Physicians' and Nurses' Opinions about the Impact of a Computerized Provider Order Entry System on Their Workflow

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Abstract

Introduction: In clinical practices, the use of information technology, especially computerized provider order entry (CPOE) systems, has been found to be an effective strategy to improve patient care. This study aimed to compare physicians' and nurses' views about the impact of CPOE on their workflow.

Methods: This case study was conducted in 2012. The potential participants included all physicians (n = 28) and nurses (n = 145) who worked in a teaching hospital. Data were collected using a five-point Likert-scale questionnaire and were analyzed using SPSS version 18.0.

Results: The results showed a significant difference between physicians' and nurses' views about the impact of the system on interorganizational workflow (p = .001) and working relationships between physicians and nurses (p = .017).

Conclusion: Interorganizational workflow and working relationships between care providers are important issues that require more attention. Before a CPOE system is designed, it is necessary to identify workflow patterns and hidden structures to avoid compromising quality of care and patient safety.

Keywords: computerized provider order entry system, workflow, clinical staff

Introduction

Healthcare quality and patient safety are fundamental concepts in healthcare organizations, and the use of computerized provider order entry (CPOE) has been suggested to improve them.[1] CPOE systems are generally subsystems of hospital information systems. Sometimes the CPOE system is supported by a decision support system, making the system able to alert physicians about drug interactions, inappropriate dosages, and other drug-related problems.[2-7] Other advantages of CPOE systems include reducing medical errors, providing standardized care, supporting clinical decisions, storing information for research, reducing costs and the length of stay in a hospital, and improving workflow in healthcare organizations.[8-12]

CPOE is also able to reduce duplication and the time required to complete clinical tasks.[13] Improving internal communications, coordinating medical teams, and reducing the time that nurses spend on reviewing, verifying, and correcting clinical instructions are other advantages of using CPOE.[14,15]

Apart from the positive impacts of a CPOE system, the literature shows that using a CPOE system may have no significant impact on the morbidity and mortality of critically ill patients.[16] Moreover, it may have negative impacts on the communication and collaboration between physicians and nurses.[17,18] For example, communication between physicians and nurses might be changed from a synchronous mode to an asynchronous mode.[19] This change, in turn, may disrupt the collaboration between physicians and nurses.[20] Other concerns are related to the decrease in physician-nurse interactions and the decrease in time spent on patient care.[21] The clinical workflow can also be negatively affected by the use of CPOE systems. This effect on the workflow might be due to the system having human-computer interaction problems, altering the sequencing and dynamics of clinical activities, providing partial support for the tasks completed by clinicians, reducing clinical situation awareness, and poorly reflecting organizational policy and procedures.[22]

To identify the positive and negative impacts of a CPOE system, investigation of users' views has been recommended. Moreover, several studies have emphasized that understanding end users' perspectives on health information technology systems, such as CPOE, is crucial for the future system's success.[23,24] While physicians and nurses are the main users of CPOE systems, few studies[25,26] have been conducted to address their views about the impact of CPOE on their workflow.

In the current study, the main aim was to investigate physicians' and nurses' opinions about the impact of CPOE on their workflow. In the setting of the study, the system had been in use for about two years, and no evaluation study had been conducted after implementation of the system. Because the system developers aimed to implement the same system in other hospitals of the city, this study was specifically conducted to inform them about the physicians' and nurses' perspectives. The CPOE system in this organization was not supported by a decision support system.

Methods

This case study was completed in 2012. The potential participants included nurses (n = 145) and physicians (16 specialists and 12 general practitioners) who worked in a teaching hospital. The hospital was a general hospital with 199 beds. To increase the response rate, no sampling method was used, and all of the potential participants were invited to take part in the study.

Research Instrument

A five-point Likert-scale questionnaire ranging from strongly disagree (1) to strongly agree (5) was used to collect data. It was based on the literature review[27-34] and was divided into six main sections: participants' demographic information, the impact of CPOE on four main areas (patient safety [8 questions], interorganizational workflow [11 questions], working relationship between physicians and nurses [6 questions], and quality of patient care [5 questions]; see Appendix), and open-ended questions about the strengths and weaknesses of the current CPOE system. The validity of the questionnaire was checked using face validity and content validity methods. The content of the questionnaire was reviewed by experts in the field of health informatics and health information management. The reliability was confirmed by calculating the internal correlation coefficient (a = 0.78).

Data Analysis

Data analysis was performed using SPSS version 18.0. To analyze data, mean values and standard deviations were calculated, and physicians' and nurses' opinions were compared using t-tests.

System Characteristics

The CPOE system was a subsystem of a hospital information system. At the time of the study, the system had been in use in the hospital for about two years. All physicians and nurses had access to the system using their unique username and password. The system was available in the pharmacy, radiology department, laboratory department, and hospital wards.

Results

A total of 173 questionnaires were distributed among the study participants, and the response rate was 65.9 percent (n = 114). The results showed that 101 of 145 nurses (69.7 percent), 3 of 16 specialists (18.8 percent), and 10 of 12 general practitioners (83.3 percent) completed the questionnaire. Most of the physicians were men (n = 12, 92 percent) and the average age of the physicians was 36.46 ± 5.66 years. Most of the nurses were women (n = 60, 59.4 percent), and the average age of the nurses was 31.67 ± 5.85 years. The average work experience for physicians and nurses was 8 ± 4.22 years and 7.61 ± 5.52 years, respectively.

The findings showed that the opinion of physicians and nurses about the impact of CPOE on patient safety was positive. In this area, the highest mean value (4.31 ± 0.48) was related to the nurses who believed that using the system helped to document drugs' names accurately. The lowest mean value (4.13 ± 0.49) was related to the nurses who thought that using the system helped to document drugs' dosage accurately. For physicians, the highest mean value (4.11 ± 0.29) was related to those who assumed that the use of CPOE prevented displacement of medical orders. In their group, the lowest mean value

(3.96 ± 0.32) was associated with documenting orders in a timely manner, ensuring timely drug administration, and reducing errors when choosing the method of drug administration (see Table 1).

Table 1: Physicians' and Nurses' Views about the Impact of Computerized Provider Order Entry (CPOE) on Patient Safety

Questions	Profession	Agree[a]	Neither Agree Nor Disagree	Disagree[b]	Mean ± SD	Difference between Means; Difference between SDs
The use of CPOE reduces medical errors.	Physicians	13 (100%)	0	0	4.00	0.27; 0.46
	Nurses	100 (99%)	1 (1%)	0	4.27 ± 0.46	
The use of CPOE helps to document drugs' names accurately.	Physicians	13 (100%)	0	0	4.04 ± 0.13	0.27; 0.35
	Nurses	100 (99%)	1 (1%)	0	4.31 ± 0.48	
The use of CPOE helps to document drugs' dosage accurately.	Physicians	13 (100%)	0	0	4.04 ± 0.13	0.09; 0.36
	Nurses	99 (98%)	0	2 (2%)	4.13 ± 0.49	
The use of CPOE improves patient safety.	Physicians	13 (100%)	0	0	4.04 ± 0.13	0.11; 0.37
	Nurses	96 (95%)	3 (3%)	2 (2%)	4.15 ± 0.50	
The use of CPOE reduces medication turnaround time.	Physicians	12 (92.3%)	1 (7.7%)	0	3.96 ± 0.32	0.20; 0.26
	Nurses	94 (93%)	5 (5%)	2 (2%)	4.16 ± 0.58	
The use of CPOE prevents displacement of medical orders.	Physicians	13 (100%)	0	0	4.11 ± 0.29	0.05; 0.29
	Nurses	94 (93%)	5 (5%)	2 (2%)	4.16 ± 0.58	
The use of CPOE helps timely drug administration.	Physicians	12 (92.3%)	1 (7.7%)	0	3.96 ± 0.32	0.21; 0.27
	Nurses	91 (90%)	10 (10%)	0	4.17 ± 0.59	
The use of CPOE reduces errors when choosing the method of drug administration.	Physicians	12 (92.3%)	1 (7.7%)	0	3.96 ± 0.32	0.20; 0.26
	Nurses	82 (81%)	14 (14%)	5 (5%)	4.16 ± 0.58	

[a]Strongly agree and agree responses were combined in one column
[b]Strongly disagree and disagree responses were combined in one column

The results also showed that the views of physicians and nurses about the impact of CPOE on interorganizational workflow were positive. Among the items in this area, the highest mean value (4.31 ± 0.52) belonged to the nurses who believed that the use of CPOE resulted in saving time in the organizational processes. The lowest mean value for nurses (3.01 ± 0.99) was related to the following item: "The use of paper-based records is easier than using CPOE." For physicians, the highest mean value (4.0 ± 0.40) belonged to timely access to clinical information and improving the working relationship between different

departments. In this group, the lowest mean value (3.35 ± 0.80) was related to saving time in the organizational processes as a result of using CPOE. Moreover, the highest differences between the mean values (0.96) and between the standard deviations (0.28) of physicians' and nurses' responses was related to this item. While most of the nurses (*n* = 100, 99 percent) agreed with saving time as a result of using CPOE, only 6 six physicians (46.2 percent) agreed with this item.

Concerning the impact of CPOE on the working relationship between physicians and nurses, the highest mean value for nurses (4.24 ± 0.45) was related to their positive feelings about the system usage, as it reassured physicians and nurses about the completeness of data. All of the physicians agreed that the legibility of data had been improved using the CPOE system (mean = 4). The lowest mean value for nurses (3.5 ± 1.0) and for physicians (3.23 ± 0.83) was associated with the impact of CPOE on the working relationship to make it more complex. This finding means that from the participants' perspectives, although the use of CPOE affected their working relationship, the relationship had not been changed to be inefficient or more complex. The highest differences between the mean values (0.51) and between the standard deviations (0.02) of physicians' and nurses' responses was related to the following item: "The use of CPOE facilitates the process of documentation." While most of the nurses (*n* = 91, 90 percent) agreed with this impact of CPOE, physicians either agreed (*n* = 7, 53.8 percent) or had no idea about this item (*n* = 6, 46.2 percent).

Regarding the impact of the CPOE system on the quality of patient care, the findings showed that both groups of participants had positive views about the effects of the system on patient care. The highest mean value for nurses (4.6 ± 0.56) was related to the documentation time, which was reduced using the system, allowing more time to be spent on patient care. In this group, the lowest mean value (4.07 ± 0.62) was related to the positive impact of timely prescription on the quality of care. For physicians, the highest mean value (3.92 ± 0.27) was related to reducing adverse drug events, improving patients' satisfaction, and improving quality of care by accelerating the process of ordering and prescribing. In their group, in contrast with nurses, the lowest mean value (3.46 ± 0.66) was associated with spending more time on patient care as a result of reducing documentation time (see Table 2).

Table 2: Physicians' and Nurses' Responses about the Impact of Computerized Provider Order Entry (CPOE) on the Quality of Care

Questions	Profession	Agree[a]	Neither Agree Nor Disagree	Disagree[b]	Mean ± SD	Difference between Means; Difference between SDs
The use of CPOE improves quality of care.	Physicians	0	11 (84.6%)	2 (15.4%)	3.85 ± 0.37	0.32; 0.19
	Nurses	94 (93%)	6 (6%)	1 (1%)	4.17 ± 0.56	
The use of CPOE reduces documentation time and increases the time spent on patient care.	Physicians	7 (53.8%)	5 (38.5%)	1 (7.7%)	3.46 ± 0.66	1.14; 0.10
	Nurses	94 (93%)	5 (5%)	2 (2%)	4.6 ± 0.56	
The use of CPOE improves patient satisfaction.	Physicians	12 (92.3%)	1 (%7.7)	0	3.92 ± 0.27	0.63; 1.23
	Nurses	86 (85%)	15 (15%)	0	4.55 ± 1.5	
The use of CPOE reduces adverse drug events (ADEs).	Physicians	12 (92.3%)	1 (7.7%)	0	3.92 ± 0.27	0.21; 0.23
	Nurses	96 (95%)	4 (4%)	1 (1%)	4.13 ± 0.50	
The use of CPOE accelerates the process of ordering and prescribing.	Physicians	12 (92.3%)	1 (7.7%)	0	3.92 ± 0.27	0.21; 0.23
	Nurses	91 (90%)	7 (7%)	3 (3%)	4.07 ± 0.62	

The comparison of physicians' and nurses' opinions about the impact of CPOE on patient safety ($p = .156$) and quality of patient care ($p = .209$) showed no significant difference between their opinions. However, there were significant differences between the opinions of physicians and nurses regarding the impact of the system on interorganizational workflow ($p = .001$) and the working relationship between physicians and nurses ($p = .017$) (see Table 3). This finding means that in comparison with physicians, nurses were more positive about the impact of the system on interorganizational workflow and the working relationship between physicians and nurses, and agreed that the system had improved the organizational workflow and physician-nurse relationships.

Table 3: Comparison of Physicians' and Nurses' Opinions about the Impact of Computerized Provider Order Entry (CPOE)

Impact of CPOE	Profession	Mean ± SD	*p*
Patient safety	Physicians	32.19 ± 1.4	.156
	Nurses	33.36 ± 2.91	
Interorganizational workflow	Physicians	41.07 ± 3.47	.001*
	Nurses	44.42 ± 2.9	
Working relationship between physicians and nurses	Physicians	23.23 ± 1.42	.017*
	Nurses	23.87 ± 2.37	
Quality of patient care	Physicians	18.92 ± 1.18	.209
	Nurses	21.52 ± 7.38	

*Significant difference between physicians' and nurses' opinions (a=0.05).

The physicians' and nurses' opinions about the impact of CPOE were also analyzed with respect to their age groups. The results showed that among physicians, the highest mean value (4.09 ± 0.22) was found at the age of 29–34 years and was related to the impact of CPOE on patient safety. The lowest mean value for physicians was found at the age of 41–47 years. It was associated with the impact of the CPOE on interorganizational workflow (3.36 ± 0.47) and the working relationship between physicians and nurses (3.36 ± 0.16). This finding suggested that elderly physicians did not agree with the positive impact of the system on the two aforementioned areas. Among nurses, the highest mean value (4.66 ± 2.57) was found at the age of 23–28 years and was related to the impact of CPOE on patient safety. In their group, the lowest mean value (3.93 ± 0.43) was found at the age of 29–34 years and was associated with the impact of CPOE on the working relationship between physicians and nurses (see Table 4).

Table 4: Physicians' and Nurses' Opinions about the Impact of CPOE with Respect to Age Groups

Impact of CPOE / Age Group		Patient Safety (Mean ± SD)	Interorganizational Workflow (Mean ± SD)	Working Relationship between Physicians and Nurses (Mean ± SD)	Quality of Patient Care (Mean ± SD)
23-28	Physicians ($n = 0$)	0	0	0	0
	Nurses ($n = 32$)	4.25 ± 0.40	4.07 ± 0.29	3.97 ± 0.38	4.66 ± 2.57
29–34	Physicians ($n = 6$)	4.09 ± 0.22	3.87 ± 0.15	3.72 ± 0.27	3.83 ± 0.19
	Nurses ($n = 44$)	4.14 ± 0.38	4.03 ± 0.28	3.93 ± 0.43	4.18 ± 0.33
35–40	Physicians ($n = 4$)	3.93 ± 0.12	3.79 ± 0.15	3.70 ± 0.28	3.70 ± 0.34
	Nurses ($n = 15$)	4.07 ± 0.30	3.99 ± 0.27	3.98 ± 0.36	4.06 ± 0.24

41–47	Physicians (n = 3)	4.00 ± 0	3.36 ± 0.47	3.36 ± 0.16	3.80 ± 0.20
	Nurses (n = 10)	4.15 ± 0.14	4.02 ± 0.13	4.16 ± 0.29	4.04 ± 0.12

A limited number of participants replied to the open-ended questions of the questionnaire. According to them, strengths of the current CPOE system used in their hospital included reducing healthcare cost, improving quality of care, and reducing duplication. Some weaknesses of the system were related to system errors, which were time consuming, and the interface of the system, which needed to be improved.

Discussion

Currently, information technology is considered to be a useful tool to improve healthcare quality and patient safety. By using CPOE systems, for example, some processes, such as ordering medical tests, can be documented and medical errors can be prevented by providing accurate information.[35]

The findings of the current study showed that a majority of physicians and nurses agreed with the positive impact of CPOE on patient safety. This impact could occur through improvement in the quality of documentation and reduction in medical errors. However, no significant difference was found between the opinions of physicians and nurses about the impact of this system on patient safety. Similarly, the results of other studies showed that using CPOE systems may lead to significant reduction in medical errors.[36-38] This system can help to resolve problems related to the illegibility of medical documentation and can help ensure that all records completed by physicians, nurses, and pharmacists are identifiable.[39,40]

The study findings also showed a significant difference between the physicians' and nurses' opinions about the impact of CPOE on interorganizational workflow. According to the research findings, nurses were more positive about the impact of CPOE on interorganizational workflow than physicians were. This finding might be related to the nurses' role and the range of tasks for which they are responsible. In fact, nurses are more involved in the process of documentation than physicians are, and they have to communicate with other departments on a daily basis. Therefore, any positive or negative impact of CPOE directly influences their daily tasks, whereas physicians' roles are different and they usually communicate with other departments indirectly, such as through nurses. Overall, the findings are in line with the results of other studies in which physicians and nurses believed that the use of CPOE systems helped to improve productivity and efficiency in a healthcare organization.[41,42] Similarly, the research conducted by Barakah et al. showed that using CPOE systems may lead to improved information sharing between healthcare providers, which in turn accelerates the provision of healthcare services.[43]

The research findings included a significant difference between physicians' and nurses' opinions about the impact of CPOE on the working relationship between physicians and nurses. The results suggested that compared to physicians, nurses were more satisfied with the positive impacts of the system on their working relationship with physicians. Note that different opinions about the impact of CPOE on the physician-nurse relationship have been reported in several studies.[44-47] For example, a study by Rahimi et al. showed that while most nurses agreed that the legibility of data improved with the use of CPOE systems, few physicians agreed with this positive impact.[48] A study by Pirnejad et al. revealed that collaboration between physicians and nurses was disrupted by the use of CPOE systems and resulted in problems in their communication.[49] In another study, Niazkhani noted that CPOE systems have positive impacts (e.g., improving legibility and completeness of data) and negative impacts (e.g., problems in collaboration between care providers).[50] Considering the positive and negative impacts of CPOE systems on the working relationship between physicians and nurses, and with respect to the contextual characteristics that might differ from one organization to another,[51] it is necessary to identify workflow patterns before designing and implementing CPOE systems to avoid any disruption in patient care. In fact, the systems have to be designed and implemented as communication tools, not simply as databases or data repositories.[52]

Interestingly, the results showed that while nurses were positive about the impact of CPOE on physician-nurse relationships, most of them agreed that the use of CPOE increases the workload for physicians and nurses. Kazemi et al. believed that an ideal system should reduce the data entry workload for physicians, although it may increase transcription activities for nurses.[53] On the other hand, some researchers reported that an increasing workload can be a cause of medical errors in healthcare settings such as emergency departments.[54] Increasing the workload might be a function of technical factors. As Avansino and Leu suggested, a systematic design can help create an easy-to-use system that can be used with a lower

cognitive workload.[55] In the present study, the positive attitude of nurses indicated that from their point of view, the benefits of the CPOE system outweighed its challenges, such as the increased workload.

In the present study, physicians and nurses agreed with the positive impact of CPOE on the quality of patient care; however, there was no significant difference between their opinions. Similarly, Holden's study showed that physicians believed that the use of CPOE can improve the quality of care by increasing the accessibility of information, providing reminders, and speeding up the delivery of care.[56] However, in the study conducted by Al-Dorzi et al., the researchers reported no improvement in patient outcomes even after 12 months of system implementation.[57] The potential positive impact of CPOE on the quality of care might be affected by other factors, such as the implementation duration, commitment to quality improvement, and the severity of illnesses.[58]

As mentioned earlier, the developers of the CPOE system discussed in this study aimed to implement the same system in other hospitals of the city. However, the results of the current study suggested that interorganizational workflow and physician-nurse relationships were areas that needed further investigation in order to design a system that would fit into the organizational workflow. Organizational and clinical workflows should be examined more in depth in the process of requirements analysis. Moreover, healthcare settings might have different contextual environments; therefore, usability testing is required to explore users' views about the system. This testing can help to reduce weaknesses of the system in future versions. In the current study, although nurses were relatively satisfied with the system, the system was not fully successful in convincing physicians about the positive impact of CPOE in the areas mentioned above. Therefore, the new versions of the system should be improved to address physicians' requirements as well as nurses' expectations.

Limitations

This study aimed to compare physicians' and nurses' opinions about the impact of a CPOE system on their workflow. However, in the city where the research was conducted, the CPOE system was used in only one hospital, and the system developers aimed to implement the same system in other hospitals. Therefore, a single teaching hospital with a CPOE system was included in the study. The study would benefit if the results could be generalized to a larger sample size.

Moreover, only physicians and nurses were invited to take part in our study, as they were the main users of the system and the main aim of the study was to compare their perspectives. Other system users, such as pharmacists, radiologists, and laboratory technicians, might have different views, and their opinions could be compared in future studies. The number of physicians who took part in the study was quite small compared to the number of nurses, and this discrepancy might affect the interpretation of the results for this group of participants. Furthermore, because this was a single case study, the results might be related to the physician and nursing roles in that particular setting rather than physician and nursing roles in general.

Conclusion

According to the research findings, physicians and nurses had relatively similar opinions about the impact of CPOE in improving patient safety and quality of care. However, a significant difference was found between physicians' and nurses' views about the impact of CPOE on interorganizational workflow and the working relationship between physicians and nurses. Generally, nurses were more positive about the impact of CPOE in the areas mentioned above. The results suggested that interorganizational workflow and the working relationship between care providers are important issues that require further investigation. Moreover, the negative impact of the system on the organizational and clinical workflow may consequently compromise the quality of care and patient safety. Therefore, workflow patterns and hidden structures need to be identified before an actual CPOE system is designed and implemented.

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Appendix: Questionnaire

Question	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Impact of CPOE on Patient Safety					
The use of CPOE reduces medical errors.					
The use of CPOE helps to document drugs' names accurately.					
The use of CPOE helps to document drugs' dosage accurately.					
The use of CPOE improves patient safety.					
The use of CPOE reduces medication turnaround time.					
The use of CPOE prevents displacement of medical orders.					
The use of CPOE helps timely drug administration.					
The use of CPOE reduces errors when choosing the method of drug administration.					
Impact of CPOE on interorganizational workflow					
The use of CPOE helps retrieve information.					
The use of CPOE helps maintain confidentiality.					
The use of CPOE accelerates providing healthcare services.					
The use of CPOE helps save time.					

The use of paper-based records is easier than using CPOE.					
The use of CPOE reduces duplications.					
It is easy to use CPOE along with performing other activities.					
It is necessary to use paper-based records along with CPOE.					
The use of CPOE helps timely access to clinical information.					
The use of CPOE improves the working relationship between different departments.					
The use of CPOE helps healthcare providers to share clinical information.					
Impact of CPOE on working relationships between physicians and nurses					
The use of CPOE increases workload for physicians and nurses.					
The use of CPOE makes working relationships between physicians and nurses more complex.					
The use of CPOE facilitates the process of documentation.					
The use of CPOE reassures physicians and nurses about the completeness of data.					
The use of CPOE improves legibility of data.					
The use of CPOE improves efficiency.					
Impact of CPOE on the quality of care					
The use of CPOE improves quality of care.					
The use of CPOE reduces documentation time and increases the time spent on patient care.					
The use of CPOE improves patient satisfaction.					
The use of CPOE reduces adverse drug events (ADEs).					
The use of CPOE accelerates the process of ordering and prescribing.					

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