Handwritten to Electronic Prescriptions: Emerging Views and Practices, Saudi Arabia

Abstract

Background: There has been little research on electronic prescribing (EP) in Middle Eastern countries. This is in part due to the slow implementation of electronic health records [EHR] integrated with EP. Electronic prescribing is associated with a considerable reduction in medication errors compared to handwritten prescriptions. **Objective:** This paper reviews the relevant literature on handwritten and EP in the Kingdom of Saudi Arabia, as well as focusing on global issues including problems related to handwritten prescribing, the role of EP in mitigating these problems, the functions of the EHR system with EP, ways of implementing EP, and identifying potential barriers and challenges in the Middle Eastern region. **Search Strategy:** Computer searches of PubMed and Google Scholar were conducted using the keywords "handwritten prescription," "pen and pencil prescription," "medication prescribing," "medication errors," "electronic prescribing," and "electronic medical records." These keywords were combined with 'mechanisms', 'standards', 'advantages', 'disadvantages', 'challenges', 'plan', and 'opportunities' with the objective of comprehensively retrieving the peer-reviewed articles published in English language journals on this subject. A total of 101 studies were included in this work. Methods: Two of the authors of this work retrieved and reviewed 101 papers that met our inclusion criteria. Any disagreements were resolved by a consensus of all three authors. **Results:** There were more articles on handwritten prescriptions that involved illegible writing that resulted in medication errors than articles on EP due to a lack of research and slow implementation of EHR system in the Middle East. At global level, e-prescribing that was supported by well-defined standards and careful implementation was associated with a reduction in serious medication errors, morbidity, mortality, and service cost, as well as an increase in work flow efficiency, a higher quality of healthcare service delivery, and greater satisfaction of both healthcare providers and consumers. Electronic prescribing is now being practiced in many major medical centers and specialist hospitals not only in KSA but also in other countries of the region. However, there remains a need to implement EP systems in hospitals, primary care outpatient settings, and throughout the private health sector where it is missing. **Conclusion:** It is time for the widespread adoption of EP, EHR, and health informatics

systems across Middle Eastern countries including KSA, as well as for systematic research to evaluate their effectiveness.

Keywords: Handwritten prescription, electronic prescribing, electronic prescribing systems, electronic health records, medication errors, Saudi Arabia

Introduction

Healthcare information technology has globally advanced medication prescribing by substituting paper-prescriptions with electronic prescribing, even though both types of prescriptions are associated with medication errors. Medication errors are unintentional errors that tend to occur during prescribing, dispensing and administration phases of a medication while under the control of a healthcare provider or a consumer. Most of medication errors are preventable. However, medication errors associated with serious adverse events contribute significantly to morbidity and mortality, poor quality of care, huge medical costs and poor outcomes [1]. Medications errors are caused both by handwritten and electronic prescriptions, although the former leads to a higher prevalence of medication errors and adverse events, due especially to the illegible handwriting of the prescriber [2]. This paper addresses a number of interconnected issues related to both types of prescribing: 1) problems with handwritten prescribing; 2) the role of electronic prescribing in mitigating these problems; 3) the functions of electronic health record systems with electronic prescribing imbedded within them; and 4) mechanisms of implementing electronic prescribing in Saudi Arabia with a further focus on identifying potential barriers and challenges.

Scope of this review

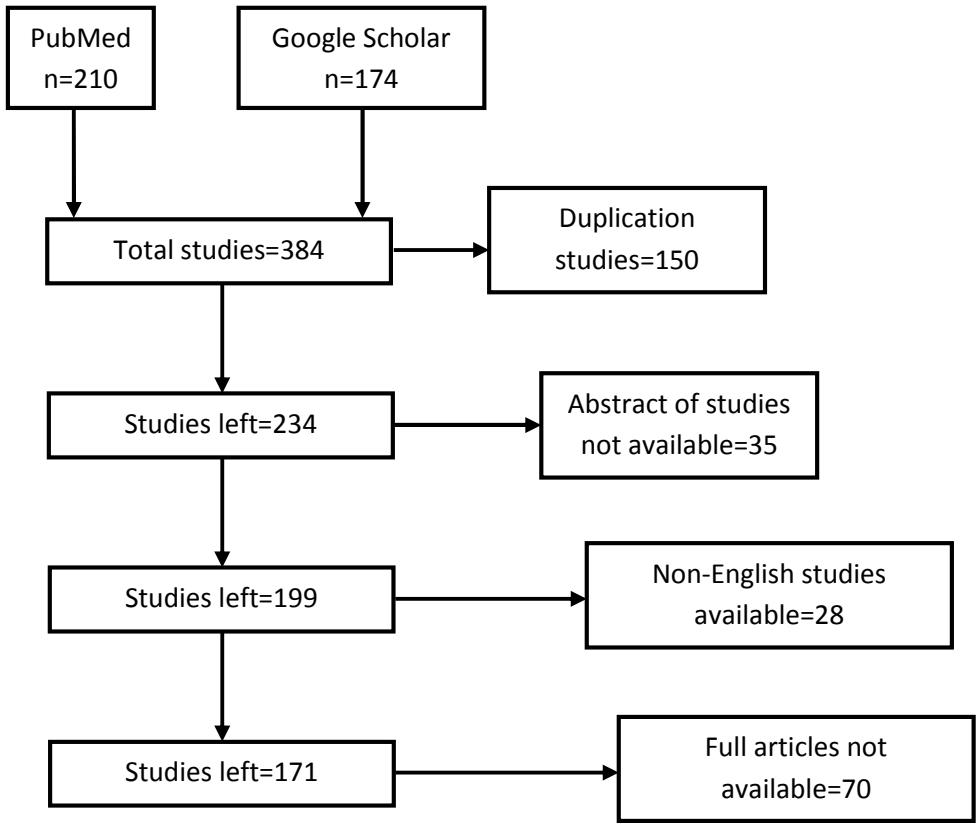
The present review focuses on EP in Saudi Arabia and other Middle Eastern countries. EP is now being practiced in many major medical centers and specialist hospitals in KSA. However, further efforts are needed to expand EHR and electronic prescribing systems in other major

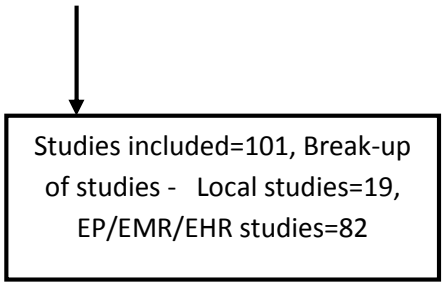
hospitals, primary healthcare centers, and private clinics and hospitals. As has occurred in the European Union [3], we hope that EHR systems with EP will be implemented over time throughout all Middle Eastern countries. This paper seeks to inform healthcare policy makers and encourage them to more widely implement EPS either as a standalone system or embedded within EHR [4].

Search Method

Computer searches of PubMed and Google Scholar (1980-2013) were conducted using the keywords "handwritten prescription," "pen and pencil prescription," "medication prescribing," "medication errors," "electronic prescribing," and "electronic medical records." We also used a strategy in which two words were combined to retrieve the peer-reviewed articles published in English language journals. The words combined with key words included mechanisms, standards, advantages, disadvantages, challenges, plan, and opportunities. In addition, we carried out hand search of English journals to identify handwritten and electronic prescribing studies. Based on our inclusion and exclusion criteria, a total of 101 studies were retained in this review [Figure 1].

Figure 1 Flow chart of selected studies





Results

Computer searches using PubMed and Google Scholar were conducted to identify relevant articles published in local and international English journals. We identified a total of 384 articles [Figure 1]. Duplication of studies across the two databases were 150, which were excluded. We did not consider studies whose abstracts were not readily accessible (n=35). We also excluded studies published in non-English journals (n=28). Studies with no full texts [n=70] were also excluded from this work. International peer-reviewed articles [n=82] that mainly focus on the mechanisms, standards, principles, advantages, disadvantages, benefits, costs and pitfalls of electronic prescribing and electronic health records were retained. Notably these studies were mainly from Western countries. We further retained those papers that explored handwritten prescriptions and e-prescribing in Saudi Arabia and other Middle Eastern countries (n=19). We focused on meta-analytic studies, systematic qualitative and quantitative reviews, randomized clinical trials, cross-sectional studies, and a few detailed case studies. Thus, a total of 101 studies were included in this review [Figure 1]. Two of us (NAQ & AMB) reviewed these studies and any arising disagreement about the inclusion of a study was resolved by three of us (NAQ, AMB & HGK).

Handwritten Prescribing

Writing prescriptions by hand is the predominant method of prescribing drugs in healthcare systems of Middle Eastern countries. A number of studies conducted between 1980 and 2005 mostly in primary healthcare settings have explored the different aspects of handwritten prescriptions in three healthcare settings in the Kingdom of Saudi Arabia (KSA) [5-14]. These studies offer a historical background on handwritten drug prescribing as it relates to both non-psychiatric [5-14] and psychotropic medications [15-16]. In a primary health care (PHC) study,

Khoja et al focused on four types of prescribing errors, finding that prescribing to relieve symptoms was the major reason for prescribing medications [8]. The number of drugs written per prescription was 3.2, which differed from other studies [6-7, 12] and was attributed to study sample size and other methodological issues. In contrast to these studies [7-8, 12], Al-Nasser reported a higher number of drugs per prescription written to the clients in Al-Baha city [6]. In Bahrain, Al Khaja and colleagues explored three types of prescribing medication errors and offered recommendations including training to improve the prescribing skills of health professionals [17]. Researchers in Iran found that general practitioners often overprescribed medications [18], and in Jordan, Otoom and colleagues reported that physicians overprescribed antibiotics and under-prescribed generic drugs [19]. Furthermore, all of these studies provided recommendations to further improve the overall quality of prescribing in PHC. In a study of informed self-medication that substantiated earlier findings [11,20], Bawazir reported that analgesics/antipyretics and dermatological drugs were the most commonly dispensed over-the-counter (OTC) drugs, while antibiotics were the most common drugs dispensed through handwritten prescriptions [9]. In addition, physicians often engaged in polypharmacy, and this prescribing pattern was similar in hospital outpatient clinics and in PHC. Bawazir recommended that regulations related to the sale of drugs be enforced and that a list of medications sold OTC be developed. In the KSA, Al-Faris and Al-Taweel found that the most frequently handwritten prescribed drugs were antihistamines (25%), paracetamol (20.3%), and antibiotics (14.7%) [21]. In more than 50% of prescriptions, the diagnosis was upper respiratory infection for which antibiotics (26%) and antihistamines (28%) are the usual treatments. This study recommended the training of both patients and doctors regarding the benefits of treatment and the importance of adherence.

In summary, the key findings of these studies [5-21] were that: 1) there is inadequate documentation in prescribing (omission errors); 2) the prescription of drugs is one of the most important factors in the rising cost of health care services; 3) most patient visits in healthcare settings end up with a drug being prescribed (often involving overprescribing); 4) doctors and pharmacists need continuing education in the area of appropriate drug prescribing drugs (prescribers not well trained); 5) informed self-medication could be appropriate and cost-effective; 6) there is need for patient education on the benefits of drug treatments especially in the management of chronic diseases (patient health literacy low); 6) more audits of the

prescribing habits of professionals are needed (the findings of these audits should be fed back to the professionals to improve the quality of prescribing); 7) brief intensive courses on mental health disorders are necessary for enhancing physicians' skills both in terms of identifying disorders and prescribing appropriate psychotropic medications ; and 8) there is a need for future studies assessing different aspects of prescribing errors, clinical as well as non-clinical. None of these reports recommended the implementation of electronic prescribing (EP) in the KSA healthcare system, although handwritten prescriptions are associated with more than twice the medication errors, higher morbidity and mortality, decreased workflow efficiency and quality of care, poorer medical outcomes, decreased patient and health providers satisfaction, and increased costs as compared to electronic prescriptions [22-24]. Although these problems of handwritten prescriptions have not been discussed extensively in KSA, research in the Western world on handwritten prescriptions largely supports our observations here. There is now a large volume of literature on physicians' prescribing and handwritten prescriptions in the western world [25-27] where currently electronic prescriptions are nearly uniform with a significant decrease in the problems related to non-electronic prescribing.

Local e-Prescribing Scenario

Few studies have explored EP in the KSA and only indirectly. One study has reviewed the implementation of electronic health records (EHRs) [28]. Another study has qualitatively explored clinicians' perceptions of computerized physician order entry (CPOE) system in the intensive care unit of a leading health care organization [29]. In the latter study, researchers surveyed 43 clinicians to assess perceptions regarding 32 factors collected from the literature related to the successful implementation of the CPOE system [29]. The factors most critical for success were as follows; 1) the provision of training prior to system implementation, 2) adequate clinical resources during implementation and 3) allowing sufficient time for ordering. Researchers concluded that the benefits expected were much higher than the risks and that CPOE reduced medication errors (MEs) and improved quality of care. Two recent surveys about the hospital pharmacy practices in Saudi Arabia found that about one-third (34.5%) of hospitals have CPOE systems with clinical decision-support systems (CDSSs) and over half (51.9%) have EMR/EHR system in place [30]. For medication dispensing, 21% of hospitals routinely use bar coding technology with automated dispensing cabinets, and for medication administration, 33%

use electronic medication administration records (eMARs), 7.4% have bar-code-assisted medication administration (BCMA), and 12% have smart infusion pumps [31]. According to this research, hospital pharmacy practices including prescribing, transcribing, dispensing, and administration are all well developed. Among recommendations made was the use of health informatics including robotic drug dispensing [32]. Both e-prescribing and robotic dispensing of drugs has been shown to substantially reduce medication errors [32, 33].

E-Prescribing System – a troubleshooting tool

In contrast to the problems associated with handwritten prescriptions, electronic prescribing (EP) has brought significant changes to how drugs are efficiently prescribed and monitored [34]. Electronic prescribing systems (EPSs) have been subject to clinical trials and then implemented in high income countries, which has resulted in improved clinician prescribing practices, increased patient safety, and improved monitoring of patients with multiple illnesses taking large numbers of medications [35,36,37]. Healthcare information technology (HIT) has opened up an exciting frontier that has the potential to tremendously improve the care and safety of patients, substantially reduce medication errors (MEs) and adverse drug events, decrease morbidity and mortality, and decrease long- and short-term health care costs [38-42]. Computerized physician order entry, for example, is a powerful method that has been used to advance and refine the process of prescribing medications across all levels of healthcare in high income countries and upper middle income countries [34,43]. Standalone EPSs or those embedded in EHR systems have the potential to empower prescribers, patients, and pharmacists to reform the quality of pharmaceutical care and improve workflow efficiency [34,44,45]. EPSs help to prevent MEs, lower the incidence of MEs, lower morbidity and mortality, lower re-admission rates; reduce the number of ME-related claims; and increase the prescription of more affordable medications (generics), EPSs also improve communication about medications, support of clinical activity through interaction with knowledge sources, improve clinical decisions at the point of prescribing and administration, enhance patient safety, and most importantly, improve the cost and quality of services provided to patients. When EPSs are implemented, health providers and managers tend to experience higher job satisfaction and there is improvement in work performance. Furthermore, the work atmosphere is less stressful and there is more cooperation and communication between professionals, technical staff, and patients [4, 44, 46]. There have also been reports, however, that EPSs increase the rate of some MEs [4]. As a result,

recommendations have been made to improve EPSs with even better systems [4, 46]. Commonly used terminology in relation to MEs, including electronic prescribing, are summarized in Table 1.

Table 1 Definitions of medication errors (MEs) and electronic prescribing (EP)

Terms	Definition
Adverse drug event (ADE)	Any injury due to medication, including known and expected injuries of medications; unavoidable but preventable. Such as drowsiness from diphenhydramine and an anaphylactic reaction to penicillin
Adverse drug reaction (ADR)	Harmful, unintended reactions to medicines that occur at doses normally used for treatment are called adverse drug reactions. ADRs are preventable and classified as Type A to Type G . Type A predictable and dose-dependent whereas Type B unknown and need to be identified and communicated quickly. Type B usually idiosyncratic and unpredictable. Other types of ADR include Type C (chronic effects), Type D (delayed effects), Type E (end-of-treatment effects), Type F (failure of therapy) and Type G (genetic reactions). Examples include respiratory depression with opiates and liver toxicity with troglitazone
Electronic Prescribing	Includes two-way transmissions between point of care and dispenser; a prescriber's ability to electronically send a prescription directly to a pharmacy from point of care; and transmission of prescription and/or related information between prescriber, dispenser, pharmacy benefit manager, and health plan, either directly or through an intermediary using an electronic system. These functions can be performed using single-purpose software or EP functionality imbedded in EHRs.
Error	The failure of a planned action to be completed as intended or the use of an incorrect plan to achieve an aim. An error may be an act of commission, an act of omission, or both
Prescription fill status	Indicates whether prescription is filled, not filled, or partially filled; includes providers, patient, and drug aspects of SCRIPT message. Not yet generally used
Medication Error	Any error occurring during the prescribing, dispensing, or administration of medication. Preventable and inappropriate use of medication or any preventable event – potential or actual – that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional or patient. "Potential errors" not considered ADRs or ADEs – they are reports of possible medication errors (Near misses or close calls). "Actual errors" may or may not reach the patient. MEs that reach the patient either cause harm or no harm.
Source: 47-49	

Electronic prescribing: standards and principles

Electronic prescribing (EP) is defined as the transmission of prescription or prescription-related information by electronic means between a prescriber, dispenser, pharmacy benefit manager, or

health plan, either directly or through an intermediary such as an EP network. EP includes two-way transmissions between the point of care and the dispenser [50]. In the U.S., the Medicare Modernization Act of 2003 advocated for EP standards and supported the electronic transmission of prescriptions and the electronic transmission of information on eligibility and benefits in terms of drug formulary, prior authorization messages, and patient instructions [51-52]. Moreover, A Clinician's Guide to Electronic Prescribing (2008) noted that a qualified EPS must be capable of performing all of the following functions: 1) generating a complete active medication list incorporating electronic data received from applicable pharmacy drug plans if available; 2) selecting medications, printing prescriptions, electronically transmitting prescriptions and conducting all safety checks including automated prompts that offer information on the drug being prescribed, potential inappropriate dose or route of administration, drug–drug interactions (DDIs), allergy concerns, and/or warnings or cautions; 3) providing information related to the availability of lower cost alternative medications; and 4) providing information on formulary or tiered formulary medications, patient eligibility, and authorization requirements received electronically from the patient's drug plan [53]. If these functions are performed accurately by an EPS, this will result in a considerable reduction of MEs, improving patient safety and quality of healthcare [54]. Furthermore, EPSs have immediate benefits in terms of improved quality and safety of prescribing, as well as providing more cost-effective medication options for patients and improving ambulatory care workflow [52-53, 55]. EPSs have standards (Table 2) and principles (Table 3) that guide ethical, technical, policy, and financial developments in this field. Stakeholders often utilize these fundamentals of EPSs as they develop strategic and tactical initiatives on EP [55-57]. One study found that physicians who used EP endorsed EP as improving patient safety but did not perceive benefits from using standardized Medication History (RxH) transaction or formulary and benefit information [58]. Therefore, researchers called for more studies of these standards in application to determine how to maximize the benefits of such systems [58].

Table 2 Electronic prescribing standards.

Standard	Remarks
Medication history*	Provides a uniform information about drugs used by the patient for healthcare providers that is useful in preventing medication errors as well as understanding medication management adherence

Formulary and benefits*	Provides prescribers with information about a patient's drug coverage at the point of care, which may include drugs on formulary, alternative drugs not on formulary, rules for prior authorization (PA), and step therapy, and the cost to the patient for one drug option versus another. Prescription of generic drugs is encouraged because of cost issues.
Prescription fill-status notification*	Intends to notify the prescriber about whether a patient has collected a prescribed medication at the pharmacy, thus following-up patients with poor drug adherence
Prior Authorization**	Insurers require patients in consultation with physicians to receive approval from the latter before certain drugs will be covered, hence streamlining process to communicate the need for PA directly to the prescribers and allow prescribers to send the necessary information along with the prescription
Structured and codified signature**	Seeks to ensure that patient instructions for taking medications (called "signatura") – such as "by mouth three times a day" – are placed at the end of a prescription
RxNorm	Provides standards for the name, dose and form of available drugs that need further refinement and evaluation before being deployed in a live setting
SCRIPT (v 8.1)	Intends to improve prescribing workflow and prescriptions that need revision and modification updates without needing to create a new order; allows for a refill to be sent from the facility to the pharmacy without the physician's intervention; and allows patient information to be updated outside the context of a prescription
Ref: 55-58,	
Notes: *Standard recommended by evaluation team; **Standard not recommended by evaluation team.	

253

254

Policymakers have divergent views about EP, including that it merely involves e-prescriptions sent and received electronically, that it is associated with higher quality of healthcare, and that it promises healthcare at lower cost [59]. EPSs use several measures for increasing the safety and convenience of prescribing: electronic prescribing, e-refilling (the electronic transmission of refill requests and authorizations), making prescription history available across multiple providers , providing information about eligibility, availability of drugs on the formulary, and vendor's commitment to customer support, and bidirectional data transmission between physicians, pharmacies, insurers, and other stakeholders [59].

Table 3 Electronic prescribing (EP) principles.

It is believed that widespread adoption of EP can provide many benefits; for example: improved medication safety, enhanced practice efficiency, cost savings, more effective medication management, increased patient adherence, and improved integrity of the prescribing process
All health care stakeholders should collaborate to encourage widespread adoption and optimal use of standards-based EP through: appropriately aligned incentives to support effective use of the technology in diverse practice settings; collaborative development and delivery of innovative programs, education resources, training, and support; efficiencies in workflow for the physician and pharmacist in diverse practice settings; and connectivity and tools to facilitate medication reconciliation, formulary and medication history information, and transmission
EP system design and/or the implementation of EP should: enhance the patient–clinician relationship by providing more comprehensive clinical information at the point of care; preserve the patient's choice of pharmacy; facilitate the clinician's informed choice of medication; and be part of an integrated plan toward full implementation of an electronic health record (EHR) system
Both EHRs and stand-alone EP may be utilized to realize the functionality and benefits of EP. Overall quality of care can be enhanced by implementation of EP that is integrated within an HER
Consumer organizations, providers, pharmacists, payers, and educators should help patients understand and experience the benefits of EP. Informed patients will play an important role in encouraging providers and pharmacists to use EP
Ref: 55-57

E-prescribing and EPS programs are associated with improved health care to patients [34]. These systems provide electronic health records (EHRs) for health organizations that establish links from primary to tertiary care [55, 59-60]. EPSs also allow access to health information about the relevant healthcare activities for each individual patient. Accordingly, EPSs have a major role in supporting a patient's treatment with the correct medications wherever they may be treated. EP provides information about treatment to any health professionals who need that information and

whenever they need it, provided they have the legitimate right to access that information. EPSs also offer online access, at the point of need, to relevant knowledge and clinical decision support systems (CDSSs). Thus, important features of EPSs include provision of access to prescriptions in multiple locations by multiple system users; automatic or semiautomatic stock control; legible prescription production; provision of access to medication records; reminders and alerts, including those relating to formulary choice, to support prescribers at the time of prescribing; support for medicine administration; and note-making abilities to support communication between all health care workers caring for a patient [59-60]. Researchers have identified several mechanisms involved in EP [58].

Advantages of e-Prescribing

According to the Institute of Medicine, preventable medication errors result in at least 1.5 million adverse drug events (ADEs) and claim more than 7000 lives each year. Medical errors result in 44,000 to 98,000 deaths annually. ADEs due to medication errors within hospitals are associated with 770,000 injuries or deaths each year in the U.S. [52-53, 61]. EP reduces MEs and improves patient safety by eliminating illegible prescriptions and providing virtual real-time checking for drug-drug interactions (DDIs), drug allergies, dosing errors, and therapeutic duplications [55]. In addition, real-time checking of drug formularies can reduce cost and improve work efficiency by minimizing pharmacy telephone callbacks [55]. According to one study, the average reduction in pharmacist labor costs from EP was about $0.97 USD for each new prescription and $0.37USD for each renewed prescription [56]. Hence, the Institute of Medicine recommended that EP should be used globally by all prescribers and pharmacies by 2010 [52-53]. The benefits of EP were further confirmed when up to 86% of serious MEs were eliminated across the Western world following incorporation of CPOE into health care systems [62]. EP also facilitates formulary compliance and supplies medicines much faster and more cost-efficiently to hospital wards at 36% of the price of traditional methods [63-64]. Electronic transfer of information on admission allows drug histories to be imported directly into EPSs. Another advantage of EP is that it allows dispensing records to become available through a national care records service as has been implemented in the USA. Likewise, information from electronic community pharmacy systems can be made available through EPSs that increase patient safety, effectiveness and efficiency of drug administration [65]. Further, the electronic capture of drug administration by scanning of pack barcodes facilitates automatic bedside stock control. EP also improves

workflow and increases the involvement of pharmacists in clinical care [60, 64]. A systematic review of the impact of health information technology (HIT) on the quality of medical care revealed that HIT interventions – primarily EHRs – improve quality by improving medication safety, increasing adherence to guidelines, and providing tools to enhance disease surveillance [57]. However, most studies documenting benefits of EP were not conducted in the ambulatory setting, where volumes are greater and complexity increases [57]. Many potential advantages of EP have been emphasized throughout the published literature worldwide [57,66].

Disadvantages of EP

E-prescribing is reported to cause a new generation of unintended MEs [67]. Accidental selection of the wrong drug, dose, or dosage form from computer dropdown list is associated with increased medication errors [68]. In a way, this replaces MEs due to illegible handwritten prescriptions. Another disadvantage is the selection of the wrong patient profile [69]. Moreover, sometimes a dosage or dosage form listed on the computer is only the dose the drug formulary allows or pharmacy stocks and does not reflect the dose range. This can lead to inappropriate dosing. Prescription duplication can also occur if the prescriber tries to change a dose and forgets to discontinue the old prescription. In addition, prescribers may ignore alerts for allergies, drug-drug interactions (DDIs), and therapeutic duplication when too many alerts flash on the screen [70]. Though not applicable to the Saudi health care setting, a transmission fee is charged in the USA for receiving prescriptions or refill approvals electronically. The average cost is about $0.25 USD per transmission. The cost of receiving an e-prescription by fax is less than receiving the prescription electronically [51].

There are other drawbacks of EP [57]. First, there are concerns about how to electronically prescribe controlled substances, which are typically used to treat severe pain or anxiety. Prescriptions for these medications may be written using an EPS but cannot be transmitted electronically to pharmacies. Typically, the physician will print such prescriptions, which may require his/her signature. In one study prescribers were optimistic about the potential for e-prescriptions for controlled substances to improve practice, but viewed the necessary security measures as a burden and a potential barrier to use [71]. Currently, prescription drug abuse is a major problem that is increasing worldwide. This trend could be reduced by prescription drug monitoring programs (PDMP), which have multiple areas of focus that include prescribing

practices. These electronic databases collect data on controlled substances so that health care providers can decrease abuse, doctor shopping, and diversion [72]. Further research is needed on e-prescribing controlled substances so that action can be taken [72].

Second, patients, physicians, and pharmacists should not think that the use of EPSs eliminates all potential for MEs to occur. Patients need to be aware of their medication history and current treatment and make sure that physicians are aware of any conditions they have, including allergies. EPSs supplement the expertise of physicians and normal medical diligence but do not eliminate the need for awareness. Third, EPSs may not have information on all the medications that a patient is taking, such as over-the-counter (OTC) drugs, which can cause allergic reactions or other problems that a physician should know about. Thus, patients must provide all relevant information about any OTC and/or complementary and alternative medicine (CAM) drugs to physicians. This is an integral component in prescribing error (PE) prevention strategies [57]. Finally, the typical data collected by an EPS might not be useful in identifying doctors at higher risk for making serious prescribing errors [73].

Legal Perspectives

There are several legal issues involved in electronic prescribing including accountability, criteria for access to electronically stored patient data, risks of unauthorized access to patient data, and misuse of electronically stored patient data. In USA, state prescribing laws applicable to other countries provide solutions for e-prescribing data collected on controlled and un-controlled medications and how to share datasets with other stakeholders including health consumers, health providers, sponsors and researchers [74]. For example, the prescription drug monitoring program (PDMP) collects designated data on substances including controlled medications dispensed in the state. The PDMP is housed by a specified statewide regulatory, administrative or law enforcement agency. The housing agencies [AHRQ and ONC] distribute data from the database only to individuals who are authorized under state law to receive the information [59, 74].

Opportunities, challenges and e-Prescribing

There are many opportunities and challenges to electronic prescribing. EPSs facilitate the patient-centered role of pharmacists in medication review and treatment plans, review of patient

response, identification of optimum dosage forms, patient education and counseling, improving accuracy of medication dispensing on hospital discharge, and communication of ongoing pharmaceutical care needs [59, 75-76]. Thus, EPSs help to improve pharmacists' contributions to the clinical care of patients. As a result, pharmacists are able to spend more time serving patients in inpatient and outpatient settings [51-53].

Challenges and weaknesses of EPSs need to be addressed. For instance, those first beginning to use EPSs tend to experience difficulties with formulary checks and RxH documentation, which are associated with prescriber distrust and unwillingness to rely on EP-based information [77]. Greater data accuracy and completeness must be assured if EPSs are to meet their objective of improving the efficiency and safety of EP in PHCs and other settings [77]. Another example concerns faxed e-prescriptions. If computer software such as SureScripts sends prescription faxes to community pharmacies [59], those pharmacies may not accept these prescriptions because they have not seen a computer-faxed prescription with an electronic signature before. This problem, however, can be easily addressed through widespread education programs.

The importance of staff training and increasing public awareness of EPSs cannot be overemphasized. The public and patients need continuing awareness campaigns about EPSs. Initially, the country that adopts EPS needs to make a huge investment not only for the purchase of a comprehensive, qualified and fully functional EPS software but also for the continued training of health staff and the mounting of public-awareness campaigns [59]. Returning to the pharmacists handling of prescriptions, rather than searching through faxes and voicemails, pharmacy staff could check e-prescriptions directly sent to their computers and dispense medications to the patient. Another challenge for EPSs concerns medical errors. MEs have detailed taxonomies [52-53, 78-89], multiple etiologies [80-81], and relevant pre- and post-EP era issues. The development of EPSs to capture all forms of MEs, then, is a daunting task. However, continuing advancements in information technology offer strategies that can help to implement clinical practice guidelines [82]. Furthermore, an interesting tool has been built to develop collaboration between patients and physicians that allows the physician to make well-informed and safe EP decisions based on personal medication records contributed by the patient [83].

The field of mental health is not yet on par with physical health around the world and this extends to EPS integration into mental health care settings. This, however, is slowly changing,

and in the USA researchers have recommended implementing EPSs in the public mental health system [84]. Hopefully, other nations will follow this important development [85].

E-prescribing Needs in KSA

Although Saudis accept the need for EP, its implementation across all health care delivery systems including the private sector has been minimal and slow, with only a few hospitals now having an EPS [28-29]. The problems associated with handwritten prescriptions need to be addressed globally. Major medical centers such as King Saud Medical City, King Fahad Medical City, King Abdulaziz Medical City, and major hospitals such King Fahd Hospital Dammam, and National Guard Hospitals have already implemented EHR that include electronic prescribing systems. The pace of implementing EHR with EPS has increased recently and at least 70 hospitals across the country now have fully functioning e-prescribing systems [30-31]. The present authors argue that the time is right for the Saudi Ministry of Health to develop a comprehensive plan for EPS implementation in all current and future hospitals in all 13 regions and urban primary health care (PHC) centers in KSA. EPSs will need to be implemented in rural PHC centers in phases. The private health sector should also be encouraged to implement EPS. Such an agenda would be in line with the recent rapid implementation of e-prescribing in Canada [86].

Discussion and Conclusions

Handwritten prescribing of medications is a common practice in the Middle Eastern countries. This practice has many disadvantages including increased minor and serious medication errors (15%) related to illegible prescriptions and failure to identify drug-drug interactions, increasing morbidity and mortality, decreasing work flow efficiency, increasing the costs of care, and decreasing the quality of healthcare services and patient safety [22-24]. Most of these medication errors could be overcome by adopting an electronic prescribing system [87-88]. In addition, omission and commission/documentation errors are frequent problems in handwritten prescriptions both among outpatients and inpatients [89-90].

Electronic prescribing systems, however, are not without problems. Surprisingly, omission errors (61% of all errors) are most frequently reported in computer-generated prescriptions in outpatient settings [69]. Electronic-prescribing may also take more time than handwritten prescriptions [91], although this finding needs to be replicated. E-prescribing may also lead to medication

errors of a different type, such as overwhelming prescribers with alerts or increasing the likelihood of selecting a wrong dose from the dropdown list of medications [4, 92].

Educational programs focused on e-prescribing that target prescribers are reported to decrease handwritten prescription errors including errors related to route of administration, illegible handwriting, and inaccurate dosages. In addition acute adverse events may also be minimized [22]. There are educational programs that target multiple healthcare providers to reduce prescribing medication errors. Medication errors have multiple determinants which educational programs need to address [93].

Electronic prescribing has considerable benefits including decreased medication errors (8%), increased workflow efficiency, enhanced satisfaction of patients and care providers, and increased attention to medication error alerts, all resulting in decreased morbidity and mortality, better patient outcomes, improved quality of care, and decreased cost [23, 94-95]. In addition, e-prescribing increases the likelihood that pharmacists' recommendations will be implemented more so than is seen with hand-written prescriptions [96]. The computerized alert systems associated with e-prescribing can significantly impact physician behavior in terms of avoiding the use of abbreviations as commonly occurs with hand-written prescriptions [97]. There are challenges, however, in the implementation of e-prescribing. These challenges include physicians' resistance, the need for a substantial initial financial investment, the need for provider training, and the increased likelihood of new types of medication errors [23, 98-100]. Financial incentives to providers for implementing EPS in USA have the use of e-prescribing, which has also increased the likelihood of prescribing generic medications that has considerably decreased medication costs [101].

Only a few studies have examined the use of EHR and EP in Saudi Arabia, and the perceptions of health providers with regard to EP [28-31]. However, based on the electronic prescribing literature in the West, EP has many advantages that make for a strong case for also implementing EPS in Middle Eastern countries such as KSA. Further studies, however, are needed to explore different aspects of EPSs in order to develop a research base for developing strategies to prevent and reduce medication errors, make clinical and policy decisions regarding implementing EPSs, and updating EPSs that are now in place, with the goal of improving the quality of healthcare services and reducing the costs of healthcare.

This overview has several limitations. There is a large literature on handwritten and e-prescribing in the Western world. This study does not include all related papers, thus raising the possibility of selection bias. Publication bias is also a possibility since unpublished research was not included in our review. We have also stepped beyond a simple objective review of the literature by advocating for the implementation of EPS despite its limitations and challenges. However, the strength of this review is the consistency of the research findings by others and the widespread recommendations made by others in support of electronic prescribing. Another limitation of this review is that it did not evaluate the quality of the studies cited, although this was not our objective. There is extensive literature on studies regarding health information technology and informatics related to the use in EHR and EPS and there is insufficient space to comprehensively review the quality of these studies here. Nevertheless, we have comprehensively reviewed the most cited studies on e-prescribing and have addressed some of the ethical and legal issues involved in this practice. We reviewed research conducted both locally in Saudi Arabia and around the world to make our case for implementing electronic prescribing systems, either those that are standalone or embedded within an EHR, here in Saudi Arabia and the remainder of the Middle East.

Recommendations

Our recommendations focus primarily on the prescribing of medications in the Kingdom of Saudi Arabia. The prescribing trend in this country is slowly changing and electronic prescribing is beginning to be adopted in major medical centers and specialist hospitals across the country. Electronic prescribing is now well defined and there exist standards for implementing EPSs. While there are many advantages to EP, there are also challenges such as the training of healthcare providers in the use of e-prescribing and the resistance of physicians in adopting this new practice. To maximize the benefit of e-prescribing, electronic prescribing systems with full functionalities should be implemented in all current and future hospitals and primary healthcare centers throughout KSA. Private sector hospitals and clinics should also adopt such systems. Other countries in the Middle East region may benefit from and follow this trend. Finally, there is need for longitudinal pre- and post evaluations of newly implemented electronic health record systems that contain EPSs following the procedures that have been recommended by others [102-103].

Ethical Consideration: Not applicable

Conflicts of Interest: The authors have no conflict of interest in this work.

Reference

1. 1. Expert Group on Safe Medication Practices (P-SP-PH/SAFE) (2006). Creation of a better medication safety culture in Europe: Building up safe medication practices. http://www.coe.int/t/e/socialcohesion/soc-sp/medication%20safety%20culture%20_report%20e. pdf).
2. Kaushal R, Kern LM, Barrón Y, Quaresimo J, Abramson EL. Electronic Prescribing Improves Medication Safety in Community-Based Office Practices. J Gen Intern Med. 2010 June; 25(6): 530–536.
3. Mäkinen M, Rautava P, Forsström J, Aärimaa M. Electronic prescriptions are slowly spreading in the European Union. *Telemed J E Health*. 2011; 17(3):217–222.
4. Koppel R, Metlay JP, Cohen A, et al. Role of computerized physician order entry systems in facilitating medication errors. *JAMA*. 2005; 293(10):1197–1203.
5. Al-Nasser AN. Prescribing patterns in primary healthcare in Saudi Arabia. *DICP*. 1991;25(1):90–93.
6. Felimban FM. The prescribing practice of primary health care physicians in Riyadh city. *Saudi Med J*. 1993;14(4):335–338.
7. Khoja TA, Al-Shammari SA, Farag MK, Al-Mazrou Y. Quality of prescribing at primary care centres in Saudi Arabia. *J Pharm Technol*. 1996;12:284–288.
8. Bawazir SA. Prescribing patterns of ambulatory care physicians in Saudi Arabia. *Ann Saudi Med*. 1993;13(2):172–177.
9. Sebai ZA, Miller DL, Ba'aqeel H. A study of three health centres in rural Saudi Arabia. *Saudi Med J*. 1980;1(4):197–202.
10. Al-Abbassi HM, Madani KA. A survey of multiple prescriptions dispensed in Saudi Arabia. *Aust J Hosp Pharm*. 1987;3:211–212.
11. Bawazir SA. Prescribing pattern at community pharmacies in Saudi Arabia. *Int Pharm J*. 1992;6:222–224.
12. Al-Dawood K. Evaluation of Drug Prescribing Habits in a Postgraduate Teaching Set-up in Saudi Arabia. *J Family Community Med*. 1995;2(1):41–45.
13. Balbaid OM, Al-Dawood KM. Assessment of physicians' prescribing practices at Ministry of Health hospital in Jeddah city, Saudi Arabia. *Saudi Med J*. 1998;19:28–35.
14. Sadat-Ali M, Al-Shafei BA, Al-Turki RA, Ahmed SE, Al-Abbas SA, Al-Omran AS. Medication administration errors in Eastern Saudi Arabia. *Saudi Med J*. 2010;31(11):1257–1259.
15. Qureshi NA, Al-Habeeb TA, Al-Ghamdy YS, Magzoub MMA, Schmidt HG. Psychotropic drug prescriptions in primary care and general hospitals, in Saudi Arabia. *Saudi Pharm J*. 2001;9 (3-4):193–200.
16. Al-Ghamdy YS, Qureshi NA, Abdelghadir MH, al-Habeeb TA, Ahmad SA. Psychotropic drugs prescriptions in Al-Qassim region, Saudi Arabia. East Mediterr Health J. 1999;5(1):27–34.
17. Al Khaja KA, Al-Ansari TM, Sequeira RP. An evaluation of prescribing errors in primary care in Bahrain. *Int J ClinPharmacolTher.* 2005;43(6);294–301.
18. Moghadamnia AA, Mirbolooki MR, Aghili MB. General practitioner prescribing patterns in Babol city, Islamic Republic of Iran. *East Mediterr Health J*. 2002;8(4–5):550–555.

19. Otoom S, Batieha A, Hadidi H, Hasan M, Al-Saudi K. Evaluation of drug use in Jordan using WHO prescribing indicators. *East Mediterr Health J*. 2002;8(4–5):537–543.
20. al-Freihi H, Ballal SG, Jaccarini A. Potential for drug misuse in the eastern province of Saudi Arabia. *Ann Saudi Med*. 1987;7:301–305.
21. Al-Faris EA, Al Taweel A. Audit of prescribing patterns in Saudi primary health care: What lessons can be learned? *Ann Saudi Med*. 1999;19(4):317–321.
22. Martinez-Anton A, Sanchez JI, Casanueva L. Impact of an intervention to reduce prescribing errors in a pediatric intensive care unit. Intensive Care Med 2012 Sep;38(9):1532-1538.
23. Tully MP. Prescribing errors in hospital practice. Br J ClinPharmacol. 2012 Oct;74(4): 668-675.
24. Chatsisvili A, Sapounidis I, Pavlidou G, Zoumpouridou E, Karakousis VA, Spanakis M, Teperikidis L, Niopas I. Potential drug-drug interactions in prescriptions dispensed in community pharmacies in Greece. Pharm World Sci. 2010 Apr;32(2):187-93)
25. Neyaz Y, Qureshi NA,Khoja T, Magzoub MA, Haycox A, WalleyT.Review of literature,Part-1: Physicians medication prescribing in primary care in Riyadh city, Saudi Arabia. EMHJ 2011; 17: 122-126.
26. Khoja T, QureshiNA,Neyaz Y, Magzoub MA, Haycox A, WalleyT.Review of literature, Part-2: Physicians medication prescribing in primary care in Riyadh city, Saudi Arabia. EMHJ 2011; 17: 126-132.
27. Qureshi NA,Neyaz Y, Khoja T, Magzoub MA, Haycox A, WalleyT.Review of literature, Part-3: Physicians medication prescribing in primary care in Riyadh city, Saudi Arabia. EMHJ 2011; 17: 132-140.
28. Altuwaijri MM. Electronic-health in Saudi Arabia. Just around the corner? *Saudi Med J*. 2008;29(2):171–178.
29. Altuwaijri MM, Bahanshal A, Almehaid M. Implementation of computerized physician order entry in National Guard Hospitals: assessment of critical success factors. *J Family Community Med*. 2011;18(3):143–151.
30. Alsultan MS, Khurshid F, Salamah HJ, Mayet AY, Al-Jedai AH. Hospital pharmacy practice in Saudi Arabia: Prescribing and transcribing in the Riyadh region. Saudi Pharm J 2012 Jul; 20(3): 203-210
31. Alsultan MS, Khurshid F, Mayet AY, Al-Jedai AH. Hospital pharmacy practice in Saudi Arabia: Dispensing and administration in the Riyadh region. Saudi Pharm J. 2012 Oct; 20(4): 307-315).
32. Beard RJ, Smith P. Integrated electronic prescribing and robotic dispensing: a case study. Springerplus. 2013;2:295. doi: 10.1186/2193-1801-2-295
33. Dixon-Woods M, Redwood S, Leslie M, Minion J, Martin GP, Coleman JJ. Improving quality and safety of care using "technovigilance": an ethnographic case study of secondary use of data from an electronic prescribing and decision support system. Milbank Q. 2013 Sep;91(3):424-54. doi: 10.1111/1468-0009.12021)
34. Schade CP, Sullivan FM,de Lusignan S, Madeley J. e-Prescribing, Efficiency, Quality: Lessons from the Computerization of UK Family Practice. J Am Med Inform Assoc. 2006 Sep-Oct; 13(5): 470–475.

35. Kaur S, Mitchell G, Vitetta L, Roberts MS. Interventions that can reduce inappropriate prescribing in the elderly: a systematic review. Drugs Aging. 2009;26(12):1013-28.
36. Goldman RE, Dubé C, Lapane KL. Beyond the basics: refills by electronic prescribing. Int J Med Inform. 2010 Jul;79(7): 507-14.
37. Kannry J. Effect of e-prescribing systems on patient safety. Mt Sinai J Med. 2011 Nov-Dec; 78(6): 827-33.
38. Ammenwerth E, Schnell-Inderst P, Machan C, Siebert U.The effect of electronic prescribing on medication errors and adverse drug events: a systematic review. J Am Med Inform Assoc. 2008 Sep-Oct;15(5): 585-600.
39. Abramson EL, Malhotra S, Osorio SN, Edwards A, Cheriff A, Cole C, Kaushal R.A long-term follow-up evaluation of electronic health record prescribing safety. J Am Med Inform Assoc. 2013 Jun; 20(e1):e52-8.
40. Eguale T, Tamblyn R, Winslade N, Buckeridge D. Detection of adverse drug events and other treatment outcomes using an electronic prescribing system. Drug Saf. 2008;31(11):1005-16.
41. Fischer MA, Vogeli C, Stedman M, Ferris T, Brookhart MA, Weissman JS. Effect of Electronic Prescribing With Formulary Decision Support on Medication Use and Cost. Arch Intern Med. 2008;168(22):2433-2439.
42. Longhurst CA, Parast L,Sandborg CI, Widen E et al. Decrease in Hospital-wide Mortality Rate After Implementation of a Commercially Sold Computerized Physician Order Entry System. Pediatrics 2010; 126 (1): 14 -21.
43. Carrasco HM, Ramos MG,Guindo PN et al. GRP-136 Pharmaceutical s and E-Prescribing Tools in a Tertiary-Care Institution.Eur J Hosp Pharm 2013;20:A49 doi:10.1136/ejhpharm-2013-000276.136.
44. Crosson JC, Etz RS, Wu SY et al. Meaningful Use of Electronic Prescribing in 5 Exemplar Primary Care Practices. Annals of family medicine 2011; v. 9 (5): 392-397
45. Raimbault-Chupin M, Spiesser-Robelet L, Guir V, Annweiler C, Beauchet O, Clerc MA, Moal F.Drug related problems and pharmacist interventions in a geriatric unit employing electronic prescribing. Int J Clin Pharm. 2013 Jul 16. [Epub ahead of print].
46. Scott JT, Rundall TG, Vogt TM, Hsu J. Kaiser Permanente's experience of implementing an electronic medical record: a qualitative study. *BMJ*. 2005;3;331(7528):1313–1316.
47. National Opinion Research Center at the University Of Chicago for the Agency for Healthcare Research and Quality (AHRQ). *Findings from the Evaluation of E-Prescribing Pilot Sites*. AHRQ Publication No. 07-0047-EF. Rockville, MD: AHRQ; 2007. Available from http://healthit.ahrq.gov/images/apr07norcerxreport/erxinterimevaluationreport.html. Accessed on July 12, 2010.
48. Nanji KC, Rothschild JM, Salzberg C, Keohane CA, Zigmont K, Devita J, Gandhi TK, Dalal AK, Bates DW, Poon EG. Errors associated with outpatient computerized prescribing systems. J Am Med Inform Assoc. 2011 Nov-Dec;18(6):767-73.
49. National Coordinating Council for Medical Error Reporting and Prevention; index for categorizing medication errors. Available; http://www.nccmerp.org/medErrorCatindex.html (accessed on May 10, 2014).
50. New developments for electronic prescribing. *Pharmacist's Letter/Prescriber's Letter.* 2007;23(3):230301.
51. Aspden P, Wolcott J, Bootman JL, Cronenwett LR, editors; Committee on Identifying and Preventing Medication Errors, Institute of Medicine. *Preventing Medication Errors*. Washington DC: National Academies Press; 2007. Available from http://www.nap.edu/catalog.php?record_id=11623. Accessed October 22, 2012.

52. Kohn LT, Corrigan JM, Donaldson MS, editors; Committee on Quality of Health Care in America, Institute of Medicine. *To Err Is Human: Building a Safer Health System*. Washington, DC: National Academies Press, 2000. Available from http://www.nap.edu/catalog.php?record_id=11623. Accessed October 22, 2012.
53. Barclay S, Barr MS, Berkery MJ, et al; eHealth Initiative, Center for Improving Medication Management, American Medical Association, American Academy of Family Physicians, American College of Physcians, Medical Group Management Assciation. Appendix IV: electronic prescribing statement of principles. In: *A Clinician's Guide to Electronic Prescribing*. Washington DC: eHealth Initiative; 2008:37. http://www.amassn.org/ama1/pub/upload/mm/472/clinicians_guide_combined3.pdf
54. Friedman MA, Schueth A, Bell DS. Interoperable Electronic Prescribing In The United States: A Progress Report. Health Affairs 2009 vol. 28 no. 2 393-403)
55. Rupp MT. E-prescribing: the value proposition. America's Pharmacist. 2005; 23–26.
56. eHealth Initiative, Center for Improving Medication Management. A Consumer's Guide to E-Prescribing: Understanding the benefits of E-Prescribing, How It Works and What You Can Do. Washington DC: eHealth Initiative; 2008. Available from http://www.emblemhealth.com/pdf/eHI_CIMM_Consumer_Guide_to_ePrescribing.pdf.
57. Wang CJ, Patel MH, Schueth AJ, et al. Perceptions of standards-based electronic prescribing systems as implemented in outpatient primary care: a physician survey. *J Am Med Inform Assoc*. 2009;16(4):493–502.
58. Adler KG. E-prescribing: why the fuss? *Fam Pract Manag*. 2009; 16(1):22–27.
59. Slee A, Farrar K. Formulary management ± effective computer management systems. *Pharm J*. 1999; 262:363–365.
60. Slee A, Farrar K, Hughes D, Ashwell S. Electronic prescribing – implications for hospital pharmacy. *Hospital Pharmacist*. 2007; 14: 217–220.
61. Bates DW, Teich JM, Lee J, et al. The impact of computerized physician order entry on medication error prevention. J Am Med Inform Assoc. 1999;6(4):313–321.
62. Reducing and Preventing Adverse Drug Events To Decrease Hospital Costs: Research in Action, Issue 1. March 2001. Agency for Healthcare Research and Quality, Rockville, MD. http://www.ahrq.gov/research/findings/factsheets/errors-safety/aderia/index.html.
63. Abu-Zayed LA, Farrar K, Mottram D. Comparative evaluation of systems for drug supply to hospital wards in the United Kingdom. *J Soc Admin Pharm*.2001;18(4):136–141.
64. Wang CJ, Patel MH, Schueth AJ, et al. Perceptions of standards-based electronic prescribing systems as implemented in outpatient primary care: a physician survey. *J Am Med Inform Assoc*. 2009;16(4):493–502.
65. Rupp MT, Warholak TL. Evaluation of e-prescribing in chain community pharmacy: best-practice recommendations. J American Pharmacists Association 2008: 48(3):364-370.
66. Thomas CP, Kim M, McDonald A, et al. Prescribers' expectations and barriers to electronic prescribing of controlled substances. *J Am Med Inform Assoc*. 2012;19(3):375–381.
67. Cowan L. Literature review and risk mitigation strategy for unintended consequences of computerized physician order entry. Nurs Econ. 2013 Jan-Feb;31(1):27-31.

68. Reckmann MH, Westbrook JI, Koh Y, Lo C, Day RO. Does Computerized Provider Order Entry Reduce Prescribing Errors for Hospital Inpatients? A Systematic Review. J Am Med Inform Assoc 2009; 16: 613-623.
69. An-Jim Longa AJ, Changa P, Lia YC, Chiu WT. The use of a CPOE log for the analysis of physicians' behavior when responding to drug-duplication reminders. International Journal of Medical Informatics 2008; Volume 77, Issue 8: 499–506.
70. Worley J. Prescription drug monitoring programs, a response to doctor shopping: purpose, effectiveness, and directions for future research. *Issues Mental Health Nursing*. 2012;33: 319–328.
71. Coleman JJ, Hemming K, Nightingale PG, et al. Can an electronic prescribing system detect doctors who are more likely to make a serious prescribing error? *J R Soc Med*. 2011;104(5):208–218.
72. Crosson JC, Schueth AJ, Isaacson N, Bell DS. Early adopters of electronic prescribing struggle to make meaningful use of formulary checks and medication history documentation. *J Am Board Fam Med*. 2012;25(1):24–32.
73. White PJ, Daniel J, Posnack S. Privacy and Security Solutions for Interoperable Health Information Exchange and Report on State Prescribing Laws: Implications for e-Prescribing 2009. Available at: http://www.healthit.gov/sites/default/files/290-05-0015-state-rx-law-report-2.pdf (Accessed on 29 September 2013).
74. US Department of Justice/Drug Enforcement Administration/Office of Diversion Control, October 2011. Available at http://www.deadiversion. usdoj.gov/faq/rx_ monitor. htm#1 (accessed on 29 September 2013) .
75. Ahmad A, Nijpels G, Dekker JM, Kostense PJ, Hugtenburg JG. Effect of a Pharmacist Medication Review in Elderly Patients Discharged From the Hospital. JAMA-Internal Med 2012; 172 (17): 1346-1347.
76. Smith M, Bates DW, Bodenheimer T, Paul D. Cleary PD. Why Pharmacists Belong In The Medical Home. Health Affairs, 29, no.5 (2010):906-913.
77. Neville RG, Robertson F, Livingstone S, Crombie IK. A classification of prescription errors. *J R Coll Gen Pract*. 1989;39(320):110–112.
78. Ross LM, Wallace J, Paton JY. Medication errors in a paediatric teaching hospital in the UK: five years operational experience. *Arch Dis Child*. 2000;83(6):492–497.
79. Weingart SN, Wilson RM, Gibberd RW, Harrison B. Epidemiology of medical errors. *West J Med.* 2000;172(6):390–393.
80. Ridley SA, Booth SA, Thompson CM; Intensive Care Society's Working Group on Adverse Incidents. Prescription errors in UK critical care units. *Anesthesia.* 2004;59(12):1193–1200.
81. Chen CC, Chen K, Hsu CY, Li YC. Developing guideline-based decision support systems using protégé and jess. *Comput Methods Programs Biomed*. 2011;102(3):288–294.
82. Nelson SJ, Zeng K, Kilbourne J. Building a standards-based and collaborative e-prescribing tool: MyRxPad. *Int J Data Min Bioinform*. 2011;5(3):252–265.
83. Rothbard AB, Noll E, Kuno E, et al. Implementing an E-Prescribing System in Outpatient Mental Health Programs. *Adm Policy Ment Health.* 2012. Epub Jan 25.
84. Case study: e-Prescribing for Mental Health at Leicestershire Partnership NHS Trust. Available at:http://www.jac-pharmacy.co.uk/~jacpharmacy/joomla/index.php/customers/18-customers/102-case-study-e-prescribing-for-mental-health-at-leicestershire-partnership-nhs-trust.. Accessed on 29 September 2013)

85. Lynas K. Physicians and pharmacists call for more rapid implementation of e-prescribing in Canada. Can Pharm J (Ott). 2013 Jul;146(4):184. doi: 10.1177/1715163513494595).
86. Devine EB, Hansen RN, Wilson-Norton JL, Lawless NM, Fisk AW, Blough DK, Martin DP, Sullivan SD. The impact of computerized provider order entry on medication errors in a multispecialty group practice. J Am Med Inform Assoc. 2010 Jan-Feb;17(1):78-84.
87. Ali J, Barrow L, Vuylsteke A. The impact of computerised physician order entry on prescribing practices in a cardiothoracic intensive care unit. Anaesthesia 2010 Feb;65(2):119-123.
88. Al Shahaibi NM, Al Said LS, Kini T, Chitme H. Identifying errors in handwritten outpatient prescriptions in Oman.J Young Pharm. 2012 Oct;4(4):267-272.
89. Hartel MJ, Staub LP, Röder C, Eggli S. High incidence of medication documentation errors in a Swiss university hospital due to the handwritten prescription process.BMC Health Serv Res. 2011 Aug 18;11:199. doi: 10.1186/1472-6963-11-199.
90. Devine EB, Hollingworth W, Hansen RN, Lawless NM, Wilson-Norton JL, Martin DP, Blough DK, Sullivan SD. Electronic prescribing at the point of care: a time-motion study in the primary care setting. Health Serv Res. 2010 Feb;45(1):152-171.
91. Gitler S. E-prescribing prone to errors. Med Econ. 2013 Jan 10; 90(1): 9.
92. Tully MP, Ashcroft DM, Dornan T, Lewis PJ, Taylor D, Wass V. The causes of and factors associated with prescribing errors in hospital inpatients: a systematic review. Drug Saf. 2009;32(10):819-836).
93. Lichtner V, Venters W, Hibberd R, Cornford T, Barber N. The fungibility of time in claims of efficiency: The case of making transmission of prescriptions electronic in English general practice. Int J Med Inform. 2013 Aug 14. doi:pii: S1386-5056(13)00172-X. 10.1016/j.ijmedinf.2013. 08. 001.
94. Lapane KL, Waring ME, Schneider KL, Dubé C, Quilliam BJ. A mixed method study of the merits of e-prescribing drug alerts in primary care. J Gen Intern Med. 2008 Apr;23 (4) : 442-446.
95. Taegtmeyer AB, Curkovic I, Rufibach K, Corti N, Battegay E, Kullak-Ublick GA.Electronic prescribing increases uptake of clinical pharmacologists' recommendations in the hospital setting.Br J ClinPharmacol. 2011 Dec; 72(6): 958-964.
96. Myers JS, Gojraty S, Yang W, Linsky A, Airan-Javia S, Polomano RC. A randomized-controlled trial of computerized alerts to reduce unapproved medication abbreviation use. J Am Med Inform Assoc. 2011 Jan-Feb;18(1):17-23.
97. Shekelle PG, Morton SC, Keeler EB. Costs and benefits of health information technology. Evid Rep Technol Assess (Full Rep). 2006 Apr;(132):1-71.
98. Corley ST. Electronic prescribing: a review of costs and benefits. Top Health Inf Manage 2003 ; 24(1): 29-38.
99. Cusack CM. Electronic health records and electronic prescribing: promise and pitfalls. Obstet Gynecol Clin North Am 2008 Mar; 35(1):63-79.
100. Joseph SB, Sow MJ, Furukawa MF, Posnack S, Daniel JG. E-prescribing adoption and use increased substantially following the start of a federal incentive program. Health Aff (Millwood). 2013 Jul;32(7):1221-7. doi: 10.1377/hlthaff.2012. 1197.)
101. Catwell L, Sheikh A. Evaluating eHealth interventions: The need for continuous systemic evaluation. PloS Medicine. 2009; 6 (8): e1000126.

758 102. Cornford T, Doukidis G, Forster D. Experience with a structure, process and
759 outcome framework for evaluating an information system. Omega: The International
760 Journal of Management Science. 1994; 22(5): 491-504.
761 103. Shekelle PG, Morton SC, Keeler EB. Costs and benefits of health information
762 technology. Evid Rep Technol Assess (Full Rep). 2006 Apr;(132):1-71.