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Commentary

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Author for correspondence:
Reza Khajouei, Medical Informatics Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, P.O. Box: 7616911320, Haft-bagh Highway, Kerman, Iran.
E-mail: r.khajouei@kmu.ac.ir; r.khajouei@yahoo.com

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Evaluating physicians' perspectives on the efficiency and effectiveness of the electronic prescribing system

Ahmad Raeesi[1,2], Reza Abbasi[3] and Reza Khajouei[2]

[1]Department of Medical Informatics, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran; [2]Department of Health Information Sciences, Faculty of Management and Medical Information Sciences, Kerman University of Medical Sciences, Kerman, Iran and [3]Health Information Management Research Center, Kashan University of Medical Sciences, Kashan, Iran

Abstract

Background. The implementation of the electronic prescribing system follows certain objectives, and users' perspectives can contribute to understanding the efficiency and effectiveness of this system. This study aimed to evaluate physicians' perspectives on the efficiency and effectiveness of the electronic prescribing system.

Methods. This study was conducted on all physicians using the electronic prescribing system in clinics and hospitals affiliated with the treatment deputy of the Social Security Organization (SSO) in Sistan and Baluchistan Province in Iran. Data were collected using a self-administered questionnaire containing three sections: (i) Six items related to demographic data and clinical experience, (ii) Specific questions based on a five-point Likert scale-related physicians' perspectives about efficiency (19 questions) and effectiveness (13 questions), and (iii) Open-ended questions about the positive and negative aspects of using the electronic prescribing system.

Results. The mean and standard deviation of the efficiency and effectiveness of the electronic prescribing system were 3.68 ± 0.67 and 3.84 ± 0.65, respectively. Patient safety had the highest mean score among all dimensions (4.0 ± 0.64). Most participants ($n = 55$, 79%) considered the efficiency and effectiveness of this system high. More than 90 percent of the physicians ($n = 63$) believed that the electronic prescribing system enables a better medication prescription by providing alerts and access to patients' medication history.

Conclusion. The findings showed that most physicians believed that the electronic prescribing system of Iran's SSO has high efficiency and effectiveness. In particular, physicians believed that using this system improves patient safety and reduces costs.

Background

Nowadays, healthcare centers are using multiple types of health information systems to collect, store, process, manage, and interoperate information with a wide array of purposes. One of the systems currently used in healthcare centers is the electronic prescribing system. The electronic prescribing system uses computerized communication networks to store and transfer physician orders to the pharmacy at the point of care (1;2). Previous studies (2–9) have shown that using the electronic prescribing system enhances the efficiency of care providers, improves patient safety, reduces medical costs, increases the effectiveness of services provided, enables access to the patient's medication history and the monitoring of medication interactions, improves medical outcomes, and reduces healthcare expenses.

In the southeast of Iran, insurance coverage and access to healthcare services are lower than other areas (10). In this area due to the small number of physicians in proportion to the population, the number of visits to hospitals and clinics affiliated to the Social Security Organization (SSO) is high, and the time spent by the physician on each patient is, therefore, limited. According to the results obtained in some studies (11–13), electronic prescriptions take more time to write compared with paper prescriptions. Also, about half of a physician's time is spent on recording data in the electronic health record (EHR) and documentation and more than 2 percent for electronic medication order entry (14). Also, a large number of errors can occur in outpatient care (13); however, previous studies have shown that these systems improve patient safety and reduce costs (8).

Efficiency means the expenditure of a certain amount of effort and resources to fully and properly achieve a goal and includes items such as time, costs, and ease of performing tasks (15;16). Effectiveness means the full and proper achievement of a goal by the user and includes items such as patient safety and the system's influence on the quality of the provided services (15;16). Considering that effectiveness can be used for measuring output, whereas efficiency

can be used to assess the resources needed to achieve these goals (15), the system's status can, therefore, be measured by the concurrent evaluation of efficiency and effectiveness. Without considering users' perspectives and their levels of satisfaction, the system will be abandoned. Accordingly, due to the high costs of developing systems, significant financial resources will be required to buy and implement an information system. Thus, it is necessary to evaluate their perspectives and their levels of satisfaction (17;18). Physicians are the main users of the electronic prescribing system.

Many countries, especially low- and middle-income countries, still use manual traditional prescribing systems. Thus, applying the experiences of countries that used the electronic prescribing system can be helpful to understand the impact of this system on its users (19).

To our knowledge, no study has been carried out concurrently to evaluate the efficiency and effectiveness of the electronic prescribing system from the perspective of physicians despite the extensive use of this system. Efficiency and effectiveness have been evaluated in a few studies as the secondary objective (20–22). To achieve the goals of the successful implementation of the electronic prescribing system, the perspectives of physicians can be useful in understanding the efficiency and effectiveness of the system. The aim of this study was to evaluate physicians' perspectives on the efficiency and effectiveness of the electronic prescribing system. This study may help attain the main goal of developing electronic prescribing systems, which is improving the quality of any services provided to patients in low- and middle-income countries.

Methods

The Electronic Prescribing System of the SSO

The Iranian social security organization has two big sections, namely insurance and medical care services. This organization is the largest health insurance organization that covers half of the country's population. Also, the SSO is the second largest provider of health services to patients after the ministry of health in Iran. All of the medical care services are provided free to patients in the healthcare centers affiliated to this organization.

The electronic prescribing system of the SSO's medical centers and hospitals is the most extensive and the only such system implemented countrywide in Iran. This system is developed by the Tamin ICT (Information and Communication Technologies) and management and consultancy services company affiliated with the SSO. This system is used in all medical centers affiliated to the SSO, including 70 hospitals and 279 general and specialized clinics throughout the country (23).

The electronic prescribing system of the SSO is used for inpatient and outpatient centers affiliated with the SSO and supports the entire electronic prescribing process. This system is the first experience of Iranian physicians to register their medications in an electronic format. However, this system has the following drawbacks: Only physicians who are working in the SSO-affiliated health centers have access to this system. The process of interoperating and integrating with other systems has not been implemented in many health information systems in Iran. Thus, healthcare centers are not able to exchange health data together.

The electronic prescribing system implemented in SSO health centers and hospitals works as part of the hospital information system in hospitals and as a separate system in clinics for the registration of medications and paraclinical procedures by physicians and is only available to physicians in these centers. This prescribing system has not been integrated with the broader electronic health systems such as pharmacies or other hospitals in Iran yet. Each SSO healthcare center has a solely electronic prescribing system that is not integrated together. Figure 1 illustrates the functional process of using the electronic prescribing system. In this system, the availability of medications is based on the national formulary pharmacopoeia of Iran (24), but the physicians can only prescribe the medications that exist in the hospital's pharmacy. Otherwise, the system informs the physicians to prescribe an alternative medication. Medications can be selected and registered by the physician through both a search and from the list of medications registered as a package.

Using this system, physicians are able to do the following activities: select the intended medications and then register their order according to a medication list, and select the method of administration and dosage. Also, in this system, the directions of use, and the total quantity authorized to be dispensed, and communicating orders to the hospital pharmacy are provided. Medications are then automatically registered in the patient's medication history. Paraclinical measures, including tests, imaging, and other

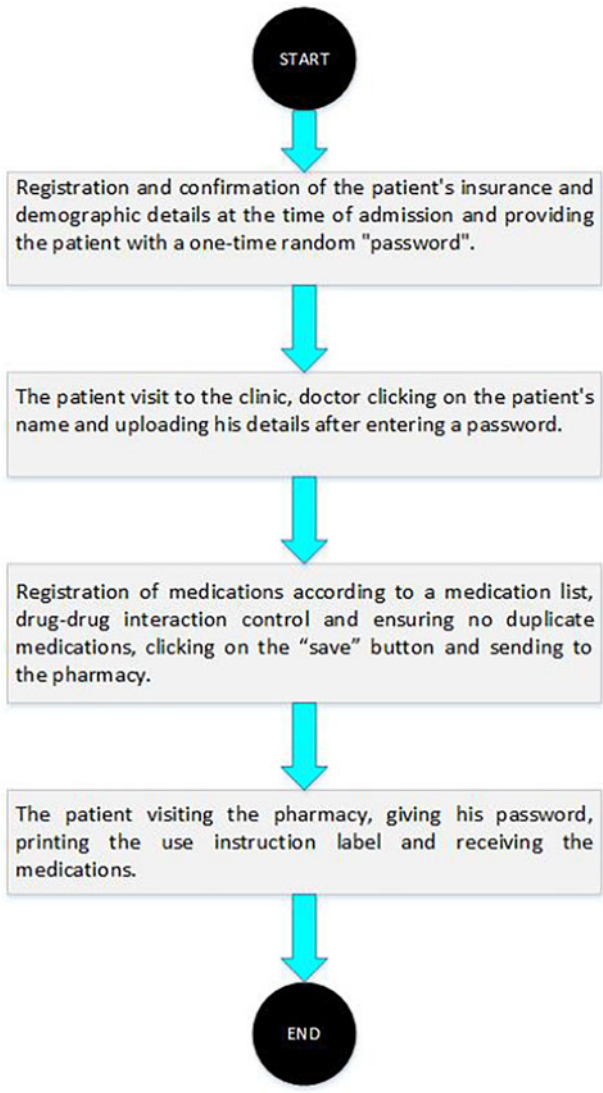

Figure 1. The process of working with the electronic prescribing system.

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procedures, can also be registered. In addition to the registration of medications and procedures, the patient's vital signs, main complaint and current illness, disease history, physical examination results, diagnosis, and diagnosis explanation and treatment plan can also be registered in this system. The system warns physicians about any drug–drug interactions or if a certain medication has already been prescribed to the patient by other physicians in recent times. At present, this system only registers the medications available in the relevant health center and other medications not available in the same center are registered as paper prescriptions.

Study Design

This descriptive-analytical study was conducted in 2018 on all physicians using the electronic prescribing system of the SSO in Sistan and Baluchistan Province. Sistan and Baluchistan Province is one of the southeastern provinces of Iran. This province is the second widest province of Iran with a population of 2.8 million. Its provincial SSO has five general and specialized clinics and two hospitals, which provide medical services to approximately one-quarter of the province's population. This study was conducted a year after the implementation of the electronic prescribing system in this province. This study was approved by the ethics committee of Kerman University of Medical Sciences (IR.KMU.REC.1397.262).

Data Collection

Data were collected using a self-administered questionnaire based on the review of relevant scientific literature (2;4;8;12;25). The validity of this questionnaire was confirmed by two medical informatics experts and two health information management experts. The reliability of this questionnaire was tested on questionnaires completed by twenty random participants using Cronbach's alpha ($\alpha = 94\%$) (17).

The questionnaire consisted of three sections:

(1) Six items related to demographic data and clinical experience, computer skills, the use of computers per shift (based on hours), and the site of using the electronic prescribing system by the participant.
(2) Questions related to physicians' perspectives on the efficiency (19 questions) and effectiveness (13 questions) of the electronic prescribing system. The efficiency was in three dimensions, time (7 questions), costs (5 questions), and other efficiency-related questions (7 questions). The effectiveness was in two dimensions, patient safety (6 questions) and other effectiveness-related items (7 questions). The items were answered based on a five-point Likert scale ("totally disagree," "disagree," "ineffective," "agree," and "totally agree"). The asked questions about the efficiency and effectiveness of the electronic prescribing system are available in Table 1.
(3) Two open-ended questions related to the most positive and negative aspects of the electronic prescribing system.

Data were collected by the researcher through a visit to the physicians' workplace while using the electronic prescribing system and asking them to complete the questionnaire. Before completing the questionnaire, the participants were briefed on the study and how to complete the questionnaire, and informed verbal consent was obtained from them; completing the questionnaire indicated the participant's consent.

Data Analysis

Data were analyzed using SPSS-18. Descriptive statistics were used to calculate the frequency and percentage of the responses. To calculate the frequency and frequency percentage of whether participants agree or disagree, we consider the "totally agree" and "agree" options reported together and the "disagree" and "totally disagree" options also reported together. For the analytical statistics, each option on the Likert scale was given a score from one ("totally disagree") to five ("totally agree"), and their mean values were taken as the efficiency and effectiveness scores.

Normality was assessed using the Kolmogorov–Smirnov test. Given the normal distribution of the data, Pearson's analytical test was used to assess the relationship of age and work experience with efficiency and effectiveness, the relationship of the efficiency dimensions with the effectiveness dimensions, and also the relationship of efficiency with effectiveness. The analytical independent *t*-test was used to assess the relationship of gender, the site of using the electronic prescribing system, and specialization with efficiency and effectiveness. The relationship of computer skills with efficiency and effectiveness was also assessed using the ANOVA.

Results

Of the eighty-two participants in the study, sixty-nine (84%) responded to the questionnaire. The mean and standard deviation of age and work experience of these participants were 42 ± 10 and 12 ± 8 years, respectively. All of the participants had one-year experience of using this system, and the educational background of all participants was medicine. The demographic information of the participants is given in Table 2. In total, 56 percent ($n = 39$) of the participants were male. The majority of physicians (73%) had a moderate level of computer skills.

The mean and standard deviation of the scores of the efficiency and effectiveness of the electronic prescribing system were 3.68 ± 0.67 and 3.84 ± 0.65 out of five, respectively. Among the effectiveness dimensions, "patient safety" had the highest mean score (4.0 ± 0.64) and the "other effectiveness-related items" the lowest mean score (3.68 ± 0.73). Among the efficiency dimensions, the highest mean score pertained to "costs" (3.79 ± 0.66) and the lowest to the "other efficiency-related items" (3.6 ± 0.70).

The impact of the electronic prescribing system on efficiency based on the physicians' perspective is shown in Table 1. In the dimension of time related to the efficiency of the electronic prescribing system, the physicians' highest agreement with the electronic prescribing system pertained to the "correction of mistakes in the shortest time while using the system" and "saving the patients' time for receiving their medications due to the prescription being based on the pharmacy's availability list" with more than 80 percent ($n = 56$). The lowest agreement pertained to "allocating more time to the patients" with 52 percent ($n = 36$).

In the dimension of costs, 81 percent ($n = 56$) of the physicians believed that the greatest savings were due to the registration of the prescribed medications in the electronic prescribing system and the lowest agreement was obtained for the "reduced patients' costs" with 52 percent ($n = 36$). In the dimension of "other efficiency-related items," the greatest agreement among the

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Table 1. The frequency and frequency percentage of the items on the impact of the electronic prescribing system on efficiency and effectiveness

	Row	Item	Totally disagree and disagree Number (%)	Ineffective Number (%)	Totally agree and agree Number (%)
Efficiency	(A) Dimension of Time				
	1	Allocation of more time to the patients	19 (27.5%)	14 (20.3%)	36 (52.1%)
	2	Reduced waiting time for the patients	16 (23.2%)	12 (17.4%)	40 (58%)
	3	Spending less time on medication prescriptions compared with the traditional method	12 (17.3%)	11 (15.9%)	46 (66.7%)
	4	Correction of mistakes in the shortest time while using the electronic prescribing system	6 (8.6%)	6 (8.7%)	57 (82.6%)
	5	Saving patients' time for receiving medications due to the prescription being based on availabilities at the pharmacy	3 (4.3%)	10 (14.5%)	56 (81.1%)
	6	Saving the physician's time	16 (23.2%)	14 (20.3%)	39 (56.5%)
	7	Speeding up task performance	15 (21.7%)	16 (23.2%)	38 (55.1%)
	(B) Dimension of Cost				
	8	General reduction in the treatment costs incurred by patients	8 (11.6%)	25 (36.2%)	36 (52.2%)
	9	Savings in the prescribing and use of medications	7 (10.1%)	13 (18.8%)	49 (71%)
	10	Reduced number of prescriptions per patient	8 (11.5%)	16 (23.2%)	45 (65.2%)
	11	Savings in the organization's resources through medication registration	4 (5.8%)	8 (11.6%)	56 (81.1%)
	12	Reduced medication costs by choosing medications covered by insurance	4 (5.8%)	16 (23.2%)	49 (71%)
	(C) Other efficiency-related items				
	13	System's ease of use and not requiring much mental effort	10 (14.5%)	17 (24.6%)	42 (60.9%)
	14	Reduced number of prescribing issues, such as illegible handwriting	7 (10.1%)	1 (1.4%)	61 (88.4%)
	15	Reduced workload for physicians	16 (23.2%)	16 (23.2%)	37 (53.6%)
	16	Reduced patients' visits to medical centers	10 (14.4%)	29 (42%)	30 (43.4%)
	17	Greater efficiency in performing tasks	5 (7.2%)	23 (33.3%)	41 (59.4%)
	18	Easier task performance for physicians	11 (15.9%)	13 (18.8%)	45 (65.8%)
	19	Medication and procedure registration in fewer steps	6 (8.7%)	14 (20.3%)	49 (71%)
Effectiveness	Dimension of Patient Safety				
	1	Increased patient safety	2 (2.9%)	10 (14.5%)	57 (82.6%)
	2	Improved medication prescribing in accordance with clinical guidelines (more effective medication prescribing)	4 (5.8%)	18 (26.1%)	47 (68.1%)
	3	Fewer medical errors	3 (4.3%)	11 (15.9%)	55 (79.7%)
	4	Increased care in providing services	7 (10.1%)	20 (29%)	42 (60.8%)
	5	Better medication prescribing by providing the system's alerts	3 (4.3%)	3 (4.3%)	63 (93.1%)
	6	Better medication prescribing by gaining access to patients' medication history	3 (4.3%)	3 (4.3%)	63 (93.1%)
	(D) Other effectiveness-related items				
	7	Better exchange of information between physicians and pharmacies	6 (8.7%)	12 (17.4%)	51 (73.9%)
	8	Eliminating physicians' work demands in medication prescribing	8 (11.6%)	23 (33.3%)	38 (55%)
	9	Medication registration during patients' visits	5 (7.2%)	7 (10.1%)	57 (82.6%)
	10	Helpfulness of the system for prescribing	11 (15.9%)	24 (34.8%)	34 (49.2%)
	11	Registration of all intended medications	20 (28.9%)	18 (26.1%)	31 (44.9%)
	12	Facilitating a greater control over the prescribing of daily medications	2 (2.9%)	16 (23.2%)	51 (73.9%)
	13	Increased general effectiveness of the physician in prescribing medications	5 (7.2%)	16 (23.2%)	48 (69.6%)

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Table 2. Demographic information of the participants

Demographic information		Frequency (Frequency percentage)
Gender	Male	39 (56%)
	Female	30 (44%)
Specialization	General	44 (64%)
	Specialist	25 (36%)
Site of use	Hospital	45 (65%)
	Clinic	24 (35%)
Computer skills	Elementary	10 (15%)
	Intermediate	49 (73%)
	Advanced	8 (12%)

Table 3. The positive and negative aspects of using the electronic prescribing system

Positive aspects	Negative aspects
Registration of the patient's medication history ($n = 14$), Assessment of medication interactions ($n = 5$), Increased speed of medication registration ($n = 3$), Reduced medication errors, Access to the patient's history if implemented nationwide, Medication prescribing based on availability at the pharmacy, Reduced uncontrolled use of medications and savings in medication use ($n = 2$), Seeing the entire list of medications and their control, Use of less paper ($n = 1$).	Duplicate registration of prescriptions due to the incompatibility of the electronic prescribing system with other systems across the city ($n = 11$), Greater interaction with the computer rather than the patient ($n = 9$), Ergonomic problems of working with the computer ($n = 4$), Sudden interruptions and disruptions in the system ($n = 3$), Limitations in medication prescribing, Nonelimination of paper prescriptions completely, Lack of access to the system outside the hospital, Physicians' dependence on the computer, No access to the patient's photo for identification ($n = 1$).

physicians pertained to the "fewer prescribing issues such as illegible handwriting" with 81 percent ($n = 61$); also, 42 percent ($n = 29$) of the physicians believed that the electronic prescribing system has no effect on the patients' visits to health centers.

Also, the impact of the electronic prescribing system on effectiveness based on the physicians' perspective is shown in Table 1. In the dimension of "patient safety," the physicians' highest agreement with the electronic prescribing system (91%; $n = 63$) pertained to "better medication prescribing by providing system's alerts and access to patients' medication history" and the least agreement pertained to "improvement in medication prescribing in accordance with clinical guidelines" (68%; $n = 47$).

In the dimension of "other effectiveness-related items," the highest agreement among the physicians pertained to the "registration of medications during the patient's visits" with 82 percent ($n = 57$) and the lowest to the "registration of all the intended medications" with 45 percent ($n = 31$).

The results of the analytical statistics showed that the mean scores of efficiency and effectiveness had no significant relationship with gender, age, work experience, specialization, the site of using the system, or computer skills ($p > .05$). Also, there was a significant relationship and correlation coefficient between the mean scores of efficiency and effectiveness ($r = +.866$; $p < .0001$). In other words, with increasing the mean of efficiency, the mean of effectiveness also increased and vice versa. Also, there is a significant relationship and correlation coefficient between all of the efficiency's dimensions (time, costs, and other efficiency-related items) and effectiveness's dimensions (patient safety and other effectiveness-related items) ($r > +.60$; $p < .0001$). In other words, with increasing the mean of every efficiency's dimension, the mean of each effectiveness' dimension also increased and vice versa.

In response to the two open-ended questions, twenty participants reported positive aspects of the system and twenty-four participants reported negative aspects, as shown in Table 3. "Registration of the patient's medication history" ($n = 14$) and "Duplicate registration of prescriptions due to the incompatibility of the electronic prescribing system with other systems across the city" ($n = 11$) were the most important positive and negative aspects of the electronic prescribing system, respectively.

Discussion

Core-Summary Findings

The majority of physicians believed that the electronic prescribing system of the SSO has a high level of efficiency and effectiveness. Most physicians agreed that the following items increased the efficiency and effectiveness of the electronic prescribing system: Enhanced patient safety, reduced medical errors, better medication prescribing by providing alerts and access to patients' medication history, the registration of medications and the correction of mistakes in the shortest time and during the patient's visit, savings in the organization's resources through medication registration, savings in the patients' time for receiving their medications due to prescriptions being based on pharmacies' availability, and fewer prescription issues such as illegible handwriting.

Physicians believed that one of the issues that reduce the efficiency and effectiveness of the electronic prescribing system is the registration of all medications intended by the physician for the patient in the electronic prescribing system, because only medications available in the affiliated medical centers are registered through this system and any medications available outside the center are registered on paper, which leads to duplications in the case of referral to other centers. The proportion of medications recorded on paper to medications registered in the electronic prescribing system is approximately 5 percent.

This study was conducted a year after the implementation of the electronic prescribing system because all physicians had adopted this system and used it in their working time. Also, they received a good perception of the efficiency and effectiveness of this system.

There is no complete and accurate information before the implementation of the electronic prescribing systems in healthcare centers affiliated to the SSO. So, we cannot report accurately and metrically how much patient safety has increased in these centers. All physicians who participated in this study were working in these centers before and after the implementation of the electronic prescribing system. Thus, we could investigate only the subjective physicians' perspective on the effect of the electronic prescribing systems on patient safety.

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Comparisons with Existing Literature

Similar to this study, the results of previous studies demonstrated that the electronic prescribing system can enhance patient safety and reduce medical errors (4;8;9;26). The present findings confirm the results obtained in a study conducted by Lapane et al. (4) to assess users' perception of the efficiency and inefficiency of the electronic prescribing system, which showed that most participants considered the system highly efficient.

Based on the results of this study, more than half of the physicians believed that using this system leads to reduced costs and the number of prescriptions. Similarly, the results of two studies (27;28) showed that using the electronic prescribing system and electronic medication exchange will reduce costs. The results obtained in McMullin et al. study (29) also showed that implementing the electronic prescribing system leads to fewer prescriptions of expensive medications.

In this study, a small number of participants argued that using the electronic prescribing system only increases physicians' interaction with the computer and reduces their interaction with the patients. Also, they believed that physicians spend a long time entering the medication data into the electronic prescribing system and will, therefore, have less time for a careful examination and eye contact with the patient. This finding concurs with the results obtained by Devine et al. (11) and Hollingworth et al. (12).

In our study, the efficiency and effectiveness of the SSO electronic prescribing system had no significant relationship with gender, age, work experience, specialization, and computer skills. Likewise, previous studies (30–33) showed that there was no relationship between age, gender, and working experience with computers of users with some electronic systems such as nursing information systems (NIS), electronic medical record system, and surgery information system. Contrary to the above results, in the two studies on the NIS and computerized physician order entry (34;35), the age of users impacted their satisfaction levels, and it was found that older users were more satisfied than their younger counterparts. This difference in the result might be because of the different types of investigated systems or questionnaires used. In the Kim study (35), the satisfaction with the NIS, the degree of satisfaction with efficacy and effectiveness, and the degree of satisfaction with safety and security were assessed.

Our findings showed that there is a significant correlation between efficiency and effectiveness. Our results are in line with the results of a study concerning the correlation between satisfaction, effectiveness, and efficiency (36). Also, the results of two studies (16;33) showed that there is a significant correlation between the efficiency and effectiveness of the surgery information system and that of the diabetes mHealth system.

Many countries are at different levels and stages of implementation of the electronic prescribing system (19). There are some similarities or differences in their healthcare and insurance systems. The electronic prescribing system had started from SSO healthcare centers in Iran as a developing country. So, the results of this study might be generalized with some developing or low- and middle-income countries. Also, some countries that have not implemented an EHR can benefit from the use of an unintegrated and solely electronic prescribing system.

Given that some of the problems in this system are caused by its incompatibility with other systems, the infrastructure facilities needed for this system's compatibility with other systems are recommended to be further considered by policy makers. Some of the problems in this system may be related to its usability. Future studies are recommended to employ usability methods to assess the efficiency and effectiveness of the system by measuring the time and resources it uses up.

Study Limitations

This study had two limitations. First, because it was conducted in only one of the provinces of Iran, the limitation arose due to the small statistical population in proportion to the total population of the users of the electronic prescribing system across the country. Thus, the information obtained should be generalized with caution; however, because the structure of human resource distribution is the same in most health centers of the SSO, conducting this study in other centers seems to not produce different results. The second limitation is that subjectively physicians' perspectives were used in this study to assess the efficiency and effectiveness of the electronic prescribing system, and the evaluation of users' perspectives may not be as accurate as the employment of other methods such as timing, which is used to estimate the amount of time spent working with the system to perform a given task. Future studies can use more objective techniques to measure these two components.

Conclusion

The results of this study show that the electronic prescribing system improves the efficiency and effectiveness of prescribing by physicians. In particular, physicians believed that using this system improves patient safety and reduces costs. This study also highlighted some of the weaknesses of this system and the aspects that users required to be improved. Also, this study provided an insight into the problems and benefits of the efficiency and effectiveness of the electronic prescribing system. The electronic prescribing system is relatively new or in the early stages of its implementation in some developing countries and many of the efficiency and effectiveness problems in this system may have been resolved in developed countries. Thus, developing countries that have recently been involved in the design and implementation of the electronic prescribing system encounter the same problems that developed countries faced. So, the results of this study may be helpful for health policy makers and system developers of these countries.

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Conflict of Interest. There are no conflicts of interest.

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