Chapter 31. Organizational Workflow and Its Impact on Work Quality

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Background

What Is Workflow?

Workflow, loosely defined, is the set of tasks—grouped chronologically into processes—and the set of people or resources needed for those tasks, that are necessary to accomplish a given goal. An organization's workflow is comprised of the set of processes it needs to accomplish, the set of people or other resources available to perform those processes, and the interactions among them. Consider the following scenario:

> On a slow Friday afternoon in the emergency room, as one nurse prepares to go off shift, the clerk looks up from the desk and asks, "By the way, since you're passing by housekeeping on your way out, would you remind them that room 12 still needs to be cleaned?"
>
> "No problem," replies the nurse, and indeed, on a slow Friday afternoon, it is no problem. The informal methods and processes that the hospital has developed over the years to keep the enterprise humming work well, in general, and can work very well in optimal times. It's no trouble to remind housekeeping to come up; it's no trouble to run a special specimen down to the lab, and certainly no trouble to catch the attending physician during rounds to get a quick signature. Even if these small adjustments are forgotten, in due time the regular hospital schedule will bring the right people to clean the room, to pick up the lab specimen, to document the encounter.

These same methods that an organization uses to get work done, however, can begin to show stress under trying circumstances. When the ward is full and it takes 12 hours for a room to be readied for the next patient, that impact is felt throughout the organization. When the number of small interruptions outweighs the amount of planned work done in a given hour, that impact is felt in slower progress, lower job satisfaction, and potentially lower quality of care. In many situations, it is very clear to all what needs to get done. Where organizations differ is in how they do it. The examination of how an organization accomplishes its tasks often concerns the organizations' workflow.

In health care, as in other industries, some workflows are designed, while others arise organically and evolve. The systems and methods by which organizations accomplish specific goals differ dramatically. Some organizational workflows seem more straightforward than others. Most often, when workflow processes are looked at in isolation, the processes appear quite logical (and even efficient) in acting to accomplish the end goal. It is in the interaction among the processes that complexities arise. Some of these interactions hide conflicts in the priorities of different roles in an organization, for example, what the nursing team is accountable to versus the physician team and its schedule. Organizations also adapt workflows to suit the

evolving environment. Over time, reflecting on organizational workflows may show that some processes are no longer necessary, or can be updated and optimized.

Why Is It Important to Nurses?

Health care has often faced the pressure to design, or redesign, its workflows to be more efficient and effective. In many cases, the trigger for examining workflow is in response to changes in how things are done. Today, the need to think about workflow design is more pressing due to several factors, including:

- The introduction of new technologies and treatment methodologies into clinical care
- The challenge of coordinating care for the chronically ill
- The participation of a growing array of professionals in a patient's care team, and new definitions in their roles
- Cost and efficiency pressures to improve patient flow
- Initiatives to ensure patient safety
- Implementation of changes to make the care team more patient-focused

One important reason that workflow is of pressing concern for today's clinicians is the introduction of new health care information technology (health IT) into clinical practice. Health IT promises many benefits for improving quality and efficiency. However, the introduction of health IT can be very disruptive to existing workflows in an organization. Health IT systems often implicitly assume a workflow structure in the way their screens and steps are organized. Organizations that are thoughtful about workflow design are more likely to be successful in adapting to health IT.[1]

In contrast to industries such as manufacturing, health care is a service industry that relies heavily on good information. In closely following and taking care of patients, nurses are guardians of a rich source of information. This valuable information can be lost when poor workflows impede communication and coordination or increase interruptions.[2] Characteristics of a poorly functioning work process include unnecessary pauses and rework, delays, established workarounds, gaps where steps are often omitted, and a process that participants feel is illogical.

The design of good organizational workflow is not simply about improving efficiency. Workflow processes are maps that direct the care team how to accomplish a goal. A good workflow will help accomplish those goals in a timely manner, leading to care that is delivered more consistently, reliably, safely, and in compliance with standards of practice. An excellent workflow process can accommodate variations that inevitably arise in health care through interaction with other workflow processes, as well as environmental factors such as workload, staff schedules, and patient load.

Research Evidence

Health services researchers have explored workflow issues from several angles, including mapping processes from other industries into health care. Literature about workflow can be found in several different domains, such as quality improvement, technology implementation, and process improvements. One common thread throughout the literature is the importance of interdisciplinary involvement in all aspects of workflow analysis and implementation.

Reviewing the evidence to date, targeted studies of particular interventions and technologies amply show that good workflow design has significant (expected and unexpected) impacts on

care delivery.[3] The literature also demonstrates a relative lack of sophistication in studies of the field: whether researchers are initially concerned with the problem or whether it arises organically from the results; whether the researchers have a theoretical framework to interpret their findings; whether there is consistency in the outcomes of interest; whether the target(s) of study are structural, cultural, and/or functional; and whether the researchers are able to generalize from the findings in one setting to another. Many studies demonstrated significant benefit from careful consideration of workflow, but few studies provided easily adaptable tools and methods for immediate, consistent implementation.

Effect on Efficiency

Workflow analysis has often been used with the goal of improving efficiency. In response to financial pressure and incentives driving provider organizations, minimizing slack time has become important. Some of the studies discussed below demonstrated the power of analyzing and changing workflow to improve efficiency.

Workflow analysis can be used to redesign existing processes. A classic study of this type is Cendan and Good's[4] analysis of the routine tasks of the various members of the operating room (OR) team. They found that there was a wide variability in functions based on clinical and organizational factors. They designed a new workflow based on the analysis and conducted a pilot study. Part of their recommended solution involved defining functions in a more consistent fashion. They were able to improve turnover and improve the mean number of cases handled in a day. A significant factor in their success was their consideration of workflow from both the physician and the nursing perspectives.

Efficiency can also be improved by carrying out processes in parallel, rather than improving the efficiency of existing steps.[5] Friedman and colleagues[6] compared the impact of administering anesthesia in the induction room versus in the OR for hernia repair patients. They found that the OR time used by the surgeon decreased without significant impacts on patient satisfaction or outcomes.[6] Harders and colleagues[7] employed a combination of approaches. They used parallel processing and process redesign to improve workflow in a tertiary care center with multiple OR suites. This combination of approaches allowed for a reduction in nonoperative time. Similarly, in a study of trauma teams, Driscoll and Vincent[8] modified task allocation so that standard tasks performed during a trauma code were conducted in parallel rather than sequentially.

In each of these approaches, role definition played a critical role in the success of the efforts. Each study found that nursing routines often included nonclinical tasks, such as tracking down missing information or supplies.[9] By defining roles and essential processes, it was possible to use ancillary staff for these tasks. In order for the redesign to be successful, nursing involvement was important from the beginning. An interdisciplinary approach provided the basis for the workflow analysis and redesign; this was cited as a success factor in multiple studies.[4, 6, 7]

Common Issues

Workflow issues often arise in studies of technology. One well-studied domain area is barcode medication administration (BCMA).[10] BCMA is a technology that has been shown to improve care quality by reducing reliance on memory, increasing access to information, and increasing compliance with best practice. However, very simple inconveniences—such as the need to access a patients' wrist for the barcode strip—have led to workflow workarounds, such

as scanning barcodes off a key ring rather than the patient. In this case, the nurses' adaptation to make their work more efficient circumvents some of the intended benefits of the defined process.

More complex interactions have also been observed. Because many BCMA systems require that the physician enter an order before the nurse can have access to the medication, some nurses have, in critical situations, "borrowed" medication from one patient on the ward to give to another until the medication for the second patient appears in the system. As a result, the nurse cannot readily document the administration of the order until the order has been entered by the physician. In some situations, a shadow system of informal paper documentation supplements, duplicates, or confuses the documentation captured in an electronic system.

When technology does not adequately support the goals of the care team, it often causes workaround workflows. These alternate workflows are a cause for concern because these informal, evolutionary systems rely on the clinicians' memories, and bypass decision-support safeguards that the system may provide. Studies have documented other negative effects,[11] such as degraded coordination between nurses and physicians, nurses dropping activities during busy periods, and decreased ability to deviate from routine sequences.

Information Transfer

Health care organizations provide valuable services that rely on large amounts of high quality information. Information transfer is complicated because caring for one patient can involve many providers and information sources. Thus, many errors occur at handoff or transition points.[12] Dykes and colleagues[13] found that many hospitals in the United States have dual paper and electronic records, leading to redundancies and inefficiencies in information. Other information tools include proprietary paper forms, the phone, the electronic record system, the whiteboard, the pager, and schedules.[14] In addition, informal meetings and verbal orders frequently also serve as information transfer devices.[15]

One attempt to address this complexity is an electronic portal that provides access to systems through one interface.[16] Though this can mitigate the problem, it cannot fully address the communication needs of a care team.

A common class of problems with information transfer and handoffs includes degradation of information.[17] If methods of transfer are informal and not documented, patient information may not be passed on when staff members leave a unit. In addition, the lines of responsibility and expectations are not always clear.[17] Incorporating formalized information transfer tools and protocols into workflow processes may help. Another problem complicating information transfer is interruptions. These interruptions often cause a break in workflow, which can impact what information is documented and passed on.[18, 19]

Intra-Professional Information Transfer

Nursing work is often fragmented and rushed, due to external pressures and the dynamic environement.[20] However, nurses serve as critical integrators and coordinators of care. Health IT tools, which can help nurses better manage and transfer information and make the information more widely available have the potential to improve practice.[21] Intraprofessional handoffs may occur within or across departments. In either case, communication and coordination is improved by having a structured documentation format.[22]

Lamond[23] reviewed the content of nursing intershift reports and found that more information was documented in the patient notes than was given in the report. The report information tended to be more overall assessments of patient care, which was not necessarily documented. Thus, it is not clear if the detailed information was transferred in subsequent reports. Perrott[24] found that customizing data fields and having nurses involved from the beginning enhanced nursing handoffs in the intensive care unit (ICU).

By understanding nursing workflow, barriers and facilitators for information transfer can be discussed and improved upon.[25] If handoff mechanisms are informal, then they might not be documented in a workflow analysis.[26] Health IT systems should not replace these handoffs, but could be used to augment the process.[27] However, when the processes are not well understood, the technology may not be used and may even be a burden.

Inter-Professional Information Transfer

Inconsistent or incomplete information during patient care transfers is a commonly cited communication difficulty.[28] This problem is exacerbated by systems and processes with duplicate or outdated information. There is a great deal of information available, but it is not always available in a streamlined or organized fashion.[29]

Clinical providers trained in different disciplines are socialized and trained differently, so they do not necessarily know what the others need.[29] Thus, when designing and implementing information technology across departments, it is important to have an interdisciplinary team involved throughout the process.[22] Physicians and nurses do not generally have the same employer and often have varying loyalties and end goals.[4] Thus, it is important to consider many perspectives when designing handoff and communication practices.

One way to look at interprofessional collaboration is to look at information needs. Reddy and colleagues[30] reviewed information needs of various providers in the ICU. They found that some roles, including nurses, served as information sources for other providers. Thus, it is important to consider the workflow implications of changing information sources. When a face-to-face communication with a nurse is replaced by an electronic report, what is lost and gained? Electronic access provides the benefits of ready access to large quantities of source data, potentially supplemented with decision support. What may be lost are functions of information synthesis, summarization, and coordination. In a survey of chief nursing officers, Dykes and colleagues[13] emphasized the role of nurses as coordinators and communicators.

Riley and Manias[31] looked at physician–nurse communication in an OR setting. They found that nurses often had informal knowledge of physicians and their habits, which they used to control practices. This knowledge was not necessarily codified formally, so new nurses would have difficulty in estimating workflow. Health care organizations have engaged in efforts to standardize inter-professional communication, for example through requiring the use of SBAR for situational briefing.[32]

It is not always necessary to have a separate process for interprofessional communication. Indeed, other efforts can be repurposed for interprofessional communication. For example, Cunliffe[33] described a nursing discharge summary process which was repurposed to provide a nurse–general practitioner communication device. A nursing discharge summary provided detailed information about nursing and social care for the patient after they left the hospital. In addition, sending this to the general practitioner (GP) provided a mechanism for communication so that the GP would be well-informed about the patient's care. Similarly, a resident sign-out

system could also be accessed by other professionals.[34] However, communication lines tend to be separate and dependent on professionals, so it is not clear how much intraprofessional access occurs. Patterson and colleagues[35] studied handoff strategies in other industries and outlined some common strategies for effective handoffs. Often, documentation was a supplement to the handoff, rather than the sole mechanism for information transfer.

Health Information Technology

Health IT, used well, can improve efficiency and organizational workflow. In health care, redundant information is often created and stored. As a result, care providers spend a great deal of time reconciling information from various sources. Integrating health IT with the workflow of various departments can help to reduce this redundancy.[22] However, if workflow is not considered and the technology is not thoughtfully implemented, the benefits cannot truly be achieved. To use technology most effectively, its potential impact to transform care delivery must be realized.[36]

While it is important to consider workflow when implementing health IT, it does not mean that health IT should leave processes intact. Health IT can bring about positive process change and better workflow. Because IT can consolidate and display information, it can be used as an opportunity to improve upon teamwork and communications.[37] Understanding existing clinical workflow prior to implementation provides a baseline to redesign systems and develop better processes.[38] Scharmhorst, Johnson, and Li[39] emphasized the importance of understanding the system prior to implementing technology, to ensure that technology streamlines nursing workflow, rather than making it more complicated. In a study of mobile cabinets with barcode scanning for medications, Braswell and Duggar[40] found that, by analyzing workflow ahead of time, both pharmacy and nursing staff reported improvements to existing work processes after implementation. Workflow concerns can lead to failure to adopt new technologies. A study of electronic prescribing systems standards finds that many of the electronic standards are adequate but provider adoption is low because the systems do not fit into workflow.[41] The evaluators recommend that the standards and systems be revised to accommodate the large role of nurses in electronic prescribing in the office setting.

Focus on Computerized Provider Order Entry

Computerized Provider Order Entry (CPOE) is an easily measurable, frequently implemented, and often intrusive instance of health IT, and has been studied often in the literature. CPOE is commonly associated with its impact on physician practice. However, there are workflow implications in CPOE implementation for the entire care team, including physicians and nurses.[42] For example, if physicians refuse to use the CPOE system, it creates adverse impacts on nursing workflow.[3, 28] Sometimes, nurses become the de facto order entry personnel, in addition to their nursing duties. These workarounds also have effects downstream. Delays in order entry can hold up medication delivery. The introduction of CPOE technology may surface informal practices that may not be in compliance with prescribing scopes of practice. Thus, nurses are a key success factor in CPOE implementation.[43] Because nurses often are primarily responsible for communication and coordination of care, understanding nursing workflows with respect to order entry is critical.[44]

Payne[45] found that implementing CPOE had a profound impact on work patterns, communication methods and roles. In analyzing workflow around electronic prescribing, the range of tasks completed by the nonprescribers was outlined.[46] After outlining the work processes and information flows, they were able to adapt the system to accommodate the necessary tasks. Similarly, Wright and colleagues[47] found that physician-nurse communications were impacted by the CPOE implementation. Paper-based order entry often relies on visual cues, such as a folded piece of paper. If the loss of context and visual cues is not accounted for in the CPOE implementation, then the nursing workflow is adversely impacted because of the uncertainty around orders.

Piasecki and colleagues[48] conducted a workflow analysis to look at the benefits of implementing CPOE in an emergency department setting. These researchers developed a return-on-investment tool to measure the outcomes of the implementation and found that many of the savings did not make a direct impact on the bottom line of the organization. This was, in part, because the changes in workflow were not fully understood until after implementation.

Though guidelines for analyzing workflow are few, the common factor was consideration of all affected roles in the organization, not only those involved with entering data into the IT system. Breslin and colleagues[49] found that having an interdisciplinary team was important in the success of a Vocera implementation. This team included clinical and nonclinical staff. By being inclusive, they learned about workflow from a variety of perspectives and were able to implement their tool in a fashion that would improve upon existing practices.

Ongoing Work in Nursing Workflow Research

Research into the workflows of nurses has long roots in studies of how nurses spend their time and how nursing teams should be staffed.[50-52] Nurse researchers embarking on observational research of nursing work can take advantage of previously developed tools for work task analysis and time motion study.[53-55]

With the introduction of new technologies, the research frontier includes studies of how nursing work is affected, with the aim of ensuring quality time at the bedside. An ongoing large multi-site time-motion study of nurse workflow[56] includes the involvement of frontline nurses in the design and improvement of their work spaces and technologies. It represents one way that lessons learned from past research can be brought to bear on future workflow design, with the intent of mitigating the pain of learning workflow and technology weaknesses through implemented experience.

Practice Implications

The research findings for these studies of operational workflows have practice implications for nurses and researchers. Throughout the literature, the importance of bringing multiple parties to the table was emphasized. Because organizational workflows often cross the lines of professional disciplines, workflow design from any single perspective runs the risk of sub-optimizing against other constraints, priorities, and schedules.

Conscious workflow design has been shown to improve the efficiency of existing work processes or enable parallelization of work. In designing such systems, researchers emphasize the importance of clearly defining roles and responsibilities, preferably with multi-disciplinary input. Designing workflow is of critical importance to all roles in a health care organization,

because the effects of decisions by an expert in one role may have downstream effects on others. A workflow optimized to serve one role, such as the nurse, can be onerous or seem irrational to another. Because each professional role deals with fairly complex, role-specific work processes, it is often difficult for experts in one role to understand and envision how proposals will affect other roles, even with the best intentions. Research on information transfer in organizational settings demonstrates that adaptations to poor workflows can lead to increased interruptions, workarounds, and informal or ill-defined communication. To improve the reliability of workflows accomplishing their desired goals, and to reduce the risk to patient safety, researchers recommend structured communications and clear agreements about roles and responsibilities in a hand-off.

Health IT systems surface many of the long-standing issues around workflow. The implementation of health IT systems can, at first glance, seem like a superficial intrusion into the way things are done. For some, it feels like the addition of another documentation step in the process of regular clinical care. This step can be disruptive and a burden, but it does not dramatically change the way work is done. Yet there are many downstream effects on communication and coordination within an organization. Analyzing workflow beforehand can help prevent some of these unintended consequences. Technology does not necessarily improve institutional efficiencies, but can bring opportunities for improvement to light.[42] Sittig and colleagues[38] found that while considering that technology was important, it was also important to consider organizational and workflow factors prior to implementation, or the benefits may not be realized. In order to realize good outcomes, interdisciplinary consideration of process and technology factors was important.[57]

In many organizations, the adoption of health IT is motivated by the desire to accomplish goals that are difficult without a structured electronic system. These goals include reducing medication errors through barcoding; improving clinical decisionmaking through decision support, such as alerts and reminders; measuring clinical quality performance; proactively reaching out to patients for population health management; or simply the ability to analyze clinical information, for example, by charting a patients' blood pressure based on nursing notes. These additional expectations of a health IT system mean that the organization can expect dramatic changes in workflow—the health IT implementation is a vehicle to trigger larger improvement activities.

It is important to realize that health IT systems have a built-in sense of how things are done, in fact, have an inherent workflow that may or may not map to the organizations' workflow. Consider the case of CPOE. Let's describe the workflow process as a series of tasks, linked chronologically, that require organizational resources. The logical model within a health IT system usually goes something like this:

1. The provider enters an order.
2. The pharmacist verifies the order.
3. The order is delivered to the point of care.
4. The nurse administers the order.

There are two things to note about this perfectly reasonable assumption about how things are done. The first is that the workflow is very linear. It will be very important to understand what happens if that linearity is disrupted somehow. For example, if the pharmacist fails to verify the order, will the system prevent the order from being "released" until this step is accomplished? Flexibility within a linear workflow is very important to the smooth operation of a complex service organization like a health care institution. Practitioners have a responsibility to check that

a health IT system reacts gracefully to a change in workflow, lest patient care be compromised. The second thing to note is that the workflow within the system only reflects one of the ways health care is delivered in an organization. In many critical care settings, for example, medications must be administered quickly, before any interaction with a CPOE system. Practitioners should also ask whether the health IT systems they are implementing reflect all of the main workflow processes within their organization.

When a new health IT system or a new technology fails to accommodate the real workflows of an organization, interacting with the technology becomes a greater burden on the organization than is required. In essence, there is "the way the world works" and then "the way the computer thinks the world works," and it is the constant responsibility of system users to reconcile the two world views. In fact, implementing health IT systems within organizations poses such a challenge that the Office of the National Coordinator for Health IT has estimated that as many as 30 percent of all implementations fail.[58] Thoughtfully constructing the workflow inherent to the technology can smooth technology acceptance.[59, 60]

Before implementing information technology in a health care environment, it is important to have an understanding of processes and information flows. In addition, it is important to consider various roles in the different departments, and to consider ideas from multiple sources.[22] Each department and role may have a different perspective of the encounter and its necessary elements.[36, 61] In addition, many organizations have a variety of tacit assumptions and information exchanges which might not be documented in a traditional analysis. Thus, it is important to consider multiple sources of data in order to develop a more complete understanding of workflow and processes.[36]

In the United States, hospitals are generally organized by functions. Because of that, workflow is also organized around these functions. Information systems were developed around these functions and were designed to meet the needs of a particular department. However, patient care takes place through a broader perspective. Thus, these functions need to be integrated.[20] In conducting a workflow assessment, it is important to consider how workflow currently functions and how it might change to improve patient care and reduce errors throughout the system.[20, 62] In addition, this kind of analysis can help find flaws in the process for which information technology can be leveraged.[20]

The truth is that many care teams do well even when workflow processes are designed poorly. Health care practitioners understand the clinical needs of patients. Health care workers often go to heroic lengths to make sure that the right thing gets done. When a problem arises, most clinicians would not hesitate to pick up the phone, run the errand, or do what is necessary to insure good care. Yet clinician resources are not unlimited. When nurses, like all people, get tired, they may become forgetful When they are rushed, they may not remember to do everything necessary.[63] These issues may be exacerbated by a health IT system that seems not to understand what the clinicians want to do—sometimes because the workflows in the health IT system do not match those in the real organization. In the seminal work on clinical error, the health care community acknowledged that most errors are the result of systematic deficiencies.[64] Good workflow processes are an aid to practitioners to insure that the system behaves to support high quality care. Nurse informaticists can work with their counterparts to apply some of the principles found in the literature to practice.

Research Implications

Workflow design is a difficult endeavor because of the complexity of most health care organizations and the division of labor into expert roles. Health care organizations are service organizations that are very flexible and interdependent in response to dynamic patient needs. For many work processes, the established workflow evolved over time in response to the kind of tasks and resources available, and were not explicitly considered or designed. Changes to organizational workflow are an opportunity to think through how the care team can provide good patient care reliably under a variety of circumstances.

Research on workflow issues can be very rewarding because of its closeness to real-world operational challenges. Study participants often experience a high level of frustration with their current situation, and are eager to have assistance in thinking through complex organizational effects. The research often starts with a theoretical model that helps define the problem space, such as conceptualizing the structure, process, and outcomes[65] or the tasks, actors, and information.[66] The model can be made operational through computer modeling, and used to represent particular problems.

In support of workflow design activities, computer simulation tools have been developed to help decisionmakers map their organizational roles and understand the impact of different workflow choices.[67-69] Models of workflow processes show the trajectories of the care providers, patients, and information. By representing workflow in a manner which is easily accessible to others, managers and researchers can identify where issues are likely to arise and develop tools to prevent them. Modeling workflow also usefully defines roles and delineates how the care team understands its job functions and work processes

For health IT, workflow design is especially difficult because many of the assumptions about workflow are implicit. The designers of IT systems benefit from conversations with their users to understand how clinical care is provided in the organization. Without the input of users, it is tempting to apply the same workflows to different organizations. Many issues can be easily resolved through small changes in user interface or clinical decision support rules—changes that are very difficult to predict in advance. Although some issues can be resolved through customizing the health IT system, others are more intractable. The health IT system may simply reveal latent problems with the old workflow. As more organizations embark on large-scale health IT implementations, a scalable method for incorporating workflow considerations is urgently needed, so that new health IT systems do not cause harm.[70] When issues have been surfaced, through conversations, observation, modeling, and other methods, researchers have the opportunity to bring to bear established quality improvement methods to workflow design. Studies to date have relied on ad-hoc methods to effect improvement after studying workflow, and there are opportunities to apply structured methods to assist an organization in responding to workflow discoveries.

Many of the research articles reviewed involved a descriptive case study. Some studies utilized a grounded theory approach. Few articles utilized a conceptual framework to frame the results. While research on service organizations has been applied to health care organizations, much work remains to be done in delineating how health care work differs from other industries, in particular to understand whether results from inquiries in other fields, such as manufacturing, can be generalized to health care. In addition, there is a need for research to demonstrate a link between performance indicators and workflow.[71] Nurse researchers have an opportunity to take the research that has been done to date and apply it on a broader scale. Much of the work that has

been done outlines specific implementation efforts or describes a single department. By taking a systems approach to organizational workflow, coordination of patient care throughout the trajectory of their stay can be improved.

Search Strategy

The search for workflow issues in delivering high quality nursing care is complicated because workflow, by its nature, touches on many organizational issues and roles. Literature that identifies specific problems in patient safety may allude to their greater systemic workflow causes or effects. Even literature that specifically considers workflow may limit the analysis to one organizational role. Thus, our literature search did not attempt to be a comprehensive search of literature published on workflow, but rather a scan of areas in the medical and nursing literature where relevant publications are likely to appear. There is also a longer history of research literature in other fields, notably industrial engineering and management.

We looked at MEDLINE® and CINAHL® articles published in English. Because workflow is not a standardized term in either database, we searched it as a keyword in its various permutations. We did the same with handoffs, as we knew that this was a common study topic where workflow issues surface. In addition, we did searches using combinations of related terms in each database. The terms we used were in categories dealing with continuity of care, care teams, information needs, information systems, and patient safety. We found that the keyword search yielded more consistent information than the standardized terms, in part because the terms were developed with specific purposes in mind. Studies of workflow are still fairly new, and it is hoped that as the field matures, it will be easier to identify a unique body of work.

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References

1. Ash JS, Sittig DF, Poon EG, et al. The extent and importance of unintended consequences related to computerized provider order entry. J Am Med Inform Assoc 2007 Jul-Aug;14(4):415-23.

2. Laxmisan A, Hakimzada F, Sayan OR, et al. The multitasking clinician: decision-making and cognitive demand during and after team handoffs in emergency care. Int J Med Inform 2007 Nov-Dec;76(11-12):801-11.

3. Campbell EM, Sittig DF, Ash JS, et al. Types of unintended consequences related to computerized provider order entry. J Am Med Inform Assoc. 2006 Sep-Oct;13(5):547-56.

4. Cendan J, Good M. Interdisciplinary work flow assessment and redesign decreases operating room turnover time and allows for additional caseload. Arch Surg 2006;141:65-9.

5. Sandberg WS, Daily B, Egan M, et al. Deliberate perioperative systems design improves operating room throughput. Anesthesiology 2005;103:406-18.

6. Friedman D, Sokal SM, Chang Y, et al. Increasing operating room efficiency through parallel processing. Surgery 2006;243:10-4.

7. Harders M, Malangoni MA, Weight S, et al. Improving operating room efficiency through process redesign. Surgery 2006;140:509-16.

8. Driscoll PA, Vincent CA. Organizing an efficient trauma team. Injury 1992;23(2):107-10.

9. Waring J, McDonald R, Harrison S. Safety and complexity: inter-departmental relationships as a threat to patient safety in the operating department. J Health Organ Manag 2006;20:227-42.

10. Patterson ES, Rogers ML, Chapman RJ, et al. Compliance with intended use of bar code medication administration in acute and long-term care: an observational study. Hum Factors 2006 Spring;48(1):15-22.

11. Kobayashi M, Fussell SR, Xiao Y, et al. Work coordination, workflow, and workarounds in a medical context. Proceedings of CHI 2005, Conference on Human Factors in Computing. pp. 1561-4.

12. Burke KG. Executive summary: the state of the science on safe medication administration symposium. J Infus Nurs 2005;28(2):87-92.

13. Dykes P, Cashen M, Foster M, et al. Surveying acute care providers in the U.S. to explore the impact of HIT on the role of nurses and interdisciplinary communication in acute care settings. J Healthc Inf Manag 2006;20(2):36-44.

14. Gurses A, Hu P, Gilger S, et al. A preliminary field study of patient flow management in a trauma center for designing information technology. AMIA Annu Symp Proc 2006:937.

15. Philpin S. Handing over: transmission of information between nurses in an intensive therapy unit. Nurs Crit Care 2006;11(2):86-93.

16. Egan M. Clinical dashboards: impact on workflow, care quality, and patient safety. Crit Care Nurs Q 2006;29(4):354-61.

17. Powell SK. Handoffs and transitions of care: where is the Lone Ranger's silver bullet? Lippincott's Case Manag 2006;11(5):235-7.

18. Brixey JJ, Robinson DJ, Tang Z, et al. Interruptions in workflow for RNs in a level one trauma center. AMIA Annu Symp Proc 2005:86-90.

19. Brixey JJ, Robinson DJ, Johnson CW, et al. Towards a hybrid method to categorize interruptions and activities in healthcare. Int J Med Inform, 2006;76:812-20.

20. Spear S. Fixing healthcare from inside, today. Harv Bus Rev 2005 Sep;83(9):78-91, 158.

21. Brown DN, McCormack BG, McGarvey H. Factors influencing the control of post-operative pain in older people. Rev Clin Gerontol 2005;15(2):149-56.

22. Guite J, Lang M, McCartan P, et al. Nursing admissions process redesigned to leverage EHR. J Healthc Inf Manag 2006;20(2):55-64.

23. Lamond D. The information content of the nurse change of shift report: a comparative study. J Adv Nurs 2000;31:794-804.

24. Perrott D. Achieving rapid implementation without disrupting workflow. Medication administration technology meets nurses' need for "perfect" technology. J Nurs Adm 2004;34 Suppl:5-6.

25. What does JCAHO expect for handoffs? OR Manager, 2006 April;22(4)11.

26. Patterson, E. Handoffs: lessons from other industries. OR Manager 2005;21(8)11-2.

27. Strople B, Ottani P. Can technology improve intershift report? What the research reveals. J Prof Nurs 2006;22(3):197-204.

28. McKnight L, Stetson PD, Bakken S, et al. Perceived information needs and communication difficulties of inpatient physicians and nurses. J Am Med Inform Assoc 2002;9:S64-9.

29. Bowcutt M, Delashmutt S, Kirkley D, et al. The nurse, M.D. and IT. Executive dialogue series. Hosp Health Netw JT 2003;77(12):61-71, 2.

30. Reddy M, Pratt W, Dourish P, et al. Asking questions: information needs in a surgical intensive care unit. Proc AMIA Symp. 2002:647-51.

31. Riley R, Manias E. Governing time in operating rooms. J Clin Nurs 2006;15:546-53.

32. Kaiser Permanente of Colorado. SBAR technique for communication: a situational briefing model. http://www.ihi.org/IHI/Topics/PatientSafety/SafetyGeneral/Tools/SBARTechniqueforCommunicationASituationalBriefingModel.htm. Accessed January 8, 2008.

33. Cunliffe J. Developing a nursing discharge summary. J Community Nurs 2003;17(3):11-2, 14.

34. Van Eaton E, et al. Organizing the transfer of patient care information: the development of a computerized resident sign-out system. Surgery 2004;136(1):5-13.

35. Patterson E, Roth EM, Woods DD, et al. Handoff strategies in settings with high consequences for failure: lessons for health care operations. Int J Qual Health Care 2004;16(2):125-32.

36. Plsek P. Innovative thinking for the improvement of medical systems. Ann Intern Med 1999;131:438-44.

37. Meadows G. Chaiken BP. Using IT to improve clinical teamwork and communication. Nurs Econ. 2003 Jan-Feb;21(1):33-4.

38. Sittig D, Ash JS, Zhang J, et al. Lessons from "Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system." Pediatrics 2006;118(2):797-801.

39. Scharnhorst A, Johnson LC, Li N. Smaller and faster: using a handheld computer to support a bedside vascular access team. AMIA Annu Symp Proc 2003;996.

40. Braswell A, Duggar S. The new look of bedside technology: the point-of-care evolution drives providers to rethink nursing workflow and medication management. Nurs Manage 2006;Suppl:14-32.

41. Department of Health and Human Services. Pilot Testing of initial electronic prescribing standards cooperative agreements required under Section 1860D-(4) (e) of the Social Security Act as amended by the Medicare Prescription Drug, Improvement, and Modernization Action (MMA) of 2003. 2007. http://healthit.ahrq.gov/images/apr07cmserxreport/erxpilotsreport.html. Accessed January 8, 2008.

42. Mekhjian HS, Kumar RR, Kuehn L, et al. Immediate benefits realized following implementation of physician order entry at an academic medical center. J Am Med Inform Assoc 2002;9(5):529-39.

43. Ghosh T, Norton M, Skiba D. Communication, coordination and knowledge sharing in the implementation of CPOE; impact on nursing practice. AMIA Annu Symp Proc 2006:928.

44. Banet GA**,** Jeffe DB, Williams JA, et al., Effects of implementing computerized practitioner order entry and nursing documentation on nursing workflow in an emergency department. J Healthc Inf Manag 2006;20(2):45-54.

45. Payne TH. The transition to automated practitioner order entry in a teaching hospital: the VA Puget Sound experience. Proc AMIA Symp 1999;589-93.

46. Johnson KB, Fitzhenry F. Case report: activity diagrams for integrating electronic prescribing tools into clinical workflow. J Am Med Inform Assoc 2006;13(4):391-5.

47. Wright MJ, Frey K, Scherer J, et al. Maintaining excellence in physician nurse communication with CPOE: a nursing informatics team approach. J Healthc Inf Manag 2006;20(2):65-70.

48. Piasecki JK, Calhoun E, Engelberg J, et al. Computerized provider order entry in the emergency department: pilot evaluation of a return on investment analysis instrument. AMIA Annu Symp Proc 2005;1081.

49. Breslin S, Greskovich W, Turisco F. Wireless technology improves nursing workflow and communications. Comput Inform Nurs 2004;22(5):275-81.

50. Linden L, English K. Adjusting the cost-quality equation: utilizing work sampling and time study data to redesign clinical practice. J Nurs Care Qual 1994;8(3):34-42.

51. Needleman J, Buerhaus P, Mattke S. Nurse-staffing levels and the quality of care in hospitals. N Engl Med 2002;346(22):1715-22.

52. Urden L, Roode J. Work sampling: a decision-making tool for determining resources and work design. J Nurs Adm 1997;27(9):34-41.

53. Moss J, Berner ES, Savell K. A mobile data collection tool for workflow analysis. Medinfo 2007;12(Pt 1):48-52.

54. Fontaine BR, Speedie S, Abelson D et al. A work-sampling tool to measure the effect of electronic medical record implementation on health care workers. J Ambul Care Manage. 2000 Jan;23(1):71-85.

55. AHRQ National Resource Center for Health Information Technology. Using time and motion studies to measure the impact of health it on clinical workflow. http://healthit.ahrq.gov/portal/server.pt?open=514&objID=5554&mode=2&holderDisplayURL=http://prodportallb.ahrq.gov:7087/publishedcontent/publish/communities/k_o/knowledge_library/features_archive/features/using_time_and_motion_studies_to_measure_the_impact_of_health_it_on_clinical_workflow.html. Accessed January 8, 2008.

56. Robert Wood Johnson Foundation. Engaging nurses in quality improvement. http://www.rwjf.org/pr/product.jsp?id=21151&catid=18. Accessed January 8, 2008.

57. Lykowski G, Mahoney D. Computerized provider order entry improves workflow and outcomes. Nurs Manage 2004;35(2):40G-H.

58. Connolly, C. Cedars-Sinai doctors cling to pen and paper. Washington Post March 21, 2005. p. A01; http://www.washingtonpost.com/wp-dyn/articles/A52384-2005Mar20.html. Accessed January 8, 2008.

59. Kirkley D, Rewick D. Evaluating clinical information systems. J Nurs Adm 2003;33(12):643-51.

60. Bahlman DT, Johnson FC. Using technology to improve and support communication and workflow processes. AORN 2005;82(1):65-73.

61. LaPenotiere L. Enhancing the pediatric ED work environment: a case study. Top Emerg Med 2004;26(4):322-30.

62. Kinney K. A systems approach to purchasing and implementing new technology. Nurs Adm Q 2007;31(1):27-32.

63. Reason J. Human error. New York: Cambridge University Press, 1990.

64. Kohn LT, Corrigan JM, Donaldson MS, eds. To err is human: building a safer health system. A report of the Committee on Quality of Health Care in America, Institute of Medicine. Washington, DC: National Academy Press; 2000.

65. Donabedian, A. Evaluating the quality of medical care. Milbank Q 2005;83(4):691-729.

66. Galbraith, JR. Organization design: an information processing view. Interfaces 1974;4(3):28-36.

67. Carley KM, Prietula MJ, eds., Computational organization theory. Mahwah, NJ: Lawrence Earlbaum, Publishers; 1994.

68. Bricon-Souf N, Renard JM, Beuscart R. Dynamic workflow model for complex activity in intensive care unit. Int J Med Inform1999;53(2-3):143-50.

69. Malhotra S, Jordan D, Shortliffe E, et al. Workflow modeling in critical care: piecing together your own puzzle. J Biomed Inform 2007 Apr;40(2):81-92.

70. Koppel R, Metlay JP, Cohen A, et al. Role of computerized physician order entry systems in facilitating medication errors. JAMA 2005 Mar 9;293:1197-203.

71. Griffin KF, Swan BA. Linking nursing workload and performance indicators in ambulatory care. Nurs Econ 2006 Jan-Feb;24(1):41-4, 72.

72. Adams JM. Applying e-health to case management. Lippincotts Case Manag 2000;5(4):168-71.

73. Ammenwerth E, Mansmann U, Iller C, et al. Factors affecting and affected by user acceptance of computer-based nursing documentation: results of a two-year study. J Am Med Inform Assoc 2003;10(1):69-84.

74. Ash JS, Bates DW. Factors and forces affecting EHR system adoption: report of a 2004 ACMI discussion. J Am Med Inform Assoc 2005;12(1):8-12.

75. Bigelow SM, Xu X, Del Fiol G, et al. Integration of interdisciplinary guidelines with clinical applications: current and future scenarios. Stud Health Technol Inform 2006;122:430-4.

76. Browne JA, Covington BG, Davila Y. Using information technology to assist in redesign of a fall prevention program. J Nurs Care Qual 2004;19(3): 218-25.

77. Campbell E. AORN guidance statement: creating a patient safety culture. AORN J 2006; 83:936-42.

78. Chan EA, Chung JW, Wong TK, et al., An evaluation of nursing practice models in the context of the severe acute respiratory syndrome epidemic in Hong Kong: a preliminary study. J Clin Nurs 2006;15:661-70.

79. Christakis D,Wright JA, Zimmerman FJ, et al. Continuity of care is associated with well-coordinated care. Ambul Pediatr 2003;3(2):82-6.

80. Clegg A, Ableу C, Tindle N, et al. Ask the experts. Single assessment process. Nurs Older People 2006;18(2):14-5.

81. Cronin P. Automation optimizes nursing workflow. An organization follows its pledge to lead with process, enable with technology. Healthc Inform 2004;21(5):56.

82. Elder KN, O'Hara N, Crutcher T, et al. Managed care: the value you bring. Am J Nurs 1998;98(6):34-40.

83. Gulliford MC, Naithani S, Morgan M. Measuring continuity of care in diabetes mellitus: an experience-based measure. Ann Fam Med 2006;4:548-55.

84. Joint Commission Resources. Focus on five. Strategies to improve hand-off communication: implementing a process to resolve questions. Joint Commission Perspectives on Patient Sadety, 2005m 5(7):1.

85. King LA, Wasdovich A, Young C. Transforming nursing practice: clinical systems and the nursing unit of the future. J Healthc Inf Manag 2004;18(3):32-6.

86. Lium JT, Faxvaag A. Removal of paper-based health records from Norwegian hospitals: effects on clinical workflow. Stud Health Technol Inform 2006;124:1031-6.

87. Manias E, Street A. Nurse-doctor interactions during critical care ward rounds. J Clin Nurs 2001;10(4):442-50.

88. Meadows G. The nursing shortage: can information technology help? Nurs Econ 2002;20(1):46-8.

89. Meadows G. Information systems & technology. Improving the patient experience with information technology. Nurs Econ 2003;21(6):300-1.

90. Pape TM. Evidence-based nursing practice: to infinity and beyond. J Contin Educ Nurs 2003;34(4):154-61;quiz 189-90.

91. Price A, Price B. Problem-based learning in clinical practice facilitating critical thinking. J Nurses Staff Dev 2000;16(6):257-64;quiz 265-6.

92. Sandberg WS, Sokal SM, Berger DL, et al., Impact on PACU workload of a direct from PACU discharge pathway after laparoscopic cholecystectomy 2006. Anesthesiology 2006;105:A1298.

93. Shefter SM. Workflow technology: the new frontier. How to overcome the barriers and join the future. Lippincotts Case Manag 2006;11(1):25-34;quiz 35-6.

94. Stahl JE, Sandberg WS, Daily B, et al. Reorganizing patient care and workflow in the operating room: a cost-effectiveness study. Surgery 2006;139:717-28.

95. Wright MJ, et al. Maintaining excellence in physician nurse communication with CPOE: a nursing informatics team approach. J Healthc Inf Manag 2006;20(2):65-70.

Evidence Table

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Adams 2000[72]	IT; workflow	Changing practice project and Published Guidelines	Case studies	Case management	Teaching hospitals	IT brings about new workflows and information recording; can be helpful for the case manager; case managers may need to transform their workflows
Ammenwerth 2003[73]	User acceptance	Pretest and post-test	Questionnaire: 3 months before system implementation, 3 months after, 9 months after	Nurses on four wards of a hospital in Germany	Questionnaire	Previous acceptance of the nursing process and the previous amount of self confidence are two important factors influencing acceptance of a new computer based documentation system; consider fit between nursing workflow and functionality of system; some wards adapted system to their needs and others did not; some felt that it shows what they do all day
Bahlman 2005[60]	Workflow; OR; Information transfer; Implementation	Pretest and Post-test	Reviewed workflow processes for redesign	OR	Changed workflow processes	Needed to review workflow processes first; figured out ideal systems and tried to have technology match them
Banet 2006[44]	Workflow; ED; Information transfer; implementation	Pretest and Post-test	Looked at implementation of CPOE in ER and nurse perceptions	ER staff	CPOE implementation	Nurse perception of effective use of design is needed for successful implementation of information system changes; introducing CPOE into workflow is complicated; documentation time might not change
Bigelow 2006[75]	Workflow; Standards	Pretest and Post-test	Case study	Hospital system	Placed standards in an accessible document repository	New format allows for changes in workflow because standards can be looked up from multiple locations. reducing time spent searching for information

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Bowcutt 2003[29]	Interprofessional communication; Information transfer	Unpublished research	Roundtable discussion	NA	NA	Systems can enhance workflows, but they need to meet user needs; there's more information to sort through; data is not streamlined enough; if physicians don't want to do CPOE, the nurse suffers; clinical staff need to know that their documentation impacts others' workflow
Braswell 2006[40]	Implementation	Pretest and Post-test	Reviewed workflow and time spent before and after implementation	Nursing unit	Added mobile cabinets with barscanning for medications	Better teamwork with pharmacy; improvement on workflow; better documentation because of bar scanning
Breslin 2004[49]	Implementation	Case–control study, Pretest and post-test study	Observation; Documented communication workflows; Looked at phone calls; Survey	Staff within units in a hospital in Baltimore	Implemented Vocera and compared units with and without it	Having the technology saved time; less overhead paging, more efficient workflow; time savings
Bricon-Souf 1999[68]	Workflow; Modeling	Noncomparative study	Modeled flow of actors and information	ICU	NA	Development of a workflow model needs to include actors and information; flexibility and adaptability of model are important because processes are complex
Brixey 2005[18]	Workflow; Interruptions	Noncomparative study	Observation; Ethnography	RNs at a level 1 trauma center	NA	Understanding context around interruptions is good for understanding workflow; good to know causes and implications of interruptions
Brixey 2006[19]	Workflow; Interruptions	Noncomparative study	Observation; Ethnography	RNs and MDs at a level 1 trauma center	NA	Categorized activities and interruptions for doctors and nurses; layout can cause break in workflow; unavailable supplies or information can cause interruptions; technologies can contribute to more interruptions

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Browne 2004[76]	Workflow; Process redesign	Noncomparative study	Description	Hospital	Integrated fall alert so that other areas can see it; feedback was positive	Redesigned fall prevention process and included it in clinical information system; developed evidence based tool; tailored interventions to specific patient risks; integrated fall risk information into system
Burke 2005[12]	Medication administration; Information transfer	Unpublished research	Discussion of medication administration	NA	NA	Many medication errors occur at patient care transition points; nurses are very important at these points
Campbell 2006[3]	Safety	Unpublished research	Discussion of unintended consequences	NA	NA	Think about broader issues of safety; many medical errors aren't reported
Campbell 2006[77]	Safety	Quality improvement	Observation, interviews, conference.	5 medical centers with different CPOE products	Identify, describe and categorize unintended consequences of CPOE implementation	More/new work for clinicians; unfavorable workflow issues; demands for systems changes; people continued to use paper systems; communication patterns and practices changed
Cendan 2006[4]	Change; Workflow; OR	Pretest and Post-test	Analyzed and improved workflow	OR staff of a tertiary care center	Workflow diagrams were redrawn; critical moments were identified	Turnover improved and the mean number of cases improved; looked at interdisciplinary patterns
Chan 2006[78]	Workflow; Efficiency	Pretest and Post-test	Interviews	Nursing staff	Changed nursing delivery model	Some nursing work is formulated in a task-oriented assembly-line approach; allocate work assignments based on skills; some routine activities are not formalized
Christakis 2003[79]	Continuity; Information transfer	Cross-sectional study	Survey	Parents of patients at a pediatric clinic who received care at multiple sites	Cross-sectional survey of patients' families compared to organizational measures	Importance of continuity of care to promote coordination; greater objective measure of coordination was associated with improved perceptions of care coordination; consistent provider contact is associated with improved care coordination

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Clegg 2006[80]	Workflow, Efficiency; information transfer; Interprofessional communication	Pretest and Post-test	Implementation of a single assessment process for elderly patients	Elderly population in the UK	Implemented the new process and changed workflow to enhance information transfer	Improved documentation helped with sharing information; changed workflow helped to make this information available to those who needed it, reducing redundant questioning of patient
Cronin 2004[81]	Workflow, Efficiency	Noncomparative study	Description	Hospital	NA	Described challenges of incorporating IT into workflow
Cunliffe 2003[33]	Discharge; Communication; Coordination	Noncomparative study	Description of rationale and processes for developing a nursing discharge summary	Hospital in UK	Developed a standardized, structured formal discharge summary	Communication and coordination help with discharge planning; could be applied to other aspects of care; information tools can be used for multiple purposes
Driscoll 1992[8]	Coordination; Team structure	Pretest and Post-test	Observation, Survey	Trauma teams in Hospitals	Organizational changes were made during resuscitations - task allocation and horizontal team organization	When the structure of trauma team changed, complexity and distribution of individual tasks came to light; hard to get team members to work simultaneously; old habits occasionally recurred
Dykes 2006[13]	Information technology; Interprofessional communication	Pretest and Post-test	Survey, Interviews	Health care professionals in acute settings	Survey by HIMSS nursing informatics task force	95% of respondents had dual paper and electronic systems; nurses communicate and coordinate about care both formally and informally; IT does not reduce clinical thinking
Egan 2006[16]	Information transfer	Noncomparative study	Reviewed a dashboard of relevant patient information	ICU and OR staff	Determined who looks at what information and at what stage of the process	A dashboard with the data nurses need could help synthesize information, across hospitals and within departments; information availability can transform workflow; real-time data flowing from disparate devices into a single interactive display

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Elder 1998[82]	Nurse role	Unpublished research	Discussion	NA	NA	Need to clarify role of nurse, which has moved from task oriented process to outcome oriented - the focus isn't just on following orders but on the entire illness and being a manager of care
Friedman 2006[6]	Change; Workflow; OR	Case–control study	Reviewed time and workflow of group with standard versus parallel processing	Patients undergoing hernia repairs under local anesthesia	Case group has anesthesia in the OR at the start of surgery; control group had local anesthesia in the induction room during turnover time	Time decreased in case group; patient satisfaction similar; outcomes didn't change; OR time used by the surgeon decreased by 1/3; roles were redefined and team cohesiveness improved
Ghosh 2006[43]	CPOE; Implementation; Interprofessional communication	Noncomparative study	Interviews, focus groups	Chief Nursing Officers	How nurses impact and are impacted by CPOE	Nurses are a primary success factor in CPOE implementation; they have a critical role in communication, coordination and knowledge sharing; understanding communication processes is key to CPOE implementation
Guite 2006[22]	Change; Workflow; Implementation	Pretest and Post-test	Ethnography, interviews, process modeling	Level 1 trauma center	Documented each step of the current process with detailed flow diagrams; looked for opportunities for improvement and implemented a new process	Use IT to help redesign process; found considerable duplicate documentation; people have to spend time reconciling info; Consider a standardized language for shared data elements; need to integrate with workflow of various departments
Gurses 2006[14]	Information transfer; Coordination	Noncomparative study	Ethnography	Case managers at a level 1 trauma center	Information tools and processes	Information tools: bed management bundle, phone, EMR, whiteboard, text pager, schedule

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Gulliford 2006[83]	Continuity; Information transfer	Unpublished research	Discussion	NA	NA	Integration, coordination and sharing of information across providers is important; need to think about patient and provider perspective; continuity has a relational, management and informational component over time
Harders 2006[7]	Change; Workflow; OR	Pretest and Post-test	Analyzed current and new workflow	OR in tertiary care	Redesigned workflow	Reduction in nonoperative time; roles were redesigned; need to think about entire process with all team members
Johnson 2006[46]	Prescribing	Noncomparative study	Modeled development of electronic prescribing	ED	Implementation of an electronic prescribing model	Activity diagrams employ flowcharting techniques to model workflows, information exchange and business processes; Large range of tasks completed by non-prescribers, so they need to be considered in implementation
Joint Commission 2005[84]	Handoffs	Unpublished research	Discussion of JCAHO expectations of handoffs			Handoffs aren't just between departments, can also be within a given department; need to discuss barriers and facilitators for communication and obtain team involvement
King 2004[85]	IT; Workflow	Unpublished research	Discussion	NA	NA	Challenge to develop systems to satisfy multiple caregivers; think through information needs and activities across departments
Kinney 2007[62]	IT; Workflow	Unpublished research	Discussion	NA	NA	Need to understand workflow of current system before implementing IT or technology created new problems and unearths existing ones
Kirkley 2003[59]	Workflow	Noncomparative study	Description	Nursing	NA	IT can help streamline processes; implement IT as part of a larger effort to reorganize workflow and processes; Understanding goals; system should think like a nurse thinks

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Lamond 2000[23]	Information transfer; Shift change	Changing practice	Content analysis of medical notes, nursing documentation and shift reports	Medical and surgical units in hospitals	Looked at types and amount of information, order of information in shift report	More information was in patient notes than what was given in shift report; some information more often communicated in shift report than in patient notes; Evaluations and judgments are part of the report; Global information about how people are doing are more often found in the shift report than in other documentation
LaPenotiere 2004[61]	Workflow; Process redesign	Changing practice	Triage process design	Triage; ED	ED expansion built to fit desired processes.	Workflow changes described
Lium 2006[86]	Workflow	Cross-sectional study	Survey	Hospital	Frequency of EMR use	Nurses reported more EMR use when they changed their routine; clinicians need to figure out how to include the system in everyday work
Lykowski 2004[57]	CPOE; Workflow	Noncomparative study	Description of CPOE implementation process	Hospital		Multidisciplinary team involvement and incorporating process and technology led to good outcomes
Malhotra 2007[69]	Workflow; Modeling; ICU	Noncomparative study	Interviews and observations to document process and information flows in ICU	ICU in U.S.	Completed models at various levels	Communication, coordination, information needed; developed a model of workflows in an ICU
Manias 2001[87]	Rounds; Roles	Noncomparative study	Ethnographic study of 6 RNs; Participant observation, journals, interviews, focus groups	Critical care unit of a hospital in Australia	Description of process	Doctors use nurses to supplement information and provide extra details about patients; nurses discussed nursing knowledge during shift change

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
McKnight 2002[28]	Information transfer; Interprofessional communication	Cross-sectional study	Surveys, focus groups	Hospital	Semi-structured survey about perceptions of information needs and communication difficulties; focus groups with physician and nurses	Information needs and communications difficulties are common and can lead to errors; problems cited were difficulty in finding information, finding inaccurate or outdated information, limited time, not knowing the system; difficulty in identifying and contacting other health care providers; limited time to lookup information; nurses mentioned patient education materials; physicians talked about paging, inconsistent communication at transfer of patient care; need feedback on order status, face to face communication where mistrust or disagreement on care plans; lack of communication leads to errors or near-misses; people want to improve their own efficiency without thinking of system efficiency
Meadows 2002[88]	Workflow; Efficiency; Staffing	Unpublished research	Discussion			Think about how to be more efficient by using technology to help redesign workflow and communications
Meadows 2003[89]	Information transfer, Interprofessional communication	Unpublished research	Discussion			Use of technology to improve teamwork and communication; Don't mimic current workflows with IT but use it to transform workflow across disciplines
Mekhjian 2002[42]	CPOE; Workflow; Implementation	Case–control study	Rapid system evaluation; time and motion study; comparison of data between areas with differential implementation of systems	Inpatient units; academic medical center;	Implemented CPOE on some units	Process breakdowns such as patient safety issues, workflow interruptions and inefficiencies; Technology may not necessarily improve institutional efficiency; incorporate safeguards for errors and interruptions; cultural change needs to be considered

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Patterson 2004[35]	Handoffs	Unpublished research	Discussion	Various industries	NA	Can learn lessons about handoffs from other industries (NASA, power plants, railroad and ambulance dispatch centers); many strategies are informal, as in health care
Pape 2003[90]	Workflow; Evidence based practice; Information transfer	Noncomparative study	Reviewed nursing practices	Nursing unit	Description of practices and implementation of evidence-based practices	IT can change in how people make decisions; discussion of how to incorporate evidence based practice and counter "cookbook medicine" arguments; how to find practices, and identify them, and implement
Patterson 2005[26]	Interprofessional communication; Information transfer	Noncomparative study	Observed handoffs; Interviews across different industries	Various industries	Description of handoff practices	Found 21 strategies for effective handoffs; provide supporting documentation in addition to the handoff; Systems highlighted can potentially be used to facilitate these strategies
Payne 1999[45]	CPOE; Implementation; Interprofessional communication	Noncomparative study	Description of first three months post implementation	Hospital	CPOE implementation	Implementing CPOE changed work patterns, communication, roles
Perrott 2004[24]	Workflow; Medication	Noncomparative study	Ethnography, Document review, Interviews	ICU nurses	Nursing handovers in an ICU	Customization of data sets; nursing education; nurse involvement in installation (from vendor and organization) were all success factors
Philpin 2006[15]	Information transfer; ICU; Interprofessional communication	Unpublished research	Discussion of nursing role	NA	NA	Nurses work with a number of other occupation groups; constant flow of other people moving in and out; discovered separate charts for observations and recording of nursing work; different providers have different documentation requirements, which may differ from organizational requirements

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Piasecki 2005[48]	CPOE	Changing practice	Review workflow to determine time and FTE savings before and after CPOE implementation	Emergency Department	CPOE implementation	Worked with business school to develop a ROI tool to measure outcomes of technology implementation; analyzed workflow before and after implementation and found savings in time and money
Plsek 1999[36]	Change; Workflow	Unpublished research	Focus groups	Clinical and support staff of a multispeciality clinic	NA	Use a high-level flow chart to show a typical visit, but need to consider different perspectives; need to mentally escape from traditional rules of workflow; can use technology to help with workflow and change how things are done
Powell 2006[17]	Information transfer; Handoffs; Interprofessional communication	Unpublished research	Discussion about improving handoffs			Problems identified: accountability of transition, transfer of information, responsibility when communicating to receiving provider - need to set expectations with sending and receiving groups; use advanced practice nurses as coordinators across sites
Price 2000[91]	Workflow; Safety	Literature review	Discussion	NA	NA	Problem based learning is done in the classroom, but should be done on the floor as part of workflow; need to think about issues of patient safety and competing demands on time

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Reddy 2002[30]	Information needs; Information transfer	Noncomparative study	Ethnography to understand information needs of physicians, nurses, students, pharmacists etc	SICU	Observed rounds; looked to see who asked questions, the kind of questions asked, resource used to answer question	Nurses and pharmacists served as information sources rather than information seekers; human sources were used more than electronic or paper sources as the first source of information; orders but not rationale is documented; need to understand clinical workflows and organizational workflows (keeping the place running); build systems to support work activities
Riley 2006[31]	Interprofessional communication; Information transfer	Noncomparative study	Observational fieldwork; Individual and group interviews using 11 nurse informants; Journaling	OR nurses	Evaluated how they dealt with each other and physicians with respect to time and identified practices	Practices found: questioning judgment and timing, controlling speed, estimating surgeons' use of time, coping with different perceptions of time; knowledge of individual surgeons was a source of power for nurses
Sandberg 2005[5]	Process redesign; OR	Cross-sectional study	Analyzed current workflow; changed and evaluated new workflow	OR Staff	Redesigned OR	Changed the process to include parallel activities and reorganized the space; improved throughput in the redesigned OR
Sandberg 2006[92]	Change; Workflow, OR	Pretest and Post-test	Looked at recovery room flow sheets, time, and nursing effort required	Ambulatory laparascopic chole-cystectomy patients	Implementation of a pathway	PACU nurses indicated that their workload increased, but the data did not support that conclusion; data looked at interventions such as pain meds and iv fluids - but is not necessarily an accurate capture of nursing workload
Scharnhorst 2003[39]	Implementation; Workflow	Noncomparative study	Workflow analysis and usability testing	Nursing staff	Implementation of handhelds	Collecting nursing data can help to define and articulate the role of nurses in health care; handhelds can help with reduction of redundancies

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Shefter 2006[93]	Workflow; Implementation	Unpublished research	Discussion	Case management	Introduction of workflow tools	Workflow technology tools can help or hinder case management; integrate patient level and organizational level data to help with workflow; information tools (databases, records) and workflow tools can help with linkages; need to consider not just training but ongoing support
Sittig 2006[38]	CPOE; Medication; Implementation	Noncomparative study	Discussion of CPOE implementation	NA	NA	Need to consider related organizational and workflow factors (not just technology); CPOE and IT efforts can alter workflow processes; we could share experiences in an M&M format; use opportunity to develop better systems
Spear 2005[20]	Change; Workflow	Noncomparative study	Multiple case studies to demonstrate best practices	Hospitals	NA	Hospital care is organized around functions, but there is not a reliable way to integrate these functions; can achieve excellence by having an environment where work is designed to reveal problems soon, are addressed quickly, solutions are quickly disseminated and people are taught to experiment at all levels of the organization; nurses spend a lot of time tracking down materials, services and information versus providing care
Stahl 2006[94]	Change; Workflow, OR	Noncomparative study	Redesigned systems before making a new OR	OR Suite	Redesigned processes emphasizing parallel processing; added staff	Increased patient throughput; added an additional nurse; considered multiple disciplines and roles
Strople 2006[27]	Information transfer	Noncomparative study	Reviewed shift report content, format and media	Nursing staff at hospitals	Analyzed content	Use of electronic systems as an adjunct to the shift report can contribute to patient care

Source	Issue Related to Practice	Design Type	Study Design and Outcome Measures	Study Setting and Population	Study Intervention	Key Findings
Van Eaton 2004[34]	Information transfer	Changing practice	Evaluation, analysis and prioritization of existing system content; Planned for a new system using a model, focus groups, modifying and implementing system	Resident run inpatient and consult services at two teaching hospitals (31 residents)	Developed and implemented system	Most residents used paper patient list to manage work so they had to recopy it; combined data from hospital information systems with resident entered details; popular and widely used; combined data needed for processes such as rounding and sign-out at the end of the day
Waring 2006[9]	Workflow; OR; Information transfer; Interprofessional communications	Noncomparative study	Ethnography, Interviews	OR in the UK; Teaching hospital	Analyzed routines and patterns of work; did some interviews; looked at different roles	Nursing staff often spent time coordinating supplies, missing items, figuring out where the patient goes next; each department seemed to be its own hub with spokes going out to other departments; each department is dependent on the work of others, yet they don't each necessarily understand the big picture; inter-departmental breakdowns; delays with schedule between surgery and floors; nurses often did transfer work themselves, which led to more delays; nurses "pitch in" and do work that other roles do not
Wright 2006[95]	CPOE	Noncomparative study	Reviewed processes and communications	Hospitals	CPOE implementation	CPOE impacts MD-nurse communications; found in implementation that significant workflow changes would be required; loss of visual cues or physical presence to give contextual information about orders; paper reports are not accurate; people know about order processes in their own departments but not how it works elsewhere or downstream impacts

* IT = information technology; EHR = electronic health record; EMR = electronic medical record; OR = operating room; ED = emergency department; CPOE = computerized provider order entry; ICU = intensive care unit; RN = registered nurse; MD = physician; HIMSS = Health Information and Management Systems Society.