Examining the Organizational Implications of IT Use in Hospital-based Health Care: A Case Study of Computerized Order Entry

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Abstract

This paper reports on the preliminary findings of an in-depth case study of the implementation of a computerized order entry (COE) system at a medium-sized, acute care hospital. In this paper, we propose a theoretically-grounded framework, based on work by Barley [8] [9], for analyzing organizational changes that may result from COE introduction and use the framework to analyze findings at the research site. The hospital studied was largely successful in implementing and utilizing the system. However, use of the COE has altered the content and structure of order-related information that passes between key participants in clinical care, affecting how these occupational groups and departments communicate and interact by creating ambiguity and uncertainty about order information. Use of the system may also be enabling increased organizational control over clinical care practices, exercised through professional norms and the clinical administrative hierarchy. Findings were consistent with other studies of COE use, suggesting that future research could focus on the consequences of structuring the content of order-related communications on interactions between clinical and ancillary departments and the need to integrate the COE with other clinical systems to minimize disruptions.

1. Introduction

A computerized order entry (COE) system is a basic building block for the clinical information systems in a hospital setting. In this application system, clinical personnel enter orders for medications, lab tests, x-rays, etc., into the COE, which are then transferred to the appropriate departmental systems for action. Physicians receive test results via computer. The COE also contains patient demographic information and may collect data on patients’ conditions from nurses’ documentation or connections to patient monitoring devices. The COE system may include decision support features for physicians, such as drug interaction warnings or procedural guidelines. The functionality of a COE and its integration with other clinical systems vary greatly among systems and hospitals, ranging from narrowly focused, stand-alone to hospital-wide, multi-functional systems.

Computerized order entry systems have the potential to improve the cost-effectiveness and quality of health care delivery in a hospital setting. By automating the creations and transfer of orders, a hospital may reduce processing costs and speed delivery of services to patients. Perhaps more important are changes in physician practice patterns, such as increased compliance with “best practice” guidelines and reduced resource utilization [10]; [19]; [20]. However, effective use of COE systems in hospitals is not yet widespread, nor are beneficial outcomes from system use assured. Successful implementation requires high levels of staff involvement, financial support, cooperation, and clinical leadership that develop over time and which are lacking at many hospitals attempting to implement such systems [11]. To foster widespread acceptance and use of COE in hospitals, decision-makers need to understand the environmental and institutional changes entailed by these types of systems [19].

Because introducing a COE can challenge the institutional culture of a hospital and may lead to unplanned changes in health care practices [17], understanding how COE technology affects the hospital at an organizational level is an important step in identifying the factors which contribute to successful implementation and in managing design and implementation efforts. For example, in a case study at University of Virginia (UVA) Medical Center, Massaro [17] found changes in workflow patterns and practices, literal interpretation by the computerized system of informal rules and procedures, ambiguity of governance policies for making practice decisions, and physicians’ lack of understanding of the long-term benefits of the system all contributed to implementation difficulties and limited anticipated benefits from system use.

In this paper, we report on the preliminary findings of an in-depth case study of COE implementation at a
medium-sized, acute care hospital. Our objectives in this paper are to propose a framework for analyzing organizational-level changes that may result from COE implementation and to use the framework to investigate changes at the research site that have facilitated or impeded successful use of the system. In the next section, we discuss a theoretical approach for studying the relationship between introduction of COE technology and organizational change. We then describe the case study approach used and the research site. We use the framework to discuss the changes that occurred with the introduction of a COE and consider the implications of these findings for understanding how context (technology, organization, and actions) affected outcomes. We conclude with a discussion of the study’s limitations and further research plans.

2. Theoretical and empirical approaches

Analyzing organizational changes that result from implementation of a computerized order entry system in a hospital setting requires examination of the technology’s impact on the organization, goals of organization members who implement the technology, and the actions of clinical users who utilize the technology in day-to-day practice [1]. To do so, technological change can be conceptualized as a nondeterminant trigger of organizational change, which may occur as organizational actors renegotiate roles and relationships around use of the new technology [8]. Barley [9] posits these effects reverberate up levels of analysis, starting with the impact on individual roles. Individual role changes typically affect interactions among pairs of roles at the dyadic level, and eventually affect an organization’s social networks. Structural changes in the organization occur if changes in social networks and roles are sustained in day-to-day interactions over time. Figure 1 depicts a simplified schematic of what Barley [9] terms a ripple effect of technological change through levels of analysis.

Role changes resulting from COE use [(1) in Figure 1]: Barley [9] posits that organizational roles are bundles of nonrelational and relational tasks and skills, and that changes in technology directly affect nonrelational aspects of roles. New technologies may alter required skills and knowledge, decision-making capabilities and autonomy, or productivity [3] [16], and specific design characteristics of the technology may affect the extent and type of changes that occur. For example, COE systems that deliver patient-specific information [such as the cost of a procedure or medication] at the point care decisions are made can influence physician’s decision-making [20]. The mediation of a COE in physician decision-making was illustrated in one study in which physicians’ practices reverted to previous patterns when the COE was withdrawn [19]. The extent to which a COE affects decision-making will be limited if physicians do not use the system directly, and physician use will depend in part on whether the system is designed to include features beneficial to physicians [2], [15]. Even when physicians are not the targeted users of a COE, role and decision-making tasks may change. Aydin [4] found the roles of nurses and unit secretaries expanded to include interpretation of physician’s intent when they assumed responsibility for entering handwritten orders into the standardized order entry system.
new issues that require resolution in day-to-day interactions [4]. Introduction of a COE may entail new interactions, such as using a common database, and role changes related to maintaining shared databases may create new role dependencies that lead to consulting/teaching interactions to facilitate system use [4].

**Shifts in social networks of roles [(3) in Figure 1]:** Technology-triggered changes in interactions at the dyadic level may propagate in shifting patterns of interactions among role sets, for example, when cliques reform, boundaries between sectors of the organization are decreased or increased, or hierarchical status become more or less differentiated [9]. Such shifts are likely when technological change reduces or creates dependencies and alters patterns of supervision in a social network [9]. Aydin [7], [4] found introduction of a COE increased communication between clinical departments and systems personnel and trainers, and that new, informal face-to-face contacts developed to support systems use. In one case, financial and administrative personnel played a more central role in the organization’s clinical operation due to their role in the system’s operation [6]. In another case, the medical records department became more prominent in clinical departments’ interactions after implementation of the system, due to their knowledge of medical coding standards [4]. Changes in social networks are likely to reflect the attitudes of occupational groups and departmental social groups towards the CEO [5], and the actions of individual actors in these groups may influence the type and extent of network changes that occur [6].

**Changes in organizational structures and institutions [(4) in Figure 1]:** Shifts in social networks may sustain existing institutions or modify them, affecting organizational structures such as the degree of centralized or decentralized control or the formality of rules and processes [9]. Introduction of information technology may also heighten the level of organizational control when various forms of control mechanisms (e.g., professional, technological, behavioral, structural) are intertwined in the design and use of an information system [18]. Clinicians’ concerns about increasing standardization and heighten administrative control of clinical practice are often mentioned as a barrier to COE use [2]; [14]. However, the incidence of such organizational changes have not been explicitly addressed in organizational research.

This framework provides an analytical tool to investigate and evaluate changes which may be triggered by introduction of a computerized order entry system, beginning at the individual role and extending to the organizational level of analysis. By linking changes to the actions of organization members [8], the framework allows consideration of the influence that the actions taken during technology implementation and users may have in determining organizational outcomes [6].

### 3. Methodology

The case study research presented in this paper is the first step in a larger research project to investigate the organizational consequences of implementing COE technology in a hospital setting. Our primary goal in the case study was to identify organizational changes, to examine the context in which they arose, and to identify areas requiring future research focus. Our objective in this paper is to develop a theoretical framework and to assess its usefulness for investigating linkages between technology design, organizational goals and, and users actions during system use on organizational outcomes. Since the potential organizational impacts of a COE vary greatly in type and location, and many of these impacts will be unforeseen during the system’s planning and implementation, we chose to do an in-depth case study at one research site, using qualitative data collection methods to obtain rich contextual data for analysis.

The study consisted of in-depth interviews with individuals from a variety of clinical departments and with IS staff. The chief information officer, in consultation with other senior managers, provided a list of potential interviewees, who we contacted and asked to participate in the research study. Over a two-month period, we interviewed twenty-nine individuals. The mix was 25% physicians, 20% nursing and clinical staff, 20% ancillary services, 20% health care analysts, and 15% IS professionals. Interviews lasted thirty to ninety minutes, with most taking sixty minutes. We used an open-ended interview protocol to guide the interview process through topics such as perceptions of the system’s utility, experiences using the system, and assessment of the system’s success. Each researcher coded data from the interviews according to the categories indicated in the theoretical framework described in Section 2. The preliminary findings presented here were arrived at through comparison and consolidation of the analysis.

### 3.1 The research site

The research site, hereafter referred to as “the hospital,” is a private, non-profit urban acute care with about 550 beds, over 3,500 employees, and 1,000 attending physicians. Gross operating revenues exceed $300 million annually. The hospital provides a comprehensive range of primary and specialized care services and has a medical school affiliation for residency training in orthopedics, obstetrics, gynecology, and surgery.
The COE system was brought on-line at the end of 1995 after three years and over $12 million in development. To address physician concerns about the system, the hospital’s strategy was to make the COE project physician-driven. A new organizational structure was created for managing the COE project. A physician’s project team was formed consisting of two physicians working full time, and five physicians working ten hours per week. This team participated in package evaluation and selection activities and was responsible for determining the implementation process, the system’s impact on physician practices, and validating the system. The team reported to a medical informatics sub-committee of the medical executive council and to the COE project steering committee. Nursing and the ancillary departments, including labs, radiology, pharmacy, pathology, and EKG, also had user groups working full-time on the project to develop and test the interface and to conduct training and support activities during implementation.

### 3.2 Key features of the COE system

The computerized order entry system utilizes 280 workstations and 104 printers in patient care areas. The most recent count shows the system is handling 36,000 clinical orders per week. Attending physicians are strongly encouraged to enter orders directly into the COE, and residents are required to do so. Physicians can use “shortcuts” for order entry -- departmental order sets (DOS) or personal order sets (POS) -- which expedite the ordering process by combining related orders into a “set.” Physicians retain the option of giving nurses verbal or telephone orders and of writing orders manually. In these cases, nurses enter the orders into the COE, and physicians give an “electronic signature” or authorization at a later time. In the year prior to the case study, over 80% of orders were being processed through the COE, with over 80% direct entry by residents and 50% direct entry by attending physicians, a rate for attending physicians higher than has been achieved in most hospitals using a COE. Informants cited the relatively unfriendly user interface, difficulties entering complex orders, time pressures on physicians, and individual physicians’ reluctance to use the system to explain the current level of direct order entry.

Figure 2 shows the COE system and the flow of order information among other information systems. Patient
information is transferred from the hospital’s administrative admitting/transfer/discharge (ATD) system into the COE on admission. Orders are entered directly into the COE, and a copy is printed for the nurse in the patient’s ward and for the ancillary service (laboratory, pharmacy, respiratory therapy, etc.). Printed orders serve as a notification to the nurse and as a backup for the automated system in the ancillary department. Pre-existing systems in the pharmacy and laboratory were retained when the COE was implemented, requiring an interface system to electronically pass information back and forth. Narrative lab and x-ray results are automatically transferred back to the COE. Nurses update or complete a limited amount of patient information, such as allergies and drug reactions, and document information on patient condition (e.g., vital signs) and nursing actions (i.e., delivery of medications) in the COE. Documentation practices vary by department, for example, no vital signs are entered in the intensive care unit.

4.0 Findings from the Case Study

In the following sections we present preliminary findings from the case study on organizational changes triggered by introduction of a COE, using the analytic framework developed in Section 2.

4.1 Changes in roles

Physicians: Implementation of the COE system has altered the tasks physicians perform to issue medical orders. Residents are required and attending physicians are encouraged to directly enter orders into the COE. Physicians now must be minimally familiar with the use of a computer interface (CRT, light pen, keyboard, mouse) and have sufficient knowledge of the system’s order pathways, or interface, to execute an order. Informants had mixed opinions about how using the COE affected physicians’ productivity when issuing orders. Some commented the process was slower for physicians than hand-writing orders, though several physicians cited reductions in time to retrieve information as off-setting additional time needed to enter orders. There appeared to be a large variation in the “fit” of the system to physicians, thus their time savings from the use of the system varied across areas of specialty (complexity of orders), practice type (inpatient, outpatient, ambulatory), and need for test results not included in the system (e.g., x-ray images).

Use of the CEO has subtly influenced physicians’ clinical decision-making. Physicians interviewed described the system as a decision-making tool, because it enables them to obtain test results faster, provides some cost information for selecting among alternative medications, and, through the departmental or personal order sets, serves as a checklist and reminder when placing orders. Several physicians reported using remote access to patient data to assess patients’ conditions (i.e., “computer rounding”) and to more efficiently plan or schedule patient visits. On the other hand, use of the system tends to limit and direct physicians’ choice of medications and procedures. Although physicians are not prohibited from creating any type of order, the system interface was designed to make it relatively easy to select pre-defined order types and more difficult to create nonstandard orders. According to clinical and IS personnel who participate in design decisions, physicians usually chose the easier, faster route to ordering and thus are more likely to select administratively sanctioned orders and medications.

Nurses: Changing from a paper-based to a computerized order entry system has entailed changes in nurses’ tasks and skills related to the order process. Because nurses now enter orders issued verbally or via the telephone directly into the COE, they must be familiar with the use of a computer interface and with the COE order pathways. Since nurses use the COE more frequently than physicians, they are relatively more proficient in its use, and many take on a consulting role, assisting physicians to enter orders, entering complex orders for them, or instructing and assisting physicians to use system features such as the personal order set. Management at the research site has commissioned several consultant studies of nurses’ documentation time using the COE. These studies indicated neither significant improvements nor reductions in nurses’ productivity in order management or documentation resulting from COE use.

Similar to physicians, use of the COE has subtle effects on nurses’ decision-making in the ordering process. When physicians directly enter orders, structuring the order in the COE reduces the need for nurses to “interpret” physicians’ handwriting or to translate their intentions into an actionable order. Use of the COE has also reduced nurses’ control over the coordination of patients’ lab tests, as will be discussed in detail in section 4.2.

Ancillary services: The case study focused on three types of ancillary services: pharmacy, diagnostic laboratory testing, and respiratory therapy (RT). Individual role changes in tasks and skills were primarily associated with the need to keep ancillary systems synchronized with the COE. Staff in each department must now verify new COE orders in their own department’s system, input orders that are not automatically transferred, and may need to cancel or alter orders in their own system or adjust COE orders entered incorrectly. They must be familiar with the COE system interface as well as their own system and with the automated data exchange process, to understand where orders may be “held up” due to built-in timing delays or unexpected system downtime. With their knowledge of both systems, pharmacy staff and to a lesser extent laboratory staff members...
sometimes serve as consultants to nurses, answering questions about how to enter an order into the COE so that it will transfer correctly to the appropriate system.

Informants in ancillary departments believed that administrative workload may have increased due to the need to synchronize dual systems, overwhelming savings that might have resulted from having orders transferred electronically into departmental systems. As systems integration problems have been resolved through system adjustments or new procedures, administrative burdens have been lessened.

Health care analysts: There are a variety of health care analyst roles at the research site, in which individuals with a clinical background (primarily nurses) gather and analyze data on clinical processes and outcomes. Depending on the position, these individuals participate in disease management task forces, in ongoing productivity and process improvement efforts, or in administrative data gathering activities. Health care analysts utilize a variety of computerized information systems and paper-based records to collect data, including the COE. Informants from this group believed the COE greatly improved their data gathering efficiency, particularly compared to manual “chart reviews,” allowing them to collect data “from their seat.” On the other hand, they have had to learn how to use the COE interface and to appreciate the idiosyncrasies of the system and of how clinicians use it, to understand what the COE offered them as a data source and to interpret data.

Information systems professionals: Like many IS implementation efforts, implementing the COE required IS personnel to become familiar with the application system, the software package vendor, new technologies (hardware or software) and system interfaces. Since the computerized order entry system was one of the first, and most substantive, IS projects to affect core clinical areas of the organization, all IS personnel associated with the project needed to become familiar with the application area. This application area required that some project personnel have detailed, specialized knowledge of clinical care practices, processes, and terminology. Clinical personnel from nursing, pharmacy and laboratory were recruited to participate full-time in the implementation project, and a team of physicians also participated in the interface design. After implementation, a permanent user liaison/analyst team composed of clinicians was established in IS to evaluate and implement system improvements, provide expert knowledge on clinical practice, and to coding changes to the system interfaces. While this type of role is not unusual in an IS department, the prerequisite knowledge of clinical practice, obtained through specialized educational programs (e.g., nursing degree) and experience, is unique to this application context.

4.2 Changes in interactions among roles

Use of the COE has altered the content and structure of order-related information that passes between key participants in clinical care, affecting how these occupational groups and departments communicate and interact.

Physician/Nurse interactions: In the paper-based system, physicians hand-wrote orders on the patient’s chart or an order form. The nurse or unit secretary transcribed onto a “cardex,” i.e., a running log of medicines, scheduled tests, etc., for the patient. Having physicians directly enter orders into the COE eliminated the need to transcribe orders to the cardex, and substantially reduced the number of orders nurses process (now about 35%). In addition, physicians can retrieve test results and check patient vital signs themselves from any COE terminal in the hospital (or in their offices, in a few cases), rather than call nurses or ask them for patient charts.

Neither physician nor nurses perceived substantive changes in their interactions related to order processing as a result of using the COE. Members of both group did note that reducing the need for nurses to interpret physicians’ handwriting reduced frustrations, and the structured order format of the COE made communications more focused and clear. One physician commented that as the nursing profession has developed over the last 20 years, nurses have not “coddled” doctors, so that expecting physicians to be responsible for their own orders was not a drastic change in the physician/nurse relationship.

On the other hand, data from interviews did suggest that nurses have assumed an ongoing consulting role vis-à-vis physicians in the use of the COE. Nurses played a key role supporting physicians during the first months of COE use. Informants described how early in the process nurses tried to insist that doctors do their own order entry. Later, trainers advised nurses not to “harass” doctors but to encourage them to use the system by offering help. Such support and consulting interactions have led nurses to accommodate physicians’ preferences about system use as they have “come to accept that certain physicians will never learn or agree to use the system.” As noted earlier, nurses still enter over 33% of all orders, including those issued verbally or via telephone.

Pharmacists/physicians: In several ways, use of the COE has improved communication between pharmacists and physicians. As soon as the physician completes a medication order in the COE, it is printed in the pharmacy, expediting the order process. If the pharmacist has questions, he or she may be able to reach the physician while she is still in the hospital, saving a call to the physician’s office and a delay in filling the order. Having access to the COE and associated data has also allowed pharmacists to expand their consulting role and improve rapport with doctors for screening certain
medication-related problems, “without leaving their seat or even without a phone call.”

However, use of the COE has also introduced redundancy and ambiguity in the communication between pharmacists and physicians, due to the COE interface design, the need to coordinate data exchange between two systems, and pharmacists’ uncertainty about physicians’ practices for using the COE. For example, the COE interface requires the physician (or nurse) to specify the desired dosage in unit amounts on the order, and, if an order is changed, the old order must be deleted and a new order created. These system limitations create ambiguity about the doctor’s intended dosage. The paper-based system gave doctors flexibility to simply specify “50 mm,” for example, and to issue changes to existing orders. With the COE, if a physician wants a 50 mm dosage, he or she has to select a specific unit amount, such as “2 times 25 mm.” If the physician later issues an order for “1 times 25 mm,” the pharmacist may question whether the physician intended to increase the patient’s dosage to 75 mm or decrease it to 25 mm, but forgot to delete the old order. If the medication is not available or stocked in 25 mm units, the pharmacist must change the order in both systems.

A second area of uncertainty involves system warnings on patients’ allergic reactions to medications. The pharmacy system provides warnings based on the patient’s record and history of medication orders. The COE system provides limited allergy warnings, and then only if the nursing staff has entered and verified the information. If the pharmacist receives a system warning about a possible allergic reaction while processing the order in the pharmacy system, he or she may be uncertain whether the physician saw this information in the COE and considered it insignificant. Physicians are supposed to “status the allergy” in the COE in this case, but they tend to skip this step or may walk away from the computer screen before the system flashes the warning. The pharmacist is left with the dilemma of calling the physician to clarify the order and risk annoying him, or assuming that he did see it but did not “status the allergy.” Before calling and possibly annoying the physician, pharmacists may look to their own system for additional information, such as a previous drug reaction, to clarify the doctor’s intent without a phone call. Given these types of ambiguities in communication, informants questioned whether using the COE had actually reduced the frequency of calls to clarify orders.

Pharmacist/nurse: Ambiguity also affect communication between pharmacists and nurses. In the paper-based system, nurses used a “MARS report” supplied by the pharmacy system to keep track of all medications and dosage amounts for each patient. Now nurses use a patient summary report from the COE of actions required for a particular shift, such as administering medication. Inconsistencies between systems may lead to dosing mistakes, if unit dosages are not clearly indicated in the COE. Pharmacists are also dependent on nurses to correctly specify patient allergy and drug reaction information in the COE, so that the system can generate the correct warnings for physicians.

As noted in section 4.1, pharmacists have become experts in ordering processes for both their own system and the COE. As such, they sometimes consult with nurses on how to enter difficult orders, particularly on night shifts when no other personnel may be available, and they may assume responsibility for entering particularly complex orders.

Laboratory/Nurses/Physicians: Use of the COE has clarified some aspects of communication between laboratory technicians and nurses and to a lesser extent, with physicians. The standard format built into the COE interface structures the request for lab tests to some extent (free text is allowed) and expedites the delivery of the order to the lab and of lab results to the physician, eliminating the need for phone calls to request results.

However, COE use has also created uncertainty and friction. Uncertainty arises from the technical process of transferring orders from the COE to the laboratory system. Users’ limited understanding of differences in the laboratory system’s and in the COE’s interfaces and uncertainty about each other’s actions in their respective systems has created communication problems. One informant commented, “so many things can go wrong” in the process, including failure of the laboratory system to receive the order, delays in orders transmission due to system downtime, and so on. As a result, calls for lab results have been replaced by frustrated calls to clarify order status from both nurses and the laboratory staff.

An issue cited by a number of informants illustrates how system constraints and users’ actions affect interactions between these occupational roles. It is often possible and desirable to consolidate similar lab orders into one battery of tests, to reduce testing costs, as well as the number of specimens collected from patients. For example an order for a “Chem 7” could likely be combined with an order for a “Chem 11,” which is a more extensive, inclusive test. In the paper-based system, nurses transcribed all lab orders onto the “cardex,” creating one listing of all pending or outstanding tests. She or he could then identify opportunities to consolidate like tests. Although the COE allows users to browse all outstanding orders for a patient, the interface is not user-friendly, and informants believed that physicians, anxious to speed the order entry process, may not do so before ordering another test. Although nurses routinely consolidated orders in the paper-based system, they are hesitant to alter physicians’ formalized orders in the computerized system. Automated consolidation of orders in the COE has not proved as effective as the nurses’ intervention. Lab technicians and nurses tend to see each other as having the responsibility to consolidate tests, and
both view physicians as the source of the problem. Although the problem has been recognized and some system adjustments made, questions about responsibility remain, and friction between laboratory personnel and nursing persists.

4.3 Changes in social networks

Implementation of the COE at the research site resulted in the creation of several subgroups, or “cliques,” in the social networks of clinicians, organized around the need to analyze and resolve the types of procedural problems discussed in Section 4.2 and to evaluate and recommend improvements in the system.

The MIS Committee: This group is composed of senior clinical administrators, primarily physicians who head clinical departments, and several nursing directors. Many present members participated in the project to select the COE software package and the interface design effort. As a result, they have some additional system privileges such as access to the COE from their offices without additional charge. The physician who served as implementation project manager chairs the committee, which meets periodically to evaluate recommended enhancements to the system and to set priorities for the IS group.

Special Interest Groups (SIGs) for pharmacy and nursing: A task group of nurses and pharmacists participated in the project to customize the COE interface and to train and support users. Some of these individuals continue to participate in a special interest group (SIG) representing their area, to work on process problems and evaluate suggested improvements to the COE. SIG members from the two groups also talk across groups.

COE development team: As mentioned in Section 4.1, a dedicated sub-group of clinician / analysts in the IS department support the COE system. Each member works closely with the SIG or MIS committee to evaluate or recommend changes to the system. These clinicians fulfill boundary overlapping roles between the IS department and clinical areas. In general, the IS department is more closely integrated with clinical areas since the COE implementation, and operational needs of IS such as scheduling system maintenance must be carefully coordinated with clinical areas.

Disease management task forces: Cross-functional disease management task forces, composed of physicians, nurses, pharmacy and/or laboratory staff, and health care analysts, have been formed to develop clinical pathways for treatment of high-cost, high-incident diseases. These groups did not arise from the implementation of the COE but they do address how to implement pathway protocols into the COE, and they utilize data from the COE and other sources to help determine “best practices.” A member of the COE development team works closely with the disease management task forces to develop and implement the clinical pathways into the COE interface.

4.4 Changes in organizational structure

Findings of the case study suggest two areas in which organizational structures at the research site may be changing, due to COE implementation and use.

Increased centralized control over clinical care processes: Use of the COE, particularly in conjunction with disease management programs, has the potential to facilitate centralized administrative control over clinical care processes. Guidelines and protocols existed before the COE was implemented, but monitoring and enforcing their use was impractical in the paper-based ordering system. With the COE, disease management task forces or departmental committees headed by clinical administrators create guidelines and have them encoded into the COE interface. Although individual physicians are not required to use the system at all, or any of the departmental order sets, building guidelines into the COE interface has proven to be effective in altering physician behaviors to improve compliance in targeted areas, such as reducing use of certain antibiotics.

Use of the COE may also facilitate administrators’ power to enforce guidelines by creating a detailed electronic database of each doctor’s ordering activity and opening the possibility of monitoring physicians’ decisions in ways that were not feasible in the paper-based order system. At the research site, COE data, along with data from administration and medical records systems, is fed into an in-house data repository for analysis, and subsequently is used in a national physician benchmarking software package to create “physician report cards.” These reports are returned to physicians for self-monitoring and may also be used in peer reviews with other physicians. Although physician profiling is still relatively new at the research site, and the COE system has not been used explicitly for monitoring physicians, informants cited incidents in which individual physicians who were not complying with specific guidelines were identified through the system and were addressed by peers, in an attempt to change their ordering behaviors.

Decentralization of decision-making authority with monitoring: The case study revealed two instances in which use of the COE has enabled decentralization of decision-making. In one case, decision-making has shifted from a role with higher status in the hierarchy (physician) to an occupational group / department. Respiratory therapists are now authorized to make decisions about specific types of procedures for a patient, based on protocols developed by a disease management group and encoded into the COE interface. Physicians maintain control through their ability to review and check the therapist’s orders.
In the second case, the decision task has shifted from a centralized administrative function to clinical departments, within one occupational group. Before the COE system was used, a centralized group of utilization review (UR) nurses were “running around the hospital looking for charts” to assess patient’s level of care requirement. Recently, this responsibility has been delegated to the charge nurse in each floor, who is responsible for assessing level of care needs each 24 hours and ensuring patient records in the COE are updated. The UR department has maintained monitoring control, because they can check the COE to see whether charge nurses are keeping up-to-date with assessments.

5. Discussion

To interpret these findings, it is important to consider contextual influences on the outcomes of COE system implementation, including the COE technology itself and associated systems, organizational goals, and actions of users in their day-to-day use of the system. The unique aspects of the research site should also be considered within the general context of hospital-based health care delivery. In this section, we discuss why organizational changes occurred, or did not occur, and whether changes facilitated or impeded successful use of the system.

Role changes due to COE use at the research site were largely limited to shifts in specific tasks and requirement for computer use skills related to issuing orders and retrieving results. The absence of major role changes was consistent with the goal of the COE project, which was to automate order processing (a relatively routine function) to improve order processing efficiency, not to alter the basic delivery of clinical care. In fact, most informants mentioned expediting order processing efficiency, not to alter the basic delivery of clinical care. In fact, most informants mentioned expediting order processing efficiency, not to alter the basic delivery of clinical care. In fact, most informants mentioned expediting order processing efficiency, not to alter the basic delivery of clinical care. In fact, most informants mentioned expediting order processing efficiency, not to alter the basic delivery of clinical care. In fact, most informants mentioned expediting order processing efficiency, not to alter the basic delivery of clinical care.

Implementing the COE did entail transfer of order entry responsibilities from secretaries and nurses to physicians -- a transfer that few hospitals have managed successfully, but was relatively successful at the research site despite widespread complaints about the hard-to-use user interface. Several factors contributed to this outcome. This was a physician-led and physician-promoted project, and attending physicians are not required to use the system. With experience using the system, nurses and physicians appear to have found a comfortable level at which nurses, by entering orders for doctors, accommodate physicians’ willingness to use the system.

All system users did develop an increased familiarity with the use of information technology and its potentially beneficial effects. The IS department acquired clinical knowledge and expertise, achieved by establishing a specialized subgroup of clinicians in the IS department. As a result of the COE project, the hospital has laid a foundation, both in terms of technological infrastructure and organizational readiness, upon which to build future technological improvements and perhaps facilitate future changes in role tasks and skills through more advanced IT-enabled clinical application systems.

Changes in interactions between roles (e.g., nurses/laboratory technicians) were modest, and related primarily to the clarification of order information and maintenance of system databases. Again, this is not a surprising finding because changes in the process of creating and transmitting orders are not expected to disrupt the occupational division of labor in hospital-based health care. Of the occupational groups interviewed, physicians perceived the least change in their interactions with others. Interestingly, although nurses identified their role in coaching, training, and supporting physicians’ use the COE, physicians did not acknowledge this as a change in interactions with nurses, perhaps viewing it as an extension of nurses’ responsibility for handling hospital administrative details. Both pharmacists and laboratory staff believed that they had taken on a consulting role with nurses, supporting nurses’ use of the COE by drawing on their expert knowledge of their own system and of the interface between their departmental system and the COE. This finding was consistent with earlier studies of COE use [4] and relates to the need for ancillary services to maintain control over their own databases.

Automation of order processing with the COE has both improved and worsened communication among various occupational roles and departments in the hospital. The frequency of face-to-face or telephone interactions to transmit and clarify routine order information has been reduced, and the timing of communications expedited. However, the ways in which order information is structured in the COE system, differences in the structure in the COE and in ancillary systems, and lack of understanding across departments of how all these system work together have created new issues and ambiguity, requiring communication and interactions on a day-to-day basis to solve specific problems and interactions between departments to find procedural solutions. Many problems are transitory and will certainly decrease with greater experience with the COE system and improved integration across systems. However, similarities in problems at the research site with those noted in earlier studies [7], [4] and the subtlety of changes in communication content that can trigger substantial problems suggest that paying close attention to communication with ancillary services is critical to effective COE use.

Changes in social networks observed at the research site stemmed from several sources. First, the need to adapt to the COE technology to the specific requirements of the hospital led to the formation of the planning, training, and special interest groups. While these groups primarily formed to
facilitate the success of the COE project, the social networks seem to be persisting, and members of these networks may be better able to exert influence on future developments of the COE. The formation of such cliques around systems development and support issues have been found in other COE studies [5], raising an interesting research question of whether such social networks gain influence or authority within the clinical setting due to their involvement with the COE. Second, use of the COE system has emphasized the information intensive nature of health care, making everyone more aware of the need to better manage and utilize information in order to improve the delivery of health care. This fact, along with the distributed nature of the information and clinical skills, has contributed to the formation of cross-functional tasks forces, such as the disease management groups. While the information systems are not directly responsible for the formation of these social networks, they do serve as a focus from which the networks operate. As new systems, more oriented toward facilitating group work, are adopted by the hospital, the technology will become more critical to the effective operation of the social networks.

Findings of the case study hinted at the possibility that, with COE use, organizational control over clinical practice may be increasing at the research site. However, no informants expressed concern about heightened enforcement of standards for clinical practice. Instead, they described the development of protocols and guidelines as ensuring more cost-effective care while maintaining quality and cited the educational value of guidelines for residents and for physicians operating outside of their area of specialty.

Interpretation of these findings requires an appreciation of the institutional characteristics of a US not-for-profit hospital and of the organizational culture of the research site. In a typical hospital, there are two control bureaucracies: the financial/administrative organization and the clinical organization [15]. In the clinical chain-of-command, physicians occupy the highest level in the hierarchy of occupational status and are the gatekeepers who control clinical decision-making. This project was physician-led, and the disease management teams that formulate and implement protocols similarly arise from the clinical administration, not the financial bureaucracy. Physicians at the research site anticipate that data collected through systems such as the COE and used in physician profiling will be used by physicians for self-monitoring, based on their desire to match or surpass their peers’ performance. In addition, clinical administrators share financial administrators’ concerns about cost control, integrating cost issues with professional norms in terms of cost-effective health care delivery. Several physicians expressed interest in receiving more cost information from the COE to help them to make care decisions, and one physician commented “The medical game is all about cost now .. without cost information, we can’t do an effective job.” Thus, procedural control may be merging with professional controls, and both may be embedded in what Orlikowski [18] terms a matrix of control, heightening the overall level of control in the hospital.

## 6. Conclusions

In this paper, we reported on the preliminary findings of a case study of the introduction of computerized order entry in a hospital. We found that the hospital was largely successful in utilizing the system and in transferring responsibility for direct order entry to physicians. Modest role changes ensued, with nurses, pharmacists, and laboratory staff assuming consulting roles to support physicians, and each others, use of the COE. However, the structuring and formalizing of data in the COE, and the need to integrate the COE with ancillary systems, created ambiguity and uncertainty in communications about orders that require day-to-day resolution as well as systemic changes. Social networks and groups within the hospital have formed to address ongoing systems development and enhancement. Use of the system may be enabling increased organizational control over clinical care practices, exercised through professional norms and the clinical administrative hierarchy, as the system has become a foundation to support cross-functional disease management groups and a data source for physician profiling.

One of our objectives in this paper was to propose a framework and to evaluate its usefulness for identifying and assessing organizational changes triggered by COE use. The framework used in this paper, based on work by Barley [8], [9], does provide a useful way to examine the effects of COE use in an orderly fashion from role-based changes up through organizational changes. This approach ensures that organizational changes observed do in fact related to the technological change. The framework also allows consideration of the impact that organizational goals and actions have on outcomes, and explicitly considers the importance of the actions of users, in their interactions around systems use, in shaping outcomes. The framework will require further elaboration in two areas: intra-role effects of COE use, such as nurse/nurse interactions, and more explicit examination of the impact of the information systems infrastructure, such as the COE’s fit with other computerized clinical information systems.

As with any case study, the findings discussed in this paper are limited to the research site and, as preliminary results, will continue to be expanded. However, findings were strikingly similar with other studies of COE in other settings, suggesting that future research could focus on the consequences of structuring the content of order-related
communications in automated systems on interactions between clinical and ancillary departments and the need to integrate the COE with other clinical systems to minimize disruptions in communication. Other interesting areas for further research suggested by this study include the changing nature of the IS profession in the health care industry, the role of information technology in new hospital control structures, the importance and development of standards, and organizational complications which will result from the integration of systems across organizational boundaries both within a hospital and between a hospital and other health care service organizations.

7. References