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The Effectiveness and Outcomes of Computerized Provider Order Entry in Emergency Care Department of Private Hospitals

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ÖZET

Özel hastane acil bakım kliniklerinde elektronik hekim orderlarının etkinliği ve çıktıları

Amaç: Bu çalışmanın amacı acil bakım kliniklerinde elektronik hekim order girişinin etkinliği ve çıktılarını değerlendirmektir.
Yöntem: Bu araştırmaya İstanbul'da hizmet veren 24 özel hastanenin acil bakım kliniklerinde çalışan 24 hekim ve 24 hemşire katıldı. Veriler elektronik hekim order girişinin etkinliği ve çıktılarına odaklanmış soruları içeren bir anket formu ile toplandı. Formda yer alan maddeler beşli likert ölçeği ile değerlendirildi.
Bulgular: Hekim ve hemşirelerin, Etkinlik boyutuna ilişkin, "ilaç listesine ulaşım", "ilaç dozları ve reçeteler", "ilaç etkileşim uyarıları", "daha hızlı reçeteleme", "reçeteleme hatalarının azaltılması", "diğer sağlık çalışanları ile etkin iletişim kurulabilmesi", "kolay çalışabilme", "kolay yönetebilme", ve "zamandan tasarruf sağlanması" maddelerinden aldıkları puanlar benzerdir (p>0.05). "Reçeteleme için daha iyi yaklaşımdır" ifadesine verilen puan hekimlerde hemşirelere göre daha yüksek olduğu belirlendi (p=0.038). Ayrıca, hekim ve hemşirelerin Çıktı boyutuna ilişkin, "hasta güvenliğini sağlama", "verinin güvenilirliğini ve okunabilirliğinin artması" maddelerinden aldıkları puanların aynı olduğu görüldü (p>0.05).
Sonuç: Elektronik hekim order giriş sistemi acil bakım kliniklerinde hekim ve hemşireler tarafından etkin bir şekilde kullanılmaktadır. Sistemin reçeteleme için daha iyi bir yaklaşım sağlaması hekimler için önemli bir faktördür. Acil bakım kliniklerinde, bu sistemin kullanımı hasta güvenliği ve sağlık hizmeti kalitesini artırmıştır.
Anahtar sözcükler: Elektronik hekim order girişi, hekim, hemşireler, acil bakım kliniği

ABSTRACT

The effectiveness and outcomes of computerized provider order entry in emergency care department of private hospitals

Objective: The aim of the study was to compare the effectiveness and outcomes of computerized provider order entry (CPOE) between physicians and nurses in emergency care (EC) services.
Methods: In this study, 24 physician and 24 nurses working as fulltime in EC services of private hospitals (n=24) were selected in Istanbul, Turkey. Data were collected by a multi-item questionnaire focused on effectiveness and outcomes of CPOE usage. Items were coded by 5-point Likert scale and compared among them.
Results: No significant difference was found in score (OF) item effectiveness regarding "accessing list of medication", "dosages and prescriptions" "alerting drug interaction", "faster prescription" "reducing prescribing error", "providing effective communication with staffs", "easy working" and "easy managing", "allowing decision making" and saving time" between physician and nurses (p>0.05). However, significant difference was seen in score of "being better approach for prescribing" between physician and nurses (p=0.038). Almost similar scores were seen in items of outcomes regarding "achieving patient safety" and "increasing reliability and legibility of data" (p>0.05).
Conclusions: Consequently, CPOE system was used effectively by physicians and nurses in EC services. Better prescribing was found to be a key factor for physicians in the system. Effectiveness and outcomes of the system improve clinical tasks, patient safety and quality of care in EC services.
Key words: Computerized provider order entry, physician, nurses, emergency care service

INTRODUCTION

The implementation of information technologies into healthcare organisations is the most significant change since primary, secondary and tertiary healthcare services link to each other and access to information is improved by the information technologies (1). Turkey's e-health strategy has been recently organised for improving health indicators and sharing health data in healthcare by Health Transformation Program in 2003. E-Health vision is to

establish National Health Information System. It is a countrywide system including national and international health informatics standards, coding, classification and determination of terminologies (2). It includes the enhancement of existing by Ministry of Health (MoH) wide area network into a National Health Platform (3). Therefore, the integration of them into daily working practices is also important for health professionals (2). In our health system, the health care needs of population could be provided by governmental hospitals and various private hospitals approved by MoH and social security organizations (4).

Hospitals as information intensive organizations use the hospital information system (HIS) to improve the gathering, storage, transmission, and processing of information with the goal of improving health care quality. It is designed to manage both clinical applications and administrative services in the complex hospital environment (5-9). HIS carries out collaborative activity, supports and enhances coordination among professional groups for the effective healthcare delivery (6). Execution time, performance, user satisfaction and ease of learning are accepted quality factors in the system. If operation takes less time to accomplish a particular task and can be learned by observing the object in system, user satisfaction and quality of health services increases. Therefore, these are critical points for software developing in health care (10). If the system can be operated with minimal training and error; it results in great saving of time not only in clinical practice, but also in the production of reports and analysis of data (11). In addition to all, both organisational structure and information technology background affect structure of the HIS (12-14). Nowadays, health data are saved, shared and transferred electronically according to E-health activities (10).

In hospitals, medication-related errors and adverse drug events are decreased and healthcare quality is improved by Computerized Physician Order Entry (CPOE) system (15) (16). The system incorporates daily workflow and carries out better documentation of orders and shorter order turnaround times (17) and reduces medical errors (18) in clinical information system. In nowadays, physicians and nurses order laboratory tests, diagnostic imaging studies and patients medications by using CPOE system electronically. After completing order, results are sent to health professionals by electronic notice for viewing in the system (19).

Emergency care (EC) services deal with high risk clinical factors in hospitals. The collaboration in workflow and efficiency in emergency care services for transferring data on real-time basis reduces time for health professionals regarding physicians and nurses in clarifying medication, laboratory and radiology orders in EC services. They are very crowded services in hospitals because of unpredicted patient variable due to high flow (20). Adaptation of CPOE into clinical tasks of health professionals could be slow. Human computer interaction is another barrier for ordering process in CPOE (21). However, diverse opinions and expectations could be seen among health professionals for CPOE system. Although health professionals such as physicians and nurses work together, their work flows were different (21). Therefore, effectiveness and outcomes of the system could be varied among them. As a result, the aim of this study was to examine CPOE in the perspective of user experience and clinical applications and to compare the effectiveness and outcomes of CPOE between physicians and nurses in EC services.

MATERIALS AND METHODS

In this cross-sectional study, 24 physician (mean age; 38.25±5.88 years) and 24 nurses (mean age; 29.04±6.43 years) working as fulltime in EC services of private hospitals (n=24) were selected in Istanbul, Turkey. A physician and a nurse were selected in each hospital. Training period, the number of entered orders per day and experience from use of CPOE that were main inclusion criteria were similar for both physicians and nurses. By this method, health professionals with similar workload and educational background in CPOE were selected to eliminate bias between groups.

The population of Istanbul, a province of Turkey, (13 854 740), is 18.3 % of the total (75 627 384) (22). In Istanbul, the hospital bed capacity was calculated as 12.6% of public hospitals and 33.3% of private hospitals (23). Therefore, study group were selected in this city since majority of private hospitals are located in Istanbul. Ninety six private hospitals accredited by MoH were interviewed and CPOE system was used in ninety two of them. Among them, health professionals in EC services of twenty four private hospitals could be included in the study due to voluntary participation within high workload in EC.

Data were collected by a multi-item questionnaire (24)

by face-to-face interview in EC services. The structured questionnaire developed by Rahimi et al. (24) was translated in to Turkish by authors. In physicians, twelve items related with effectiveness, 12 items for outcomes of CPOE were used in the questionnaire. In nurse's questionnaire, 10 items for effectiveness section and 11 items for outcome section were used according to original version. They were administered to a small group of potential respondents (8 physicians and 7 nurses) in a pilot study. Items were coded by Likert type scale (from strongly disagree: 1 to strongly agree: 5 points) and scores were compared between physician and nurses in the same items.

The study was performed according to the principles of the Declaration of Helsinki and approved by the Ethical Committee of Marmara University Medical School.

Statistical Analysis

Data were analysed by using SPSS 11.5 statistics programme (SPSS Inc, Chicago, IL). Cronbach- alpha values for internal reliability of the effectiveness and outcomes sections of the questionnaire were found to be high as 0.852 and 0.824 in physicians and 0.779 and 0.774 in nurses, respectively. As similar scoring method was used in these sections, reliability analyses were carried out for them. Chi-square test, Mann-Whitney U test and Spearman correlation tests were used for the comparison of groups. Since the numbers of groups were less than 30, non-parametric tests were used in the analysis. Data were presented as median, %25th-75th percentiles in Tables. A p value equal or less than 0.05 was accepted as significant.

RESULTS

In the present study, 24 resident physician and 24 nurses in EC services were included in the study. Scores in efficiency items and outcomes items of CPOE were compared between them. "Experience for use of CPOE system", "entered orders in the COPE in a normal day" and "training period" were similar in physicians [median: 33.00 (25th-75th percentiles: 12.75-63.75, respectively) months; 10.00 (2.25-30.00) days and 2.00 (0.25-5.50) hours] and nurses [25.50 (10.50-78.00) months; 20.00 (3.50-25.00) days and 2.00 (1-4) hours] [p=0.910; p=0.868; p=0.645, respectively] (Table 1).

Score in efficiency of medication usage regarding oral medications, injections, infusions and inhalation were similar in both groups (p>0.05) (Table 2).

Effectiveness

No significant difference was found in scores of "accessing list of medication", "dosages and prescriptions" "alerting drug interaction" and "faster prescription" "reducing prescribing error", "providing effective communication with staffs", "easy working" and "easy managing" and "saving time" between physician and nurses (p>0.05). However, significant difference was seen in score of "being better approach for prescribing" between physician and nurses (p=0.038) (Table 3).

Outcomes

Almost similar scores were seen in items of outcomes regarding "achieving patient safety", "correction errors in prescription", "increasing reliability and legibility of data", "exchanging information between caregivers", and "contributing double documentation" (Table 4). Among items of outcomes in CPOE, scores including "causing doubts of reliability", "increasing computer dependency", "leading to computer-related problems" and "leading to more adverse events" were similar in both physicians and nurses and were fairly low when compared to scores of other items in the same section (p>0.05) (Table 4).

In nurses, age was positively correlated with scores of

Table 1: General Information About CPOE System According to Physician and Nurses

	Physician (n=24) Median (%25th-75th percentiles)	Nurses (n=24) Median (%25th-75th percentiles)	p*
Experience from use of CPOE system (months)	33.00 (12.75-63.75)	25.50 (10.50-78.00)	0.910
Entered orders in the CPOE system in a normal day	10.00 (2.25-30.00)	20.00 (3.50-25.00)	0.868
Training period (hours)	2.00 (0.25-5.50)	2.00 (1.00-4.00)	0.645

*Mann-Whitney U test was used in the analysis.

Table 2: Efficiency of CPOE System in Medications of Emergency Care Services According to Physician and Nurses

	Physician Median (%25th-75th percentiles)	Nurses Median (%25th-75th percentiles)	p*
Oral medications	4.00 (4.00-5.00)	4.00 (4.00-5.00)	0.876
Injections	4.00 (4.00-5.00)	4.00 (4.00-5.00)	0.865
Infusions	4.00 (4.00-5.00)	4.00 (4.00-5.00)	0.928
Inhalations	4.00 (3.25-5.00)	4.00 (4.00-5.00)	0.701

*Mann-Whitney U test was used in the analysis.

Table 3: Efficiency of CPOE System in Clinical Practice of Emergency Care Services According to Physician and Nurses

	Physician Median (%25th-75th percentiles)	Nurse Median (%25th-75th percentiles)	p*
1. Provides access to a public listing of medicines	4.50 (4-5)	4.00 (4-5)	0.812
2. Provides a structured overview of current and previous dosages and prescriptions for the patient	4.50 (4-5)	4.00 (4-5)	0.490
3. Provides clinically relevant alerts for drug interactions	4.00 (3-5)	4.00 (3-4)	0.346
4. Is faster for handle the prescription than in the paper record	4.50 (3-5)	4.00 (3-5)	0.563
5. Reduces the risk of prescribing error	4.00 (4-5)	4.00 (4-4)	0.176
6. Provides an opportunity for effective communication with other staff in the treatment of the patient	4.00 (4-5)	4.00 (4-5)	0.129
7. Is easy to work within routine work	4.00 (3-5)	4.00 (4-5)	0.445
8. Is easier to manage than paper records	4.00 (3-5)	4.00 (4-5)	0.733
9. Has a better approach than paper for prescribing	4.00 (4-5)	4.00 (3-4)	0.038
10. Saves time for staff	4.00 (3-5)	4.00 (3-5)	0.552
11. Provides an opportunity to change. suspend and terminate medication regimensβ	4.00 (4-5)	-	-
12. Allows more efficient decision-making when you want to prescribe drugs β	4.00 (3.25-5)	-	-

* Mann-Whitney U test was used in the analysis.

β: These items are not included in original questionnaire of nurses and not analysed.

Table 4: Outcomes of CPOE system in Clinical Practice of Emergency Care Services According to Physician and Nurses.

	Physician Median (%25-75)	Nurse Median (%25-75)	p*
1. Helps to achieve a high level of patient safety	4.00 (4-5)	4.00 (4-5)	0.910
2. Makes it possible to correct errors in prescriptions	4.00 (3-5)	4.00 (4-5)	0.895
3. Provides clinical decision-making support when the physician wants to prescribe medicines β	4.00 (3-4)	-	-
4. Increases the reliability of data	4.00 (4-5)	4.00 (4-5)	0.729
5. Increases the legibility of the data	4.00 (4-5)	4.00 (4-5)	0.217
6. Contributes to information exchanging between different caregiver	4.00 (4-5)	4.00 (4-5)	0.251
7. Increases un-safety in the pharmacotherapy	4.00 (4-5)	4.00 (3.25-5)	0.566
8. Contributes to/requires double documentation	4.00 (4-5)	4.00 (4-5)	0.293
9. Cause doubts about reliability/completeness of data	2.00 (2-3)	2.00 (2-3)	0.687
10. Leads to computer-related problems (software and hardware). which impacts on time	2.00 (2-3)	2.00 (2-3)	0.538
11. Increasing computer dependency	2.00 (2-3.75)	2.00 (2-3)	0.702
12. Leads to more adverse drug events	3.00 (3-4)	3.00 (2-3)	0.140

* Mann-Whitney U test was used in the analysis.

β: This item is not included in original questionnaire of nurses and is not analysed

Table 5: Opinions about CPOE system and Their Clinical Practice in Physician and Nurses.

	Physician (n=24) n (%)	Nurses (n=24) n (%)	p*
Opportunity to practice during working hours			
Yes	16 (66.3)	22 (91.7)	0.072
No	8 (33.3)	2 (8.3)	
Has the system use over the last ten days when you used the system enabled you to prevent medication error before the error reached the patient?			
Yes	2 (8.4)	6 (25)	0.245
No	22 (91.6)	18 (75)	
Would you like to completely go back to the previous system?			
Yes	1 (4.2)	1 (4.2)	1.000
No	21(87.5)	17(70.8)	
Not sure	2 (8.3)	6 (25.0)	

* Chi-square test was used in analysis.

both "reducing the risk of prescribing error" (r=0.42, p=0.039) and "allowing more efficient decision-making in prescribing" (r=0.40 p=0.049). Score of "experience from use of CPOE" was correlated with contributing documentation in both physicians (r=0.41 p=0.043) and nurses (r=0.45 p=0.025).

In the group, 8.4% of physicians and 25% of nurses prevented medication error over the last ten days. Majority of group in physicians (87.5%) and nurses (70.8%) didn't go back to the previous system (p=1.000). Moreover, nurses (91.7%) had more chance to practice CPOE system than physicians (66.3%), no significant difference was seen among them (p=0.072) (Table 5).

DISCUSSION

Health information technologies produce, manage and share health data in the health systems (25). Since health care is an information intensive business with huge volumes of data, multidisciplinary communication and team work are essential in healthcare. Information technology may improve both the quality of care and the communications among staffs in the hospitals (11,13,14,26-28). The CPOE system as a health information technology allows health professionals to enter medication orders, diagnostic tests and procedures, electronically (25). It improves patient safety by obtaining relevant patient information and clinical knowledge at the moment of ordering medications (20).

In the present study, physicians and nurses working in EC services were selected. Experience from use of CPOE, entered orders and training period were similar in both groups. They were main inclusion and standardisation criteria for the groups. Moreover, CPOE was effectively used for oral medication, injection, infusion and inhalation in the present study. CPOE system has critical properties regarding effect of workflow, medication safety, efficiency (24) and changing communication pattern (29). Technological enhancement modifies care process, alters work activities and creates opportunities for quality improvement in EC. Therefore, physicians and nurses evaluated the effectiveness and outcomes of CPOE system in EC services of private hospitals by structured questionnaire developed by Rahimi et al. (24).

In the present study, score of "better approach for prescribing" was significantly higher in physicians compared to nurses in effectiveness section. It was a critical finding for EC unit since medication related problems regarding morbidity, mortality and adverse events are the major concerns for patient safety in healthcare. CPOE has been shown to decrease medication errors (29-31). The Institute of Medicine (IOM) supports information technology application for safer practice and eliminating medical errors (16,32). CPOE improves patient safety because the system detects incorrect doses and medication interactions (33). It also reduces the misinterpretation of orders and prescriptions due to handwriting problem (18,20).

Physicians and nurses were similarly expressed compatibility of CPOE since scores of efficiency items regarding providing medication list, alerts of drug interaction, past and present prescribing were not different in physicians and nurses. The efficiency of a CPOE is defined as accuracy and completeness of the system which

physicians achieve medication ordering (18). Moreover, the effective time management and collaboration in workflow could be reduced by CPOE (19). Since safe medication use in workflow and time saving are critical important in EC services that deal with mix patient population having high risk in clinical practice, this could be related with successful implementation of CPOE in clinical tasks EC services (20). These results are consistent with the previous studies (29,34). However, CPOE system could be found inefficient and difficult than paper-based systems for physicians and nurses in another study. Adaptation of the clinical setting is satisfied for nurses whereas physicians report CPOE as compatible with professional values and more complex structure (24). Since preparation of order sets, organisational change, system content design, clinician training and hospital infrastructure are milestones of successful implementation of technology in EC (34), physicians and nurses in EC satisfied the system similarly according to our results in the present study.

Advantages of CPOE system were examined in the outcome section of the questionnaire. Scores of outcome items in CPOE system including information exchange between caregivers, legibility and reliability of data, correction of error, improving patient safety, saving time, providing effective communication, being better approach for prescribing, reducing medication risk, being simple, fast and easy to use were similar in both groups. Moreover, they did not go back to previous system. Information technology supports the work of physician and nurses to improve patient safety, quality of care and organizational efficiency (35) and clinicians decision-making process (36).

CPOE system quickly transmits patient's treatment instructions to relevant departments via internet (37). CPOE system can lead to errors due to problems in faulty computer interface (20), duplicate orders by different providers on rounds (38), communication problem, lack of adequate decision support, human errors and communication problem among health professionals (39,40). Scores of computer related items in outcome section were lower in physician and nurses than the other items in the questionnaire. CPOE is a part of the clinical information system that physicians enter the orders directly to the computer. Therefore, CPOE system is real-time decision making system (29). It can improve the quality of care and patient safety within the hospital environment (27). However, health professionals could spend more time for managing clinical information in the complex system architecture (37,41-43) by changing their workflows (38,44). Since patient care is primary figure of health professionals, computer usage could be thought the second duty (45). Therefore, the close relationship is seen among using information technology attitude of staffs and individual impact of technology, perceived usefulness, perceived ease of use and computer experience in EC unit (46).

In addition to all, increase in experience related with improved documentation for physicians and nurses in CPOE. In nurses, increase in age was found to be correlated with reducing prescribing errors and improving decision making in prescribing. Similarly, older nurses are more positive about the easy usage of the system. This could be explained that multifunctional electronic devices are increasingly used by younger people. Younger nurses may have higher expectations relating easy usage of computer technology (21).

Technology adaptation such as CPOE can be influenced by physician resistance (47), organisational factors (48), hospital characteristics regarding economic profile, poor integration into workflow (20,47), ownership and environmental factors such as competition and technology adaptation behaviour of neighbouring hospitals (49). In addition to these universal factors, the lack of healthcare workforce is the main problem in our health system. The number of physicians and nurses per 10.000 and bedside capacity are not satisfactory when compared to developed countries (50). Therefore, the evaluation of information systems such as CPOE is critical for health sector in the frame of effectiveness and outcomes.

Strengths and Weaknesses of the Study

As strength, we examined the effectiveness and outcomes of CPOE by the perspective of physicians and nurses in EC unit where patients with urgent or life threatening illnesses or injuries can seek immediate assistance. The data gives information about CPOE usage in EC units of private hospitals for health managers. However, this study has some limitations when interpreting our CPOE results. First, a limited number of private hospital was included the study due to voluntary participation in the study. Since EC services have very high workload, it was

fairly difficult to find volunteers to participate in the study. Therefore, some private hospitals were eliminated in the analysis. This condition affected the sample size of the study group and low response rate of the study. Second, we did not validate the questionnaire in EC services because it was fairly difficult to contact same health professionals for validation procedure. Yet, Chronbach's alpha values were calculated for internal reliability for physicians and nurses separately. They were found to be reliable for effectiveness and outcomes in both groups.

Consequently, CPOE system was used effectively by physicians and nurses in EC services. Better prescribing was found to be a key factor for physicians in the system. The effectiveness and outcomes of the system improve clinical tasks, patient safety and quality of care in EC services. For health managers, CPOE as a part of the health information technologies improves healthcare quality and effectiveness of a health system in the digital age.

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