ORIGINAL RESEARCH

Analysis of reported e-prescribing near misses in King Saud Medical City, Riyadh

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Background: In the health care context, a "near miss" is a drug presciption error that happened but did not affect the patient. These errors are captured and corrected before reaching the patient fortuitously or purposefully by designed system controls. This study analyzed the reported near misses in a tertiary care hospital in Riyadh city.

Methods: This cross-sectional study evaluated consecutively collected near miss report forms over a period of 6 months from January 1, 2012 to June 30, 2012.

Results: The total number of near miss report forms was 1,025 and each form contained one or more near misses. Of these near miss report forms, 58.73% (n = 602) were related to male patients. Most frequently reported near misses were wrong frequency (n = 266, 25.95%), followed by improper doses (n = 250, 24.39%), wrong drug prescribed (n = 126, 12.29%), wrong duration (n = 97, 9.46%), wrong concentration (n = 92, 8.98%), and wrong dosage form (n = 57, 5.56%). Stages where most near misses were identified included transcription and entering (n = 676, 55.32%), physician ordering (n = 397, 32.49%), and dispensing and delivery (n = 115, 9.41%). Physicians and nurses made most of the near misses (n = 929, 89.1%), whereas pharmacists identified most of the near misses (n = 1,002, 97.3%). Most frequently reported reasons for near misses were lack of staff training (n = 419, 34.12%), communication problems related to drug order (n = 387, 31.5%), staff, workflow and milieu problems (n = 199, 16.2%), and missing drug information (n = 121, 9.85%). Sites related to most near misses were the general hospital outpatient department (n = 453, 44.67%), the general hospital emergency room (n = 237, 23.37%), and the maternity hospital outpatient department (n = 203, 20.02%). Pharmacists intervened by correcting drug-related items in most near misses (n = 702, 34.58%), waited for a response from source of errors (n = 358, 17.64%), called reporter for clarifications (n = 471, 23.20%), or did not dispense the drug (n = 331, 16.3%). Drugs most frequently involved in near misses were anti-infective (n = 239, 22.61%), cardiovascular (n = 207, 19.58%), and central nervous system (n = 154, 14.57%) agents.

Conclusion: This prospective study provides some important tentative pharmacovigilance insights into near misses, which are comparable with current international trends in near misses. Further studies on near misses are warranted in the Kingdom of Saudi Arabia.

Keywords: near miss, medication errors, e-prescribing, electronic prescribing system, Saudi Arabia

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Introduction

Handwritten prescriptions, the predominant mode of drug prescribing in the Eastern world, are often associated with preventable medication errors including near misses/close calls. Conversely, the electronic prescribing system reduces such errors considerably, and also results in improved patient satisfaction, decreased morbidity and mortality,

positive impact on ambulatory care workflow, and overall patient safety. The electronic prescribing system empowers both prescribers and pharmacists to efficiently deliver high-quality health care services, although it may also facilitate occurrence of medication errors.[1,2] Electronic prescribing systems have defined principles, working mechanisms, and standards that stakeholders tend to utilize for efficient electronic prescribing e-refill, prescription history across multiple providers, eligibility and formulary information, authorization, and interoperability.[3–6] Arguably, there is much less literature on electronic prescribing in the Eastern world.[7,8] The electronic health records[7] and perceptions of clinicians about the computerized physician order entry in the intensive care unit[8] have been explored in the Kingdom of Saudi Arabia (KSA). Forty-three clinicians were surveyed to assess their perceptions regarding 32 critical success factors that were collected from the relevant literature. The reported top-rated critical success factors were the before-go-live training, the availability of adequate clinical resources during implementation, and the ordering time, together with a reduced rate of medication errors and improved quality of care.[8] Further, Qureshi has reviewed the electronic prescribing literature and made a strong case for implementing an electronic prescribing system in all public and private health care settings, not only in KSA but also across the Eastern world.[9,10]

No study has so far explored electronic prescribing near misses in Saudi Arabia. However, there are substantial data on near misses in the Western world.[11–21] Near misses may occur in handwritten as well as electronic prescriptions. In the medical context, a near miss is a medication error that happened but did not reach the patient. A near miss may also be defined as an error that reached the patient but did not result in harm.[22] However, according to the Agency for Healthcare Research and Quality, a near miss is an event or situation that did not produce patient injury only because of chance.[23] This definition, however, is criticized by the Institute for Safe Medication Practices (ISMP).[22] The ISMP considers a near miss as a close call, which is an event, situation, or error that took place but was captured before reaching the patient. Further, Kessels-Habraken et al extensively reviewed the literature on the definition of near misses and defined three near miss incidents (type 1–3) based on a combination of "patient reached" and "patient harmed", focused on error handling processes (detection, explanation, countermeasures, and their combinations), and developed a near miss incident matrix.[21] Accordingly, near misses and medication errors are considered medical incidents.[17] This paper explores multiple

aspects of voluntarily reported near misses, an avenue yet to be investigated in KSA.

An electronic prescribing system was implemented at King Saud Medical City (KSMC) in 2006 and since then no study has been carried out on medical incidents. Therefore, the aim of the present study was to analyze different aspects of reported near misses in this setting. Identification of possible facilitating factors associated with near misses may help guide health professionals to develop an action plan to prevent electronic medical incidents in the hospitals.

Materials and methods

This cross-sectional, prospective study was conducted over a 6-month period in 2012. The setting for this study was KSMC, which is a major tertiary care hospital with a 1400-bed capacity in Riyadh region. An average of 1,200 electronic prescriptions are written daily. These prescriptions cover only electronic prescriptions and do not include paper prescriptions or medication orders written on prescription charts. In 2006, KSMC became the first Ministry of Health hospital to implement an electronic prescribing system. Currently, other hospitals are also in the process of adopting the electronic prescribing system. This hospital serves a wide range of patients drawn from a large population, many of whom present with complex medical comorbidities and are referred from different regions of KSA. The hospital's MEDI system (electronic health record system) has been upgraded regularly since 2006. The electronic prescribing system is connected to the MEDI system.

Medical incidents from all divisions of the medical city are reported voluntarily to the medication safety unit of KSMC. All health care providers and consumers can report medication errors to this unit. Two coordinators, one from pharmacy and the other from the Drug Poisoning Information Center, work on electronic medication error data collection, its entry into the computer, and statistical analysis. They also produce a medication error report. Notably, all medication error reporters are required to complete a medication error reporting form. The completed medication error forms are screened and reviewed by the pharmacy designee in the medication safety unit for deciding whether or not the reported medication error is a near miss. Thereafter, this medication error form is sent to the Drug Poisoning Information Center for further review and statistical analysis. Sentinel errors are investigated by a committee using root cause analysis (a related separate paper is forthcoming on this). Two other methods for reporting near misses not used in this study are web and telephone.

Data collection

All medication error report forms were evaluated by the pharmacist and Drug Poisoning Information Center staff. The relevant data were abstracted from these forms. The variables examined in this study were gender, medication-related variables (such as drug type, dose, frequency of administration, route of administration, dosage form, concentration, and duration), details on reporters and interveners, types of errors, causes of errors, stages of near misses made, setting where near misses made, actions taken against near misses, and suggested recommendations for preventing near miss errors in the future. From an ethical perspective, the research team submitted the required documents to the academic department of KSMC that gave permission to analyze and publish the reported near misses.

Data analysis

The data were entered into the computer and analyzed using Statistical Package for Social Sciences version 17 software (IBM Corporation, Armonk, NY, USA). Descriptive statistics were used to calculate frequencies and percentages.

Results

From January 1, 2012 to June 30, 2012, the number of near miss report forms was 1,025 (Figure 1). The minimum (n = 55) and maximum number (n = 238) of near miss report forms were collected in the months of April and May, respectively. Male patients represented 58.73% (n = 602) of all cases; gender was not recorded on seven forms. Drug-related variables noted in near misses were wrong frequency (25.95%), incorrect dose (24.39%), wrong drug prescribed (12.29%), wrong duration (9.46%), wrong strength (8.98%), wrong dosage form (5.56%), monitoring error (5.17%), wrong quantity (2.73%), wrong patient (2.05%), and miscellaneous (Table 1). Stages where near misses were identified were as follows: transcription (55.32%), physician order entry (32.49%), dispensing (9.41%), and miscellaneous (Table 2). Physicians made most of the near misses, followed by nurses and pharmacists (Table 3). However, those who identified and reported most near misses were pharmacists (99.14%), followed by nurses and physicians (Table 4). The distribution of immediate interventions/actions taken by pharmacy personnel is shown in Table 5. Most errors related to drug variables were corrected by pharmacy staff in consultation with other staff and near miss reporters (Table 5).

According to the perceptions of near miss reporters, the main causes of near misses were lack of staff training
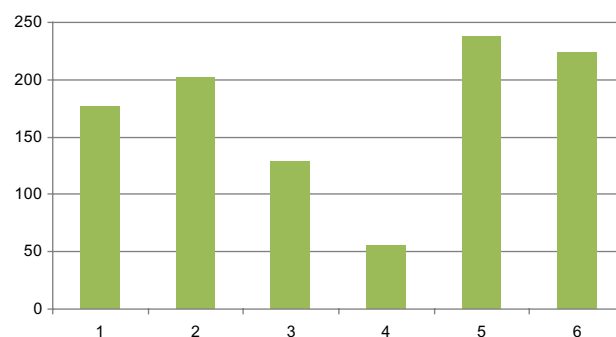

Figure 1 Near miss medication error report forms (n=1025) by months (January to June, 2012).

Table 1 Distribution of drug-related variables in near miss medication errors

Medication variables in near misses	Cases (n)	%
Wrong frequency	266	26.0
Incorrect dose	250	24.4
Wrong drug	126	12.3
Wrong duration	97	9.5
Wrong strength/concentration	92	9.0
Wrong dosage form	57	5.6
Monitoring error, drug-drug	53	5.2
Wrong quantity	28	2.7
Wrong patient	21	2.1
Omission error	14	1.4
Wrong documentation	12	1.2
Wrong route	4	0.4
Wrong rate	3	0.3
Wrong time of administration	2	0.2
Total	1,025	100%

Note: The number of near misses is >NM report forms because some forms contain >1 NM error [Tables 2–6, 8 and 9] except Table 7 where the near miss (NM) number is lower because of hoax reports.

Table 2 Stages during which near miss medication errors were discovered

Stages involved	Cases (n)	%
Transcription and entering	676	55.3
Physician ordering	397	32.5
Dispensing and delivery	115	9.4
Monitoring	24	2.0
Administration	10	0.8
Total	1,222	100%

Table 3 Health professionals who committed near miss medication errors

Error made by	Cases (n)	%
Physicians	493	47.3
Nurses	436	41.8
Pharmacists	66	6.3
Assistant pharmacists	48	4.6
Total	1,043	100%

Table 4 Health professionals who identified near miss medication errors

Error identifiers	Cases (n)	%
Pharmacist	1,002	97.3
Nurse	14	1.4
Assistant pharmacist	10	1.0
Clinical pharmacist	2	0.2
Physicians	2	0.2
Total	1,030	100%

Table 6 Causes of near miss medication errors

Cause of error	Cases (n)	%
Lack of staff education	419	34.1
Miscommunication of drug order	387	31.5
Environmental, staffing, or workflow problem	199	16.2
Drug information missing	121	9.9
Drug name, label, package problem	40	3.3
Lack of quality control or independent check system	39	3.2
Clinical information missing	15	1.2
Drug delivery device problem	4	0.3
Drug storage or delivery problem	3	0.2
Patient education problem	1	0.1
Total	1,228	100%

(34.12%), communication problems (31.5%), staff/workflow issues (16.2%), missing drug information (9.85%), and miscellaneous causes (Table 6). The sites where most near misses were made were the general hospital outpatient department (44.67%), the general hospital emergency room (23.37%), and the maternity hospital outpatient department (20%, Table 7). Classes of drugs most commonly involved in near misses were anti-infective agents (22.6%) followed by cardiovascular drugs (19.6%), central nervous system medications (14.6%), nutritional products (6.5%), gastrointestinal agents (6.34%), and coagulation modifiers (6%, Table 8). Various recommendations suggested for preventing near misses were double checking orders (50.1%), training of health care providers (31.1%), training regarding physician entry (18.5%), and other measures (Table 9). Finally, although the number of near miss report forms was 1,025, each form could contain one or more near misses. Hence the number of near misses as shown in the various tables varied accordingly.

Discussion

This cross-sectional study explored important aspects of near misses in a tertiary care hospital in Riyadh City. Unlike in

Table 7 Locations where near miss medication errors were made

Site of errors	Cases (n)	%
General hospital outpatient department	453	44.7
General hospital emergency room	237	23.4
Maternity hospital outpatient department	203	20.0
Inpatient pharmacy	53	5.2
Pediatric hospital outpatient department	23	2.3
Outpatient pharmacy	22	2.2
Pediatric hospital emergency room	12	1.2
Pediatric hospital operating room	7	0.7
Others	4	0.4
Total	1,014	100%

Table 8 Medications involved in near miss medication errors

Medications	Cases (n)	%
Anti-infective drugs	239	22.6
Cardiovascular agents	207	19.6
Central nervous system agents	154	14.6
Nutritional products	69	6.5
Gastrointestinal agents	67	6.3
Coagulation modifiers	64	6.1
Metabolic agents	46	4.4
Hormones	39	3.7
Respiratory agents	37	3.5
Topical agents	29	2.7
Genitourinary tract agents	19	1.8
Psychotherapeutic agents	17	1.0
Antineoplastics	13	1.2
Miscellaneous agents	57	5.4
Total	1,057	100%

Table 5 Actions taken by pharmaceutical staff in response to near miss medication errors

Action	Cases (n)	%
Change to correct dose/drug/duration/frequency/rate/route/dosage form/patient/strength/quantity	710	35.0
Pharmacist note and wait for response	358	17.6
Call reporter for clarification	471	23.2
No dispensing	331	16.3
Educational session	48	2.4
Cancelled drug	28	1.4
Forward order to nurse/physician/pharmacist	28	1.4
Discontinuation of drug	24	1.2
Informed nurse/physician to change the order	12	0.6
Occurrence variance report for further investigation of near misses	11	0.5
Supervise the assistant pharmacist/pharmacist during dispensing	9	0.4
Total	2,030	100%

Table 9 Recommendations to avoid near miss medication errors

Recommendation	Cases (n)	%
Double check	822	50.1
Continuous medical education	511	31.1
Physician entry	303	18.5
Medication reconciliation	3	0.2
Patient counseling	2	0.1
Total	1,641	100%

medication errors, males were overrepresented in this study despite the fact that, in ambulatory care, females tend to utilize more health care services than males. Hence females who utilize more health care services paradoxically tend to have fewer near misses as evidenced in this study. This finding diverges from other reports[24] and therefore needs further study. Other important observed sites where near misses were made were pediatric and adult emergency service settings and maternal ambulatory care services, which is consistent with other studies.[11–12,19,25] In general, multiple factors, including gender of patient, age, weight, diagnosis, prescribed medications, experience of health care providers, practice setting, and the presence or absence of an electronic prescribing system have a strong impact on the prevalence of medication errors.[9,10,24] Similar factors tend to predict the occurrence of near misses.[26] In a study that involved 1,737 nurses, Tanaka et al[26] examined the predictors of near misses and adverse events, including age, gender, years of nursing experience, frequency of alcohol consumption, work place, ward rotation, frequency of night shifts, sleepiness during work, frequency of feeling unskilled, nurses' job stressors, working conditions, and depression. The predictors of near misses and adverse events in this study were quite similar, although years of experience, frequency of night shifts, ward location, and time pressure were significantly related to both near misses and adverse events. Thus, it probably makes little difference whether near misses or adverse events are chosen for identifying possible causes of adverse events.[26] Myers et al also found that the causes and contributing factors for medication errors are similar to the causes of and factors contributing to near misses.[14]

According to the present study, omission and commission near misses were commonly found, as also reported by others.[4,27] Incorrectly written prescriptions often led to medication errors and near misses resulting in adverse consequences and a poor outcome.[4,9,10,26,27] The purpose of identifying and capturing near misses is to improve the management of health care systems so that risks are reduced and patient safety is improved. However, near misses are frequently underreported.[17,19,28] A variety of medication-related data, such as wrong dose frequency, wrong dose, wrong drug, wrong duration of drug use, wrong drug concentration, and wrong dosage forms, found in the present study are consistent with other reports.[29–31] Therefore, there should be electronic checks in the process of prescribing and dispensing medications in order to prevent medication errors and the adverse health consequences and economic losses involved.[1,2] The correct and complete documentation of patient, health provider, and medication-related variables

in electronic prescriptions is strongly recommended in clinical and pharmaceutical practice worldwide. Only then will patient safety, better quality care, and cost reductions, together with decreased morbidity and mortality be ensured across the health care system.[9,10] This claim has been substantiated in one study of near miss events in labor and delivery, in which medication and patient identification errors were the most common near miss events.[11] In another study of perceptions of perioperative nurses, factors reflecting "communication between team", "inconsistent information", and "incorrect monitoring" were the most frequently identified causes of near misses.[13]

Near misses/close calls and adverse harmful events occur in a ratio of 1:300–339.[15,32] The estimated prevalence rates of medication errors range from 5% to 38%.[33] Among the reported errors, 58% were "significant", which means they could have caused adverse effects such as diarrhea, headaches, or rashes; 42% were "serious", meaning they could have caused low blood sugar, reduced heart rate, or fainting; and none were considered life-threatening.[33] Arguably, if near misses are not captured and corrected, the prevalence of medication errors will rise considerably, resulting in medication errors with associated economic losses, poor quality of care, and low patient safety. Variations in the reported prevalence rate of medication errors have been attributed to differences in methodology, definitions of medication errors, study settings, classifications of medication errors, and sample size.[34,35] The prevalence of near misses also varies probably due to the same factors. Approximately 35% of medication errors are potentially preventable adverse events/near misses.[36] In a study of near misses in the blood transfusion setting, Kaplan reported that approximately 90% of events are near misses, with 10% caught after the order has been issued but before transfusion. Accordingly, near miss reporting may increase total reports by ten-fold.[15] In a systematic review of definitions and characteristics of medication errors, Lisby et al included 45 studies that reported prevalence of medication errors ranging from 2% to 75%, with no association found between definitions and prevalence. However, the majority of studies reported prevalence rates below 10%, despite a wide variation in rates reported.[35]

Medication errors can occur at any one of the five stages/phases involved in the process of medication administration: prescribing the medicine; dispensing the medicine; preparing the medicine for administration; administering the dose using the appropriate route; and method and monitoring the effect of the medicine on the patient.[28] Further, a study that focused on three systems of medication prescribing found

results compatible with the present study: in the traditional system, the error rate was 13.59%; in the single-dose system it was 6.43%; and in the electronic prescription system it was 8.86%.[37] The highest error rates in all phases were found in the traditional system; the phase affected by the most errors in all three models was transcription; and the least affected phase was administration, except for the single-dose system, in which prescription was the worst. The effects of errors in the administration phase were greater in the traditional system, although less so than when the system was automated.[37] In another study, nurses reported medication administration (19%) and transcription errors (10%) as the most frequent types of near misses.[16] The causes of near misses were more likely to be personal factors rather than institutional factors, including not following policy, inappropriate decision-making, and incorrect assumptions, the latter being work-related interruptions, distractions, and poor communication concerning the patient. Top techniques to mitigate near misses included STAR (stop, think, act, review) and verification of proper procedures. In conclusion, education about mitigating techniques for near misses is imperative for nurses.[16] In the psychiatric setting, medication administration errors were the most common errors (88.8%) and distraction, poor communication, and being unfamiliar with the ward were common contributory factors.[18] These results are consistent with those reported in the present study and underscore the importance of double checking, training health professionals to avoid making such errors, and focusing on physician entry are recommended in order to reduce near misses.

According to this study, physicians and nurses made the most near misses, whereas pharmacists and nurses identified and reported the most near misses. Pharmacists were most likely to intervene in order to prevent these errors, as many other studies have also found, and this role and the related tasks of clinical pharmacists have been discussed in the literature.[29–31] Similarly, pharmacist interventions were those most likely to prevent medication errors (11%–89%).[30,31,38] The present study highlights the important role of the pharmacist and nurse in the prevention of near misses omitted or committed by physicians and nurses while writing e-prescriptions and administering the medicine, respectively. Based on the Eindhoven model, Henneman and Gawlinski proposed how nurses as operators can manage medical errors by identifying and correcting them.[39] Evidently, health professionals often do not report near misses because of lack of understanding, fear, blame, the belief that reporting may not result in improvement, and complaints about available reporting methods.[40] In a pilot study of pharmacy staff, Boyle et al

used structural equation modeling to identify factors for improving the reporting of medical incidents, and found that individual-perceived self-efficacy, medical incident process capability, medical incident process support, organizational culture, management support, and regulatory authorities all influenced the completeness of medical incident reporting, which, in turn, influenced medical incident service recovery and learning.[17] Other investigators have also identified innovative approaches for capturing near misses in order to develop a patient safety culture.[36]

According to the present study, anti-infective, cardiovascular, and central nervous system agents, nutritional products, gastrointestinal agents, and coagulator modifiers were the most frequent medications involved in near misses. The issue of near misses has been explored globally from many perspectives, including those related to transfusion medications,[15,41] bedside medications,[42] intravenous medications,[43] and top ten lists of medications.[44] As we found in the present study, antibiotics are prescribed most frequently in hospitals and are the most common source of adverse drug events.[45] In addition, intravenous medications from multiple drug groups have been associated with up to 54% of potential adverse drug events/near misses and 56% of medication errors.[43]

Researchers have suggested that the counseling of patients regarding medication use and the documenting of details in e-prescriptions by physicians are key in preventing medication errors.[46] However, the results of the present study contrast with those findings, in that most physicians and pharmacists did not follow the recommended steps associated with medication error prevention. On the other hand, the importance of patient counseling from several perspectives by trained clinical pharmacists is gaining ground globally.[47] Patient counseling has multiple advantages, including prevention of medication errors, enhanced concordance and adherence, and improved outcomes.[46,47] When counseling patients regarding medication use, pharmacists should focus on the following: name and description of the medication, route of administration, dose, dosage form, duration of drug therapy, special directions and precautions for preparation of drugs, administration and use by the patient, side effects, interactions and therapeutic contraindications, techniques for self-monitoring drug therapy, proper storage, refill information, and appropriate action in case of a missed dose. Counseling of patients regarding medication use by pharmacists and the documenting of notes in e-prescriptions by physicians are essential for quality health care services; this benchmark is associated with greater safety for health consumers and, therefore, enhanced health consumer satisfaction,[48] which is the ultimate aim for

health care providers and health managers. Patients and their family members are an important source of identifying medical incidents affecting health care.[49] In addition to counseling patients and caregivers, appropriate training and engagement in identification of errors in the emergency department may further boost health care safety.[49]

The present study has certain limitations. What proportion of near misses are reported to the medication safety unit cannot be deduced from this study. The inherent weakness of cross-sectional studies is that they cannot give definite cause-effect relationship; this also applies to the present study. In light of the proactive approach of capturing and correcting of near misses, their real consequences and severity cannot be determined. Furthermore, many of the implications included in our discussion are speculative, which is an inherent weakness in any cross-sectional design. The authors have attempted to discover the underlying causes of near misses by identifying the types of errors, but types of errors may not reflect the true reasons for near misses. Although the process of medication prescription and administration is a complex issue governed by multiple factors, other dynamic factors related to electronic prescribing were not available in this research. The present study was also conducted in only one tertiary setting in the Riyadh region, so its results cannot be generalized to other hospitals with electronic prescribing systems in KSA. Evidently, most near misses were reported by pharmacists, which could represent a reporting bias. Arguably nurses and doctors identify near misses but do not report them, as supported by a study suggesting that administration errors and transcription errors are 19% and 10%, respectively.[16] Nurses will often simply refer the matter to a prescriber and seek clarification of the prescriber's intent. Despite these limitations, the present study has reported important findings with regard to the pharmacovigilance of e-prescription near misses, and has identified types of near misses and possible etiologies, and has made recommendations to improve reporting, correcting, and decreasing near misses, which are its strengths. Several innovative approaches have been recommended for mitigating near misses, and this study has highlighted them throughout the discussion. This research calls for future studies of near misses in KSA.

Conclusion

This cross-sectional, descriptive study provides important pharmacovigilance insights into electronic prescribing near misses. The findings and recommendations emanating from these are comparable with the current international landscape regarding electronic prescribing near misses. Based

on our brief literature review and the opinions of near miss reporters and identifiers, this study has made several recommendations for further mitigating electronic prescribing near misses in hospitals, which may be implemented in similar hospitals across the nation. A near miss (also known as a close call) is an unplanned event that did not result in injury to the patient. However, electronic prescribing systems connected to the MEDI system need to be upgraded for capturing and correcting them in order to prevent the occurrence of real medication errors associated with compromised patient safety, increased economic cost, and increased morbidity and mortality.

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Disclosure

All authors except NAQ are affiliated to the tertiary care hospital where this study was conducted. NAQ has no conflicts of interest in this work.

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