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The Effect of a Modification to the Computerized Provider Order Entry (CPOE) to Identify Patients at Risk of Severe COVID-19 Based on Smoking Status

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Keywords: CPOE (Computerized Provider Order Entry); COVID-19; Smoking; Respiratory.

Abstract

Background: CPOE (Computerized Provider Order Entry) is used to enter patient orders electronically. COVID-19 is a respiratory disease. Smokers are at risk for severe COVID-19 requiring enhanced respiratory and ventilatory support. However, it is unknown how modifying the CPOE system will identify patients at risk for severe COVID-19 based on smoking status. With a CPOE modification, the knowledge and training of physicians and respiratory therapists need to be evaluated regarding usability and adoption of the CPOE modification to identify patients at risk for severe COVID-19 based on smoking status.

Study Aim: This research study aimed to find out if physicians and respiratory therapists using CPOE modifications can improve care for patients hospitalized with COVID-19 and at risk for severe COVID-19 based on smoking status.

Study Methodology: This cross-sectional study used an end-user clinical prospective survey. Twenty-two study participants (physicians and respiratory therapists) were selected using stratified convenience sampling. The participants work in the ICU at Piedmont Hospital, Atlanta, Georgia. The investigators built an online survey to collect data on physicians' and respiratory therapists' perceptions of the CPOE modification. The survey collected both quantitative and qualitative data. Quantitative descriptive statistics were collected and displayed as tables and graphs to analyze the data. In addition, qualitative data generated from the open-ended questions were evaluated for common threads.

Results: The results of the survey showed that the majority found the CPOE modification took 3-5 minutes to use (52.9%), were extremely satisfied with the modification (44.4%), was easy to use (50%), improved the efficiency of CPOE for medications, lab tests, and x-rays (61.1%), was integrated into the workflow (44.4%), improved productiv-

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ity (44.4%) and improved quality and decision making (55.6%). These results answered the hypothesis, and the research question of the study, that a CPOE modification was beneficial according to the participants.

Conclusion: CPOE is a well-research effective method of provider order entry, which reduces human errors, improves patient care coordination, improves efficiency, improves healthcare provider's clinical adoption outcome, and tracks data over time. This study may show that modifying the CPOE may help identify patients at risk for various complications, such as severe COVID-19, based on patient factors, such as smoking status.

Introduction

Effective and efficient information technology, e.g., Electronic Health Records (EHRs) and connected or standalone Computerized Provider Order Entry (CPOE) tools, are needed to improve patient safety and clinical outcomes and enhance the quality of healthcare services [1,2]. CPOE is a health information technology that healthcare providers use to enter and send patient care instructions such as medication, radiology, and laboratory orders through a computer application instead of paper, telephone, or fax [2]. However, when implementing or modifying CPOE, there can be problems such as disrupting the order entry workflow, difficulties in patient charting, and lack of computer literacy amongst different providers [2]. Starting around December 1, 2019, in Wuhan, China, COVID-19 caused by the SARS-CoV-2 virus caused a respiratory illness pandemic. Smoking is also a known risk factor for respiratory problems such as pneumonia and lung inflammation [3,4,5,6,7,8]. A systematic review study conducted in 2021 concluded that the COVID-19 admitted patients with any smoking history were susceptible to severe COVID-19 and vulnerable to experiencing COVID-19-related clinical complications [8]. The same study recommended that clinicians plan and develop targeted therapies and preemptive and supportive interventions to decrease morbidity and mortality amongst COVID-19- Infected current and former smokers [8].

COPE order sets related to COVID-19 could be modified to help identify those patients at increased risk for severe COVID-19 about smoking and needing enhanced observational and respiratory support. Most CPOE modifications can instantly provide prompts to clarify order entry, make suggestions, ensure order completeness, and check for errors such as wrong dosage, drug interactions, medication allergies, or other potential problems [9]. However, a study asserts that CPOE users need adequate staff training, technical support, and maintenance as part of the CPOE system transition [10]. Furthermore, a study that used a cross-sectional survey in Intensive Care Unit (ICU) showed a significant difference in satisfaction with CPOE among end-users such as physicians and respiratory therapists [11]. The scholars declare that information technology was crucial to patient safety when modifying a COPE during the COVID-19 pandemic [12]. However, these studies show a gap in knowledge as to the benefit of adjusting the CPOE Order Set to improve care for patients at risk for severe COVID-19 based on smoking status [9, 10, 11, 12].

The current study aimed to determine if physicians and respiratory therapists could adopt new CPOE modifications to determine if COVID-19-infected patients were at risk for severe COVID-19 symptoms and complications based on smoking status. In addition, this study aimed to investigate if a CPOE modification would better enable physicians and respiratory therapists to determine if a patient hospitalized for COVID-19 was at risk for severe COVID-19, needing enhanced observational and respiratory support, based on smoking status as a risk factor for severe COVID-19.

The current study hypothesized that with a modification to the CPOE of a hospital in Atlanta, GA, physicians and respiratory therapists could better determine if a hospitalized patient was at greater risk for severe COVID-19 and needed enhanced observational and respiratory and respiratory support based on smoking status. Therefore, this research study aimed to determine if physicians and respiratory therapists could adopt new CPOE modifications to improve care for patients hospitalized with COVID-19 and at risk for severe COVID-19 based on smoking status. The investigators shared the current study findings with the target audience of physicians, and respiratory therapists, who use CPOE to care for patients at risk for severe COVID-19 along with ICU administration at Piedmont Hospital, Atlanta, Georgia.

Methodology

Study Design

The current study's design is a descriptive research study design with a prospective survey about the adoption of new CPOE modification to evaluate the knowledge and training of physicians and respiratory therapists concerning the usability and adoption of a further CPOE modification to identify patients at risk for severe COVID-19 based on smoking status. The survey included quantitative and qualitative research questions online via Google Forms**.** The study was conducted in ICU at Piedmont Hospital, Atlanta, Georgia, where they care for patients with severe COVID-19 and enter orders using the hospital's CPOE system.

Data Collection / Study Tools

This cross-sectional study used an end-user clinical Google Forms survey to collect data on doctors' and respiratory therapists' perceptions of the CPOE modification. Participants were contacted, and the survey was sent out on November 7, 2022. The time frame of the study was eight weeks.

The study survey used mixed types of questions, including open-ended and close-ended. Close-ended questions had limited options such as multiple choice, Likert Scale, or "yes" or "no." The open-ended questions asked the participants to elaborate to learn more about their experiences with the new CPOE modification. The investigators used an online survey to allow for flexibility as most healthcare providers are busy yet use computers frequently.

The first domain of the survey consisted of seven multiple-choice questions covering demographic data such as age, gender, title (physician or respiratory therapist), and years of experience using CPOE. In addition, other baseline questions were related to participants' overall perceptions of CPOE, such as usability, usability, performance, satisfaction, and barriers that may hinder the use of CPOE in clinical practice.

The second domain of the survey consisted of ten questions using a five-point Likert scale, ranging from "strongly disagree" (1) to "strongly agree" (5). The questions addressed the performance of the modification of the CPOE system compared to the previous system to address the impact of the CPOE modi-

fication on the productivity of the participants and the quality of patient care they offer patients. Questions also discussed the usability, efficiency, workflow integration, and productivity of the CPOE to improve staff communications, patient care decision-making, patient safety, and risk reduction. Other questions addressed the participant's education and training related to the CPOE modification and if the modification is secure and maintains patient privacy. The survey was sent via the hospital's assigned email to all physicians and respiratory therapists working in that ICU as full-time or part-time providers (Appendix 3A).

Study Participants

Participants were recruited using stratified random sampling, and 22 study participants were selected who work in the ICU at Piedmont Hospital, Atlanta, Georgia. All physicians and respiratory therapists who work full- or part-time in the ICU were contacted via email to participate using Google Forms. Physicians and respiratory therapists who only occasionally work in the ICU (PRN) were excluded as they would be less familiar with the CPOE and the modification. Stratified convenience sampling was used in this study to separate participants, based on whether a physician or a respiratory therapist, to evaluate the data among the two subgroups.

Before starting the study, an application was submitted to the Institutional Review Board (IRB) for human subjects research, and permission to conduct the study was requested from the hospital management via email. After receiving consent and the hospital's IRB approval, the investigators sent invitations via email targetted physicians and respiratory therapists to participate in the survey.

A reminder was sent to the participants one week after the invitation survey was sent, asking them to acknowledge their receipt of the invitation and to let them know that the study link would expire at the end of the second week. The survey ran between November 7, 2022, and November 14, 2022.

Statistical Analysis of Data

For the quantitative data, descriptive statistics were used. Both frequency and percentage of responses for each question, along with averages and summary data, were displayed as tables and graphs in order to analyze the data. In addition, the qualitative data generated from the open-ended questions were evaluated for common threads.

Target Audience

The results of this study were shared with the target audience of physicians and respiratory therapists within the ICU hospital setting at Piedmont Hospital, Atlanta, Georgia, and other physicians and respiratory therapists who use CPOE and care for patients at risk for severe COVID-19. The results provided important information on the effectiveness of a CPOE modification in positively impacting patient care, especially for ICU physicians and respiratory therapists caring for patients at risk for severe COVID-19 based on smoking status. In addition, the findings of this research study were shared with Piedmont's ICU administration, along with the physicians and respiratory therapists who work in the ICU. Results were also shared with the broader community of physicians and respiratory therapists through specialty conference presentations. In addition, this study's findings advanced IT involvement's help and knowledge to modify, educate, train, and redesign workflow as needed to increase efficiency and performance.

Results

The results section of the study summarizes data collected from the participants. The findings of this descriptive data include narration, tables, and graphs to make it easy to understand.

Participants

The study's participants comprised physicians and respiratory therapists who work directly with a CPOE system. 18 participants responded to the survey out of 22 invitations. Therefore, the response rate was 82%, and the sample size was adequate.

Demographic data of the respondents

The survey collected demographic data about the participants, including their background characteristics, job titles, how long they used a CPOE system, and average time spent using the CPOE modification. The participant's responses are summarized in **(Table 1)**. There were 33.3% males and 66.7% females. Physicians comprised 22.2%, and respiratory therapists 77.8% **(Table 1)**. Also, most participants (33.3%) were between the ages of 54-64 and had worked with the CPOE modification for over five years (50%).

Table 1: The Demographic Data of the Respondents.

Demographic Measurement	Physicians and Respiratory Therapists Numbers (%)
Sex	
Male	6 (33.3%)
Female	12 (66.7%)
Age	
18-24	1 (5.6%)
25-34	3 (16.7%)
35-44	2 (11.1%)
45-54	4 (22.2%)
54-64	6 (33.3%)
+56	2 (11.1%)
Job Title	
Physician	4 (22.2%)
Respiratory Therapist	14 (77.8%)
Years working with CPOE modification	
0-2 years	6 (33.3%)
2-4 years	3 (16.7%)
+5 years	9 (50.0%)
Average time spent on CPOE use	
0-2 minutes	1 (5.9%)
3-5 minutes	10 (52.9%)
+6 minutes	7 (41.2%)

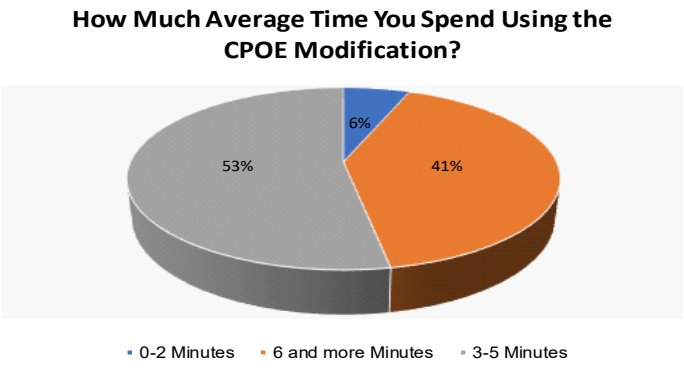

Figure 1: Average Time the Participants Spent Using the New CPOE Modification Per Patient.

As seen in **Figure (1)**, there were ten (52.9%) of the participants surveyed stated that it took them 3-5 minutes to use the new CPOE modification system per case, seven (41.2%) participants said that it took them six or more minutes to use the new CPOE modification system per case, and ten (52.9%) of surveyed users stated that it took them up to 2 minutes to use the new CPOE modification system per case **(Figure 1)**.

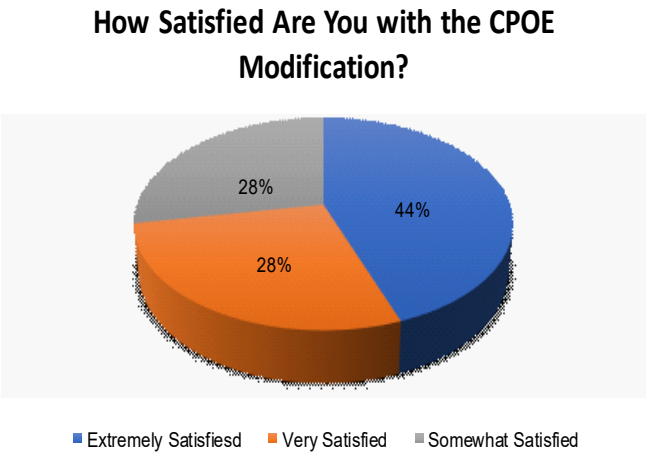

Figure 2: The New CPOE Modification Users' Satisfaction.

Regarding the respondent's satisfaction with using the new CPOE modification, the majority of eight (44.4%) participants were extremely satisfied with the new modification. Additionally, five (27.8%) of the respondents were very satisfied, and five (27.8%) were somewhat satisfied **(Figure 2)**.

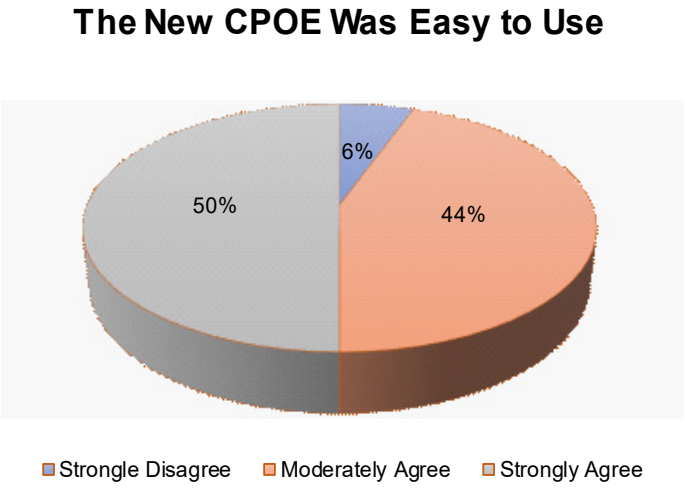

Figure 3: How Easy to Use the New CPOE Modification System.

In **Figure (3),** nine (50%) of the participants strongly agreed that the new CPOE modification was easy to use, eight (44.4%) moderately agreed that the new CPOE modification was easy to use. On the other hand, one (5.6%) strongly disagreed that the new CPOE modification was easy to use.

In Figure 4, the results show that eleven (61.1%) participants strongly agreed that the new CPOE modification was efficient for medications, lab tests, and radiology orders. Six (33.3%) of participants moderately agreed that the new CPOE modification was efficient for medications, lab tests, and radiology orders. One (5.6%) of the participants was unsure if the new CPOE modification was efficient for medications, lab tests, and radiology orders.

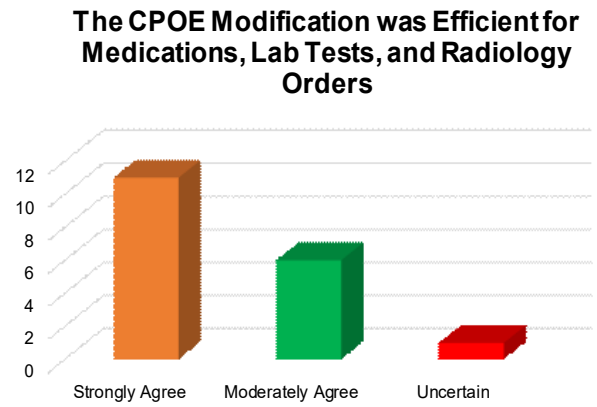

Figure 4: CPOE Efficiency for Medications, Lab Tests, and Radiology Orders.

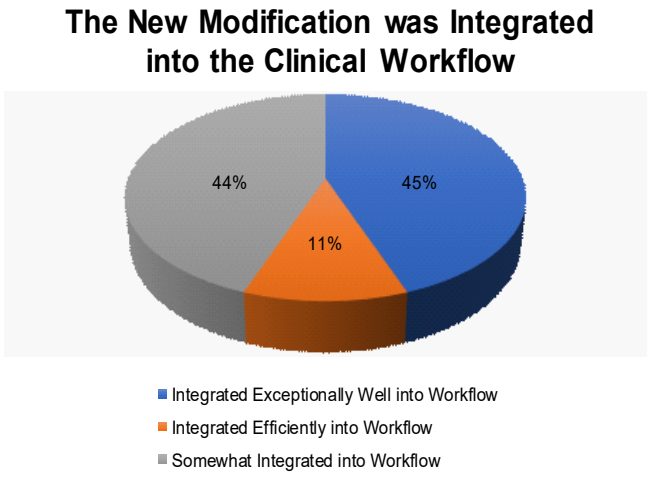

Figure 5: CPOE and Workflow Integration.

The participants were also asked about CPOE modification integration into their workflow system. Eight participants (44.4%) noted that the new modification integrated exceptionally well with their workflow, and another eight participants (44.4%) indicated that the new modification was somewhat integrated into their workflow system. Only two (11.1%) participants were unsure if the CPOE was integrated efficiently into their workflow **(graph 5)**.

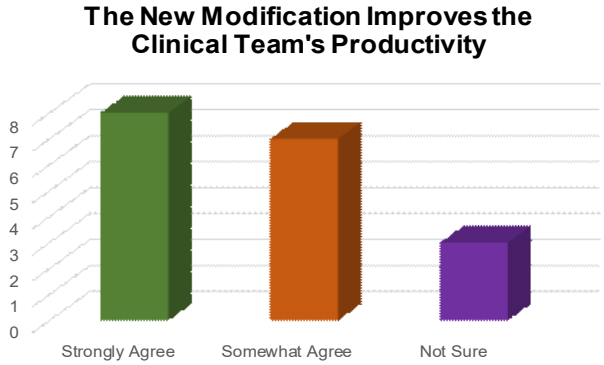

Figure 6: CPOE Modification and the Clinical Team's Productivity.

Eight participants (44.4%) strongly agreed that CPOE modification very much improved productivity; seven participants (38.9%) found it somewhat likely to improve productivity, and three (16.7%) of the participants were not sure if the CPOE modification improved productivity **(Figure 6)**.

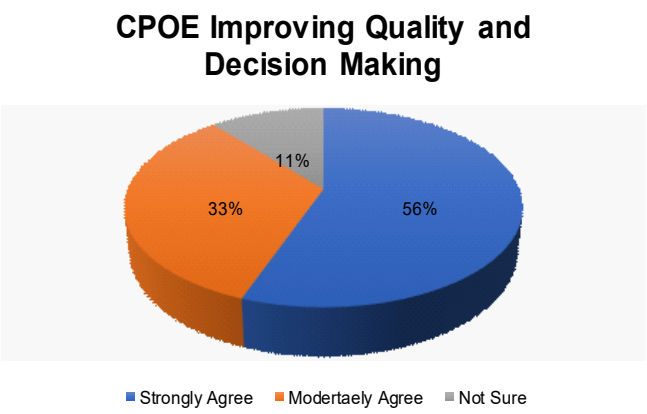

Figure 7: CPOE Improving Quality and Decision Making.

The majority of the participants, ten (55.6%), strongly agreed that the new CPOE modification very much improved quality and decision making, six (33.3%) moderately agreed that CPOE modification enhanced clinical decision making, two (11.1%) of the participants were not sure if CPOE modification improved the quality of their decision making **(Figure 7)**.

In looking at the results, there was a correlation between those who were extremely satisfied with the new modification CPOE and those who moderately agreed that the new CPOE modification was easy to use (r= 0.9).

Discussion

The responses of physicians and respiratory therapists to an online survey were analyzed concerning their experience with adopting a new CPOE modification. Of the physicians and respiratory therapists who returned the survey, 50% found the new modification very easy to use. Also, respiratory therapists had more opportunities to introduce the new CPOE to their work routine than physicians. In contrast, physicians found the new CPOE modification more time-consuming than respiratory therapists. Malden et al. (2021) explain how CPOE can be easy to use because it offers many advantages over traditional paper-order writing systems [12]. These advantages can avert problems with handwriting, order specification, similar drug names, and drug interactions.

When asked about CPOE education and technology support, the participants' responses showed an information deficit regarding the new CPOE modification. 22.3% of participants thought they needed more education and information (IT) support **to** efficiently use the new CPOE modification. These results indicate that new CPOE modification requires detailed training with hands-on experience. Holden et al. (2010) recommend adequate staff training, technical support, and maintenance as part of a CPOE system transition. The same study asserts that the chosen vendor should provide CPOE training. Including super users in the process can be beneficial for support and training. Also, assessing staff knowledge, understanding of the modification, and staff computer skill levels can enable the organization to identify future obstacles [13].

When asked about CPOE efficiency for medications, lab tests, and x-rays, many participants strongly agreed that CPOE modification improved efficiency. Prgomet et al. (2016) assert that most CPOE applications include tools that instantly check for any wrong dosage, drug interactions, medication allergies, and other potentially harmful problems. This instant method of feedback during order entry can help physicians and respiratory therapists process treatments, laboratory tests, and medication orders efficiently, thus decreasing medication errors, improving communications, improving patient safety, and saving time [10].

However, the result of this study showed that most physicians and respiratory therapists strongly agreed that CPOE modification significantly improved productivity. Studies have shown that a CPOE modification can enhance productivity by making provider orders more accessible and faster than paper charting or using standalone ordering technology. According to Prgomet et al. (2016), CPOE application use has many benefits, such as ensuring legible orders, real-time order entry, reducing costs, reducing medication errors, and improving patient quality of care and safety. For instance, lowering errors impacts patient safety because CPOE can ensure that physicians' orders are legible and complete [10]. In addition, the results showed that physicians and respiratory therapists agreed about increased prescription legibility.

Also, the results showed that most physicians and respiratory therapists disagreed that the new CPOE modification supported evidence-based decision-making. The result of this study is consistent with previous studies. The lack of evidence-based decision-making could be due to insufficient compatibility between the CPOE system and clinical tasks. According to Miller et al. (2005), it is crucial to offer decision support systems within a CPOE to provide both clinical end-users and institutional leadership with various opportunities to change how organizations carry out their work. These decision support systems within the CPOE could improve patient care, quality, and safety [14].

A new CPOE modification could benefit busy clinicians if adequately integrated into clinical decision support. However, recent research on safety in human-machine interaction suggests that some users need to be more convinced of the completeness and reliability of the support provided by the system [14,15].

Finally, the target audience in this study was physicians and respiratory therapists within the clinical healthcare field. The research study's findings provided insight into why physicians and respiratory therapists did not fully adopt the CPOE system. This insight helps formulate recommendations that could be used by information technology (IT) and expert CPOE users to mitigate problems as well as to improve the process of care and satisfaction for both healthcare providers and patients.

Limitations

Although the survey response rate was 82%, a limitation was that only 22.2% were physicians who were the prescribers responsible for using the modifications to enter orders. Nurses who serve as mid-level providers and prescribe were not included.

Based on this study, some recommendations for future researchers include determining if a modification to a CPOE system could help physicians, respiratory therapists, and nurses determine if a hospitalized patient is at greater risk for complications related to other disease processes or to drug-drug or drug-disease interactions. In addition, future researchers could stratify data based on participants, whether physician, respiratory therapist, nurse, or other healthcare professional. Also, future researchers need to consider goals and work setting related to CPOE, think about how to involve a new IT strategic plan for support and management, consult with an EHR system vendor for knowledge and training, conduct workflow and process

analysis and strategy, conduct, evaluate and provide adequate staff training related to the CPOE modification. In addition, this study's findings can help advance IT involvement knowledge to modify, educate, train, and redesign workflow as needed to increase efficiency and performance.

Conclusion

Different metabolic conditions of COVID-19 contracted patients according to their age, gender, nutrition, smoking, and other environmental factors determine the individual susceptibility to different clinical severity starting from mild condition to death [16, 17]. Therefore, customized risk assessment and managing approaches are critical to protecting COVID-19-infected smokers from preventable severe symptoms and clinical complications.

Computerized Provider Order Entry (CPOE) is the information technology that healthcare providers use to enter and send patient care instructions such as medication, radiology, and laboratory orders through a computer application instead of paper, telephone, or fax. The survey results showed that the majority found the CPOE modification was extremely satisfied with the modification and admitted that the new strategy was efficient and easy to use. Most participants indicated that the CPOE modification had improved the efficiency of CPOE for medications, lab tests, and x-rays and has successfully integrated into the ICU's workflow. Furthermore, the studied modification has improved the participants' productivity and sharpened the clinical decisions. These results supported the hypothesis and research question of the study. The CPOE effectively reduces human errors, improves patient care coordination and efficiency, improves healthcare providers' clinical adoption outcomes, and tracks data over time. In addition, this study showed that modifying a CPOE may help identify patients at risk for various complications to other disorders, other than severe COVID-19, based on patient factors such as smoking status.

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