

C O N T I N U I N G E D U C A T I O N



Capturing Nursing Care Workflow Disruptions

Comparison Between Nursing and Physician Workflows

SEONAH LEE, PhD, RN
BEVERLY MCELMURRY, EdD, FAAN

Introduction of clinical information systems (CIS) in healthcare has led to new designs from paper-based systems to computer-based systems, promising quality of patient care and reduction of medical errors.¹ The new designs require changes in existing workflows in patient care and communications among clinical staff² because designing CISs outweighs the mere construction of technological artifacts.^{3,4} The changes often give rise to confusion and lead to inefficient and ineffective clinical practices.³ Within the healthcare system, nurses are responsible for integrating multiple sources of information and for coordinating services of multiple healthcare providers in the comprehensive daily management of patients.² Without exception, introduction of a CIS requires changes in nursing practice.² The changes are not unilateral^{3–5}; they are negotiation between the changes required by the introduction of a CIS and the existing work practices in nursing care. The negotiation is possible only with the correct understanding of nursing practice.

BACKGROUND

Nursing Perspective

A nursing perspective on patient care affects how a CIS is used and must be compatible with nursing care workflow.¹ Nurses coordinate patient care activities, ensure that treatments are carried out on schedule through a

Clinical information systems implementation in healthcare delivery has changed clinical work patterns. Nursing practice is under pressure of the changes, which often lead to dysfunctional workflow. The purposes for this literature review were (1) to identify what has been examined about disruptions of nursing care workflow in using Clinical information systems and (2) to obtain a lesson for future research to investigate disruptions of nursing care workflow in using Clinical information systems. In reviewed studies, nursing workflow disruptions have limitedly been reported. Nursing care workflow has not been investigated sufficiently; thus, what happened to nursing care workflow by using a Clinical information system has not been fully known. Nurses have a need for the use of a Clinical information system in aspects of nursing perspective in patient care. Unless the use of Clinical information systems provides effective workflow of nursing care, it will result in confusion in nursing practice as well as poor quality of patient care. It is essential to capture disruptions and/or effectiveness in nursing care workflow from the perspectives of nurses. The required research approach to clinical settings is to identify all facets of adverse consequences triggered from the use of a Clinical information system by following the context of nursing care workflow.

KEY WORDS

Clinical information system • Nursing care workflow

three-shift system, and are faced with the distress of patients and relatives.⁶ Nurses make decisions based on patient needs as they become aware of them in familiar relationships with patients and their families, whereas physicians tend to make decisions based on aspects of pathology and treatments.^{7,8} Often, an on-call team of

Author Affiliations: University of Illinois at Chicago, College of Nursing.
Disclaimer: Authors declare no conflict of interest.

Corresponding author: SeonAh Lee, PhD, RN, Room 1116 (M/C 802), 845 S Damen Ave, University of Illinois at Chicago, College of Nursing, Chicago, IL 60612 (slee230@uic.edu).

physicians is responsible for ward work on weekends and on public holidays.⁶ This different temporal-spatial organization of medical and nursing work creates different perspectives and priorities that are a source of strain.⁶ Different perspectives and priorities on patient care will give rise to different perspectives in the use of CISs.¹

A nursing perspective on patient care shapes nurses' needs, interests, criteria, and expectations for nursing care in the use of CISs that are different from other healthcare providers' perspectives.^{1,2,9,10} An awareness of the differing demands of nursing care on technology can be gained by scrutinizing the influence of CISs on nursing care workflow.^{1,10} Factors of a CIS that conflict with the workflow of nursing activities will impose additional work tasks on already heavily burdened nurses.¹¹ The adverse factors will never become apparent unless the speakers are nurses.

Purposes

The purposes of this study are (1) to identify what has been examined about disruptions of nursing care workflow in using CISs and (2) to obtain a lesson for future research to capture nursing care workflow disruptions triggered from using CISs.

Definition of Nursing Care Workflow Disruptions

Nursing care workflow has not been defined, although examples using words of nursing workflow¹² and nurse workflow do exist.¹³ Nursing care workflow disruptions by use of a CIS can be defined by "characteristics of poorly functioning nursing work."^{14,15} Nursing work is a set of clinical tasks a nurse performs for patient care.¹⁴ When a computational model does not reflect actual nursing practice in real-world clinical settings, a CIS highlights poorly functioning nursing work.¹⁵ Characteristics of poorly functioning nursing work include unnecessary pauses and rework, delays, established workarounds, gaps where steps are often omitted, and a process that nurses feel is overloading.¹⁴ For example, "a drug ordered three times a day had been discontinued, but one dose had already been given. The computer system would not allow the nurse to chart one dose because the system considered it an incomplete execution of the task."^{11(p108)} To discontinue a drug, it might impose additional paper tasks on nurses.¹¹ "During transfers between the emergency department and a patient ward, orders would not be transferred or new orders could not be entered in the system because the patient was not yet in the system. Once an order had been entered by a phy-

sician, that physician expected it to be carried out, but if the administrative data had not yet been entered, the physician's order might never be executed."^{11(p108)} A poorly designed CIS might generate unnecessary delay in patient care and disrupt nursing care workflow.

Recognizing the nature of clinical work and identifying the negative effects of workflow disruptions will be explored in the literature review section.

LITERATURE REVIEW

Nature of Clinical Work

The nature of clinical work is not simple.^{3-5,10} It is not easy to fit technological applications to clinical practice.^{10,16} The nature of clinical work is shaped by patient trajectories.¹⁷ The term *trajectory* refers not only to the pathophysiological unfolding of patient disease but also to healthcare providers' involvement in the process of patient care within a patient care context.^{10,17} The patient trajectory involves diverse actions and skills of healthcare providers and other resources.¹⁰ Patients have an evolving and unpredictable character; thus, their cues require continual readjustment and communication.¹⁰ Depending on the condition of the patient, the management of the trajectory evolves.¹⁰

The nature of clinical work shaped by a patient trajectory is a complex mixture of routine and exceptional events.^{1,18} Healthcare providers generally follow standards and prescribed plans of care, but they must also deal with exceptions on a daily basis.¹ Clinical work is cooperative; decisions about patient care are the result of involvement of diverse healthcare providers, sometimes including the patient and his/her family.^{11,17-19} The clinical workflow is not a linear process with clear-cut inputs and outputs.^{18,20} In reality, it is not sharply demarcated,¹⁸ and technological application is thoroughly intertwined with the clinical practice in which it functions.^{3,4,9} The complex nature of clinical work would both add and hide the errors related to workflow disruptions.^{11,15}

Clinical Workflow Disruptions

Clinical workflow disruptions caused by the use of CISs should be identified and addressed to prevent negative influences on patient outcomes and work effectiveness. (To avoid confusion in use of terms, the term *clinical workflow* was used because it was applicable to most of healthcare providers who work for patient care. *Clinical workflow* is not limited only to nursing care workflow or nurses.) Examples of this point are found in two

studies^{21,22} that reported contradictory results in mortality rates of ICUs from the use of the same commercial computerized physician order entry (CPOE) system.²⁰ Han et al²¹ analyzed mortality rates in 13 months before and 5 months after implementation of CPOE. After the use of the system, the mortality rate increased. Del Beccaro et al²² also analyzed the mortality rates 13 months before and 5 and 13 months after implementation of the same system at their site. No significant change in the mortality rate was found after CPOE implementation, and there was workflow effectiveness. Del Beccaro et al²² designed a CIS that matched their real work practices, using lessons learned from Han et al.²¹ As a result of meetings with administrative and clinical staff at the Del Beccaro et al²² study site over many months before the go-live date, almost all problems uncovered by Del Beccaro et al²² were addressed in the Del Beccaro CIS.²¹ A multidisciplinary team validated the functionality of the system application and end users were heavily involved in the design. Han et al found that²¹ workflow disruptions were the result of a mismatch between the functioning of a CIS and the real-life demands of clinical work. On the other hand, Del Beccaro et al²² showed the feasibility of preventing workflow disruptions from the implementation of a CIS by well-organized plans and actions, despite the complex nature of an ICU. Del Beccaro et al²² demonstrated the arguments of recent investigations that the causes of clinical workflow disruptions by the use of CISs lie in poorly designed CISs.¹⁶

METHODS

MEDLINE and CINAHL were searched using the terms “electronic medical record, workflow,” “electronic medical record, evaluation,” “computerized physician order entry,” and “nursing information systems.” Only studies accessible in full text versions were selected to avoid misunderstanding of the original contents. To achieve the two purposes of this study, it was judged desirable to broadly retrieve studies relevant to improvements and/or disruptions of clinical workflow (including nursing care workflow) according to use of a CIS. It was also assumed that the literature would most likely report both disruptions and improvements. Inclusion criteria were studies that (1) examined positive and/or negative changes of clinical workflow triggered by use of a CIS; positive and/or negative changes of clinical workflow were based on the definition of characteristics of poorly functioning nursing work above; (2) that evaluated a CIS that fully operates in the environment of a real hospital information system combined with systems of various departments (eg, pharmacy or laboratory); studies that evaluated a CIS in the design stage and/or a controlled environment (eg, a laboratory) were ex-

cluded; and (3) that evaluated a CIS in acute inpatient settings; studies that evaluated a CIS in noninpatient settings (eg, home care settings and outpatient care settings) were excluded.

A total of 40 studies were retrieved. Of these, eight studies reporting stages of designing a CIS and two studies in outpatient settings were excluded. A total of 30 studies were included.

RESULTS

In Table 1, the 30 studies that met the inclusion criteria were arranged by three types: physician workflow, nursing care workflow, and others. Each type of workflow was divided by whether workflow was completely examined. Table 1 shows studies by methods for data collection used and elements measured. The 13 studies reported poorly functioning workflow triggered by use of a CIS (see the studies with a superscript “a” in Table 1).

In physician workflow in Table 1, the nine studies in detail examined changes in physician workflow. Seven of the nine studies reported physician workflow disruptions (from here on, they are called “the physician workflow-disruptions studies”). Details of the seven studies are provided in Table 2. The five studies in the other group reported improved results in use of CISs, but there were no measurements for other factors of a CIS that might influence physicians’ workflow. Therefore, these five studies were grouped as studies that did not deal with details in workflow.

Table 1 shows there were no studies that examined in detail nursing care workflow disruptions. Charting completeness and quality, charting time, and medication errors were mainly investigated. Nurse attitude and acceptance were also examined. Five of the eight studies reported negative effects or no differences from use of CISs (from here on, they are called “the nursing care workflow-disruptions studies”). Details of the five studies are provided in Table 2.

In others in Table 1, Georgiou et al²⁴ examined details of workflow disruptions in a laboratory department. Outcomes of the studies using chart review in the other group were associated with effectiveness and/or improvements in clinical workflow (including nursing care workflow and physician workflow), but there were no measurements or mention about other factors of a CIS that might influence clinical workflow. Therefore, these chart review studies were grouped as studies that did not completely examine workflow. Also, these chart review studies were classified as others because results of these studies could be applicable to interest of all types of healthcare providers who work for patients.

Table 2 provides details (ie, computer application, research sites, and methods for data collection) of the

Table 1

Studies Related to Workflow in Use of Clinical Information Systems



Physician Workflow	Nursing Care Workflow	Others
<p>Workflow was completely examined: Ash et al¹¹ (2004)^a Campbell et al¹⁵ (2006)^a Cheng et al²⁵ (2003)^a Han et al²¹ (2005)^a Koppel et al²⁹ (2005)^a Embi et al³¹ (2004)^a Rose et al³⁴ (2005)^a Reuss et al³⁵ (2004) Observation and interview about use of a mobile CIS Van Eaton et al³⁷ (2005) Observation, interview, and questionnaire for examining workflow efficiency and continuity of care</p> <p>Workflow were not completely examined: Ozdas et al⁴¹ (2005) Chart review for examining use of an order set Vigoda et al⁴³ (2006) Chart review for examining anesthesia record completeness Driscoll et al⁴⁵ (2007) Chart review for examining anesthesia record completeness Overhage et al⁴⁶ (2001) Observation for examining physician order time Pizziferri et al⁴⁷ (2005) Observation for examining physician time saving in clinic sessions</p>	<p>Workflow was not completely examined: Ammenwerth et al²³ (2001)^a Ammenwerth et al¹² (2003)^a Larrabee et al²⁶ (2001)^a Menke et al²⁷ (2001)^a Smith et al³⁰ (2005)^a Korst et al³² (2003) Observation for examining charting time Paoletti et al¹³ (2007) Observation for examining medication errors Cordero et al³⁸ (2004) Chart review for examining medication turnaround time, prescription medication errors, and radiology completion time</p>	<p>Workflow was completely examined: Georgiou et al²⁴ (2007)^a Observation and interview for examining workflow disruption in a laboratory department</p> <p>Workflow was not completely examined: Boord et al²⁸ (2007) Chart review for examining glycemia control Nam et al³³ (2006) Chart review for examining thrombolysis time Zanier et al³⁶ (2007) Chart review for examining ICP control Bates et al³⁹ (1999) Chart review for examining medication errors Upperman et al⁴⁰ (2005) Chart review for examining medication errors Abboud et al⁴² (2006) Chart review for examining laboratory monitoring Ali et al⁴⁴ (2005) Chart review for examining use of an order set, intravenous drugs drips, ventilation management order, and length of stay</p>

Abbreviation: ICP, intracranial pressure.

^aReported workflow disruptions and/or negative effects from the use of CISs. Seven studies with (^a) in physician workflow are called "physician workflow-disruptions studies"; five studies with (^a) in nursing care workflow are called "nursing care workflow-disruptions studies." Details of these studies were provided in Tables 2 and 3.

physician workflow-disruptions studies and nursing care workflow-disruptions studies from Table 1; results of these workflow-disruptions studies will be included and analyzed in the discussion section. In the physician workflow-disruptions studies, the computer application mostly examined was CPOE systems. Some of the studies included nurses as subjects. In nursing care workflow-disruptions studies, nursing documentation systems were examined, and only nurses were included in subjects of these studies. These studies compared selected nursing activities before and after use of nursing documentation systems. Different methods for data collection were used to measure different items. Research sites of the studies in Table 2 all were inpatient settings.

Table 3 is an example that compares the results between the physician workflow-disruptions studies and

the nursing care workflow-disruptions studies. Nursing care workflow-disruptions studies showed negative and/or positive results in the same measurements. It makes clear beforehand that there was a sort of arbitrariness of the authors in combining and grouping the results of the physician workflow-disruptions studies, even though original groupings that were presented in each of the studies were considered as references.

In the discussion section, information in Tables 2 and 3 (ie, the physician workflow-disruptions studies and the nursing care workflow disruption-studies) will be analyzed for achieving the two purposes of this study (ie, to identify what has been examined about nursing care workflow disruptions and to obtain a lesson for future research to capture nursing care workflow disruptions triggered by using CISs. The study of

Table 2

Details of the Studies Reporting Physician and Nursing Care Workflow Disruptions



Authors	Computer Application	Research Sites	Data Collection Methods
Physician workflow disruptions studies			
Ash et al ¹¹ (2004)	PCIS	Four hospitals (US), public hospitals (Australia), two hospitals (the Netherlands)	Observation and interview (physicians, nurses, allied health professional, and pharmacists), and chart review
Campbell et al ¹⁵ (2006)	CPOE	Five academic and nonacademic hospitals	Observation and interview (physicians, nurses, pharmacists, ward secretaries, IT staff, and administrators)
Cheng et al ²⁵ (2003)	CPOE	A 15-bed medical/surgical ICU	Observation (physicians, nurses, pharmacists, and a respiratory therapist)
Han et al ²¹ (2005)	CPOE	An ICU in children hospital	Chart review
Koppel et al ²⁹ (2005)	CPOE	An urban tertiary-care teaching hospital	Observation and interview (physicians and surgery chair, pharmacists, nurses, IT staff, and an infectious disease staff)
Embi et al ³¹ (2004)	CPD	A teaching hospital	Focus groups and questionnaire (house staff) Semistructured interview and focus group interview (faculty and resident physicians)
Rose et al ³⁴ (2005)	EMR's subsystem	Two hospitals	Observations (physicians and nurses) Focus group interview (physicians)
Nursing care workflow-disruptions studies			
Ammenwerth et al ²³ (2001)	NDS	A teaching hospital	(Studies below are pretest/posttest studies.) Self-observation using a checklist (documentation time) Chart review using a checklist (documentation completeness) Interview with structured questionnaire (user acceptance)
Ammenwerth et al ¹² (2003)	NDS	A teaching hospital	Questionnaire and follow-up focus group interview (nurse acceptance)
Larrabee et al ²⁶ (2001)	NDS	Two medical/surgical units in a teaching hospital	Chart review using a checklist (documentation completeness)
Menke et al ²⁷ (2001)	NDS	A pediatric ICU	Observation in time-motion study (time for charting and patient care) Chart review using a checklist (medication errors, clinical decision making, documentation completeness)
Smith et al ³⁰ (2005)	NDS	A hospital	Questionnaire (attitude on care continuity) Observation using a checklist (charting time) Chart review using a checklist (documentation completeness) Questionnaire (nurse attitudes)

Abbreviations: CPD, computerized physician documentation; EMR, electronic medical record, IT, information technology; NDS, nursing documentation system; PCIS, patient care information system (including CPOE, EMR, and medication system).

Georgiou et al²⁴ (Table 1) will also be included in the Discussion.

DISCUSSION

What Has Been Examined About Nursing Care Workflow Disruptions

The nursing care workflow-disruptions studies investigated the effects of CIS implementations on selected

nursing activities (Table 2). Measurement of the selected nursing activities repeated a trend across all five studies. These studies did not trace all facets of adverse consequences that might be triggered by the use of CISs in the context of nursing care workflow (Table 3). The results of the nursing care workflow-disruptions studies were insufficient to fully explain nursing care workflow disruptions.

The physician workflow-disruptions studies highlighted mismatches between intended and actual workflow in real clinical settings. Scrutinizing physician workflow relevant

Table 3
Comparison of Disrupted Workflows: Physician Workflow-Disruptions Studies Versus Nursing Care Workflow-Disruptions Studies

Categorization of Disrupted Workflows for Physician^a	References^a	Categorization of Disrupted Workflows for Nurses^b	References^b
(1) Creating new work in entering information Time-consuming structure to fill out Awkward navigation Inconvenient computational interface Worse understanding by massive data	1,2,4-7	(1) Documentation time No overall time saving Time saved in some of items measured in a computer group	1,4,5 1
(2) Creating new errors in entering information Interface resulting in juxtaposition errors Confusing order options, poor formatting Inappropriate templates, a dense list of patients Low pixel, color, and contrast of screen	1-3	(2) Documentation completeness and quality No overall quality improvement Improved in a computer group	1 1,3,4
(3) A lack of communication among clinical staff Miscommunication Delayed execution of orders Less team discussion on care coordination Loss of feedback from clinical staff Creating errors as a resident alone enters a series of orders after patient rounds	1,2,4,6	(3) Medication errors Increased in a computer group because of delayed medication delivery	4
(4) Delayed system activation and system access Not activated until patient's arrival to the hospital for full registration into the system Postsurgery medications failure due to system activation delay Failure of late-in-day orders Lack of documentation availability at bedside Slow or no access to submodules of a system	4,5,7	(4) Nurse attitudes Positive experiences in a computer group Negative experiences in a computer group	4 5
(5) System inflexibility Not permitting small changes in given order entry Not permitting alternative routes of drug regardless of urgency	1,2,4,6	(5) Nurse acceptance Increased in a computer group Decreased in a computer group	1,2 2
(6) Inappropriate customization of order sets Absence of order sets for specific unit Order templates inappropriate to workflow	3,4,7		
(7) Unclear log on and off Entering medications in log-on terminal of a previous physician	3,5		
(8) Difficulties in ordering medication Unreal dosage assumed by the computer Medication renewal/discontinuation failure by poor interface Unusual medication schedule failure Allergy information delay Wrong medication selection by too many medication screens Tension between pharmacists and house staff for drug entered	5		
(9) Difficulties in medication delivery Worry on readministration of medications when order is "activated" after workarounds Relocation of all medications resulting in slow delivery of lifesaving drugs	1,4,5		

Table 3

(continued)



Categorization of Disrupted Workflows for Physician ^a	References ^a	Categorization of Disrupted Workflows for Nurses ^b	References ^b
(10) Nonfunction for shutdown Frequent downtime during peak operation periods Loss of data, order, time, and focus due to system shutdown Not immediately informed on a variety of changes occurred during system shutdown	1,4		
(11) Excessive, nonhelpful decision support overload	1		
(12) Slow speed of a system and poorly integrated with other computer systems	2		
(13) Mistakes, concern, and decreased confidence Automation leading to a loss of reflective thinking Plagiarism of others' notes	1,6		
(14) Others Never-ending demands for training/readapting to new systems	1-3		
Negative emotion on shifting clinical practices and workflow	2		
Loss of autonomy against computer's clinical guidelines	2,6		
Work duplication by existence of paper system	1,2		
Overdependence on technology	2		
Computer terminal workstation at a distance from bedside	3		

^aPhysician workflow-disruptions studies: (1) Ash et al¹¹ (2004), (2) Campbell et al¹⁵ (2006), (3) Cheng et al²⁵ (2003), (4) Han et al²¹ (2005), (5) Koppel et al²⁹ (2005), (6) Embi et al³¹ (2004), and (7) Rose et al³⁴ (2005).

^bNursing care workflow-disruptions studies: (1) Ammenwerth et al²³ (2001), (2) Ammenwerth et al¹² (2003), (3) Larrabee et al²⁶ (2001), (4) Menke et al²⁷ (2001), and (5) Smith et al³⁰ (2005).

to the use of CISs offered detailed information about dysfunctional workflow, from technological problems to incorrect uses of each individual and to socio-organizational problems in clinical practice (Table 3).

However, nursing care workflow disruptions were not a focus of the physician workflow-disruptions studies. Some of the studies in Table 2 included nurses as subjects of their study, but their focus was on disruptions of physicians' workflow. In the context of creating and processing physicians' orders, nurses coordinated and/or implemented the resources needed to ensure the orders are completed.^{11,15,25,29,48} Nursing roles and activities were obviously affected by physician orders, so any changes in the process of originating and implementing physician orders impacted on nursing roles, activities, and in turn nursing care workflow. But mediating and being affected by physician orders are part of nursing roles.⁴⁹ Results of the physician workflow-disruptions studies did not systematically organize disruptions of nursing care workflow that could occur in other many facets of nursing roles and activities in a fast-flowing and dynamic work environment.⁴⁹

Consequently, the physician workflow-disruptions studies reported details in disrupted workflows for physicians while rarely focusing on nursing care workflow disruptions. The nursing care workflow-disruptions studies did

not also capture all domains of adverse consequences from use of CISs that could be derived from a nursing perspective on patient care, because they measured only selected nursing activities. For the first purpose of this study, nursing care workflow disruptions from use of a CIS have been examined with selected nursing activities and not fully investigated, so what happens to nursing care workflow has not been fully recognized.

Implications for Future Research to Fully Capture Nursing Care Workflow Disruptions

Clinical information systems have not yet reached full maturity in healthcare environments.¹¹ Unintended adverse consequences in technological applications have been distributed in almost all CIS implementations in clinical settings.^{11,18,48} Also, adverse findings are rarely revealed until after the first encounter with the system in use.¹¹ Therefore, adverse consequences in the use of CISs have to be captured from the context of clinical work.^{18,19} Otherwise, implementation of a CIS will not allow integration into clinical workflow of healthcare providers directly involved in patient care. Nursing care workflow should be examined thoroughly in the context

of nursing care. Such an examination will facilitate the design of CISs that are supportive of nursing care as adverse findings are addressed.^{16,25,50} Unfortunately, such research is still lacking. There was also the limited discussion about qualities of a CIS to address the adverse consequences in nursing care workflow.

The physician workflow-disruptions studies are a good model, even though they did not focus on nursing care workflow disruptions. As shown in Table 3, the comparison indicated a large difference between the results from investigations of physician workflow disruptions and the results from investigations of nursing care workflow disruptions. These studies provided rich information about physicians' difficulties in the use of a CIS. Details about dysfunctional workflow provided actual ideas for quality improvement of a CIS to improve effectiveness of physician workflow (Table 3). This is a strong point of the physician workflow-disruptions studies.

The study of Georgiou et al²⁴ (Table 1) is also a good model. The study provided an opportunity to appreciate needs and expectations of laboratory staff on the use of a CIS. Their adverse findings were new categories that were applicable to laboratory staff, which could not be recognized by healthcare providers in different departments (eg, confusion by nonmatch between specimen collection time and order entry time, difficulty of discriminating added test orders from original test orders). Georgiou et al²⁴ pointed to the need for clear processes on renegotiation of work practices used in different departments to improve the workflow of laboratory staff.

For the other purpose of this study, implications for future research are to fully investigate disruptions and/or improvements in nursing care workflow according to use of CISs from nursing perspectives and in the context of nursing care, as demonstrated in the physician workflow-disruptions studies and the study of Georgiou et al.²⁴

Conclusion

It is important to construct a technological application that fits into what healthcare providers actually do in their everyday practices.^{9,10} Adverse consequences from the use of CISs should be identified to eliminate workflow disruptions and to bring workflow effectiveness to nursing practice. The reviewed studies provided limited information about the compatibility of CISs on nursing care workflow. This study demonstrated that physician workflow disruptions have been examined in detail while report of nursing workflow disruptions has been limited in the existing literature. The compatibility of CISs on nursing care workflow, that is, nursing care workflow disruptions, needs to be fully captured. The required research approach to clinical settings is to identify all facets of adverse consequences triggered from the use of

a CIS in the context of nursing care workflow. Nurses have a need for a CIS based on nursing perspective in patient care. Unless the use of CISs effectively captures the workflow of nursing care, it will result in confusion in nursing practice¹ as well as poor quality of patient care.¹¹ It is essential to carefully consider workflow perspective of nursing in the use of CISs.

Acknowledgments

The authors thank Dr Chang Gi Park, Dr Gail M. Keenan, Dr Mi Ja Kim, Dr Annette L. Valenta, and Dr Carrol Smith, University of Illinois at Chicago, for critical review of draft materials that resulted in this article.

REFERENCES

1. Pratt W, Reddy MC, McDonald DW, Tarczy-Hornoch P, Gennari JH. Incorporating ideas from computer-supported cooperative work. *J Biomed Inform.* 2004;37(2):128-137.
2. Courtney KL, Demiris G, Alexander GL. Information technology: changing nursing processes at the point-of-care. *Nurs Adm Q.* 2005;29(4):315-322.
3. Berg M. Patient care information systems and health care work: a sociotechnical approach. *Int J Med Inform.* 1999;55:87-101.
4. Berg M, Langenberg C, Berg I, Kwakkernaat J. Considerations for sociotechnical design: experiences with an electronic patient record in a clinical context. *Int J Med Inform.* 1998;52:243-251.
5. Berg M. Implementing information systems in health care organizations: myths and challenges. *Int J Med Inform.* 2001;64:143-156.
6. Allen D. The nursing-medical boundary: a negotiated order? *Sociol Health Illn.* 1997;19(4):498-520.
7. Cohen-Mansfield J, Lipson S, Horton D. Medical decision-making in the nursing home: comparison of physician and nurse perspectives. *J Gerontol Nurs.* 2006;32(12):14-21.
8. Taylor F. A comparative study examining the decision-making processes of medical and nursing staff in weaning patients from mechanical ventilation. *Intensive Crit Care Nurs.* 2006;22:253-263.
9. Ash JS, Gorman PN, Lavelle M, et al. Perceptions of physician order entry: results of cross-site qualitative study. *Methods Inf Med.* 2003;42:313-323.
10. Goorman E, Berg M. Modeling nursing activities: electronic patient records and their discontents. *Nurs Inq.* 2000;7(1):3-9.
11. Ash JS, Berg M, Coiera E. Some unintended consequences of information technology in health care: the nature of patient care information system-related errors. *J Am Med Inform Assoc.* 2004;11(2):104-112.
12. Ammenwerth E, Mansmann U, Iller C, Eichstadter R. Factors affecting and affected by user acceptance of computer-based nursing documentation: results of a two-year study. *J Am Med Inform Assoc.* 2003;14(1):69-84.
13. Paoletti RD, Suess TM, Lesko MG, et al. Using bar-code technology and medication observation methodology for safer medication administration. *Am J Health Syst Pharm.* 2007;64(1):536-543.
14. Cain C, Haque S. Chapter 31. Organizational workflow and its impact on work quality. http://www.ahrq.gov/qual/nursesdbk/docs/CainC_w.pdf. Accessed June 20, 2008.
15. Campbell EM, Sittig DF, Ash JS, Guappone KP, Dykstra RH. Types of unintended consequences related to computerized provider order entry. *J Am Med Inform Assoc.* 2006;13(5):547-556.
16. Kushniruk A. Evaluation in the design of health information systems: application of approaches emerging from usability engineering. *Comput Biol Med.* 2002;32:141-149.

17. Strauss AL, Fagerhaugh B, Suzek B, Weiner C. *Social Organization of Medical Work*. Chicago, IL: University of Chicago Press; 1985.
18. Aarts J, Ash J, Berg M. Extending the understanding of computerized physician order entry: implications for professional collaboration, workflow, and quality of care. *Int J Med Inform*. 2007;76S:S4–S13.
19. Ammenwerth E, Talmon J, Ash JS, et al. Impact of CPOE on mortality rates—contradictory findings, important messages. *Methods Inf Med*. 2006;45:586–594.
20. Gorman PN, Lavelle MB, Ash JS. Order creation and communication in healthcare. *Methods Inf Med*. 2003;42:376–384.
21. Han YY, Carcillo JA, Venkataraman ST, et al. Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system. *Pediatrics*. 2005;116(6):1506–1512.
22. Del Beccaro MA, Jeffries HE, Eisenberg MA, Harry ED. Computerized provider order entry implementation: no association with increased mortality rates in an intensive care unit. *Pediatrics*. 2006;118(1):290–295.
23. Ammenwerth E, Eichstadter R, Haux R, Pohl U, Rebel S, Ziegler S. A randomized evaluation of a computer-based nursing documentation system. *Methods Inf Med*. 2001;40:61–68.
24. Georgiou A, Westbrook J, Braithwaite J, et al. When requests become orders—a formative investigation into the impact of a computerized physician order entry system on a pathology laboratory service. *Int J Med Inform*. 2007;76:583–591.
25. Cheng CH, Goldstein MK, Geller E, Levitt RE. The effects of CPOE on ICU workflow: an observational study. *AMIA Annu Symp Proc*. 2003:150–154.
26. Larrabee JH, Boldregghini S, Elder-Sorrells K, et al. Evaluation of documentation before and after implementation of a nursing information system in an acute care hospital. *Comput Nurs*. 2001;19(2):56–65.
27. Menke JA, Broner CW, Campbell DY, McKissick MY, Edwards-Beckett JA. Computerized clinical documentation system in the pediatric intensive care unit. *BMC Med Inform Decis Mak*. 2001;1(3):1–7.
28. Boord JB, Sharifi M, Greevy RA, et al. Computer-based insulin infusion protocol improves glycemia control over manual protocol. *J Am Med Inform Assoc*. 2007;14:278–287.
29. Koppel R, Metlay JP, Cohen A, et al. Role of computerized physician order entry systems in facilitating medication errors. *J Am Med Assoc*. 2005;293(10):1197–1203.
30. Smith K, Smith V, Krugman M, Oman K. Evaluating the impact of computerized clinical documentation. *Comput Inform Nurs*. 2005;23(3):132–138.
31. Embi PJ, Yackel TR, Logan JR, Bowen JL, Cooney TG, Gorman PN. Impacts of computerized physician documentation in a teaching hospital: perceptions of faculty and resident physicians. *J Am Med Inform Assoc*. 2004;11(4):300–309.
32. Korst LM, Eusebio-Angeja A, Chamorro T, Aydin CE, Gregory KD. Nursing documentation time during implementation of an electronic medical record. *J Nurs Adm*. 2003;33(1):24–30.
33. Nam HS, Han SW, Ahn SH, et al. Improved time interval by implementation of computerized physician order entry—based stroke team approach. *Cerebrovasc Dis*. 2006;23:289–293.
34. Rose AF, Schnipper JL, Park ER, Poon EG, Li Q, Middleton B. Using qualitative studies to improve the usability of an EMR. *J Biomed Inform*. 2005;38:51–60.
35. Reuss E, Menozzi M, Buchi M, Koller J, Krueger H. Information access at the point of care: what can we learn for designing a mobile CPR system? *Int J Med Inform*. 2004;73:363–369.
36. Zanier ER, Ortolano F, Ghisoni L, Colombo A, Losappio S, Stocchetti N. Intracranial pressure monitoring in intensive care: clinical advantages of a computerized system over manual recording. *Crit Care*. 2007;11(1).
37. Van Eaton EG, Horvath KD, Lober WB, Rossini AJ, Pellegrini CA. A randomized, controlled trial evaluating the impact of a computerized rounding and sign-out system on continuity of care and resident work hours. *J Am Coll Surg*. 2005;200:538–545.
38. Cordero L, Kuehn L, Kumar RR, Mekhjian HS. Impact of computerized physician order entry on clinical practice in a newborn intensive care unit. *J Perinatol*. 2004;24:88–93.
39. Bates DW, Teich JM, Lee J, et al. The impact of computerized physician order entry on medication error prevention. *J Am Med Inform Assoc*. 1999;6(4):313–321.
40. Upperman JS, Staley P, Friend K, et al. The impact of hospital-wide computerized physician order entry on medical errors in a pediatric hospital. *J Pediatr Surg*. 2005;40:57–59.
41. Ozdas A, Speroff T, Waitman R, Ozbolt J, Butler J, Miller RA. Integrating “best of care” protocols into clinicians’ workflow via care provider order entry: impact on quality-of-care indicators for acute myocardial infarction. *J Am Med Inform Assoc*. 2005;13(2):188–196.
42. Abboud PA, Ancheta R, McKibben M, Jacobs BR. Clinical informatics outcomes research group. Impact of workflow-integrated corollary orders on aminoglycoside monitoring in children. *Health Inform J*. 2006;12(3):187–198.
43. Vigoda MM, Gencorelli F, Lubarsky DA. Changing medical group behaviors: increasing the rate of documentation of quality assurance events using an anesthesia information system. *Anesth Analg*. 2006;103(2):390–395.
44. Ali NA, Mekhjian HS, Kuehn L, et al. Specificity of computerized physician order entry has a significant effect on the efficiency of workflow for critically ill patients. *Crit Care Med*. 2005;33(1):110–114.
45. Driscoll WD, Columbia MA, Peterfreund RA. An observational study of anesthesia record completeness using an anesthesia information management system. *Anesth Analg*. 2007;104(6):1454–1461.
46. Overhage JM, Perkins S, Tierney WM, McDonald CJ. Controlled trial of direct physician order entry. *J Am Med Inform Assoc*. 2001;84:361–371.
47. Pizziferi L, Kittler AF, Volk LA, et al. Primary care physician time utilization before and after implementation of an electronic health record: a time-motion study. *J Biomed Inform*. 2005;38:176–188.
48. Ash JS, Sittig DF, Poon EG, Guappone K, Campbell E, Dykstra RH. The extent and importance of unintended consequences related to computerized provider order entry. *J Am Med Inform Assoc*. 2007;14(4):415–423.
49. Allen D. What do you do at work? Profession building and doing nursing. *Int Nurs Rev*. 2007;54(1):41–48.
50. Sittig DF, Ash JS, Zhang J, Osheroff JA, Shabot MM. Lessons from “unexpected increased mortality after implementation of a commercially sold computerized physician order entry system.” *Pediatrics*. 2006;118(2):797–801.

For more than 15 additional continuing education articles related to electronic information in nursing, go to NursingCenter.com/CE.