Computerized Provider Order Entry System – Does it Support the Inter-professional Medication Process?

Lessons from a Dutch Academic Hospital

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Summary
Objectives: To assess the effects of a CPOE system on inter-professional workflow in the medication process.
Methods: Twenty-three semi-structured interviews with physicians, nurses, and pharmacists were conducted in a Dutch academic hospital. In addition, the handwritten and system-generated documents used daily were collected for analysis. Data was analyzed on the basis of three conceptual themes in the inter-professional workflow: division of tasks, flow of information, and task coordination.
Results: The CPOE system reorganized the existing work procedures, affecting the workflow among the three professional groups both advantageously and disadvantageously. The system resulted in the reassignment of tasks and reallocation of areas of expertise in the medication process. Moreover, patients' medication-related information became fragmented in both the paper records and in the electronic records, as well as in different professional domains. The system provided limited support for professional groups to coordinate their tasks temporally. It also made it difficult to build mutual intelligibility upon new changes in the medication plan. To integrate tasks, the professional groups had to bypass the system or add new steps and extra coordinative tasks.
Conclusion: We identified several workflow integration issues after the implementation of a CPOE system. Our insights into these issues can help ensure that the system design or redesign properly integrates all tasks, information, and areas of expertise of professional groups into those of the physicians.

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1. Introduction

The deployment of computerized provider order entry (CPOE) systems in hospitals is increasingly encouraged, especially after the Institute of Medicine (IOM) advocated these systems in its two consecutive reports [1, 2]. Despite all the interest in and potential benefits with regard to implementing these systems, the real implementation and application rate is relatively low [3]. Their implementation especially in inpatient settings has proved to be difficult, partly because CPOE systems have been shown to support clinical workflow poorly [4–6].

An issue that is gaining attention in the literature is that the workflow model embedded in CPOE systems does not match actual workflow between professionals [7]. These systems enforce a linear, sequential, and unidirectional model of care processes, while clinical workflow is distributive, collaborative, and interruptive [8]. Moreover, the design of these systems is often narrowly focused on the work of physicians, with the result that the collaborative and multi-professional nature of medical workflow has been overlooked [9, 10]. Studies have shown that, for example, nursing records may have important medication data that are critical for safe management of medications but they may be overlooked when these systems are used [11, 12].

There is evidence to suggest that CPOE systems transform the roles and responsibilities of care professionals and the way they carry out their tasks and establish and maintain work relationships [13–15]. Such transformations can frequently cause interruptions or overloads in the work of care professionals [6]. To compensate for such breakdowns and to ensure a smooth workflow, professionals may frequently be forced to deviate from the underlying workflow model required by these systems [8]. Despite the importance of the topic, the literature to date has paid little attention to how well the design of these systems takes into account the multi-professional and interdependent nature of clinical workflow. In fact, very few studies have evaluated the impact of CPOE systems specifically on the *inter-professional* relationship in the medication process.

The objective of this study was to analyze the effects of a CPOE system on inter-professional medication work in a Dutch hospital. In a quantitative, before-and-after implementation study, nurses reported

that the computerized system did not support their workflow in the medication process better than the paper-based systems did [16]. A mixed-method study in internal medicine wards showed that although the system improved the main non-supportive features of the paper-based system, it lacked its main supportive features for nurse-physician collaboration [17]. Intrigued by these findings, we aimed at further evaluating the workflow among the three main professional groups involved in the medication process: physicians, nurses, and pharmacists. For this purpose, we conducted a qualitative study, in which we examined the role of the system in integrating the work of one professional group with that of the others. In particular, we were interested in identifying areas of the inter-professional medication work which are either supported or impeded by the implementation. The insights from this study can help in the redesign of both systems and care processes, thereby creating a better fit between the system and the multi-professional nature of the medication process.

2. Theoretical Background

Our study was inspired by Wears and Berg, who pointed out that "many of the difficulties do not result from bad parts of the systems but are inherent in the perspectives and theories of medical work (and the role of IT in this work)" on which these systems are founded [18]. The medication process, for example, involves multiple health professional groups. Although they may be spatially distributed throughout a hospital, their work is highly interconnected because they are dependent upon each other in terms of skill, knowledge, expertise, and physical assistance [19]. This interdependency, combined with the ad hoc nature of medical work, makes it highly collaborative. For healthcare information systems (HISs) to fit in this work, they should adequately support collaboration among different professional groups [20].

To examine the interplay between the collaborative nature of healthcare work and HISs, we drew upon studies of medical work carried out in the social sciences and in the field of computer-supported cooperative work (CSCW). Three themes were identified to be relevant to conceptualize the workflow between professional groups using information systems: division of tasks, flow of information, and task coordination [21–23].

In the medication process, an effective division of labor is required that takes into account the work domains of different professional groups [21]. This can help to avoid possible conflicts among co-working professionals and enable them to construct actions as well as interactions. However, the conditions of the practice greatly influence how strictly to follow this division [24]. Moreover, the medication process is information-intensive. Each professional domain collects and documents a set of patients' medication-related data. The medication data produced in different professional domains should be communicated timely and clearly and integrated with that of others in order to enable collaboration among them [22]. Strauss called this "information work" [24]. However, the ad hoc nature of the medication process can cause a medication plan to change frequently. Different professional groups therefore are required to coordinate their interrelated tasks and also to ensure a shared understanding of the medication plan [23].

▶Figure 1 provides a visual model of the inter-professional workflow in the medication process among physicians, nurses and pharmacists. It also depicts the relationship among the three concepts discussed above. In this model, the division of tasks among the three professional groups serves as a core. On the basis of this division and the flow of information gathered in different professional domains, these professional groups can coordinate their interdependent tasks.

3. Methods

This study is based on a qualitative study of a CPOE implementation at Erasmus University Medical Center, a 1237-bed academic hospital in Rotterdam, the Netherlands. This hospital began to implement a commercial computerized medication order entry system (Medicatie/EVS®, iSOFT, Leiden, the Netherlands) in 2001. A detailed description of Medicatie/EVS can be found elsewhere [25]. It took five years to implement the system hospital-wide in both inpatient and outpatient settings. The last inpatient unit implemented the system in March 2005. Medicatie/EVS was chosen for implementation because of its compatibility with the hospital's existing information systems. The system has been integrated into other existing information systems in the hospital except the patient data management system used in the intensive care units (ICUs). Medicatie/EVS can be accessed in all physicians' offices as well as through every computer that is connected to the hospital network.

Order entry by physicians into this CPOE system has been mandatory since the introduction of the system; in principle, nurses and pharmacy staff do not accept hand-written prescription orders. As a result, for hospitalized, non-ICU patients, physicians directly enter almost all medication orders into the system. Nurses then receive printed medication-order labels

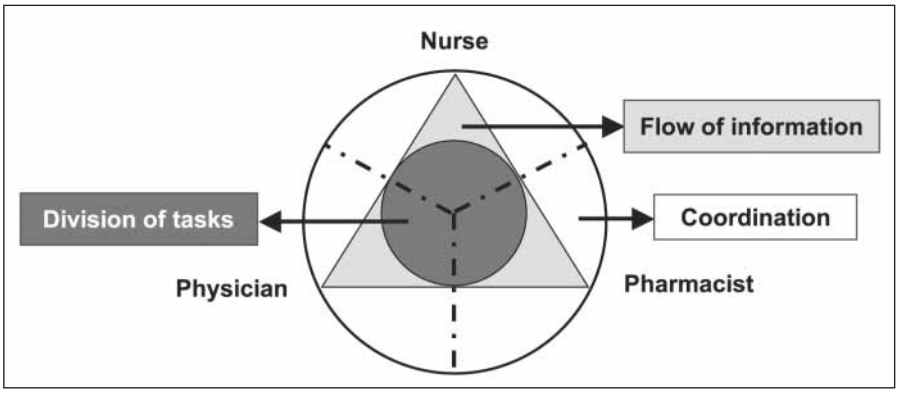

Fig. 1 A conceptual model for inter-professional workflow in the medication process

(MO labels), which they affix to a paper-based medication administration record (Kardex-card). Nurses register the administration of a prescribed medication by placing a signature in front of each MO label. Details of these documents have been published elsewhere [17]. Nurses use the electronic system to request non-stock medications from the pharmacy. The medication ordering and administration process after the CPOE system in this hospital has been described in detail elsewhere [16, 17].

We conducted 23 semi-structured interviews between November 2006 and June 2007. The first and second authors, who have a background in medicine and health informatics, carried out the interviews. The interviews were in-depth, one-on-one, and face-to-face. The interviewees were among the informant key users of the system. In clinical wards, we interviewed 12 nurses and eight physicians, who acted as a link between the implementation team and the clinical end-users. They were recruited from medical specialties, including general internal medicine, gastroenterology, nephrology, hematology, and pulmonology and surgical specialties, including general surgery, urology, and neurosurgery and pediatrics. We also interviewed two hospital pharmacists – one of them was also the project leader of the implementation team – and one pharmacy technician.

The majority of the interviewees had experienced working with the paper-based medication systems in the hospital before implementation of the CPOE system. They also had everyday interaction with the electronic system after implementation. All the interviews were performed in the interviewee's working environment. This allowed the interviewers to observe how the interviewees used the system in the medication process. This also made it possible for the interviewees to provide us with a concrete example in the event that something was difficult to explain in words.

During the interviews, we reviewed and discussed the medication process, the interviewees' role in the process, and the effect of the system on their work. We were specifically interested in the effects of the system on the areas of medication work shared between two or three professional groups and requiring their close collaboration and coordination. The interviews were voice-recorded and transcribed and the transcripts were analyzed on the basis of the three themes defined in our conceptual model (▶Fig. 1). The first two authors analyzed data and the results were discussed among the other authors. To analyze their role in the workflow, we also examined the documents used in daily work, both handwritten artifacts (including medication administration records, what-to-do lists, and appointment forms) and system printouts (including MO labels and the patients' current medication overviews [AMO]). These documents were accessed through both the interviewees and the implementation team.

4. Results

The results are presented here on the basis of the three themes defined in our theoretical background. Per theme, we particularly focused on workflow between two or more professional groups in the medication process.

4.1 Division of Tasks

By forcing strict levels of authorization for executing tasks, the CPOE system reinforced professional boundaries. In some cases, this was perceived as beneficial. All professional groups had no doubt that the electronic medication orders had been initiated by physicians because only physicians were authorized to do so. The pharmacy's doubts about the legitimacy of nursing staff to request non-stock drugs were, for example, considerably removed because this could be simply checked in the system. Furthermore, nurses were happy that they were no longer questioned by other professionals about who made changes in an order, and when and why. Only physicians could change medication orders in the new situation, and all changes were registered in the system.

In other cases, however, this strict task division negatively affected workflow by reallocating areas of expertise and by reassigning tasks. The concept of physician order entry in this system enforced a central position for physicians in the order entering process. This meant that, for example, physicians were sometimes forced to decide on the details of orders that were beyond their areas of expertise. One physician, although generally satisfied with the system, commented:

> "When you have to put 10 prescriptions, then you have to check for all [details], [for example] let's go to IV: IV white, IV peripheral, IV central… or just IV; it doesn't matter… these are very specialized." (February 2007)

Physicians also had to react to safety alerts related to drug administration interval recommendations that could normally be handled by nurses. Nurses frequently referred to their need for such decision supports for their own work; however, they had no access to it, nor did they have access to the responses of the physicians to the alerts given at the time of ordering.

Order entry by the system removed order decryption and transcription tasks for nurses in the handwritten practice; however, the centralized decision-making by physicians violated the nurses' work domain in some instances. Nurses experienced difficulties in implementing physicians' detailed medication orders, particularly with regard to time and route of administration. For example, they often had to adjust the administration timing to fit into nursing work routines, and they did so by manually registering these adjustments on the order labels. Although this approach worked well for available drugs in the ward stocks, problems arose when such adjustments required nurses to request non-stock drugs from the pharmacy. For instance, before the implementation of the CPOE system in surgical wards, nurses could, on their own initiative, change a patient's IV antibiotics to oral forms after three days of infusions. After the implementation, however, they had to remind it to physicians and wait for them to change the orders in the system, because the pharmacy would refuse the nurses' requests for drugs in the absence of electronic orders.

It emerged from the interviews that the boundaries between professional groups

with respect to the decision-making process may blur in practice. Physicians and nurses often referred to instances in which physicians delegated the decision-making to nurses and the nurses were supposed to take action independently, especially in hectic situations. The following quote from a neurosurgery nurse spells the point out:

> "…In such [emergency] conditions we administer the drugs by ourselves and we do not wait for MO labels. It depends on trust-making between doctor and nurse … When you start to work here, you do not get someone like a doctor to work with you and supervise your work completely. Sometimes the physician says "You do this and if you have a problem then contact me"... Sometimes you have to make a decision." (February 2007)

4.2 Flow of Information

Using the CPOE system enabled physicians to have an overview of the availability of drugs or the alternatives at the pharmacy. This in turn decreased interruptions caused by the pharmacy calling to discuss an alternative for an unavailable prescribed drug. Furthermore, the system improved the flow of patient-specific, medication-related information from physicians to nurses and to the pharmacy. This was especially the case due to legible and complete electronic medication orders, saving many callbacks to physicians for order verification and prescription reason inquiries. The following note from a nurse highlights this:

> "In the paper-based medication system it was hard to read the handwriting of doctors and sometimes you had to show it to three people, each one telling you something different. But now the prescriptions are readable and you know when to start what, when to stop it, and which doctor wrote it." (February 2007)

A pharmacist also explained:

> "Sometimes physicians don't want to order the medication that is selected by the system, but another one; then they enter the reason [into the system] why they want to have another drug." (November 2006)

In routine daily work, nurses received large numbers of MO labels after physicians entered their orders into the system. This required nurses to sort the labels out per patient and put them into the correct administration records. Nurses perceived this step to be highly error-prone. They frequently stressed the necessity to be extra vigilant when working with these small labels, mainly because their uniform black and white structure sometimes caused nurses to mix them up for different patients. While comparing the new process with the paper-based ordering process, an internal medicine physician remarked on this issue:

> "… [Now] I don't think that there is less [possibility for] mistakes because of MO labels. Because there is a very small place for comments [on MO labels] and everything is very, very tiny and small." (June 2007)

To ensure an accurate flow of information, nurses therefore had to ensure that they had attached the correct medication labels to the right patient's Kardex-card. For this purpose, nurses were obliged to double-check once a day each patient's MO labels with a medication overview printed out from the system (AMO). Moreover, in order to decrease the chance of missing certain information such as the remarks at the bottom of the labels or the stop dates for drugs, the first nurse who noticed this information was supposed to mark them with a colored highlighter pen so they would be easily noticeable for others as well. During the double-checking phase, nurses looked for any probable discrepancy between the physicians' orders and the MO labels they had collected in a patient's paper-based administration record. This procedure was perceived by them to be extremely time-consuming.

The improvement in information flow was unidirectional: from physicians to other professional groups. Unfortunately, the system lacked the functionality to allow information transactions in the reverse direction. Because nurses recorded medication-related information on the Kardex-card, the medication data became fragmented in the electronic and the paper-based systems. During prescription by the system, physicians therefore had practically no easy access to the administration records, which were affixed on a mobile medication administration cart. Because the system was not available at the patients' bedsides, both physicians and nurses used a printout of the system (AMO) to gain an overview of a patient's current medications. Nevertheless, this printout could not provide all the medication information needed during medical rounds because it was only a list of what had been prescribed, not what had been administered, or when and how often. To develop comprehensive and integrated patient medication information, this information therefore had to be communicated directly between physicians and nurses.

The flow of information through the system between nurses and the pharmacy was insufficient, although it had been improved compared to the way it was before the implementation. To compensate, both groups were using phone calls to acquire necessary information, as was reflected in the interviews with nurses and the pharmacy technician.

4.3 Task Coordination

Coordination through the system was mainly asynchronous. The medication-related tasks among professionals were therefore coordinated by other methods of communication and not only through the system. In fact, none of the professional groups actually counted on the system for secure coordination. While phone calls played an important role in coordinating interdependent tasks between professionals from different services (such as physicians and pharmacists, or nurses and pharmacy technicians), physicians and nurses who worked closely together still relied on face-to-face communication.

In most of the specialties interviewed, physicians and nurses discussed the overall medication plans in medical rounds, during which the majority of the decisions on changing medication plans were made. For reference, nurses often made notes on these decisions or, in some wards, they asked physicians to issue preliminary, concise, hand-written medication orders before the orders could be entered into the system. Without these rounds, there was little possibility for a shared understanding of the medication plan to be developed; both groups therefore depended on direct communication and discussion.

Nevertheless, despite discussions during medical rounds, the necessity to have synchronized discussions and order entry process was frequently pointed out by physicians and nurses alike. Both reported it to be common for a patient, for instance, to receive an extra dosage of a medication that should be stopped or to miss one or two dosages that should be started earlier. A physician commented:

> "… [In the paper-based system] There was less confusion for the nurses … because at the time you were writing [the prescription at the bedside], they were with you, and they could see what you wanted and what your plan was. I found it better and easier." (June 2007)

If a change was necessary during the evening or night shifts, physicians would have to inform nurses directly. Or, if nurses were busy with other duties at that moment, they would need to coordinate the change through a paper-based form called "appointment form". This form was primarily a communication medium between nurses and physicians, helping them to coordinate laboratory tests and radiology requests. However, after implementation of the system, they also used it to communicate some of their medication-related tasks, especially during evening and night shifts; physicians could write the related changes to the medication plan and/or nurses could use the form to ask any of their medication-related questions.

It was considered risky to rely simply on the system and on the printed labels to coordinate these changes timely. In fact, it was possible for a medication order label to be lost among other papers in the nursing station, or for a printer to fail to print out orders. In such instances, none of the nurses or physicians would be aware of and be able to resolve the problem quickly, unless they noticed the printer's red warning light in time or performed a double-check of AMO and the printed MO labels. It was also possible that nurses received unexpected new order labels or changes in a patient's medication plan. In such cases, they often contacted the prescribing physician, as one senior head nurse noted:

> "…in such a case [a change in the medication plan], physicians usually tell us; otherwise, if we see there is a controversy between the medication label and our notes, then we [will] call physicians and ask for the reason." (January 2007)

Similarly, the procurement of non-stock drugs required nurses to take extra coordinative steps beyond the system. Because the system was not available at the bedside, physicians entered the orders later in their offices. Due mainly to the time pressure caused by other clinical responsibilities after their medical rounds (e.g., operations, outpatient visits, and laboratory results inquiries), they often delayed entering their orders into the system. As a result, nurses were able to send the electronic drug requests to the pharmacy only later in the day. These late non-stock drug requests forced nurses to call the pharmacy when they wanted the drugs the same day:

> "If I put it [a non-stock drug request] in the computer before 12 o'clock, I will get the drug in the afternoon. But after that time, I need to call [the pharmacy technicians] to tell them that I need it today. Then they will put it in our ward container so that I can get it today. If I put the request in after 12 o'clock and I don't make a phone call, the drug will be here tomorrow." (a nurse, December 2006)

The pharmacy technicians checked the electronic requests per ward/per patient twice a day at 8 and 12 o'clock. This way of checking orders was due to an internal policy at the pharmacy to cope with wholesaler delivery times and with the high workload in managing the drug supply for the entire hospital during the course of a day. To emphasize the necessity of same-day drug delivery, this coordination redundancy therefore had become a part of routine and was referred to by nearly all the nurses interviewed.

5. Discussion

The CPOE system in our study reorganized the existing work procedures, affecting the workflow among the three professional groups both advantageously and disadvantageously. We noticed that the system mainly benefited physician-pharmacy and nurse-pharmacy workflows, while impeding the physician-nurse workflow. Our study also identified instances in which the system inappropriately integrated the three professional domains, forcing them to bypass the system (e.g., paper-based adjustments to the electronic medication orders), to take extra steps (e.g., double-checking the orders), and to perform extra coordinative tasks (e.g., paper notes, phone calls, or face-to face communication).

5.1 Practice-oriented Inter-professional Workflow

Our analysis of the benefits and pitfalls revealed that the workflow model underlying this CPOE system overlooked the overlaps and interdependencies that exist between professionals involved in the medication process. As a result, it challenged their effective collaboration by reassigning tasks, reallocating the areas of expertise, and reinforcing strict boundaries around professional domains. These findings are in accordance with the argument of Gorman et al. [7], supporting that under this system the workflow is indeed conceptualized as linear, stepwise, and unidirectional: the flow runs from physicians to the other professional groups. Yet, as elaborated upon in our theoretical background, the medication work is highly distributive and collaborative without a sharp division of tasks among collaborating professionals. Our findings are also in accord with those

studies that have emphasized that CPOE systems alter roles and responsibilities established in hand-written practices over a period of years [13, 14, 26]. They also support the argument that these systems may result in centralized decision-making by physicians in the medication process [27]. Physician dominancy in the ordering phase can cause nurses to experience difficulties in their workflow, as seen in our study. Nevertheless, studies have shown that nurses are capable and experienced in managing certain medication-related issues independently, such as handling time adjustments in drug-drug interactions [28, 29].

In the case we studied, the unilateral flow of information from physicians to other professionals together with the limitation of feedback in the reverse direction led to medication-related information becoming fragmented in both the paper records and in the electronic records, as well as in different professional domains. Physicians thus had no easy access to the medication-related information produced by nurses. This condition could be improved by the deployment of an electronic medication administration registration system [30]. However, it must be taken into account that a similar lack of effective data integration has also been found in a highly advanced CPOE with computerized medication administration registration [12]. Therefore, for a safe and aligned medication process, it is fundamental that the interrelated pieces of medication information produced by different professionals are effectively integrated while these systems are being designed and implemented.

We also found that the providers had limited support through the system to coordinate their tasks temporally. Care professionals are busy and mobile, working mainly in places other than around computers and printers. CPOE systems enable providers to enter or change orders from locations outside of clinical units. This is often accompanied by a lack of visual clues such as the presence of a physician at a bedside or the physical existence of paper orders [8]. This can have detrimental effects on providers' situation awareness [31]. The awareness of orders can be improved by proper and timely notifications to the intended professionals. In an approach to identify and address workflow changes after CPOE, it is described how real-time, visual alerts as orders are processed can help different professional groups to maintain their situation awareness [32].

Furthermore, the implementation also impeded shared understanding with regard to changes in patient medication plans. Studies have shown that negotiation between co-working professionals is critical to creating a shared sense of a care plan and to adjusting the work of one professional group with that of another [33, 34]. In our study case, these purposes were served by the medical rounds, which enabled physicians and nurses to negotiate their overall medication plans. Nevertheless, this was not helpful with regard to the details of orders and also to changes that were made beyond rounds: extra communication methods such as paper-based notes, phone calls, and face-to-face communication were used to supplement the information registered in the system. Other CPOE studies have also reported similar coordination redundancies among professional groups for clarification purposes [4, 15]. These methods in turn can increase the workload of already overburdened professionals and can also be a source of interruption.

In this paper, we reported on the basis of common themes that emerged in the work of specialties we studied. However, it is noteworthy that there were subtle differences among the specialties concerning the way they organized the medication process using the same system. Other social and organizational factors were also influential. First, their work was greatly dependent on the nurse-physician relationship in different wards and the way they co-constructed their interrelated medication tasks around the same system. For example, while the electronic orders were considered necessary in some units to authorize administration of a drug, in others a physician's verbal order was still being accepted by nurses. Moreover, the implementation team in this hospital took great efforts to customize the system based on the wishes of different wards. For example, the hematology wards in this hospital were using a number of different IV-routes in the paper-based system, which were not present in the CPOE system. Because of the complexity of hematology therapy, the hematology department requested adding different IV-routes to the system. However, the generalization of such customizations to other specialties sometimes resulted in annoyance, confusion, and workflow obstructions.

The last, our study identified workflow integration issues in one of the successful implementation sites where all of the physicians were entering their orders directly into the system and the system was fully being used at the time of this study. This is consistent with the argument [5, 35] that CPOE systems may be operational only because providers devise workarounds to bypass the difficulties rather than have the system respond to their needs. There are other examples of how clinicians work around workflow blocks to continue their work after the implementation of an information technology [36]. Similarly, in our case study, professionals frequently bypassed the system and added extra coordinative tasks to integrate interrelated work. The outcome of such workarounds may be varied that merits attention (see further).

5.2 Computerized vs. Practice-oriented Inter-professional Workflow

Our study shows a mismatch between the developer's computational workflow model and the real-world, pragmatic inter-professional workflow. It shows how and why a system that is intended to automate and improve one critical step in the medication process thoroughly impacts the other phases as well, both advantageously and disadvantageously. The insights gained in our study invite developers to work closely with different professional groups involved in a clinical process in order to understand, design, and embed more practice-oriented, inter-professional workflow models in HISs. These clinicians are in a unique position to provide feedback on the development process of complex HISs and their impact [37]. Their extensive experience and rich knowledge of a pragmatic workflow would allow developers to accommodate these systems on the basis of users' needs, concerns, and work contexts.

5.3 Strengths and Weaknesses of the Study

Our study is a qualitative evaluation study having triangulation of different sources of qualitative data as its strong point. To our knowledge, this study is one of the few CPOE studies that specifically focused on the inter-professional workflow among key professionals with a bird's eye view of the medication process. Many of the CPOE studies looked at subsets of individual professionals' workflow and not at the overall workflow in a clinical process in the course of a day. As our study also showed, having an overall view of a clinical process, especially one shared among different departments across a hospital, can help to recognize and take into account the conflicts that may exist among their goals and incentives [38]. However, our study has limitations as well. Although it provides a general overview of different specialties, specific workflow impediments may not be well generalized to all specialties in this hospital. Furthermore, some of the impediments in workflow were produced because there was no bedside order entry system or electronic administration system in place. Next, this CPOE system is widely used in other hospitals throughout the country. However, differences exist in the ways the same system has been introduced and applied in these hospitals. In several hospitals, for instance, nurses are allowed to enter orders into the system. Hence, it is possible that the site used in our study is not truly representative of all sites using the same system.

5.4 Recommendations for Future Research

Diverse social, technical, and organizational factors can influence a CPOE system's effects on workflow [6, 16]. In depth qualitative studies are necessary to understand the interplay between these factors following the implementation of a system. Ethnographic studies, for example, are needed to identify context-specific requirements of workflow (e.g., in surgical vs. non-surgical specialties) in order to consider them in the (re)design of a CPOE system. Studies also needed to understand and solve in situ workflow impediments. In-depth workflow analyses are able to characterize the providers' responses (such as workarounds) aimed at bypassing the workflow impediments [39]. More importantly, the outcome of these responses in terms of the workload of professionals and patient safety should be carefully evaluated in future studies. Finally, a same CPOE system may be implemented in different context of different hospitals. Thus, evaluation of inter-professional workflow with the system in different contexts can provide valuable lessons for system (re)design, implementation, and integration into workflow.

6. Conclusion

With regard to inter-professional medication workflow, the implementation of a CPOE system is a double-edged sword. Our study not only contributes to a deeper understanding of the interdependent nature of medication-related tasks among professional groups working in the same or different services, but it also identifies where the problems lie with the CPOE system implemented. In our case study, the system caused the physicians to dominate other groups, whose work became contingent on the timely and appropriate execution of physicians' tasks. In order to distribute the benefits of work efficiency fairly, the real-time, ad hoc, and interdependent nature of the medication process has to be considered in the design of these systems. Nurses' and pharmacists' inputs into this process should also be taken into consideration. Only then can CPOE systems support actual inter-professional relationships in the medication process.

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