim of this study was to investigate pharmacists' and doctors' attitudes towards e-prescribing systems, and assess the predictors of their satisfaction. *Method* A cross-sectional survey was conducted, with 67 pharmacists and 335 doctors in three English hospitals completing a pre-piloted, postal questionnaire. *Results* The majority of pharmacists and doctors agreed that their e-prescribing system improved the efficiency of prescribing, and reduced dosage regimen errors. However, the majority did not believe that the system created more time for near-patient clinical activities, or sped up patient discharge. More pharmacists than doctors believed that the system improved the quality of patient care. Doctors were more likely to perceive that the e-prescribing system reduced formulation and omission errors. Doctors and pharmacists from the same hospital had similar opinions about the strengths and weaknesses of the e-prescribing system. Nine variables (out of 29 potential independent variables), seven of which were related to e-prescribing system efficiency, were significant predictors of user satisfaction. *Conclusion* Overall, respondents were satisfied with the systems; however, pharmacists were generally more satisfied than doctors. The number of satisfaction predictors related to the feelings about e-prescribing system efficiency was larger than those predictors related to the quality of patient care. *Implications for practice* These findings contribute to better understanding of how pharmacists and doctors perceive e-prescribing systems, and also have implications for system development, training, and how an e-prescribing system can be most effectively 'marketed' to different user groups.

Keywords Attitude · CPOE · Doctor · E-prescribing system · Pharmacist · Physician · Satisfaction · United Kingdom

Impact of findings on practice

- E-prescribing system developers need to work closely with pharmacists and doctors, in order to enhance the efficiency attributes of the system.
- E-prescribing systems can be improved by improving system's response time, increasing the number of computer terminals, introducing mobile technology and explicit clinical decision support.
- E-prescribing system developers must be sensitive to users' suggestions and to the workflow change e-prescribing brings, in order for the implementation of the system not to fail.

Introduction

Electronic prescribing (e-prescribing) systems have heralded many potential benefits for healthcare professionals and patients. Examples are: improving legibility of and

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accessibility to medication orders from any computer terminal [1], enhancing the use of formulary and cost-effective medications [2], providing in situ clinical decision support and clinical guidelines to the prescriber [3, 4], and decreasing total hospital stay and charges [5]. These advantages have helped improve staff efficiency and decrease medication errors and adverse drug events in secondary care [6].

Despite this growing evidence, there has been a slow adoption of e-prescribing by both health organisations and healthcare professionals; this has been attributed to several factors, such as complexity of electronic system structuring and implementation, high cost, and user satisfaction issues [7–9].

Implementation of a system by hospitals does not necessarily mean its acceptance or adoption by different groups of healthcare professionals. Measuring satisfaction of technology users along with satisfaction determinants is important to identify potential problems [10] and enhance system utilisation. In addition, investigating users' attitudes towards e-prescribing systems could prove valuable, as clinical software systems could cause new types of errors when prescribers have difficulty adopting them [11]. Only seven full papers [10, 12–17] and four conference abstracts [18–21], from the United States of America (US), have described healthcare professionals' views about hospital e-prescribing systems. None of these surveys has investigated and contrasted views of doctors and pharmacists (among different hospitals).

Aim

The aim of this study was to identify pharmacists' and doctors' attitudes towards and predictors of user satisfaction with e-prescribing systems at three hospitals in the north-west of England. Comparison was made between doctors and pharmacist, and between junior and senior staff.

Methods

Settings and subjects

The three study hospitals are described in Appendices 1 and 2. The time since system implementation was different in the hospitals, which provided the opportunity to investigate any differences in users' attitudes that could be related to the age of the e-prescribing system. All doctors and pharmacists who had access to the e-prescribing systems on all wards, where they were operational, were included in the study (The accident and emergency, palliative care, maternity, neonatal services and anaesthesiology departments were excluded because an e-prescribing system was not implemented in these settings in all hospitals). This included all doctors and pharmacists currently using, not using (but with previous experience of using e-prescribing systems), or choosing not to use the e-prescribing systems. Senior pharmacists were those with grade bands 8b, 8c, 8d or 9, and holding a managerial position. Junior pharmacists were those who did not fulfil these conditions. Senior doctors were the consultants and specialty-training doctors. Junior doctors were the foundation-years 1 and 2. Around one-third of pharmacists in Hospital A were relatively new to the e-prescribing system as they were newly employed by the hospital. The authors identified the doctors from the hospital's Medical Staffing roster, and pharmacists from the Pharmacy Department.

Questionnaire

The authors utilised and modified a previously developed questionnaire [16] relevant to this study. In addition, strengths and weakness associated with the use of e-prescribing were extracted from the literature [12, 22–24].

Two versions of the questionnaire (available upon request) were created to reflect the difference in doctors' and pharmacists' clinical roles. The questionnaires included 30 and 31 questions with seven-point Likert scales (with '7' Strongly Agree and '1' Strongly Disagree), measuring domains of the e-prescribing systems for doctors and pharmacists, respectively (Appendix 3). Both questionnaires collected demographic information and asked participants to describe the top perceived advantages and disadvantages of the systems. Prior experience with personal computers was measured on a seven-point scale, with '7' being an excellent user and '1' being a non-user.

Both questionnaires were pre-piloted on 22 pharmacists and doctors, to help ensure questionnaires' face and content validity and relevance to UK health settings in general, and to the e-prescribing systems at study settings in particular. The subsequent piloting stage helped test the practicalities of sending and completing questionnaires, which were sent to randomly selected 10% ($n = 40$, 36 doctors and 6 pharmacists) of the potential population in Hospital A (where the authors had the chance to follow-up with some potential respondents to increase the response rate). Data from all respondents ($n = 15$) in the piloting stage were included in the study.

In the second week of November 2008, about 4 months after hospital rota changes of junior doctors, postal questionnaires were distributed to Hospitals A and B; a reminder was sent 5 weeks later. Given the recent introduction of e-prescribing in Hospital C, questionnaires were sent in December 2008, when users would have 3 months

of experience with their e-prescribing system; reminders were sent in mid-January 2009 to avoid the Christmas and New Year holidays.

Data analysis

Data were analysed using SPSS® v.15.0 (SPSS Inc., Chicago Ill.). For the Likert-scaled items, differences in ratings of the possible effects of e-prescribing systems between doctors and pharmacists were assessed by Mann–Whitney–U test, Kruskal–Wallis test, or chi-square linear-by-linear association test. To facilitate presentation of results, responses of scale numbers 1, 2, and 3 were combined into 'disagree' category, and those of 5, 6, and 7 into 'agree' category.

Independent variables were selected a priori (shown in Table 6), and tested using multivariate logistic regression, as to whether they significantly predicted the "overall satisfaction with e-prescribing system", converted into a binary variable (6,7 into 'satisfied' and 1,2,3,4,5 into 'dissatisfied'). Only doctors' data were assessed for potential predictors as the sample size was large enough to run logistic regression.

Responses to open-ended questions were listed and categorised based on the frequency of occurrence. Cronbach's alpha was used to assess the internal consistency of questionnaires; a high alpha (0.7 and higher) assumed that all scale items measured the same construct. The study was deemed service evaluation by a local research ethics committee and therefore did not require formal approval.

Results

Response rate and internal consistency

From 1812 questionnaires sent to potential participants, 617 were returned; 127 individuals were uncontactable and 88 questionnaires were unsuitable for data analysis. Therefore, 402 questionnaires (response rate: 44.3%) were used for analysis (Table 1). There was no statistically significant difference between junior and senior doctors or pharmacists in relation to respondents' ratio for Hospitals A, B or C. The Cronbach's alpha ranged from 0.78 to 0.9, indicating that the items were measuring the same construct.

Comparisons among study hospitals

Comparison among doctors

The key findings are shown in Table 2**.** The majority of doctors in all hospitals agreed that the e-prescribing system reduced dose and formulation errors and most agreed that the system improved the quality of patient care. Generally, the majority were satisfied with their e-prescribing systems.

However, doctors in Hospital C had significant negative attitudes towards the items related to time, such as e-prescribing system's increasing their efficiency, sparing time for near-patient clinical activities, and speeding up discharge.

Table 1 Respondent rates to the first and second mailings

Hospital	Grade	First mail						Second mail					% Overall response rate
		Resp	UC	US	Population	UC and US	% Response rate	Resp	UC	US	UC and US	% Response rate	
A	Junior doc	28	29	0	107	29	35.9	12	0	0	0	24.0	51.3
	Senior doc	57	20	36	316	56	21.9	45	3	6	9	23.2	40.6
	Pharmacists	18	0	0	39	0	46.2	9	4	0	4	52.9	77.1
	Total	103	49	36	462	85	27.3	66	7	6	13	25.3	46.4
B	Junior doc	13	11	0	66	11	23.6	8	0	0	0	19.0	38.2
	Senior doc	75	39	13	287	52	31.9	33	3	2	5	21.3	47.0
	Pharmacists	20	0	0	52	0	38.5	10	0	0	0	31.3	57.7
	Total	108	50	13	405	63	31.6	51	3	2	5	22.3	47.2
C	Junior doc	22	3	0	99	3	22.9	8	0	9	9	12.3	34.5
	Senior doc	23	12	9	117	21	24.0	11	3	11	14	18.6	41.5
	Pharmacists	6	0	0	40	0	15.0	4	0	2	2	12.5	26.3
	Total	51	15	9	256	24	22.0	23	3	22	25	14.7	35.7
Grand total		262	114	58	1123	172	27.5	140	13	30	43	21.7	44.3

UC uncontactable, *US* unsuitable, *Resp* respondents

Table 2 Frequency of doctors in all hospitals agreeing to examples of attitudinal items

Item number in questionnaire	Item	Agree, *n* (%) Hospital A	Agree, *n* (%) Hospital B	Agree, *n* (%) Hospital C
2	Has negative impact	8 (5.6)	13 (10.1)	7 (11.0)
3	Reduces dose errors	88 (62.0)	105 (81.4)	46 (71.9)
4	Reduces form errors	93 (67.3)	94 (72.9)	46 (71.9)
5	Reduces omission errors	53 (38.7)	35 (27.2)	24 (38.1)
7	Gives information	75 (60.0)	85 (65.9)	47 (73.5)
9	Slow response time	31 (24.8)	19 (14.8)	29 (46.0)
17	Confusing user interface	34 (27.4)	23 (18.6)	31 (48.4)
20	Complex prescribing	80 (62.1)	64 (49.7)	26 (41.9)
22	Improves communication	93 (71.5)	81 (62.8)	61 (95.3)
21	Access PC	63 (48.9)	27 (21.6)	42 (65.7)
23	Pharmacy Staff	78 (56.0)	47 (36.5)	32 (50.0)
24	I am satisfied	90 (67.7)	77 (59.7)	33 (51.6)
1	Increases efficiency*	99 (69.7)	84 (65.1)	30 (47.0)
13	Downtime slows*	56 (46.7)	71 (55.0)	32 (51.6)
14	More time near-patient*	47 (38.8)	44 (34.2)	5 (7.9)
18	Speeds up discharge*	68 (53.9)	82 (63.6)	12 (18.7)
19	Discharge easy*	64 (52.9)	94 (75.8)	17 (26.6)

* Test applied was χ^2 linear-by-linear association; $P < 0.05$

Comparison among pharmacists

The majority of pharmacists believed that the e-prescribing system increased the efficiency of prescribing, was easy to use, improved the quality of patient care, and had a good response time with a clear user-interface. However, only a minority agreed that the system decreased omission errors, allowed more time for near-patient clinical activities or sped up discharge. In general, the majority were satisfied with their e-prescribing systems.

Pharmacists in Hospital A reported significant differences from other hospitals in their belief that the e-prescribing system was not able to reduce dose or formulation errors or provide medicines-related information (Table 3).

Comparison between doctors and pharmacists

The majority of doctors and pharmacists agreed that the e-prescribing system improved the efficiency of prescribing, and reduced dosage regimen errors. However, the majority of both disagreed that the system spared more time for near-patient clinical activities, or sped up discharge.

Table 3 Frequency of pharmacists in all hospitals agreeing to examples of attitudinal items

Item number in questionnaire	Item	Agree, *n* (%) Hospital A	Agree, *n* (%) Hospital B	Agree, *n* (%) Hospital C
1	Increases efficiency	19 (70.3)	18 (60.0)	7 (70.0)
2	Has negative impact	0 (0.0)	1 (3.3)	0 (0.0)
5	Reduces omission errors	4 (14.8)	0 (0.0)	5 (50.0)
6	Easy to use	21 (77.8)	22 (73.3)	6 (60.0)
9	Slow response time	1 (3.8)	4 (14.4)	3 (30.0)
17	Confusing user interface	6 (22.2)	6 (20.0)	2 (20.0)
14	More time near-patient	6 (23.1)	11 (37.9)	1 (10.0)
18	Speeds up discharge	8 (29.6)	14 (46.7)	2 (20.0)
20	Complex prescribing	15 (60.0)	7 (24.1)	5 (50.0)
23	Reduces medicines supply time	4 (15.3)	15 (50.0)	1 (14.3)
25	I am satisfied	23 (85.1)	26 (86.7)	7 (70.0)
3	Reduces dose errors*	12 (44.4)	25 (83.3)	8 (80.0)
4	Reduces form errors*	5 (18.5)	27 (90.0)	7 (70.0)
7	Gives information*	7 (29.2)	24 (82.7)	9 (90.0)

* Test applied was χ^2 linear-by-linear association; $P < 0.05$

Almost all pharmacists (62/67, 92.5%), compared to 39.5% (131/332) of doctors, reported that they used the system at least 1–2 times per day (χ^2 65.7, df = 1, $P < 0.001$). Higher proportions of pharmacists than doctors believed that the e-prescribing system improved the quality of patient care. Doctors were more likely to perceive that the system reduced formulation and omission errors. In contrast, pharmacists were more likely to indicate that the system was easy to use or learn. Generally, a higher proportion of pharmacists were satisfied with the e-prescribing system (Table 4).

Comparing junior and senior doctors

Junior and senior doctors' data from each hospital were separately analysed to detect differences within the same hospital. Findings from Hospitals A and C were similar. Junior doctors reported that they used the e-prescribing system more frequently than senior doctors. More junior than senior doctors reported excellent experience with computers. A higher percentage of junior than senior doctors agreed that the system improved the efficiency of prescribing, improved the quality of patient care and was easy to use. Junior doctors were more satisfied than senior doctors (Hospital A: $\chi^2 = 8.9$, df = 1, $P = 0.003$; Hospital C: MW–U test 278.0, $z = -3.2$, $P = 0.002$). However, although junior doctors in Hospital B reported that they used the e-prescribing system more frequently than senior doctors, junior doctors were less satisfied than senior doctors.

Open-ended questions

Direct accessibility to and legibility of prescriptions, and the availability of pre-defined orders were the features liked most by respondents (Table 5). However, the least liked features were: lack of computer terminals, and long time taken and inflexibility to enter orders (Table 6).

Predictors of overall satisfaction for doctors

Table 7 shows the predictive power of attitudinal items towards overall satisfaction of doctors. The significant predictors were: 'e-prescribing system increasing efficiency'; 'e-prescribing system having negative impact on patient care'; 'e-prescribing system giving enough information'; 'e-prescribing system's slow response time'; 'system downtime slows prescribing'; 'system providing more time for near-patient activities'; 'e-prescribing system speeding up discharge'; 'pharmacy making prescribing safer and not the e-prescribing system'; and 'decision support is useful.

Discussion

This was the first study to investigate and compare doctors and pharmacists attitudes towards hospital e-prescribing systems. Pharmacists and doctors showed different attitudes towards the system. Overall, pharmacists and doctors were satisfied with their e-prescribing systems; however, pharmacists were generally more satisfied than doctors.

Table 4 Frequency of pharmacists and doctors in all hospitals agreeing to examples of attitudinal items

Item number in questionnaire[a]	Item	Agree, *n* (%) Pharmacists	Agree, *n* (%) Doctors
1 (1)	Increases efficiency	44 (65.7)	213 (63.6)
3 (3)	Reduces dose errors	45 (67.2)	239 (71.3)
14 (14)	More time near-patient	18 (27.3)	96 (30.7)
17 (17)	Confusing user Interface	14 (20.9)	88 (28.2)
18 (18)	Speeds up discharge	24 (35.8)	162 (50.8)
20 (20)	Complex prescribing	27 (42.2)	170 (53.1)
2 (2)	Has negative impact[c]	1 (1.5)	28 (8.4)
4 (4)	Reduces form errors[b]	39 (58.2)	233 (70.4)
5 (5)	Reduces omission errors[b]	9 (13.4)	112 (34.0)
6 (6)	Easy to use[c]	49 (73.1)	174 (55.1)
8 (8)	Improves quality[c]	55 (82.1)	195 (58.2)
12 (12)	Avoid Using system[c]	1 (1.5)	67 (21.6)
16 (16)	Easy to learn[c]	57 (85.1)	230 (73.5)
21 (21)	Access PC[b]	39 (58.2)	132 (41.5)
24 (24)	I am satisfied[c]	56 (83.6)	200 (61.3)

[a] Item number shown is that in the doctor's questionnaire ($N = 24$ items), whereas the item number in the pharmacist's questionnaire ($N = 25$ items) is shown between brackets

[b] Test applied was Mann–Whitney U test

[c] Test applied was χ^2 linear-by-linear association; $P < 0.05$

Table 5 Most common responses to the open-ended question: 'Name two things you like most about the electronic prescribing system.' by doctors and pharmacists

Hospital	Doctors				Pharmacists			
	No.	Answers to 'Like most about e-prescribing system'[a]	N	%	No.	Answers to 'Like most about e-prescribing system'[a]	N	%
A[b]	1	Accessibility to patients' orders from remote location other than specific ward	15	23.1	1	Ability to amend orders from outside the ward/accessibility	10	30.3
	2	Availability of past drug history	12	18.5				
	3	Ability to prescribe orders without being on the ward	5	7.7				
	4	Pre-defined (default) orders, if unsure of dose	5	7.7	2	Orders easily changed	9	27.3
	5	Documents can be printed if lost	5	7.7				
B[c]	1	Legibility of orders.	15	30.6	1	Legibility	18	30.0
	2	Pre-set orders/Drug doses are already worked out	7	14.3	2	Accessibility of prescriptions at all times on a computer	11	18.3
	3	Ability to prescribe off-ward	5	10.2	3	Pre-defined orders	7	11.7
	4	Improved accuracy of prescribing dose and frequency	5	10.2				
C[d]	1	Legibility	12	22.2	1	Legibility	5	29.4
	2	Pre-set orders	8	14.8				
	3	Easy to use	5	9.3				
	4	Quicker than handwriting	5	9.3				

[a] The clearest comment among all similar comments was categorised. Only categories with ≥ 5 responses are shown

[b] Responses from 41 doctors and 26 pharmacists

[c] Responses from 32 doctors and 30 pharmacists

[d] Responses from 29 doctors and 9 pharmacists

The number of satisfaction predictors related to the feelings about system efficiency was larger than those predictors related to the quality of patient care.

Study limitations

The overall response rate of 44.3% might indicate response bias; the most positive- or negative-thinking users were more likely to return their questionnaires, thus the results might not be representative of all users in the hospitals. Statistical data showed no significant differences between junior and senior doctors or pharmacists, which decreased the likelihood of bias related to respondents' grade. The use of three English teaching hospitals from the same geographical location may also limit the generalisability of the findings. Also, the survey investigated respondents' perceptions that may be totally different from their behaviour in practice [15].

The statistical analysis drew on the measurement of 'overall user satisfaction' using a single item; a multiple-item questionnaire might provide a more reliable measure of satisfaction. For the purpose of keeping the questionnaire short and easy, however, the authors used a single-item measurement of the overall satisfaction, as recommended by some researchers [25, 26].

Pharmacists' and doctors' attitudes

Comparisons among doctors or pharmacists across the hospitals, and between doctors and pharmacists produced three key findings. First, the majority of doctors and pharmacists generally were satisfied with their e-prescribing systems; however, pharmacists were more satisfied than doctors. Although the systems had been in place for different periods, the overall satisfaction for both respondent types among the hospitals was above the mid-point (>4 on a seven-point scale). Although there are reports in the literature about user resistance to the implementation of e-prescribing systems [27, 28], the users in this study generally appeared to have accepted their systems.

Several reasons might explain why pharmacists were more satisfied with the e-prescribing system than doctors. Doctors were dissatisfied with most of the system's attributes related to patient care improvement and work efficiency; a finding consistent with the literature [12, 14, 15]. Doctors' level of chronic stress and time constraints may have contributed to the overall tendency to convey relatively negative attitudes towards the system. In addition, pharmacists reported that they used the system more frequently than doctors, which might have helped them realise the benefits of this technology more than doctors [29]. It is

Table 6 Most common responses to the open-ended question: 'Name two things you dislike most about the electronic prescribing system' by doctors and pharmacists

Hospital	Doctors				Pharmacists			
	No.	Answers to 'dislike most about e-prescribing system'[a]	*N*	%	No.	Answers to 'dislike most about e-prescribing system' ¥	*N*	%
A[b]	1	Not enough computers.	6	9.5	1	Lack of access to PCs.	9	23.1
	2	Long time taken to enter medicines.	5	7.9	2	Chance to choose wrong formulation.	8	20.5
B[c]	1	Very basic-old fashioned (1980 interface).	13	13.1	1	Massive amount of paper generated.	6	10.7
	2	Not good for complex prescribing.	11	11.1				
	3	Many drugs are not on PCIS and require typing in.	7	7.1	2	Not windows-based/Old-fashioned.	5	8.9
	4	Time-consuming compared to paper prescribing.	7	7.1				
	5	Reduces flexibility.	6	6.1				
C[d]	1	More time-consuming to prescribe than paper prescribing.	15	22.1	1	Spending much less time seeing patients and much more time in front of a computer screen making sure the documentation's clear.	5	29.4
	2	Very few computers available.	8	11.8				
	3	Finding certain drugs is difficult.	7	10.3				
	4	Inflexible in what can be ordered.	7	10.3				

[a] The clearest comment among all similar comments was categorised. Only categories with ≥ 5 responses are shown

[b] Responses from 47 doctors and 26 pharmacists

[c] Responses from 50 doctors and 28 pharmacists

[d] Responses from 30 doctors and 9 pharmacists

also expected that the system improves legibility, which decreases telephone calls seeking clarification, might have enhanced pharmacists' satisfaction.

Second, system attributes the majority of doctors and pharmacists were dissatisfied with centred on: (1) decreasing time on near-patient clinical activities, (2) lack of computer terminals, and (3) concerns about its ability to decrease omission errors. Decreasing time spent with patients could be attributed to increased time required to enter medication orders (or complex prescribing scenarios) into the system. In addition, due to the lack of bedside technology, the majority of interaction with the system took place at fixed terminals, meaning that healthcare professionals reviewed patients at the bedside and then had to go to the computer to update the electronic record. Demands on time were also created by system response time, system's 'old-fashioned' interface (especially in Hospital B), and number of available terminals. The same has been reported in other studies [12, 16, 30, 31]. Regarding omission of prescriptions, the systems are only as good as the data inputted; therefore, it is expected that staff felt that the e-prescribing system did not reduce omission errors.

Third, doctors in Hospital C tended to have negative attitudes towards the items related to work efficiency, where satisfaction scores reflected the experience of doctors who were still beginners in learning and using the e-prescribing system. Interestingly, this was also true for the pharmacists in Hospital A; around a third of them were relatively new to the hospital's e-prescribing system during the study. It has been reported that, with time, users may develop positive attitudes towards the system [10, 13]. Moreover, a study [32] reporting on doctors' readiness to adopt e-prescribing systems claimed that people move through a 'continuum of motivational readiness'. Doctors in Hospital C, and pharmacists in Hospital A, could be considered as being at the 'naïve' end of this continuum.

Most and least liked e-prescribing system attributes

Two key findings emerged when respondents were asked about the most and least liked e-prescribing system features. First, doctors and pharmacists in the same hospital showed similar opinions. Second, between the hospitals, answers were different in nature and priority. This differs from two other studies [12, 16], which have shown that doctors found different e-prescribing system features more attractive than, for example, nurses.

As doctors and pharmacists often have responsibilities for patients on many wards at the same time, and are required to write and review medication orders, both of them valued legibility and accessibility that helped them

Table 7 Multivariate logistic regression for predictors of doctors' satisfaction ($N = 321$)

Item number in questionnaire	Item	*P* value	OR	95% CI for OR	
				Lower	Upper
Which specific aspects do drive overall satisfaction?					
1	Increases efficiency	**0.04**	**1.3**	**1.1**	**3.7**
2	Has negative impact[a]	**0.002**	**0.3**	**0.1**	**0.6**
3	Reduces dose errors	0.5	3.2	1.6	8.4
4	Reduces form errors	0.5	1.4	0.6	3.1
5	Reduces omission errors	0.4	2.1	0.8	4.8
6	Easy to use	0.3	2.1	0.7	6.4
7	Gives information	**0.008**	**2.3**	**1.2**	**4.2**
9	Slow response time[a]	**0.002**	**0.4**	**0.2**	**0.7**
13	Downtime slows[a]	**<0.001**	**0.3**	**0.1**	**0.5**
14	More time near-patient	**0.01**	**3.8**	**1.4**	**8.4**
15	Improves legibility	0.8	0.2	0.6	1.5
16	Easy to learn	0.3	0.5	0.2	1.7
17	Confusing user Interface[a]	0.7	0.9	0.5	1.5
18	Speeds up discharge	**0.001**	**5.5**	**2.0**	**7.6**
19	Discharge easy	0.5	1.3	0.6	2.6
20	Complex prescribing[a]	0.3	2.2	0.7	5.5
21	Access PC[a]	0.3	0.8	0.6	1.2
22	Improves communication	0.3	1.6	0.7	3.7
23	Pharmacy staff[a]	**0.004**	**0.4**	**0.2**	**0.6**
25	Pre-defined orders	0.7	1.3	0.4	4.4
26	Decision support	**<0.001**	**0.03**	**0.05**	**0.2**
27	Access to orders	0.1	2.0	0.9	4.6
28	Display past orders	0.1	2.5	0.7	8.15
29	Display current orders	0.2	0.3	0.1	1.6
30	Audit trail	0.4	2.6	1.3	4.5
What type of person is happy with the e-prescribing system?					
33	Medical speciality	0.3	0.8	0.4	1.3
34	Junior doctor	0.8	1.1	0.6	1.7
35	How often e-prescribing usage	0.2	0.4	0.09	1.7
36	Experience with PC	0.1	1.2	0.9	1.5

Satisfaction ratings from 1 to 5 indicate dissatisfaction, whereas 6 and 7 indicate satisfaction

-2 Log Likelihood $= -91.196$

[a] Negative statement about electronic prescribing system

OR odds ratio. Significant predictors are highlighted in *bold*

enter orders at a single location. Most of the attributes written by respondents have been reported in the literature [10, 12, 14, 17].

Predictors of satisfaction with the e-prescribing systems

Almost all the statistically significant predictors were related to work productivity or efficiency, as opposed to attributes related to quality of patient care. There were no predictors related to doctor's grade, speciality, frequency of system use or prior computer experience; findings consistent with the literature [10, 12, 16, 17].

Sviokla [33] differentiated between 'efficiency technology', which enhances current ways of performing ongoing tasks [12], and 'transformational technology', which changes the nature of the work. E-prescribing is a transformational technology. Instead of speeding up the prescribing process, the system changes the way, for

example, doctors make decisions about prescribing by providing pre-defined medication orders and other related information. Therefore, doctors and pharmacists are required to adapt to the new transformational technology and 'behave differently' [28].

Although users' satisfaction with the e-prescribing system was primarily predicted by efficiency attributes, this does not mean that users did not embrace the ability of the system to improve patient care. Efficiency attributes of the system might be more conspicuous to users than patient care attributes. For example, if system's response time was slow, the user would realise this immediately and directly link this delay to the e-prescribing system. However, the transformational attributes, such as offering pre-defined orders, occur more subtly [10, 12, 14, 16]. Thus, the overall picture may suggest that users valued the 'instant' efficiency factors in day-to-day practice, whereas they cared about patient care on a long-term basis.

Junior versus senior doctors' attitudes

The finding that junior doctors were more satisfied than senior doctors (except in Hospital B) was congruous with the literature [15, 16, 29], where the overall attitude score declined progressively from junior to senior doctors. Junior doctors reported that they used the e-prescribing system more frequently than senior doctors; therefore, it is expected that junior doctors realised benefits of the system more than senior doctors. It has been reported [15] that doctors' positive opinions of using new technology decreases as they become more experienced; doctors become more set in their ways and more constrained by time, leading to less frequent usage of, for instance, the e-prescribing system.

Although junior doctors used the e-prescribing system more frequently than senior doctors in Hospital B, surprisingly they expressed less favourable opinions; however, this finding was consistent with one study [34] which reported that exposure to computer systems during training may not result in broad acceptance in clinical practice.

Implications for e-prescribing system development and future research

E-prescribing system developers must be sensitive to users' suggestions and to the workflow change e-prescribing brings, so implementation of the system does not falter [28]. System developers must understand how doctors and pharmacists 'work' so that "e-prescribing systems can be woven into current prescribing processes" [14]. Decreasing the number of screens displayed when entering a medication order, increasing the number of available terminals (with mobile technology in place), and arming the system with clinical decision support would enhance user satisfaction, as evidenced by this work. In addition, pharmacist and doctors appeared to appreciate the same e-prescribing system's attributes, including those related to work efficiency. This would better lend credence to the transformational values of the e-prescribing system [14, 17].

In future research, longitudinal attitudes research is required to investigate whether users differ in their attitudes towards the e-prescribing system at different levels of experience, especially with a newly implemented e-prescribing system, such as Hospital C in this study. Investigators should assess the measures of satisfaction in greater detail. Broader and larger samples should also be surveyed which include all types of users, such as nurses and pharmacy technicians.

Conclusion

In this study, the majority of doctors and pharmacists generally were satisfied with their e-prescribing systems; however, pharmacists were more satisfied than doctors. Pharmacists and doctors were concerned about the e-prescribing system's decreasing time on near-patient clinical activities, lack of computers, and the ability of the system to decrease omission errors. Almost all the statistically significant variables that predicted users' satisfaction with e-prescribing system were related to work efficiency.

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Conflicts of interest None.

Appendix 1

See Table 8.

Table 8 Description of e-prescribing system at three hospitals in the north-west of England

	Hospital A	Hospital B	Hospital C
Trust type	Foundation trust, teaching trust	Foundation trust, teaching trust	Foundation trust, teaching trust
Composition of trust	One hospital	Four hospitals: inpatient services at two	One hospital
FCE (2007/2008)	105,759	117,154	80,664
Outpatient consultations (2007/2008)	294,843	315,239	301,408
Clinical services	General medical, surgical, maternity and accident and emergency services to the local adult population only.	General medical, surgical, maternity and accident and emergency services to the local population.	General medical, surgical, maternity and accident and emergency services to the local population.
Specialist clinical services	Renal, intestinal failure and neurosciences	–	Respiratory medicine, cardiology, cardiothoracic surgery, and Burns and plastics
Main system(s)	EPR: iSOFT® clinical manager	EPR: TDS7000 (PCIS®)	JAC®, clinical information system
Supplier	iSOFT	Eclipsys	JAC
Functionality	Patient demographics, ordering (referral, pathology, medication) without "active" clinical decision support, results reporting, immediate discharge summaries, clinical documentation, medicines administration recording.	Patient administration, ordering with limited clinical support, and results reporting, inpatient prescribing, discharge summaries, prescribing support, medicines administration, some clinical documentation	Discharge summaries, allergy status, drug interaction support
Interfaces	Primarily: pathology, radiology, PAS, Medisec.	All laboratory/clinical investigations	Lorenzo (patient administration System), pharmacy JAC system
Access	Static, networked terminals throughout trust, wireless access. Some local PCT access (including GP).	Static, networked terminals throughout trust. Limited number of mobile workstations. Some local GP access	Static, networked terminals throughout trust. Plan for wireless access by 2009
Age of EPR in 2008	Approx. 9 years	Approx. 18 years	New. Started in September 2008

E-prescribing electronic prescribing, *EPR* electronic patient record, *FCE* finished consultant episode, *MDIS* McDonnell information systems drug management system, *Medisec* medical secretaries' letters, *PAS* patient administration system

Appendix 2

See Table 9.

Table 9 Description of how pharmacists and doctors used the e-prescribing systems in the three study hospitals

Hospital A	Hospital B	Hospital C
Hospital A was a 904-bed teaching hospital, which cared for an average of 320,000 people a year in the north-west of England. Prescribers generated more than 100,000 electronic discharge medication orders per year. There were more than 400 doctors and 35 pharmacists working in the hospital. A comprehensive pharmaceutical service was provided by the Pharmacy Department between 9:00 am and 5:00 pm on weekdays.	Hospital B was a 900-bed teaching hospital, which provided acute healthcare services to around 400,000 in the north-west of England. There were more than 400 doctors and 45 pharmacists working in the hospital. A comprehensive pharmaceutical service was provided by the Pharmacy Department between 9:00 am and 9:00 pm on weekdays. Out of hours, the pharmacy service was provided by a team of resident pharmacists.	Hospital C was a 900-bed teaching hospital, which cared for an average of 442,000 people a year in the north-west of England. There were more than 350 doctors and 40 pharmacists working in the hospital. A comprehensive pharmaceutical service was provided by the Pharmacy Department between 9:00 am and 5:00 pm on weekdays.

Table 9 continued

Hospital A	Hospital B	Hospital C
An EPR system was installed in the hospital in 2000. Until very recently (March 2008), it had enabled e-prescribing for patients at the time of discharge only. The immediate discharge summary, prepared using an e-prescribing system (Isoft Clinical Manager™), included many sections that could be electronically completed; one of them was the list of medicines that the patient was taking at the time of discharge. The prescriber (approximately 90% of medication orders were prescribed by doctors in this hospital, mostly done by the junior doctors) selected the required medication from the system's drug catalogue. The drug catalogue came in a medicines 'look-up' list providing suggested default dosage regimens and formulations for most medications, which appeared upon typing the first letters of a medication's approved name. Free-text could be entered by the prescriber if the medication or one of its characteristics did not exist in the look-up list. At the time of the study, no further explicit clinical decision support was enabled in the system. Any doctor or pharmacist discontinuing a medication order had to select (from a pull-down menu) or type in (as free-text) a reason for discontinuation. Only one reason could be entered into the field for each discontinued medication order	An EPR system was installed in the hospital in 1992. This includes an electronic prescribing module that was used to generate in-patient and discharge prescriptions for the majority of patients across the Trust. Prescribers selected the required medication from the system's drug catalogue. The drug catalogue contained prescribing screens that provided suggested default dosage regimens and formulations for most medications. Free-text could be entered by the prescriber if the medication or one of its characteristics did not exist in the drug catalogue. The system utilised some forms of clinical decision support. This took the form of indication based prescribing for certain medications and a comprehensive paediatric prescribing pathways. Discharge prescriptions were created mainly by identifying those drugs on the in-patient list that needed to be continued after discharge.	An electronic discharge prescribing system (JAC) was installed in the hospital between October and December 2008 as part of an immediate discharge summary. Many sections about a patient admission are completed electronically including the list of medicines that the patient was taking at the time of discharge. The prescriber selected the required medication from the system's drug catalogue provided by First Data Bank. The drug catalogue came in a medicines 'look-up' list providing suggested default dosage regimens, but not formulations, for most medications, which appeared upon typing the first letters of a medication's approved name. At the time of the study, clinical decision support was limited to serious drug- drug interactions and warnings about prescribing antibiotics to a patient who was allergic to them. Any doctor or pharmacist discontinuing a medication order had to select (from a pull-down menu) a reason for discontinuation. Only one reason could be entered into the field for each discontinued medication order
Once the discharge medication order was completed, a copy was printed out to be clinically checked by the pharmacists who were usually allocated to one directorate. Each weekday, the pharmacists routinely checked the discharge medication orders electronically prescribed by doctors, and compared them with the inpatient paper-based drug chart to ensure that all orders were clear, legal, complete and clinically appropriate. Weekend prescriptions were checked by the dispensary pharmacist working on Saturdays and Sundays, supported by a home-based pharmacist on-call service. If any discrepancy, ambiguity, or error existed in the discharge electronic order, the pharmacist might call the prescriber, discuss the matter, and correct it (or let the prescriber correct it) accordingly. Alternatively, if the pharmacist covered the ward on which the patient is located, and had a complete picture about the patient's condition, she or he might change the prescription independently without consulting the prescriber	Once the discharge medication order was completed, a copy was printed out at ward level to be clinically checked by the pharmacists who were usually allocated to one directorate. Each weekday, the pharmacists routinely checked the discharge medication orders electronically prescribed by doctors, and compared them with the inpatient electronic prescription to ensure that all orders were clear, legal, complete and clinically appropriate. Weekend prescriptions were checked by the dispensary pharmacist working on Saturdays and Sundays, supported by a resident pharmacist on-call service. If any discrepancy, ambiguity, or error existed in the discharge electronic order, the pharmacist might call the prescriber, discuss the matter, and correct it (or let the prescriber correct it) accordingly	Once the discharge medication order was completed, a copy was printed out to be clinically checked by the pharmacists who were usually allocated to one directorate. Each weekday, the pharmacists routinely checked the discharge medication orders electronically prescribed by doctors, and compared them with the inpatient paper-based drug chart to ensure that all orders were clear, legal, complete and clinically appropriate. Weekend prescriptions were checked by the dispensary pharmacist working on Saturdays and Sundays, supported by a home-based pharmacist on-call service. If any discrepancy, ambiguity, or error existed in the discharge electronic order, the pharmacist might call the prescriber, discuss the matter, and correct it (or let the prescriber correct it) accordingly. Alternatively, if the pharmacist covered the ward on which the patient is located, and had a complete picture about the patient's condition, she or he might change the prescription independently without consulting the prescriber
All users of the system were required to go on 1-week training before they could log into and use the system	All users of the system were required to go on 1 day's training before they could log into and use the system	All users of the system were required to have a 1 h training session before they could log into and use the system

Appendix 3

See Table 10.

Table 10 Measures of satisfaction in the questionnaire for doctors and pharmacits

Item number[a]	Questionnaire's item[b]
6 (6)	The electronic prescribing system is *easy to use*
16 (16)	It is *easy to learn* how to use the electronic prescribing system
7 (7)	The electronic prescribing system gives me the *information* I need to write accurate medication orders (e.g., standard drug doses, patient's current drugs)
20 (20)	The system's functionality is *not* flexible in handling *complex prescribing requests* (e.g., prednisolone reducing dose over several weeks)
9 (9)	The system's *response time (speed)* for electronic prescribing is slow
13 (13)	The electronic prescribing system *downtime (breakdowns)* slows me down
21 (21)	*Access to available computers* is a problem when I need to write medication orders
17 (17)	The electronic prescribing system's *user interface* (screen design, layout) is confusing
23	It's the *pharmacy staff* who make my prescribing safer, not the electronic prescribing system
10 (10)	When I have a prescribing-related problem with the electronic prescribing system, I just *ask someone for help*
1 (1)	Generally, the electronic prescribing system improves the *efficiency* of prescribing medication orders
11 (11)	I feel that I could benefit from *refresher training courses* on the electronic prescribing system
12 (12)	I try to *avoid using* the electronic prescribing system
14 (14)	The electronic prescribing system allows me to spend more time on *near-patient clinical activities* (e.g., diagnosis, monitoring treatment response, speaking to patients)
22 (22)	The electronic prescribing system improves *the communication of medicines-related information between hospital staff*
24 (25)	Overall, *I am satisfied* with the electronic prescribing system
(23)	The electronic prescribing system reduces the *time taken to supply medicines* to patients
(24)	The electronic prescribing system helps *streamline pharmacists' work* in terms of clinically checking medication orders
3 (3)	The electronic prescribing system reduces *errors of dosage regimen (wrong dose and frequency)* when entering medication orders
4 (4)	The electronic prescribing system reduces *errors of formulations (wrong drug dosage form)* when entering medication orders
5 (5)	The electronic prescribing system reduces *errors of omission* (e.g., omitted drugs)
15 (15)	The electronic prescribing system improves the *legibility* of medication orders
2 (2)	The electronic prescribing system has a *negative impact on patient care*
8 (8)	The electronic prescribing system *improves the quality of patient care*
18 (18)	The electronic prescribing system *speeds up the patient discharge*
19 (19)	The electronic prescribing system helps make *the discharge process easy for me*

[a] Item number shown is that in the doctor's questionnaire ($N = 24$ items), whereas the item number in the pharmacist's questionnaire ($N = 25$ items) is shown between brackets

[b] The italic words in each item helped draw the respondent's attention towards specific information needed in the questionnaire

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