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CPOE in Iran—A viable prospect? Physicians' opinions on using CPOE in an Iranian teaching hospital

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ABSTRACT

Background: In recent years, the theory that on-line clinical decision support systems can improve patients' safety among hospitalised individuals has gained greater acceptance. However, the feasibility of implementing such a system in a middle or low-income country has rarely been studied. Understanding the current prescription process and a proper needs assessment of prescribers can act as the key to successful implementation.
Objectives: The aim of this study was to explore physicians' opinions on the current prescription process, and the expected benefits and perceived obstacles to employ Computerised Physician Order Entry in an Iranian teaching hospital.
Methods: Initially, the interview guideline was developed through focus group discussions with eight experts. Then semi-structured interviews were held with 19 prescribers. After verbatim transcription, inductive thematic analysis was performed on empirical data. Forty hours of on-looker observations were performed in different wards to explore the current prescription process.
Results: The current prescription process was identified as a physician-centred, top-down, model, where prescribers were found to mostly rely on their memories as well as being over-confident. Some errors may occur during different paper-based registrations, transcriptions and transfers. Physician opinions on Computerised Physician Order Entry were categorised into expected benefits and perceived obstacles. Confidentiality issues, reduction of medication errors and educational benefits were identified as three themes in the expected benefits category. High cost, social and cultural barriers, data entry time and problems with technical support emerged as four themes in the perceived obstacles category.
Conclusions: The current prescription process has a high possibility of medication errors. Although there are different barriers confronting the implementation and continuation of

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Computerised Physician Order Entry in Iranian hospitals, physicians have a willingness to use them if these systems provide significant benefits. A pilot study in a limited setting and a comprehensive analysis of health outcomes and economic indicators should be performed, to assess the merits of introducing Computerised Physician Order Entry with decision support capabilities in Iran.

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1. Introduction

Adverse drug events (ADE) and medication errors at hospitals are common causes of prolonged hospital stay, injuries and even deaths [1]. It has been estimated that in United States approximately 98,000 deaths per year occur due to medical errors and more than 7000 deaths are related to medication errors [2].

In recent years, expectations that clinical decision support systems might provide important clinical knowledge at the moment of prescription and reduce the number of medication errors has gained greater acceptance [3].

Computerised Physician Order Entry (CPOE) is a part of a clinical information system that enables physicians to enter the orders directly into the computer. Such systems may also provide real-time clinical decision support [4]. One study reported that CPOE systems had reduced the incidence of non-intercepted serious medication errors by 55% [5]. Since, in a CPOE system, the end user is the prescriber, the role of prescribers and their compliances to accept the system are quite important in the development process [6,7].

Due to the software engineering standards, requirement elicitation and analysis that are essential primary steps in any information system development, should only focus on the users' views [8]. Therefore, the better the understanding we have regarding users' needs and points of view, the less resistance will occur among them [3]. Resistance to CPOE among physicians, specialists and sub-specialists is a major problem in many hospitals [9]. Therefore, physicians' acceptance and their collaboration have been recognised as the key factor in successful implementation of CPOE systems [10].

Few studies have been conducted to assess essential requirements for the implementation of CPOE in middle-income countries, including the Middle East. In this region, the Islamic republic of Iran is a middle-income country, with almost 70 million inhabitants in 2005 [11].

One study reported that medication related problems in Iran were responsible for 11.5% of admissions, and that 92% of them were either preventable or probably preventable [12]. In another study, adverse drug reaction rate was 16.8%, and about half of the adverse events could have been prevented if dose, interval and choice of the prescribed drugs were appropriate and proper laboratory tests were performed [13]. A third study on the elderly population of Iran revealed that 27.6% of them were prescribed at least one inappropriate medication per every visit and that 10% of the prescribed orders contained at least one drug–drug interaction [14]. These studies reveal that Iranian healthcare may have much to gain by introducing CPOE and decision support functionalities to clinical information systems.

Iran has promised in its cooperation strategic plan with the World Health Organisation to put efforts into extending the use of health information technology and evidence based decision making in the health sector [15]. However, to the best of our knowledge at the time of this study there was no implemented CPOE system in Iranian hospitals. Paper-based medical records are used as the primary source of all medical information [16], and physicians are not responsible for any computerised registrations of inpatients.

In Iran, medical faculty members are specialists who have treatment, teaching and research responsibilities. Overcrowding of patients, involvement in therapeutic activities, and constraints on time have forced these physicians to spend less time on educational and research activities [17,18].

Studies have shown that it is difficult to adopt systems which are considered as time consuming and 'not likeable' by physicians [19]. Therefore, to convince these busy physicians to change their daily habits and spend time on CPOE will be a challenge.

A preferred solution to reduce prescribers' resistance is to design the system in close collaboration with them [20]. Consequently, before starting implementation of a CPOE system in Iran, a thorough understanding of the current prescription situation and the opinions of different groups of prescribers should be investigated.

The aim of this study is to explore physicians' opinions on the current prescription process, and expected benefits and perceived obstacles to the employment of CPOE in an Iranian teaching hospital.

2. Methods

2.1. *Setting*

Hamadan is a province in the North West of Iran, with 1,700,000 inhabitants. Ekbatan is a 234 bed teaching general hospital in the capital city of Hamadan. The former hospital information system (HIS) in Ekbatan hospital was replaced with an order-entry-based HIS in May 2005 (Sayan-HIS), which enables implementation of CPOE. When this study was performed, the HIS did not provide functionalities to prevent medication errors. To the best of our knowledge at the time of this study, aside from Sayan-HIS, there was no order-entry-based HIS fully implemented in any other province in Iran.

2.2. *Investigation methods*

In order to investigate the current prescription pattern in its normal context, on-looker observations were performed. focus group discussions were employed to develop an interview guideline. Based on this guideline, semi-structured

interviews were conducted to explore the physicians' point of views on the subject.

2.3. Observation of the current prescription pattern

The first author, who had worked at the Ekbatan hospital for 1 year as an intern, conducted 20 sessions of on-looker (non-participant) observations [21] in different wards of the hospital practicing internal medicine, paediatrics, urology and cardiology.

The observations were performed between December 2006 and January 2007. The average observation time per session was nearly 2 hours. Fourteen sessions were held between 8 and 12 a.m. Others were performed during afternoons and nights. The reason was to capture both group and individual prescription decision-making processes. Observations mainly focused on the role of different actors, including senior and junior physicians and nurses during the joint or individual visits in the prescription process. The observer took notes during the observations.

2.4. Focus group discussions to develop interview guideline

In order to select participants, fulltime faculty members from different departments and senior residents at the hospital were invited to a meeting and the CPOE project was explained to them. Maximum variation purposive sampling [22] was used to select participants who expressed more interest on the subject and could provide different views and constructive ideas.

Finally, eight persons were selected. The members were one faculty member in cardiology, the director of the hospital (who is a faculty in nuclear medicine), one sub-specialist in children's infectious diseases (who is a faculty member of the paediatric department), one sub-specialist in paediatric gastrology (who is also a faculty of the paediatric department), the head of the surgery department, one faculty of the urology department, the head of the pharmacology department, and the chief resident of paediatrics at the hospital. The first author moderated all sessions.

After six sessions, the guideline was finalised, consisting of 20 questions. During the interviews, three important questions emerged and were added to the guideline. The questions concerned four different concepts: ordering behaviours (Appendix A, questions 1–3), attitude toward medication errors (Appendix A, questions 4–10), computers and employing them in daily practice (Appendix A, questions 11–15), and finally prerequisites, advantages and obstacles to the implementation of a medication error prevention system at the hospital (Appendix A, questions 16–23).

2.5. Semi-structured interviews with prescribers

To select interviewees, all prescribers at the hospital (specialists, sub-specialists, residents and interns) were invited by the hospital chancellor to a meeting on the subject.

In the meeting, the first author explained the entire project and demonstrated the order-entry-based HIS which was ongoing at the hospital. Since clinical decision support did not exist, prototyping was used to provide a clear view of the future project for the prescribers. Epocrates Rx (Free version) (http://www.epocrates.com, accessed on 2008-03-18) was used to simulate order entry style by physicians and medication error warnings by the system.

Maximum variation sampling [21] was used by selecting people with different specialties and with different levels of expertise in prescription to capture different views on the subject. Before starting an interview session, the first author explained the project and the ongoing order-entry based information system, as well as the idea of Computerised Physician Order Entry for each of the interviewees to be sure that all of them had the same understanding of the future project.

Of 20 invited physicians, 19 willingly agreed to take part in the interviews. Of these, 12 were specialists or sub-specialists in different subjects (cardiology, internal medicine, paediatrics, surgery and urology), 3 were residents, and 4 were interns.

All interviews were recorded using a digital recorder. The interviews were held in the Persian language (Farsi). The first author transcribed all interviews verbatim. His first language is Persian. The identity of the informants was removed during transcription, to guarantee confidentiality.

The analysis method was inductive thematic analysis [21]. Meaning units were condensed and primary codes were extracted using content analysis. Codes with similar meaning were categorised into the same category. All meaning units were translated into English, and the co-investigators checked the coding process, and categories were discussed.

The results of the semi-structured interviews and the observations were used to present a graphical model of the present prescription workflow. The model was introduced to the hospital physicians and nurses in different group meetings at the hospital and was accepted by them with minor changes. Most importantly, they also identified transitions within this model having a higher possibility of errors.

2.6. Ethical considerations

The National Ethical Committee at the Ministry of Health and Medical Education in Iran issued ethical permission in 2005. Participations in focus groups and interviews were arbitrary, and participants could withdraw at any time. Participants were informed of their rights, and a verbal informed consent was tape-recorded before the start of each interview. All physicians accepted to take part free of charge.

3. Results

After analysing the data, three main categories were extracted as: current prescription process at the hospital, opinion of the physicians on the current prescription process, and finally, opinion of the physicians concerning a possible future migration toward CPOE and using the dose and interval decision support systems.

3.1. Current prescription process at the hospital

The prescription process is shown in Fig. 1. This description is based on interviews (questions 1–3 in the interview guideline, Appendix A) and observations by the first author.

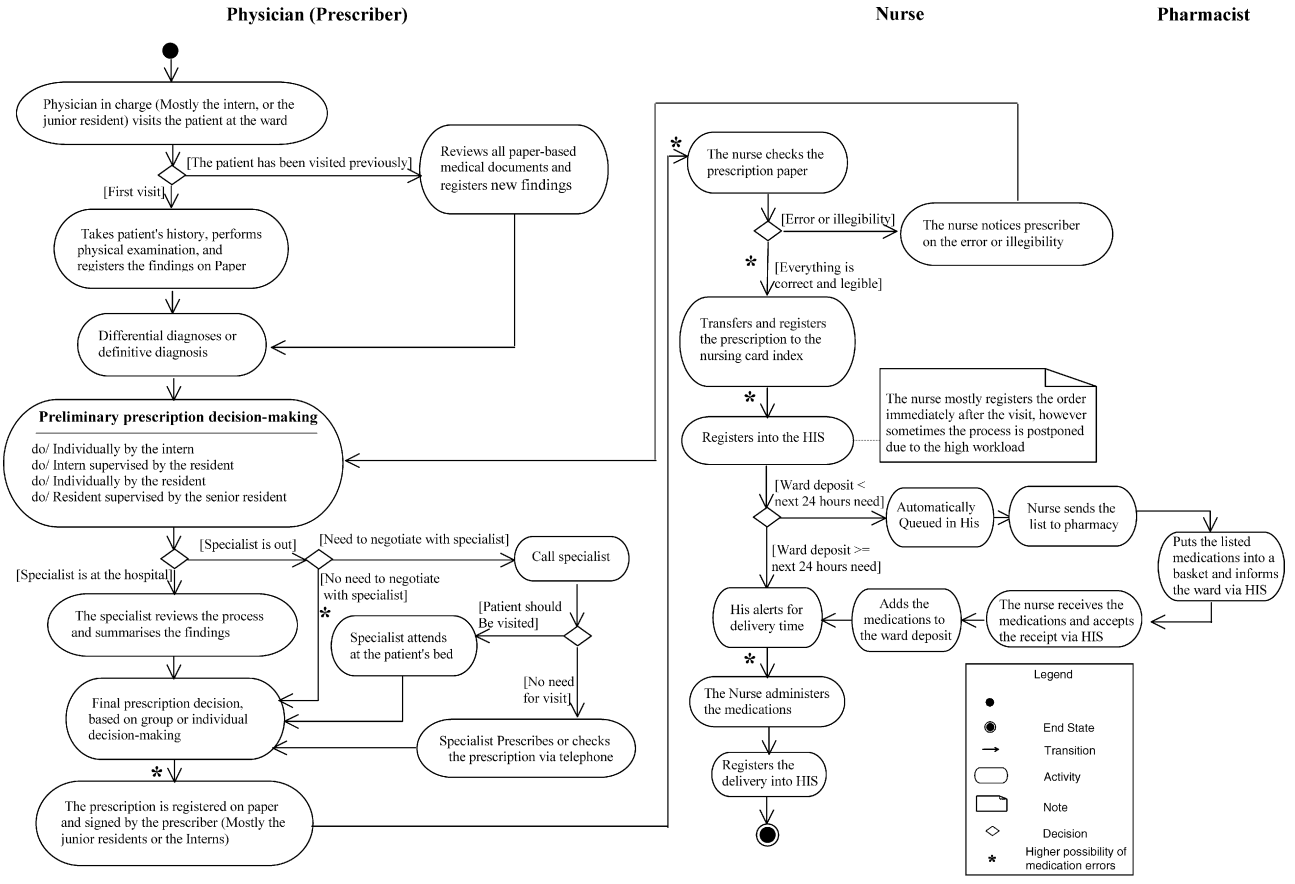

Fig. 1 – The current prescription process in the Ekbatan Hospital (UML activity diagram).

The process starts as the physician in charge takes the patient's history, performs physical examinations, and reviews available medical documents, including progress notes, laboratory findings, and imaging. These data sources guide the physician(s) to a set of differential diagnoses or a definitive diagnosis, which help the prescriber(s) to select appropriate treatment for the patient.

The prescriber will then register medical records on paper. Currently, physicians do not interact with the HIS system. The nurse then reads the paper-based prescription and registers the new prescriptions into the HIS. In Iran, nurses have no authority to prescribe, or to change prescription. Following the data entry, the system reminds the nurse concerning the accurate drug administration time. The nurse administers medications and registers their delivery into the HIS.

3.2. *Opinion of the physicians on the current prescription process*

In Fig. 1, a star mark (*) identifies a transition with higher probability of medication errors. Based on interviews, three themes emerged in this category: decision-making, transcription, and overconfidence errors.

3.2.1. *Decision-making errors*

All interviewees (19 out of 19) believed that, in Iran while prescribing drugs, doctors often rely on their memory and rarely look for dosages or intervals in their references. Physicians with less experience on the subject, and particularly interns, may easily make erroneous decisions and the patient may suffer from such mistakes. This sentiment was expressed by one intern as:

> '*In Iran you have to have everything in your mind. We start to memorise doses when we are students and continue that when we become interns. If we forget something we try to find it in our small pocket references hush-hush and far from patients*'.

3.2.2. *Transcription errors*

Physicians believed that multiple transfers from one sheet to another may lead to transcription errors. The probability will increase when several groups of prescribers, such as specialists, residents and interns with more or less illegible handwriting are involved in the registration process and nurses and operators with different clinical insight transcribe them.

3.2.3. *Overconfidence errors*

In our study, none of interviewees had previously received any feedback on their possible medication errors. When asked to rate themselves, most of them (16 out of 19) believed that they did not make critical and frequent mistakes while prescribing. This tendency towards overconfidence was exemplified by one of the specialists as:

'*Errors can happen but it depends on how careful you are when you are prescribing. If you try to be careful like me, it will rarely happen. Otherwise, you can make big mistakes*'.

3.3. *Opinion of the physicians concerning a possible future migration toward CPOE and using the dose and interval decision support systems*

Physicians' opinions were categorised as: *expected benefits*, and *perceived obstacles*, while employing a CPOE system.

3.3.1. *Expected benefits*

Three themes emerged in this category as: *confidentiality issues, reduction of medication errors, and educational benefits*.

3.3.1.1. Confidentiality issues. Physicians liked to receive feedback on their practice but did not like their errors to be disclosed to the nurses; they preferred to enter their prescriptions by themselves so as to get the feed back directly. This is a typical reply:

'*It is much better to give the feedback to the prescriber. In that case, the physician will cooperate better and will show less resistance. Also if the new medication or the changed dosage is also incorrect, the prescriber will receive the feed back immediately*'.

3.3.1.2. Reduction of medication errors. In our study, all interviewees believed that physicians commit mistakes and errors.

They mentioned that dose and interval are more important sources of medication errors in comparison with selection of the drug, because drug selection is based on the prescriber's knowledge but regulating dose and interval are based on memory and accurate calculation.

When we presented the results of the previous studies and informed them concerning the possibility and preventability of medication errors, the physicians expressed great interests to move toward on-line prescription and CPOE. The interviewees believed that a well-designed medication error preventing decision support system could prevent various unintentional errors and reduce their strain of holding everything in their mind.

3.3.1.3. Educational benefits. All interviewees believed that they did not have sufficient academic training on prescription methods, and that they had learned from each other at the hospital. This lack of training was expressed by one physician as:

'*We did a research and in that research only 1 out of 403 prescriptions (for out patients) had performed all 17 different mandatory rules of prescribing*'.

They believed that by using pre-constructed orders and standardised prescribing formats, new prescribers and trainees can use the system as a self-learning and educational program.

3.3.2. *Perceived obstacles*

Four themes emerged in this category as: *high cost, social and cultural barriers, a time consuming system will fail and problems with technical support*.

3.3.2.1. High cost. Interviewees believed that since Iran is a middle-income country and hospitals are economically autonomous, it would probably be difficult for the hospital to afford the relatively high costs of the project from its revenue.

3.3.2.2. Social and cultural barriers. One third of interviewees were concerned about the future of advanced computer technology in Iran, since this is mostly produced by companies in the United States. One of them expressed this concern as:

'*We have threats around this country and there could be situations where we lose support for our technologies especially political threats. If we become totally dependent on them, but can not get enough support, what shall we do?*'

They also mentioned that the social expectation is that physicians should be able to fulfill their job everywhere in the country. One of the specialists stated:

'*With the traditional system by using the light of a candle and a piece of paper in a far poor rural area, it is still possible to prescribe and save lives. But what if the physician becomes totally high-tech dependent and lose the clinical proficiency? Is it possible to afford these technologies everywhere in Iran?*'

Another social expectation from doctors is to have everything in their memory, without opening any book at the point of care.

'*I always recommend my students that if you want to look for a specific dosage you cannot do it in front of the patient. Opening the book and visiting the patient at the same time will induce [in the patient's mind] that this doctor definitely knows nothing. This is cultural*'.

3.3.2.3. A time consuming system will fail. Interviewees mentioned that the most important threat to the continuation of a CPOE system is the time spent for data entry. Physicians will get frustrated and will quit if they have to type many things into the computer, especially in the early phases. Even, new source of errors, such as data entry errors, could arise. One of the interviewees said:

'*I have started an electronic patient record system in my private clinic. Since then I have to spend four times more than what I was spending on paper based documentation. If your system wants to be time consuming like the one that I have, most of the physicians will get frustrated and will quit. You should think about it carefully*'

Another interviewee mentioned that

'*Even in the present system, I have seen nurses are mostly sitting in front of the computer and they miss the patients. The patient shouts and cries to have the nurse at the bed but the nurse replies "I'm entering your data into the computer!" It seems that formalities have dominated practice.*'

Shortcuts, menus, pre-constructed order sets, as well as close collaboration with prescribers while designing the system, were mentioned as some solutions to this problem.

3.3.2.4. Problems with technical support. Since in Iran most of the HIS systems are locally developed by small size com-

panies with limited resources, interviewees were concerned about the future support and maintenance of the system. One of the physicians mentioned:

> *'Here is Iran! Sometimes systems are down and there is nobody to help. If there is a bug in the software and we can't find the programmer and all clinical procedures are dependent on computer, the hospital will be in crisis. What will happen if the wireless network goes down? We have to cancel all visits? We need immediate support in this case. Are you sure the hospital can afford such immediate support?'*

Because of the mentioned obstacles, our interviewees suggested a pilot study in one ward before trying CPOE in all wards in the hospital to find appropriate solutions to these obstacles and determine whether the benefits outweigh the costs.

4. Discussion

The prescription process in Iran is a physician-centred, top-down, model, where the prescriber has all the authority and responsibility to prescribe or change the prescription, and each junior physician is supervised by a senior. Students and interns are at the bottom, the attending is at the top, and residents are in between. In this situation, feedback from junior prescribers and nurses could be interpreted as incompetence of the senior prescribers. Therefore, senior physicians do not like their errors to be disclosed to other staff especially to nurses. They gradually become resistant to feedback and since they are mostly relying on their memories, they become overconfident. They believe that errors happen only to other prescribers. Relationship between health care providers in Iranian hospitals [23] is perhaps different with some hospitals in Western countries where a patient-centred collaborative approach has been introduced and there is a close collaboration between nurses and physicians in clinical decision-making [24,25]. Iranian physicians try to fulfill their daily practice, and are not interested in the HIS and electronic patient record since it does not have any clinical or educational benefit to them. It is just used to calculate the patients' bills. Therefore, managers have mandated nurses to enter all prescriptions from the prescription papers into the computer. Frequent transcriptions and transfers between paper and computers have imposed lots of duplications onto the system. In the USA and some European countries, by eliminating paper registration and using on-line prescription directly by physician they have tried to reduce errors derived by sequential frequent paper registrations [26].

The expected benefits in our study were quite similar to the findings in the USA and other high-income countries. Educational benefits of CPOE for medical students and interns which were identified in our study, have been previously mentioned by Knight and colleagues [27]. As in the report from the Institute of Medicine in the USA [2], all prescribers in our study believed that 'To error is human' and nobody is immune from committing mistakes and errors. Similarly to our results, many articles perceived CPOE as a powerful tool to provide clinical decision support at the time of ordering [28], reduce dose and interval errors, and lead to patient safety [29].

Apart from all the positive expectations, studies in other countries demonstrate that introduction of electronic health records represents a substantial change in doctors' workflow, and electronic health record system imposes a greater burden on clinicians [6,30,31]. In our study, some physicians complained about the extra formalities the current order based system has imposed on nurses because of the data entry time, and its negative effects on their clinical activities. Interviewees were suspicious that if the same story is going to happen to the physicians after implementation of the CPOE. Previous studies have shown the failures of systems demanding a high workload of data entry, due to the users' frustration and withdrawal of cooperation [19], which highlights the importance of these concerns. Appropriate user interface design [32] and strong leadership support [9,33] during a move to on-line prescription system have been introduced as key factors in successful implementation.

Strong leadership is also important to support the high costs of CPOE for implementation and maintenance [33]. A similar project at the Brigham and Women's Hospital (BWH) in the USA has cost approximately 11.8 million US dollars over 11 years [34], and our interviewees were doubtful whether their hospital can even afford one fifth of this budget within 10 years. High costs have been mentioned as an important barrier for implementation and adoption of CPOE systems in high-income countries [9,35].

Social expectation of an Iranian physician to be able to prescribe on a piece of paper is another problem. Physicians believe that a computerised system might lead to that their professional knowledge will decrease over time. Moreover, they were also afraid that if the database contains errors, or if the system is not available because of some technical problems, then the results would be dangerous for the patients. Even in developed countries, for many physicians changing clinical competency with technology seems to be a 'Win-Lose game' [36,37]. While maintenance and technical support is a worldwide concern [36,38,39], the problem becomes more prominent in Iran when there is no support for the software produced by American companies [40], although sometimes indirect support might be obtained [41]. The country is now gradually moving toward using open source software [42].

4.1. *Limitations in this study*

Since this study was primarily a qualitative study, we could not speak with all physicians at the hospital, but we tried to interview with representatives who could provide as much information as possible. Therefore, this study could not be generalised to the whole country (statistical generalisability).

4.2. *Conclusions and suggestions*

The current prescription process is a physician-centred, top-down, model, with a high possibility of decision-making errors as well as duplication and transcription errors, which favours CPOE implementation. There are numerous economic, social, cultural and technological barriers confronting the implementation of a CPOE system in Iranian hospitals, but physicians are willing to use technology if the system provides capabilities to

Summary points

What was already known before our study

- Medication errors could be prevented by CPOE implementation.
- Physicians' satisfaction play important role in successful implementation.
- In the hospitals that there are good collaborations and have good communications between physicians, nurses and other care providers, CPOE has been implemented with higher success rate.
- Very few studies have been conducted on CPOE in middle-income countries, no previous study has been performed in Iran.

What did our study add to the body of knowledge

- Prescription pattern in Iranian teaching hospitals is a physician-centred, top-down, model with a high possibility for different medication errors.
- Economical constraints are important obstacles for CPOE implementation in middle-income countries like Iran.
- Cultural and social barriers are specific obstacles, which have not been previously addressed.
- Iranian physicians have positive attitude toward CPOE but they must gain important benefits to accept the risk of all obstacles.

reduce formalities, improve prescription efficiency and accuracy, and leads to the patient's safety and fewer medication errors.

We support the interviewees' recommendation, that a pilot study in a limited setting with a proper analysis of costs, benefits and the extent to which this system can reduce the number of dose and interval medication errors, should be performed to assess the merits of introducing CPOE with decision support capabilities in Iran.

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Contribution: All authors contributed to the final approval of the submitted manuscript. Alireza Kazemi contributed to conception and design of the study, performed observations and interviews, moderated focus group discussions, transcribed interviews, conducted the analysis with co-authors, designed the prescription diagram and drafted the manuscript. Johan Ellenius was involved in conception of the study, analysis, revising the prescription diagram, and revising the manuscript. Shahram Tofighi was involved in analysis and revising the manuscript. Aref Salehi was involved in design of the study and revising the manuscript. Fatemeh Eghbalian was involved in analysis and revising the manuscript. Uno Fors contributed to development of the study, analysis, revising the prescription diagram, and revising the manuscript.

Appendix A. Physicians' opinions interview guideline

1. What resources are you using while you decide dose and frequency for your prescription? (Textbooks in your own specialty, pocket references, hand outs, pharmacology textbooks, your own knowledge, internet web sites, computer programs or others (please specify)).
2. To what extent do you use anything other than your own expertise when deciding drug dose and frequency?
3. What are the different methods you use to register prescriptions in patient medical document (yourself directly in medical record, yourself on separate piece of paper, nurse, telephone call to nursing staff, residents, interns or any other way, . . .) (could be changed a little, based on interviewee)?
4. In your opinion, is there any possibility for making mistakes while prescribing? If yes, does this influence your daily job? In what way (please specify)?
5. What is the principal cause of medication errors in your hospital (miscalculation of dose and interval, choosing inappropriate drug, while the data is transferred to medical document, or any other area)?
6. Do you think if there is any way to avoid these kinds of mistakes?
7. In your opinion, is the percentage of occurrence of miscalculation in dose or frequency high or low?
8. What is your suggestion to reduce dose miscalculation errors?
9. What is your suggestion to reduce frequency errors?
10. How we can improve prescription methods?
11. To what extend are you familiar with computers?
12. How many hours (minutes) do you spend on computers and/or the internet weekly (on average)?
13. Are you using any kind of software in your specialist field or general medicine?
14. Have you ever visited websites that provide their clients with information about drugs, their interactions and side effects for free?
15. Have you ever read anything about medication error prevention by using computers?
16. In your opinion, to what extent might computerised systems be useful for clinical decision making on drug dosage and frequency?
17. What are the advantages of this method?
18. What are the disadvantages and obstacles for such a method?

19. If the system could be implemented in your ward, are you willing to use it? Why?
20. What requirements do you think are necessary for you in order to achieve the maximum benefit in working with a possible decision support system for medications? (Please specify.)
21. Do you prefer to enter the data beside patients' beds and receive feedback yourself, or do you want to write on paper and leave other staff to put them on the computer and receive feedback and tell you about it? (Entering the data might be time consuming; it may force some duplication, you can make errors while typing.)
22. What clinical criteria in a patient should be considered while ordering? (For example: age, diagnosis, what else?)
23. If you were the person who wanted to start such a project, which ward would you prefer to start with? Why?

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