A literature review of the training offered to qualified prescribers to use electronic prescribing systems

Brown, Clare L.; Reygate, Katie; Slee, Ann; Coleman, Jamie; Pontefract, Sarah; Bates, David W; Husband, Anthony; Watson, Neil; Slight, Sarah

DOI:
10.1111/ijpp.12296

A literature review of the training offered to qualified prescribers to use electronic prescribing systems: Why is it so important?

Clare Brown[1,2], Katie Reygate[3], Ann Slee[4,5], Jamie J. Coleman[5], Sarah K. Thomas[5], David W. Bates[6,7,8], Andrew K. Husband[1], Neil Watson[2], Sarah P. Slight[1,2,6]

Author affiliations:

1. Division of Pharmacy, School of Medicine, Pharmacy and Health, Durham University, Stockton on Tees, Durham, U.K.;
2. Newcastle upon Tyne hospitals NHS Foundation Trust, Queen Victoria Road, Newcastle upon Tyne, Tyne and Wear, U.K.;
3. Health Education KSS Pharmacy, Downsmere Building, Princess Royal Hospital, West Sussex, U.K.;
4. eHealth Research Group, Centre for population health sciences, University of Edinburgh, Edinburgh, U.K.;
5. College of Medical and Dental Sciences, University of Birmingham, Edgbaston, Birmingham, U.K.;
6. The Center for Patient Safety Research and Practice, Division of General Internal Medicine, Brigham and Women's Hospital, Boston, MA, USA;
7. Harvard Medical School, 250 Longwood Ave, Boston, MA, USA;
8. Harvard School of Public Health, 677 Huntington Avenue, Boston, MA, USA.

Correspondence to:

Dr. Sarah P. Slight MPharm, Ph.D, PGDip

School of Medicine, Pharmacy and Health,

Holliday Building,

Queen's Campus,

Stockton on Tees,

TS17 6BH

Tel: +44 191 334 0548

Fax: +44 191 334 0374

email: s.p.slight@durham.ac.uk

Keywords: Education; Educational Measurement; Teaching; Electronic Prescribing; Medical

Word Count: 3507

Abstract

Objectives: A key element of the implementation and on-going use of an electronic prescribing (ePrescribing) system is ensuring that users are, and remain, sufficiently trained to use the system. Studies have suggested that insufficient training is associated with suboptimal use. However, it is not clear from these studies how clinicians are trained to use ePrescribing systems or the effectiveness of different approaches. We sought to describe the various approaches used to train qualified prescribers on ePrescribing systems and to identify whether users were educated about the pitfalls and challenges of using these systems.

Methods: We performed a literature review, using a systematic approach across three large databases: Cumulative Index Nursing and Allied Health Literature (CINAHL), Embase and Medline were searched for relevant English language articles. Articles that explored the training of qualified prescribers on ePrescribing systems in a hospital setting were included.

Key Findings: Our search of 'all training' approaches returned 1,155 publications, of which seven were included. A separate search of 'online' training found three relevant publications. Training methods in the 'all training' category included clinical scenarios, demonstrations and assessments. Regarding 'online' training approaches; a team at the University of Victoria in Canada developed a portal containing simulated versions of electronic health records, where individuals could prescribe for fictitious patients. Educating prescribers about the challenges and pitfalls of electronic systems was rarely discussed.

Conclusions: A number of methods are used to train prescribers; however the lack of papers retrieved suggests a need for additional studies to inform training methods.

INTRODUCTION

Electronic Prescribing (ePrescribing) systems have been associated with a range of potential benefits over paper-based systems, particularly when implemented with clinical decision support (CDS).(1-4) Benefits, including improved patient outcomes, safer patient care and potential cost savings from improved formulary management, by prompting clinicians to prescribe generic rather than branded medications,(5) has meant that the number of ePrescribing systems (home grown and commercial), implemented across a diverse range of settings is growing. The

implementation of these systems in United Kingdom (U.K.) hospitals has surged and is expected to continue increasing partly due, to the financial incentives offered such as the National Health Service's (NHS) Integrated Digital Care Fund, the Safer Hospitals Safer Wards Fund and the recent government recommendations to encourage increased productivity.(6-8) Similar increases in the use of healthcare technology have also been seen in the United States, where the use of computerized provider order entry (CPOE) systems has more than tripled since 2010.(9) This has been largely driven by The Health Information Technology for Economic and Clinical Health (HITECH) Act, which offered financial incentives to organisations that could demonstrate 'meaningful use' of Electronic Health Records (EHRs).(10) Australian government incentives, have also been associated with increased uptake of computerised prescribing in primary care.(11)

A key element of the implementation and on-going use of an ePrescribing system is ensuring that users are, and remain, sufficiently trained and competent to use the system effectively. The user training should be comprehensive enough to cover all aspects of how a user may need to interact with a system to undertake their role, but also highlight potential pitfalls and challenges that they may encounter. Organisations can learn from those who have experienced the implementation process about what 'went well' and 'not so well'. Ash et al. stressed the importance of educating clinicians about the unintended consequences of ePrescribing systems, so that clinicians do not fall into the trap of over reliance on technology, and risk patient harm.(12) The number of different professionals (e.g. nurse or pharmacists) who can prescribe is also expanding, thus the training provided needs to accommodate users' varying backgrounds and roles. These systems are continuously evolving and offer an ever increasing range of new features thus it is important to not only consider

introductory training but also the approaches used to inform existing staff about system changes. Training is not sufficient to overcome poor design, but vendors should be incentivised to develop systems using user-centred design principles.

Organisations face challenges in delivering effective training including: large numbers of staff; staff resistance/availability to attend training; rotation between wards and specialties; and temporary/short term staff. Little evidence has been published on the training strategies used to familiarise staff with these systems, many of which change following implementation through local customisation and system upgrades. Online training strategies have been utilised in medical education and can offer a potentially convenient and efficient way of training large numbers of practitioners;(13) however, the effectiveness of this approach for users of ePrescribing systems is not clear.

Some studies suggest that insufficient training is associated with suboptimal use of a system.(14, 15) Baysari et al. found that large numbers of CDS alerts were generated by the improper use of the system, leading to the production of 'technically preventable' alerts.(14) Additionally, high override rates of CDS alerts have been reported.(16) Her et al. found that almost 1 in 5 non-formulary medication alerts were inappropriately overridden, thus reducing the potential for cost savings.(5) Shulman et al. also found that the rate of errors made when using an ePrescribing system, decreased over time, demonstrating a learning curve that had taken place.(17) Such studies highlight the pitfalls of these systems and the importance of training and education both in facilitating successful implementation of electronic systems and averting errors. Furthermore, although there are fundamental differences between the provision of healthcare services between clinical settings and countries, there are key

elements of the prescribing process that all prescribers must perform, such as the selection of a drug dose and frequency.

We conducted a literature review to describe the approaches used to train qualified prescribers on ePrescribing systems in a hospital setting. We were also interested in knowing whether online training approaches were used and whether training covered the pitfalls and challenges of using these systems.

METHODS

Inclusion and Exclusion Criteria

Articles that explored the training of qualified prescribers (including medical and non-medical practitioners) on ePrescribing systems in a hospital setting were included. We chose to focus on the training of qualified and practicing prescribers due to the specific challenges associated with training large groups of busy clinicians, which can be different to the challenges faced with training undergraduate students in a more 'relaxed' environment. We were interested in the types of training approaches used, the relative effectiveness of any specific approach (if discussed), and any challenges encountered. Studies that explored training of undergraduate medical students, training of clinical skills other than prescribing, or the use of ePrescribing or EHRs in medical education (e.g., to enable students to monitor patient progress) were excluded (Appendix 1 and 2). Studies did not need to include a comparator group, as this may have presented practical and ethical challenges to carrying out the study in a hospital population.

Search Strategy and Study Selection

Three large databases were searched including: Cumulative Index Nursing and Allied Health Literature (CINAHL), Embase (OVID), and Medline (OVID). The search terms used are listed in Table 1. Sets of search terms employed included "Electronic Prescribing" OR "Computerized Provider Order Entry" in Set 1; and "Clinical Decision Support" OR "Decision Support System" in Set 2; and "Electronic Medical Record" in Set 3; and "Education Clinical" OR "Medical Education" in Set 4; and "Education Distance" in Set 5; and "Prescribing" in Set 6 (Table 1). These sets were combined and our full search strategy for one database can be accessed in appendix 3. The search was performed on the 15th May 2015. Only papers published in English were considered. A separate search, which included 'electronic prescribing' and 'online training', was also conducted. We did not restrict the timeframe for these searches. In addition, we searched the websites of vendors of electronic prescribing systems supplied in the U.K for suggested training approaches. We included all publication types (including editorials and opinion pieces).

Data Extraction and Synthesis

All duplicate articles were removed. Titles and abstracts were initially reviewed followed by the full text by one author (CLB) and any queries were discussed with a further reviewer (SPS), if necessary. Reference lists were also examined for additional papers. Data were abstracted onto a customised data extraction sheet by one author (CLB), which included variables such as: title of the study; country of origin; decision to include and justification for the choice. A narrative synthesis of all eligible studies was undertaken. Papers were read and re-

read, and key recurring themes and sub-themes were identified iteratively from the data. In keeping with the aim of this review, we focused on the types of training approaches used to train qualified prescribers in the hospital setting and the challenges associated with training.

RESULTS

The search for 'all training' returned a total of 1,155 publications; after reviewing titles, abstracts and full texts, a total of 1,149 were excluded (Figure 1). After reviewing the reference lists of the remaining publications, one further article was included. A total of seven articles were included, comprising of three full text publications from the US,(18-20) and two from Canada.(20, 21) The remaining two articles were conference abstracts, one from the UK (22) and one from Pakistan/Tanzania.(23) Further detail about the range of study types can be obtained in Appendices 1 and 2. The authors of the conference abstracts were contacted and asked for additional information, including (i) the type of training delivered and whether online training methods were used (if unclear from the publication), (ii) whether a competence assessment was used, and (iii) whether the training was developed internally or by the vendor. We obtained responses from all authors apart from one.(23) We decided to include the two studies by Borycki et al. and Kushniruk et al., as there was potential for these training methods to be used for practicing prescribers.(20, 21)

The separate search for the use of 'online' training methods returned 25 publications. After reviewing the titles, abstracts and full text, three relevant articles were identified (Figure 2), two of which were previously identified and included in

the search of "all training" approaches. The additional article found in this separate 'online' search(24) was included making eight publications in total.

Traditional training approaches

Typically, a variety of training methods were used such as classroom-based sessions, which included 'run through' demonstrations and practical exercises, as well as face-to-face or ward-based training facilitated by 'super-users' (expert staff members that have received additional training). Super-users were found to play a valuable role in providing ward-level support and reduce the need for costly external training.(25) Tools such as e-learning packages, quick reference guides, for example a list for keyboard short cuts and 'how to' guides, were also provided.(18, 22) Three studies used traditional classroom-based learning to train users; one on a paediatric intensive care unit,(22) another across an integrated delivery system(18), and a third study conducted at two United States (U.S.) hospitals.(25) Users were given an overview of the specific features of their system, using a combination of demonstrations, lectures and practical exercises, thus allowing the users to gain 'hands-on' experience of using the system.(18, 22) In particular Bredfeldt et al. encouraged staff to customise their own live version of the EHR by, for example, creating preference lists, thus allowing users to experience the benefits of this functionality immediately.(18) Ensuring clinicians have ample opportunities to attend training was important, so weekend and out-of-hour sessions were organised in one study.(25)

In terms of user evaluation, formal assessments, quizzes and feedback methods were utilized in three studies.(18, 22, 23) Bredfeldt et al. evaluated post-

training performance of two skills (covered during the training session) to measure the effect of training.(18) Classroom-based training and 'hands-on' activities were found to have been associated with improved utility of certain functions.(18) However, users would have appreciated more opportunities to receive training on the 'live' system and felt that the range of topics covered should be broader.(18) Bredfeldt et al. also sent e-mails to users to report their usage of specific features and compared their activity with that of their peers, serving to remind users of the learning material and track their progress.(18)

Online training approaches

Web-based demonstrations were used in only one study.(23) Three papers describe the work of one team, which have developed an online portal, which housed a range of simulated versions of different EHRs containing electronic prescribing functionality. Healthcare professional students, practicing professionals and healthcare informaticians were given access to this portal where they could prescribe for fictitious patients in a safe environment.(20, 21, 24) The portal also provided an opportunity for users to learn about the design of different systems that influence clinical practice.(20, 21, 24)

Evaluation of online training methods was limited. Experiences and lessons learned from the University of Victoria's EHR portal appeared to be positive, with users perceiving the experience as valuable and having a greater understanding of how EHR systems were to be used in practice.(20) Ayoub et al. did not specify how quizzes were developed or which areas were assessed; although trainees reportedly scored highly in these.(23) Jimenez highlighted the importance of providing timely

feedback to users after completing exercises.(19)

Clinical scenarios and exercises

Two studies described using targeted clinical scenarios that focused on particular problem areas to train staff. Foster et al. developed exercises based on commonly encountered prescribing errors, such as the prescribing of Tazocin® (piperacillin-tazobactam, an antibacterial) at non-standard times.(22) Bredfeldt et al. targeted training to specific clinical areas, such as pre-operative patient visits, where there had been a number of support requests from existing users.(18) Developing expertise-specific scenarios relevant to clinicians from different specialist areas was considered important.(19, 24)

DISCUSSION

The papers identified a range of approaches used to train qualified prescribers, including the use of 'traditional' training, online training, and clinical scenarios and exercises. The use of a range of different approaches may appeal to individual learning styles, with users appreciative of relevant and tailored clinical-scenarios in particular. We chose to search for published studies in three large databases. However, it is possible that studies may have been published in other databases or unpublished work (e.g., reports or working papers) may exist in the grey literature. We only focused on the training of qualified prescribers due to the specific requirements of their training. However, we are conscious that some training approaches used for other groups, such as undergraduate students, may have been

potentially applicable and possibly useful. We also acknowledge that only one researcher (CLB) conducted the data extraction and no quality assessment of the included studies was undertaken. Notwithstanding these limitations, it is clear that there is a lack of published research in this area, which needs to be addressed; organisations should also share any lessons learnt from their experiences of training prescribers during the implementation stage and after continued use of ePrescribing systems to fill the knowledge gap.(26)

The papers identified outlined a number of methods used to train qualified prescribers, including classroom-based sessions,(18, 22, 25) demonstrations and 'hands-on' exercises. Some studies incorporated assessment, which allowed users to track their own progress and informed senior staff about those who may need further assistance.(18, 22, 23) Clinical scenarios aimed at addressing commonly encountered prescribing errors or frequent technical support requests were also used.(18, 22) Such problem areas may reveal systems flaws that may contribute to the occurrence of errors or poor usability. For instance, although ePrescribing can decrease prescribing of 'non-formulary medicines',(27) formulary alerts are often inappropriately overridden.(5) Therefore, understanding how users interact with these systems is important for the development of informed training strategies.

This review found that combinations of different learning methods were used, which appealed to the learning styles of different users. For example, Ross and Banchy used a combination of one-to-one and group classroom-training sessions to address the specific needs of medical staff and maximise attendance.(25) Evidence of this was also apparent when training staff on other non-ePrescribing forms of healthcare-information systems. For instance, McCain et al. reported how challenging it was to get nurse and physician users to attend classroom-based training sessions on

an EHR system (as opposed to an electronic prescribing system) due to other clinical commitments. Users felt that these sessions failed to address their learning needs by either being too simplistic or too advanced. This resulted in a blended learning strategy being adopted that included a combination of computer-based learning exercises and a training CD, which facilitated 'self-study' where users could train at a convenient time and pace.(28) Clearly, this approach may be beneficial when training prescribers on ePrescribing systems. Therefore, due to the heavy workloads and often unpredictable schedules of prescribers, it would seem reasonable to suggest a training approach that allows users to train at their own pace and convenience. Laramee et al. found that participants preferred written guidance on how to perform tasks rather than computer 'help' functions. Organisations should therefore consider providing a range of learning tools to meet users' needs.(28-30) Notably, we found a relatively small number of studies, which have been conducted either on one particular ward or organisation, thus may not be generalisable to other settings. The workforce in rural or remote locations for instance, may lack sufficient resources to hire healthcare informatics staff who are important for the deployment and ongoing support of ePrescribing systems, therefore more targeted and accessible approaches such as checklists and toolkits may be useful.(10)

It is likely that other training methods employed in practice are not discussed in the small number of articles found in this review. Suppliers of ePrescribing systems may provide a range of training options, such as workshops or e-learning; however these are typically focused towards key internal staff who will disseminate training to others or are primarily delivered during the implementation phase, rather than during the later stages when the systems are embedding (on-going support).

The use of e-learning as a method of training clinicians on an ePrescribing system was considered important in the included studies.(18, 19) A study, which delivered educational material primarily to nurses via an e-learning tutorial, was associated with high completion rates of the training module (74% of the 2,080 nurses) and perceived improvements in the completeness of documentation within the EHR, thus supporting this approach.(31) The American Health Information Management Association (AHIMA) and the American Medical Informatics Association (AMIA) developed recommendations related to workforce issues during EHR implementation and suggested that a range of innovative learning techniques, including electronic-methods, should be used.(26) E-learning material should be engaging, potentially including interactive scenarios, simple and concise, clearly specify learning outcomes, and take care to limit the amount of information presented.(31) With organisations choosing to migrate from one system to another (e.g., Brigham and Women's hospital in Boston recently transitioned from a home-grown system to a commercial system), and clinicians often rotating between sites (e.g., between a tertiary care and a community hospital) or specialities (e.g., between a medical and a surgical rotation), it is important that users feel able to carry out their key tasks on different systems. Tools such as the University of Victoria's EHR portal that provided users with an opportunity to train on a range of systems may be particularly useful. These 'virtual learning environments' should replicate as much as possible the interoperability issues associated with using multiple systems (e.g. failure to integrate allergy information from the EHR into the ePrescribing software)(32) so that prescribers are prepared for these challenges. The importance of intra-system interoperability, and the need to improve the transfer and use of information between systems is well-recognised in the literature.(33, 34)

Training specifically aimed towards educating prescribers about the challenges and pitfalls of ePrescribing was rarely discussed. However, studies frequently include education and training as a solution to some of "the issues" encountered, or as an explanation for why users fail to use the system as intended.(14, 35-37) Sittig et al. made specific recommendations, such as, providing adequate training opportunities for clinicians to experience the system before implementation, potentially enforcing a minimum level of training before use of the system is authorised. They also proposed that organisations deliver 'walk-throughs' of the different processes for specific clinical staff.(36) This supports the studies by Foster et al. and Bredfeldt et al, which highlight the need to tailor the clinical scenarios and content of training to the role, expertise and tasks performed by the user.(18, 22, 38, 39) Training approaches should encompass both procedural tasks (e.g., prescribing) and cognitive tasks (e.g., interpreting CDS alerts) so that prescribers realise the full potential of the system.(38) Importantly, prescribers should be able to identify and address gaps in their own knowledge;(26) learning outcomes can provide a benchmark for users to judge themselves against.(40) Alongside training, it is important for system developers to improve the design and usability of ePrescribing and CDS systems. Increasing CDS alert specificity and sensitivity to produce more 'patient-centred' recommendations is likely to reduce the impact of alert-fatigue and improve patient outcomes.(41, 42) Implementation is costly,(3) therefore the effect of interventions, should be evaluated to inform practice.

CONCLUSION

Organisations are currently using a range of learning methods to train qualified prescribers to use electronic systems. Online learning may facilitate the training for many users. However, the lack of papers retrieved suggests a need for additional studies to inform training and assessment methods. Finally, further research should explore the best way of training users about the pitfalls and challenges associated with electronic systems.

Competing Interests Statement: The authors have no competing interests to declare.

References

1 Bates DW et al. The impact of computerized physician order entry on medication error prevention. *J Am Med Inform Assoc*. 1999 Jul-Aug;**6**(4):313-21.

2 Garg A et al. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes. A systematic review. *JAMA*. 2005;**293**:1223 - 38.

3 Kaushal R et al. Return on investment for a computerized physician order entry system. J Am Med Inform Assoc 2006 May-Jun;**13**(3):261-6.

4 Nuckols TK et al. The effectiveness of computerized order entry at reducing preventable adverse drug events and medication errors in hospital settings: A systematic review and meta-analysis. *Syst Rev*. 2014 June 04;**3**(1).

5 Her QL et al. The frequency of inappropriate nonformulary medication alert overrides in the inpatient setting. *J Am Med Inform Assoc*. 2016 ocv181; DOI: 10.1093/jamia/ocv181

6 NHS England. The Integrated Digital Care Fund: Achieving integrated health and care records. NHS England. 2014.

7 NHS England. Safer Hospitals, Safer Wards: Achieving an Integrated Digital Care Record. NHS England. 2013.

8 Lord Carter of Coles. Operational productivity and performance in English NHS acute hospitals: Unwarranted variations. Department of Health RHJH. 2016.

9 The Leapfrog Group. Results of the 2014 Leapfrog Hospital Survey: Computerized Physician Order Entry; 2014.

10 Slight SP et al. Meaningful Use of Electronic Health Records: Experiences From the Field and Future Opportunities. *JMIR Med Inform*. 2015;**3**(3):e30.

11 Henderson J et al. Extent and utilisation of computerisation in Australian general practice. *Med J Aust*. 2006 Jul 17;**185**(2):84-7.

12 Ash JS et al. Some Unintended Consequences of Information Technology in Health Care: The Nature of Patient Care Information System-related Errors. *J Am Med Inform Assoc*. 2004 March/April;**11**(2):104-12.

13 Ruiz JG et al. The impact of E-learning in medical education. *Acad Med*. 2006 Mar;**81**(3):207-12.

14 Baysari MT et al. Failure to utilize functions of an electronic prescribing system and the subsequent generation of 'technically preventable' computerized alerts. *J Am Med Inform Assoc*. 2012;**19**(6):1003-10.

15 Noblin A et al. EHR implementation in a new clinic: A case study of clinician perceptions. *J Med Syst*. 2013 August;**37**(4).

16 van der Sijs H et al. Overriding of drug safety alerts in computerized physician order entry. *J Am Med Inform Assoc*. 2006 Mar-Apr;**13**(2):138-47.

17 Shulman R et al. Medication errors: a prospective cohort study of hand-written and computerised physician order entry in the intensive care unit. *Crit Care*. 2005 Oct;**9**(5):R516-R21.

18 Bredfeldt C et al. Training providers: beyond the basics of electronic health records. *BMC Health Serv Res*. 2013;**13**(1):503.

19 Jimenez A. E-learning supports EHR implementations. In addition to meaningful use, we need to define meaningful training. *Health Manag Technol*. 2010 Nov;**31**(11):22-3.

20 Borycki EM et al. The University of Victoria Interdisciplinary Electronic Health Record Educational Portal. *Stud Health Technol Inform*. 2009;**143**:49-54.

21 Kushniruk AW et al. Bringing electronic patient records into health professional education: towards an integrative framework. *Stud Health Technol Inform*. 2009;**150**:883-7.
22 Foster S et al. Competency based training program for electronic prescribing improves patient safety. *Pediatr Crit Care Med*. 2011 May;**1)**:A19. [conference abstract]
23 Ayoub N et al. Developing competency through webinar to establish oncology pharmacy services at the Aga Khan Hospital Dar-es-Salaam Tanzania. *Pediatr Crit Care Med*. 2014 June;**1)**:10.[conference abstract]
24 Borycki EM et al. From Prototype to Production: Lessons Learned from the Evolution of an EHR Educational Portal. *AMIA Annu Symp Proc*. 2009;**2009**:55-9.
25 Ross C, Banchy P. The key to CPOE: thoughtful planning, flexible training and strong staff involvement leads to a successful CPOE implementation. *Health Manag Technol*. 2007;**28**(11):22.
26 American Health Information Management Association AMIA. Building the Work Force for Health Information Transformation. 2006.
27 Fischer M et al. Effect of electronic prescribing with formulary decision support on medication use and cost. *Arch Intern Med*. 2008;**168**(22):2433 - 9.
28 McCain CL. The right mix to support electronic medical record training: classroom computer-based training and blended learning. *J Nurses Staff Dev.* 2008 Jul-Aug;**24**(4):151-4.
29 Edwards G et al. Innovative health information technology training: exploring blended learning. *Comput Inform Nurs*. 2011;**30**(2):104 - 9.
30 Laramee AS et al. Learning from within to ensure a successful implementation of an electronic health record. *Comput Inform Nurs*. 2011 Aug;**29**(8):468-77; quiz 78-9.
31 Topaz M et al. Educating clinicians on new elements incorporated into the electronic health record: theories, evidence, and one educational project. *Comput Inform Nurs*. 2013 Aug;**31**(8):375-9; quiz 80-1.
32 Halamka J et al. E-Prescribing Collaboration in Massachusetts: Early Experiences from Regional Prescribing Projects. *J Am Med Inform Assoc*. 2006 May/June;**13**(3):239-44.
33 Ash J, Bates D. Factors and forces affecting EHR system adoption: report of a 2004 ACMI discussion. *J Am Med Inform Assoc*. 2005;**12**(1):8 - 12.
34 Poon EG et al. Overcoming barriers to adopting and implementing computerized physician order entry systems in US hospitals. *Health Aff*. 2004 Jul-Aug;**23**(4):184-90.
35 Campbell EM et al. Overdependence on Technology: An Unintended Adverse Consequence of Computerized Provider Order Entry. *AMIA Annu Symp Proc*. 2007;**2007**:94-8.
36 Sittig DF et al. Assessing the anticipated consequences of Computer-based Provider Order Entry at three community hospitals using an open-ended, semi-structured survey instrument. *Int J Med Inform*. 2008;**77**(7):440-7.
37 Zhou L et al. How Many Medication Orders are Entered through Free-text in EHRs? - A Study on Hypoglycemic Agents. *AMIA Annu Symp Proc*. 2012 11/03;**2012**:1079-88.
38 van Stiphout F et al. Task analysis of information technology-mediated medication management in outpatient care. *Br J Clin Pharmacol* 5 JUN 2015 DOI:10.1111/bcp.12625
39 Ross S, Patey R, Flin R. Is it time for a nontechnical skills approach to prescribing? *Br J Clin Pharmacol*. 2014 Oct;**78**(4):681-3.

40 Biggs J. Aligning teaching for constructing learning. The Higher Education Academy. 2003:p1-4.
41 Coleman JJ et al. On the alert: future priorities for alerts in clinical decision support for computerized physician order entry identified from a European workshop. *BMC Med Inform Decis Mak.* 2013;**13**:111.
42 Seidling HM et al. What, if all alerts were specific - estimating the potential impact on drug interaction alert burden. *Int J Med Inform*. 2014 Apr;**83(**4):285-91.

Table 1: Search Terms

535

Set 1 (Electronic Prescribing)	Set 2 (Clinical Decision Support)	Set 3 (Electronic Medical Record)	Set 4 (Education Clinical)	Set 5 (Education Distance)	Set 6 (Prescriber (Included in Embase Search Only))
Computerized prescriber order entry Computerized provider order entry Electronic physician order entry Electronic order entry Electronic prescribing Electronic prescription Computerized physician order entry CPOE Computerized order entry Medical order entry systems	Clinical decision support Decision support system CDS Drug therapy, computer assisted	Electronic medical record/ Electronic health record Electronic patient record	Education Clinical education Training Course Competence Medical education Clinical competence Competence assessment Prescriber training Prescriber assessment	Education Distance Distance learning Educational non-traditional (CINAHL only)	Prescribed Prescribing Prescription