IMPACT OF INFORMATION TECHNOLOGY ON HEALTH CARE PROFESSIONALS AND PATIENT CARE: A MULTIPLE CASE STUDY IN COMMUNITY HOSPITALS

by

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ABSTRACT

The purpose of this study was to investigate two questions: 1) What, if any, is the perceived difference in impact of Patient Care Information Systems (PCIS) on health care professional groups in hospitals? 2) What factors explain such perceived differences in impact among these groups? A multiple-case methodology was used as this approach permitted factors within the organizational context to be considered. Four professional groups participated in the study, including laboratory technologists, pharmacists, nurses and physicians. They were located in five community hospitals in British Columbia that had achieved various levels of PCIS implementation.

From the literature review an analytic framework based on successful information technology (IT) in other industries was developed to investigate impact. To more closely reflect the goals of IT in the health care setting, the framework was adapted by using Donabedian's (1988) three measures of quality (structure, process, outcome). For each participant group these measures were examined at Grusec's (1986) three levels of impact: substitution, proceduralization and new capabilities.

Three types of data were collected: interviews, document review and observation. Eighty-five semi-structured interviews were conducted and a selected number of participants were observed using the PCIS. Written documentation and archival material relevant to the adoption and use of the PCIS were reviewed for each site. These included IT proposals, strategic IT plans, task force and steering committee minutes, internal and external correspondence. The data were analyzed manually and with textbase management software

called FolioVIEWS® 3.1 for Windows. This software facilitated the searching of interview transcripts in ways defined by the investigator and building hypertext linkages in the data.

The study findings include differences across hospitals and groups. The hospitals are community based and differ on one important variable: the extent of PCIS implementation. Differences are expected to be related to this variable. Generally this is true, as Hospitals 1 and 2 demonstrate more evidence of impact in structure at levels 1 and 2 for all groups. As expected, Hospitals 4 and 5 do not demonstrate this level of impact. However, unexpectedly these two hospitals are able to identify specific evidence of linkage between the measures of structure, process and outcome.

Five themes emerge that illustrate the perceived differences among the professional groups with respect to the impact of PCIS use. The first theme relates to increased **efficiency and productivity** that result from automating clerical tasks, particularly sending and receiving orders. This theme relates more to **pharmacists and laboratory technologists** as changes in **structure** take place when their tasks are automated.

The second theme relates to **role and responsibility changes**, particularly those experienced by **nurses and physicians**. This is partly due to the expected changes in **process** (e.g. decision-making) arising from changes in structure (e.g. faster lab results). Role changes also occur when technology can be used by one group to accomplish tasks formerly completed manually by another group. For example, historically physicians write orders on paper charts and unit secretaries transcribe those orders onto paper requisitions, which are then sent to the appropriate department. Nurses are responsible for ensuring this is done correctly and the results forwarded to physicians as needed. When physicians or nurses enter orders directly into the computer, all three roles change. The participants are unable to identify how they expect these changes to unfold.

"Visible" accountability is a change experienced by all four groups. For **laboratory technologists and pharmacists** this change occurs primarily in measures of **structure**. Automating tasks such as reporting results or medication profiles creates an electronic audit trail that documents the volume and accuracy of work accomplished (e.g., the number of orders processed, number of errors). For **nurses and physicians,** this change occurs in the **process** measures as decisions with respect to care are recorded and immediately available for inspection by other professional groups.

All four groups experience **unexpected consequences of electronic communication**. The levels of electronic mail (e-mail) use varies by system availability in each hospital and demonstrates changes in **structure**. This medium replaces a paper-based system as well as supports new opportunities for committee and group work through multiple access to single documents. Participants predict other uses in use of on-line clinical practice guidelines and interdisciplinary documentation of patient care.

The fifth theme, **training to use technology versus learning to use information,** suggests that users must be able to do more than simply "use the technology" to achieve the potential benefits. This affects **pharmacists, nurses and physicians** in particular as they attempt to determine linkages between **structure, process and outcome**.

The study contributes to understanding the impact of IT in health care by identifying where differences between professional groups in community hospitals occur. The study concludes that linkages between structure and process or process and outcome must be determined before users can expect the computer system to have the intended effect. One example of this is when changes in the work of laboratory technologists and pharmacists (structure) is expected to change the work of nurses and physicians (process). Use of IT also creates role and responsibility changes that contribute to its impact.

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ACKNOWLEDGMENTS

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Impact of Information Technology on Health Care Professionals and Patient Care: A Multiple Case Study in Community Hospitals

Chapter 1 - Introduction

1.1 Why is the Study of Impact Important?

Throughout the world, health care is becoming more complex, and high costs precipitate calls for reform (Lorenzi, et al., 1995; Vayda & Deber, 1994; Deber & Thompson, 1992, Evans, 1984). Health care institutions are under mounting pressure to create a cost effective system by controlling operating costs while maintaining quality of care and service (Anderson, et al., 1994). Information technology (IT)[1] has the potential to increase timeliness, accuracy and accessibility of information. For this reason it has been expected to have a measurable impact on the provision of health services and to provide solutions for some of the major management problems in the health care system (Anderson, et al., 1994; Anderson & Jay, 1987; Mahajan, 1979). However, unlike other information-intensive industries such as airlines and banking, health care is characterized by slow adoption of IT (Melvin & McLoone, 1991; Kaplan, 1987).

Despite the often disappointing or limited success of IT (Conklin, et al., 1988), investment continues to climb (Weill, 1992) with the service sector having little in productivity increases to show for its spending (Roach, 1988). Difficulties in realizing and measuring benefits occur for a variety of reasons related to the technology and context in which it is used. These include:

- limited availability of technology (Blum, 1989) as well as underutilization (Gardner, 1990);
- antecedents, such as funding mechanisms, organizational structure and the accepted role of management (Stoelwinder & Abernathy, 1989);
- the nature of providing health care which is both art and science (Caceres, 1984) and therefore the applicability of IT;
- professional characteristics of the potential users of the technology. Professionals in the field are well educated, operate with a high degree of autonomy and have strong, ingrained, procedural traditions that serve as barriers to change (Minard, 1991b; Jay & Anderson, 1987);
- differences in goals and values between both health policy makers and developers of these systems, and the intended users (Kaplan, 1987);
- users and producers of information are often different groups. For example, clinicians are primarily interested in patient procedures, while managers are interested in the stability of patient costs and improving procedures to reduce those costs. However, managers cannot generate correct information for patient costs unless they have the data for patient procedures and clinicians may not benefit from providing this information (Baugh, et al., 1995); and
- changing characteristics of the organization in moving from hospital to community and the technology moving from mainframe to personal computers (Scherrer, 1988).

Context is important in determining the success of any innovation and therefore measures of its impact (Rogers, 1995). Prescriptives for IT are often derived from small samples in the private sector (Bretschneider, 1990). However, public and private organizations differ in many respects, such as the organization of work, personnel and financial management (Pickett & Hanlon, 1990). The public hospital environment is complex, with a variety of major stakeholder groups, including the board, administrators, physicians, nurses and other clinical or professional groups (Kim & Michelman, 1990; Friedman, 1985). Given their respective roles and tasks, these groups may also have different expectations about the nature and function of information systems (Ferrand, et al., 1993). Potential for conflict among the groups also arises out of the dual hospital structure with its medical and administrative hierarchies, the relative independence and practice of physicians and the role of information in maintaining autonomy of each professional group.

In many cases hospitals anticipate better care and more efficient administration will result from their costly infusion of IT. To realize these benefits, they must also commit to major and continuous change. This includes investing energy to develop and sustain a new and flexible organizational climate that can focus on the relationship between information and outcome goals for patients. Other issues arise when contemporary, frequently parochial, information systems in Finance, Medical Records or the Laboratory become constituent components of integrated hospital information systems. Formerly they were stand-alone, or separate, systems under the control of their respective functional departments (Counte & Kjerluff, 1988). The information produced by this new generation of technology may be more powerful than the people who are expected to use them are prepared to handle (Barone & Chickadonz, 1991).

Paradoxically, while information technology is "revolutionizing how businesses operate" (Walton, 1989), this has not been the case in the health services sector as a result of individual, organizational and system wide reluctance to change. A well-known example is the patient record. It has essentially remained unchanged since the early part of the twentieth century (Bronzino, et al., 1990). This dormancy is in spite of more than thirty years of exploratory work and millions of dollars in research and implementation of computer systems in health care institutions[2] (Institute of Medicine, 1991). To address this concern the Institute of Medicine (IOM) conducted a study on the health care environment, needs of those who use the patient record, technology and barriers to computer-based patient record (CPR) development. They concluded the CPR was an essential technology and recommended its widespread implementation within a decade. Although health care was in desperate need of CPR's, they noted technology was not the limiting factor and a concerted effort could make them a reality.

This change has not been easily accomplished. At a midpoint in the decade for implementation predicted by IOM, Detmer & Steen (1995, p. 55) note: "Although a broader understanding of CPR's has been achieved and more leadership for CPR development exists today, substantial work remains to be accomplished." Incremental progress is evident in almost all areas identified in the earlier IOM report. However, they describe the current state of CPR development as still having "only pockets of excellence rather than full market saturation." Many hospitals have implemented systems related to various aspects of patient care, collectively called Patient Care Information Systems (PCIS), which form the basis for a computer-based patient record.

As IOM (1991) and others have suggested, successful management of technological change is dependent on humanistic as well as technological factors (Sankar, 1991; Zuboff, 1988; Mumford, 1981). Many researchers and practitioners in the field are beginning to realize that harnessing the technology will depend on understanding and managing the complex relationship between the technology, the organization and its stakeholders. Little is known about what these changes are, the definition of success and how to manage the technology and its users to produce the desired impact. An automated record may make it easier for health care professionals to access information. However, the effect it will have on the delivery of health care, on aspects of worklife[3] for health care professionals (such as interaction between groups or decision making) and patient outcomes remains unclear. To date the study of impact has been limited to more quantitative measures of the effects intended by developers and implementors. This lacks an understanding of how the technology becomes integrated into the organization and into professional practice.

1.2 Objectives of the Study

This study was undertaken to explore the type and degree of impact of Patient Care Information Systems (PCIS) on health care professionals in community hospitals. Defining impact from the users' perspectives as well as understanding how and why it occurs are important factors in the future success of information technology in health services generally, both from investment and implementation perspectives. This study set out to identify areas of impact in this context and the contributing factors, as well as to develop a framework to facilitate this and future research efforts.

The specific research objectives were to:

- develop a theoretical framework for evaluating the impact of PCIS on health care professionals in community hospitals;
- use this framework to describe how health care professionals in several organizations perceive the impact of using PCIS on their work;
- identify differences in impact among professional groups and possible explanations for those differences.

1.3 Organization of the Thesis

The remainder of this document is organized as follows. In Chapter 2 the literature review summarizes practice-based and empirical evidence of studies of impact. Three different approaches to IT and change in the organization provide the framework for discussion. Chapter 3 describes the research design, a detailed data collection protocol and strategies for analysis of the data.

The findings for each of the hospitals are presented in Chapters 4 - 8. Each chapter outlines findings for the individual professional groups within that site and ends with a summary section. Chapter 9 discusses the differences in impact across professional groups and hospitals. In Chapter 10, implications of the study for research and practice are discussed. A glossary in Appendix H provides the reader with definitions of terminology that are commonly used in the health care context.

Endnotes

1 Information technology (IT) and information systems (IS) are frequently used interchangeably in the literature. In some cases they are used in distinctly different ways to represent the hardware and use of the technology, respectively. In an organizational context, use of the software and hardware on which it resides have no purpose one without the other. In this study, only IT will be used as a broad concept which includes: "both IS applications and the IT platform (the hardware, software and communications networks) used to enable the IS applications to function" (Lay & Ferrand, 1995, p. 5).

2 Classic examples of these systems which have been developed on-site at large teaching centres include COSTAR (Barnett, 1984), PROMIS (Fischer, et al., 1987) and HELP (Gardner & Lundsgaarde, 1994).

3 "Worklife" is used in the context of describing aspects of work such as decision-making and control (Kraemer and Danziger, 1990), and not in the sense of human resource planning where it is used to represent number of productive years of work.

Chapter 2 - Theoretical Framework

2.0 Introduction

As discussed in Chapter 1, a prime objective in health care is improving or maintaining cost-effective patient health outcomes. There is a growing need for the health care industry to better understand the implications of investments in IT and their contribution to patient care. An evaluative strategy must go beyond the technical aspects of IT to understand how well the technology is actually functioning within the organization (Anderson, et al., 1994). This is important in forming a basis for developing specific interventions to enhance system success, as well as to determine strategies for future investment.

In health care there has been a long history of high expectations for the role IT will play in change efforts aimed at controlling costs or maintaining quality of care. As the technology and organizations change, it is often unclear what that role is. This may be the case because underlying assumptions about how IT affects organizations imply quite different perspectives on what causes change to occur (Anderson, et al., 1994). The change perspective taken influences the nature of inquiry into "impacts," as well as interpretation of the results. Within a particular perspective, determining the impact of IT relates to three factors: the impact expected to occur, the impact that actually occurs and the reasons for the differences.

Three different perspectives of the role of IT in organizational change will be reviewed in Chapter 2. Each of these perspectives is examined in detail in relation to changing technology, organizations and expectations for impact of IT in health care. The chapter concludes with specific questions that direct the research study.

2.1 The Role of IT in Organizational Change

The underlying assumptions about what causes change to occur provide the impetus for researchers to select study questions and practitioners to choose intervention strategies. Four different, yet similar, perspectives will be discussed. They each focus on factors thought to be responsible for change: the technology, the people in the organization, and a process involving both people and technology (summarized in Table 2.1). Each of these perspectives is briefly described, followed by a more detailed discussion in relation to IT, specifically in health care.

In the earliest of these frameworks, Markus and Robey (1988) suggest three perspectives of IT and change: technological imperative, organizational imperative and emergent perspective. A technological imperative views IT as an external force that constrains or determines behavior of individuals and organizations. IT is responsible for effects such as changes in organizational structure, skill enhancement, deskilling of workers, or change in employment opportunities. The organizational imperative, however, assumes the user has unlimited choice over technological options and consequences. Choices and behaviors of managers and system designers contribute to an IT design that satisfies organizational needs for information. They manage impact of IT by attending to technical and social concerns. These are different from the emergent perspective, where uses and consequences of IT emerge unpredictably from complex social interactions.

	Focus in Change Perspective		
Author (year)	**technology**	**people**	**process**
Markus & Robey (1988)	-technological imperative - IT viewed as cause for organizational change	-organizational imperative - motives and actions of designers of IT are cause of organizational change	-emergent perspective - uses and consequences of IT emerge unpredictably from complex social interactions
Kaplan (1991)	-research, development and diffusion models - rational, orderly transition of knowledge	-problem solving models - change agents collaborate with client in identifying needs and finding solutions	-social-interaction models - stages through which individuals pass in decision to adopt and mechanisms of diffusion
DeSanctis & Poole (1994)	-decision-making (positivist) approach - characteristics of technology overcome human weaknesses and cause change	-institutional (interpretive) approach - technology is flexible and organization directs change	-socio-technical (combination of positivist and interpretive) approach - mutual influence of advanced technology and social processes shape each other
Anderson, et al. (1994)	-computer as external force - brings about change in behavior of individuals and organizations	-IT is shaped by organizational needs and change occurs in a rational fashion through efforts of managers, developers and implementors who identify needs and solve problems	-complex social interactions within the organization determine use and impact

Table 2.1 - Theoretical Perspectives of IT and Change

Markus and Robey (1988) note that in this case it is unclear whether interventions are required because it is impossible to predict the indeterminate outcomes. Researchers may advocate 'emancipatory' strategies, such as extensive user participation in the analysis, design and implementation of IT. A central tenet of this perspective is "the social meaning ascribed to IT. This perspective accounts for conflicting research findings about impacts by demonstrating the different meanings that the same technology acquires in different social settings" (Markus and Robey, 1988, p. 595).

In developing the second framework, Kaplan (1991) suggests that evaluation research often does not specify underlying assumptions about models of change that may influence both the study questions and accompanying research strategies. Awareness of these models may also enrich information systems research by identifying further areas for study and research strategies for studying changes inherent in the development and use of information systems. Based on early work by Havelock, et al. (1971; cited in Kaplan, 1991), Kaplan introduces three types of change models. In "Research, Development and Diffusion Models" rational, orderly transition of knowledge occurs from research to development, diffusion and adoption. These models focus on the researchers, developers and disseminators. The recipient of the new product is treated as essentially passive and Kaplan suggests many researchers in information systems hold these models. In "Problem Solving Models," change agents diagnose client needs in collaboration with the client. Change occurs in stages where they identify needs, seek solutions and apply them. Lewin's stage theory (with unfreezing, moving, freezing) and force field analysis (Havelock, et al., 1971; cited in Kaplan, 1991) are examples. "Social-Interaction Models" emphasize the diffusion aspect of change. They focus on stages that individuals go through as they decide whether or not to adopt an innovation and the mechanisms of diffusion through the adopting group. Kaplan identifies Rogers' (1983) classic "Diffusion of Innovations" theory as a well-known representative of this model, where knowledge flows back and forth within complex networks and relationships.

In the third framework DeSanctis and Poole (1994) examine the role of IT and change with respect to advanced technology. These offer new opportunities for change involving group, rather than individual, use. They describe two existing schools of thought that underlie the study of IT and organizational change and suggest a third new perspective for advanced technologies, particularly Group Decision Support Systems (GDSS). The Decision-Making school of thought "adopts a psychological approach to the study of technology and change," that "emphasizes cognitive processes associated with rational decision-making." Technology has structures (data, decision models) designed to overcome human weaknesses (bounded rationality, process losses). Once applied, technology is expected to bring productivity, efficiency and satisfaction to individuals and organizations. Failure to achieve the desired change reflects failure in technology, its implementation or its delivery to the organization. DeSanctis and Poole indicate that while this perspective has yielded extensive literature on GDSS's and other advanced technologies, it has not produced consensus on how these systems should be designed or how they affect the people or organizations who use them.

The second perspective described by DeSanctis and Poole (1994) is the Institutional School, which views technology as an opportunity for change rather than as a causal agent.

This perspective focuses less on structures within the technology and more on evolution of social practices within institutions. It considers technology to be interpretively flexible. "Analysis is the process of looking beneath the obvious surface of technology's role in the organizational change to uncover the layers of meaning brought to technology by social systems" (p. 125).

DeSanctis and Poole (1994) synthesize these two schools of thought into a third new perspective, Social Technology. This is a more complete view and accounts for the "power of social practices without ignoring the potency of advanced technologies for shaping interaction and thus bringing about organizational change. Technology has structures in its own right, but social practices moderate their effects on behavior." They propose an Adaptive Structuration Theory that explains the dynamic way technology and social structures shape each other over time.

Anderson, et al. (1994) describe a fourth framework in a recent book that outlines a range of methods for evaluating health care information systems. Three models of change prevalent in information systems research (based on Markus and Robey, 1988; Kaplan, 1991) are suggested. In their first model they view the computer system as an external force that brings about change in the behavior of individuals and organizational units. Controlled studies in a laboratory setting exemplify this perspective. These studies focus on users' response to the technology, not on how the systems fit into daily work of the organization where they will be used (Benbasat, 1989). In the organizational setting, evaluation focuses on technical performance aspects such as cost, speed and accuracy. Organizational and technological characteristics are assumed constant. In their second model, the information needs of managers and clinicians, as system users, determine system design. They consider IT external to the organization and shaped by organizational needs. Change occurs in a rational fashion through efforts of managers, developers and implementors who identify needs and solve problems. They assume control over the technical aspects of the system and the consequences of its implementation. In Anderson's third model, complex social interactions within the organization are determinants of use and impacts of IT. Organizational change occurs over time and includes dynamic social and political processes as well as characteristics of the individual and organization.

While the perspectives in each of these four papers are slightly different, they do present three similar foci in the role of IT and change: technology controls change, people control change through controlling technology, technology and people are interactive and shape each other. Each of these perspectives will be examined with respect to IT in health care.

2.2 Technological Imperative in IT and Change

The technological perspective assumes characteristics of the IT will create change. For example, tasks are automated so they can be completed faster and more accurately. The organization applies technology to the task and determines its impact by the number of tasks completed, how fast and at what cost, as illustrated in Figure 2.1.

Hospitals first acquired computer systems during an era when they based payment for care on cost reimbursement. Two critical issues were accounting for costs and sending bills out quickly. For this reason financial applications were among the first to be implemented.

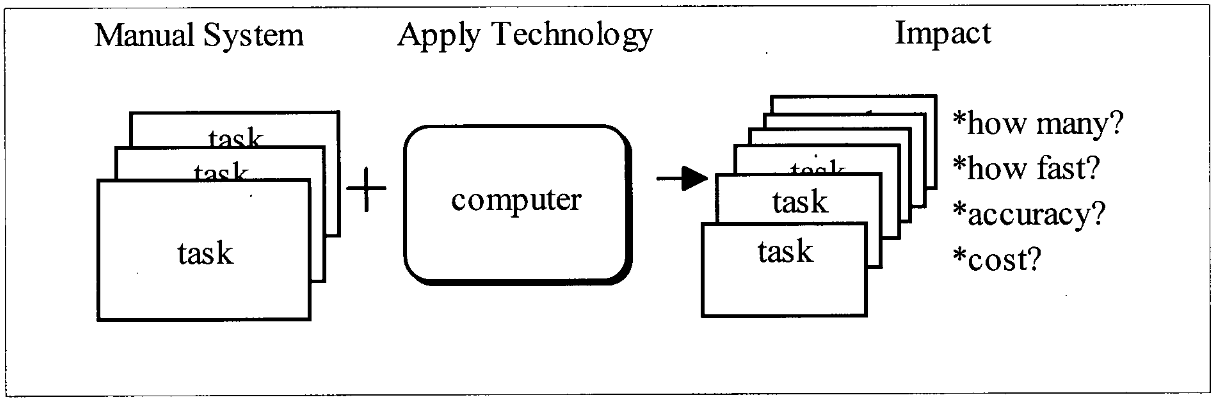

Figure 2.1 - Technological Imperative and IT

In the 1970's and 1980's individual hospital departments began to develop stand-alone systems to meet their own specific needs and generally addressed automation of clerical tasks. In areas with high transaction processing, such as Laboratory and Pharmacy, they expected IT to improve operational efficiency and lower costs. The prime focus was on identifying sufficient benefits to justify the investment, either internally to the organization or to external funding bodies such as the Ministry of Health.

From the advent of early systems, organizations assume that automating processes and increasing efficiency, decreases costs. Coffey's (1980) classic description of the assessment of economic impact in one of the first instalments of a hospital information system (the Technicon Medical Information System at El Camino Hospital in Mountain View, California) illustrates this. His study results indicate that the system improved productivity in the medical care departments and caused an overall reduction in patient length-of-stay. However, from a total hospital cost perspective, the results were not definitive because they assumed that increased support department costs were not directly caused by the system.[1]

IT is usually expected to achieve certain operational efficiencies and personnel savings, and therefore high costs often lead to unrealistically high expectations. Aside from simply replacing manual operations, a number of other issues limit the effectiveness of computers in public organizations: data quality and accessibility, system evolution and interface difficulties, and organizational and political concerns (Tien and McClure, 1986). Studies and reports often focus on indicators of technical performance, such as cost, speed and accuracy. However, despite rapid diffusion of IT into the community hospital sector, there is still limited evidence whether adoption makes financial sense. Glandon and Shapiro (1988) identify three areas of concern in the evaluation IT in health care that are very similar to why impact of innovations is not often evaluated (Rogers, 1995):

1. despite the multibillion dollar investments in IT and annual operations, comprehensive, well-documented, methodologically sound evaluations are virtually non-existent;

2. despite the wide variety of systems evaluated, the numerous study settings, and the diverse methods, most studies conclude that IT was beneficial;

3. barriers to evaluation include an incentive to acquire technology that provides any potential improvements in clinical or administrative practice; methodological and resource constraints to conducting evaluations; and a "water under the bridge" phenomenon. Once the IT is in place, the cost of evaluation usually overwhelms benefits for the individual hospital.

Early efforts at evaluating impact of IT focused almost exclusively on cost factors. However, determining the effect of integrated PCIS on hospital operations is more difficult because no single concept or set of concepts in the information or social sciences define the issues involved (Melvin and McLoone, 1991). Review of the literature suggests a diversity of views about the purpose of IT, its organizational implications, costs and benefits.

Although outcomes are often described in dollar terms, it is difficult to demonstrate how claimed savings were accomplished and to isolate the role of IT in achieving those savings, particularly in areas such as the patient's length of hospital stay.

Assuming that characteristics of IT induce change, organizations expect automating manual tasks to be of financial benefit through improved efficiency and productivity. This reflects the thinking behind early stand-alone systems in health care that focused on automating financial operations and transaction processing. Impact could be determined through counting the number of transactions completed, or measuring the length of time to complete each transaction. As systems became more sophisticated and powerful, a broader perspective on the role that IT played in change emerged. Users became more knowledgeable and began to manage the technology to suit their needs.

2.3 Organizational Imperative in IT and Change

An organizational imperative perspective assumes that characteristics of the IT can be shaped to solve problems identified in the organization. They can determine the impact by how well the technology matches organizational need by whether people use the IT, as Figure 2.2 illustrates.

This view was prevalent as users became more involved in system selection, development and implementation. The early 1980's saw PCIS providing the first centralized database of patient information by building on a Central Patient Index. This was useful in later applications that crossed departmental boundaries, such as patient location (admission/discharge/transfer systems) and order communication to ancillary departments with results automatically reported back to the Nursing Unit (Worthley and DiSalvio, 1989). As IT became more complex, managers began to try to control some of the factors they thought influenced success.

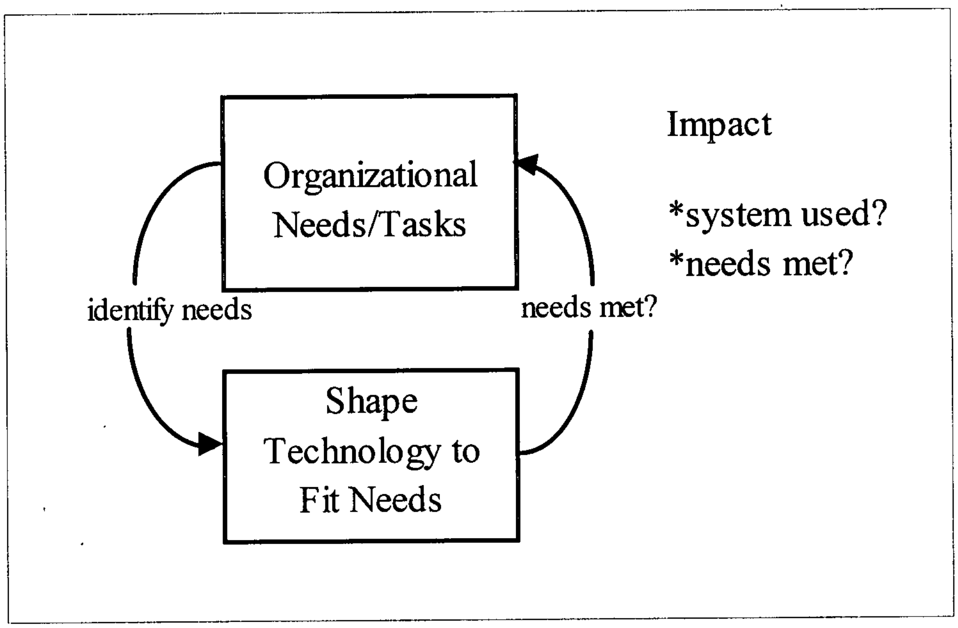

Figure 2.2 - Organizational Imperative in Using IT

However, IT must be utilized for it to be valuable in problem-solving and there has been a lengthy interest in why some innovations succeed and others do not. This has lead to extensive investigations of factors that affect adoption of particular innovations and their diffusion in organizations and societies (Rogers, 1983; 1995). Characteristics of the organization, individual adopter and the innovation itself (in this case, IT) play a role in this process[2] as Figure 2.3 illustrates. Identifying factors important for successful adoption and diffusion of IT assists managers and developers to ensure success of the IT.

Researchers and practitioners recognize that IT must be used successfully to have an impact. A continuing focus of IT research is the link between the nature of the IT introduced into organizations and its impact on users' work performance. The literature on organizational effectiveness suggests that defining and measuring IT effectiveness via user perceptions is both appropriate and practical (Miller, 1989). This perspective produces a shift away from using characteristics of the individual, organization or technology as predictors of use, toward factors such as satisfaction, perceptions of usefulness and ease of use. These variables have been studied extensively and Figure 2.4 illustrates one conceptualization of their relationship.

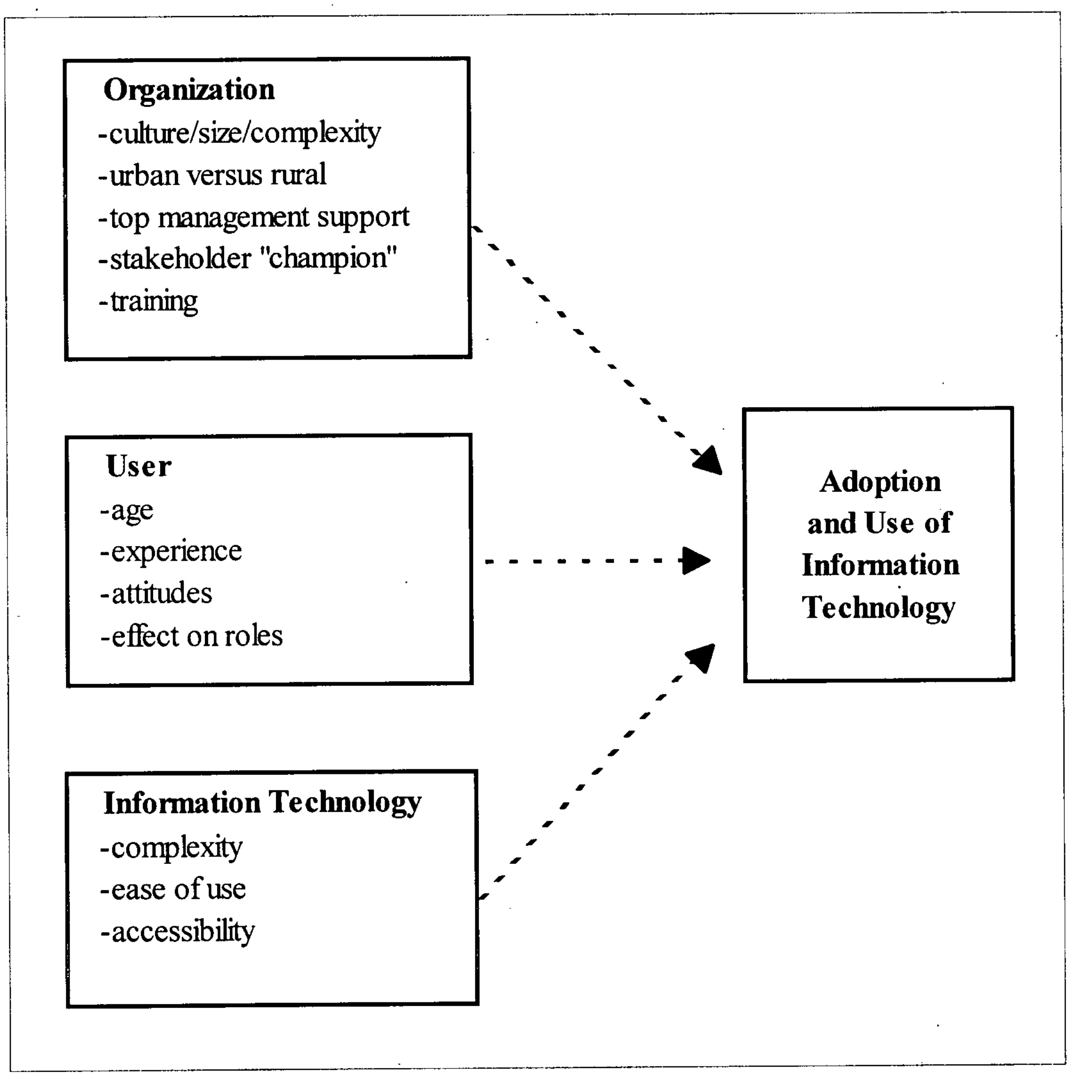

Figure 2.3 - Factors Influencing Use of Information Technology

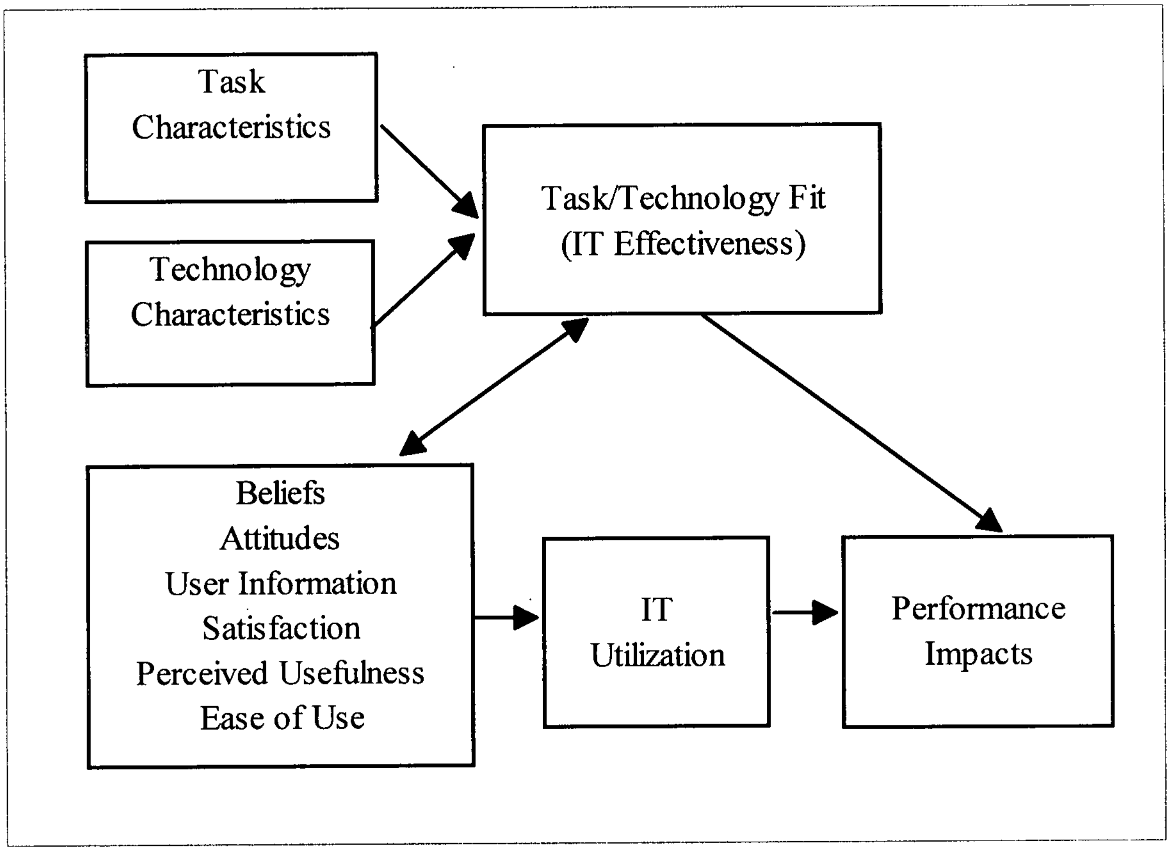

Figure 2.4 - Variables Related to IT Effectiveness (modified from Goodhue and Thompson, 1995)

Early studies by Raymond (1985) and Srinivasan (1985) investigated relationships between User Information Satisfaction (as a measure of perceived effectiveness) and use that they expected to produce Management Information System success. Goodhue (1988, 1990), Miller (1989) and others felt User Information Satisfaction was too imprecise a measure. They directed their attention to the fit between technology and task, its influence on attitudes and beliefs about using IT, and ultimately through that, performance.

Davis (1989) and Davis, et al. (1989) developed a Technology Acceptance Model that focused attention specifically on one aspect of the task-technology fit. They were attempting to explain and predict user acceptance through causal linkages between two key beliefs:

perceived usefulness and perceived ease of use. The question of "fit" was also approached from a prospective, rather than retrospective, viewpoint in a number of other studies. They suggested one way to ensure fit was through user participation and involvement in the development process (Barki and Hartwick, 1994; Newman and Noble, 1990). Understanding the gap between actual and expected system characteristics is another predictor of satisfaction with the fit between technology and task (Shirani, et al., 1994).

From a review of 180 studies of Management Information System's success, DeLone and McLean (1992) develop a framework that represents an integrated view of this diverse research. Their taxonomy reflects earlier work in communication theory and the role of information in changing behavior. It has six different "dimensions of success" including System Quality, Information Quality, System Use, User Satisfaction, Impact on Individual User and Impact on the Organization. This is a useful tool to organize the multitude of studies in order to gain a sense of the breadth and history of this research.

A large proportion of practice literature is based on single case studies and relates IT success to characteristics of users, technology or the organization. Many writers described the experience of their health care facilities with selection, development and implementation of PCIS during the 1980's (for example, Woodend and Cluett, 1992; Kennedy, 1987; Komes, 1987; Hebert, 1985). Limited empirical evaluation and published research on advanced PCIS is available. The difficulty in using the available studies is they come from academic medical centers that have programs in medical informatics, where systems are, for the most part, self-developed (Metzger, 1995). More research is needed on the transferability of successful systems in these sites, to practice environments in community hospitals and physicians' offices.

The diffuse nature of IT use in health care, coupled with the lack of common nomenclature or theoretical framework, makes it difficult to consolidate the history of the research and publications in this area. As Figure 2.5 illustrates, the body of IT literature in health care can generally be mapped onto DeLone and McLean's (1992) six dimensions. (See Appendix I for a detailed review of articles.) For many of the descriptive articles, use of the system seems to be the implied goal. This is their ultimate measure of success, with much of the selection, training and implementation activities directed toward this end. What is obviously different between the health care literature and that reviewed by DeLone and McLean is the effect IT is expected to have in supporting better patient outcomes at the same or lower cost.

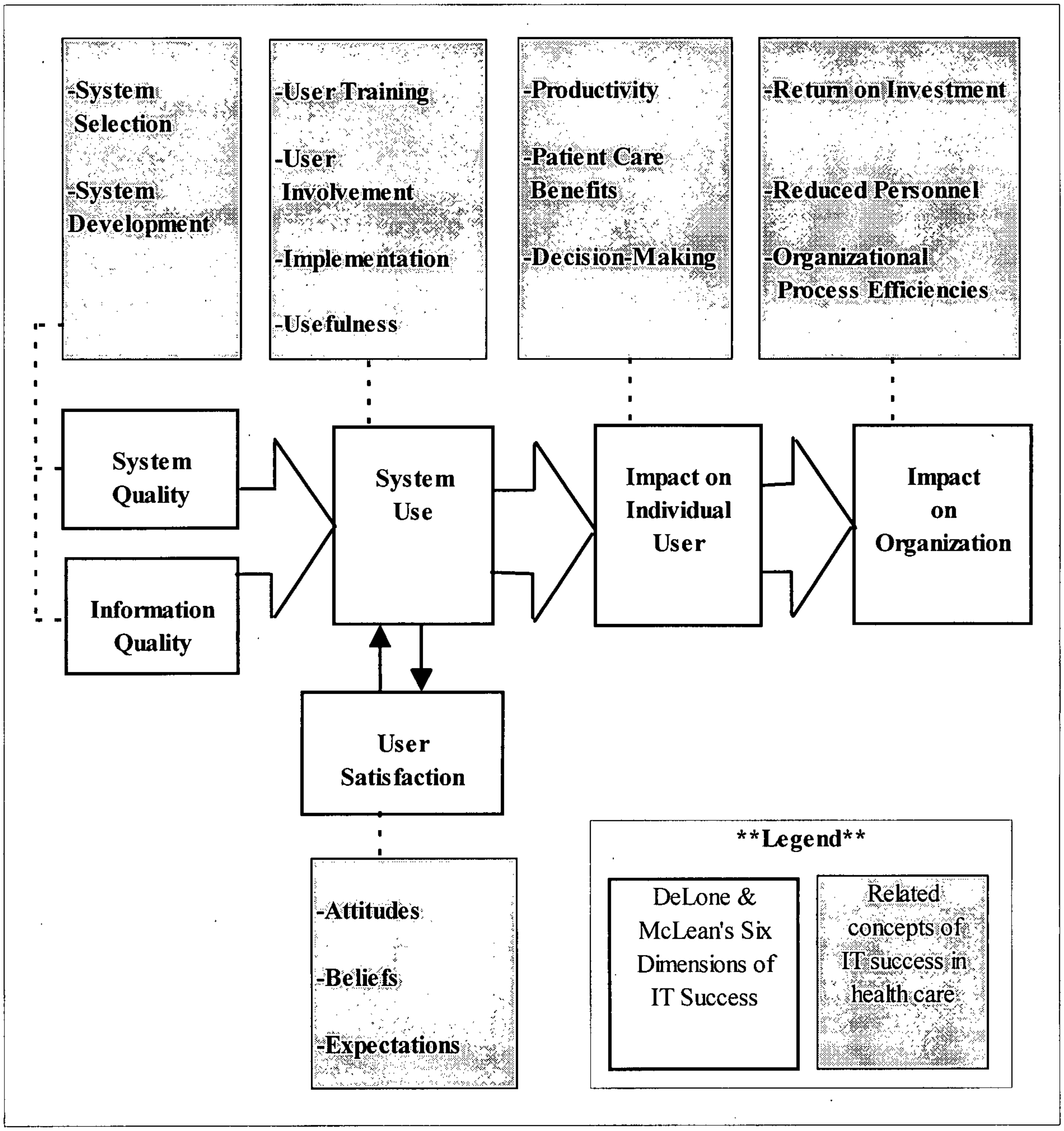

Figure 2.5 - DeLone and McLean's (1992) Framework Applied to Health Care IT

DeLone and McLean's (1992) six dimensions of IT success and their application to the health care literature are summarized below. An additional category, impact on patient outcomes, has elements of individual and organizational impacts and has been included to reflect this additional interest in health care:

1. **System Quality** - direct access to better quality information, reliability, available wherever decisions are made about care, easy to enter and retrieve

2. **Information Quality** - more complete, timely, accurate information; quick, value added access to information

3. **Use** - easy to learn and use. Training and attitude are expected to influence use. In integrated systems that cross departmental and program boundaries, use is generally mandatory because the automated systems replace manual ones. In this case, counting the number of times a system is utilized is not particularly valuable information.

The relationship between use and impact has been tested empirically in narrowly focused studies. For example, a randomized control trial was used to assess resource use associated with physician inpatient order writing on microcomputer workstations (Tierney, et al., 1993). The results demonstrated lower patient charges and hospital costs could be achieved but the system required more physician time than the paper charts did.

4. **User Satisfaction** - sometimes identified in relation to other "success" variables such as information or system quality, in other words, satisfaction with timeliness of information or accessibility of terminals. Drazen (1995) identifies three common measures of computer acceptance: user attitudes, system use, and user satisfaction. She notes user attitude was the most common measure in early studies and was predictive of diffusion of computers in the health care environment.

Since it seems clear that computers will be used in health care settings, assessing general attitudes toward computers is no longer seen as a high priority (Drazen, 1995). However there may be new uses for detailed attitude surveys, such as planning for optimal implementation of new computer systems (Hebert and Benbasat, 1994; Lundsgaarde, et al., 1989). Once computers have been introduced into health care delivery, the most relevant question becomes, "Are these systems useful?" and two common measures of usefulness are voluntary use of the computer and user satisfaction. In situations where use of the system is mandatory Drazen suggests satisfaction is the only way to determine acceptance, although others have developed direct measures of usefulness (Davis, 1989; Moore and Benbasat, 1991).

5. **Individual Impact** - improved efficiency, more time spent with patients. Individual impact of IT is a function of the people who convert data into the information they require to deal with the complexity of work and decisions for which they are responsible. For example, there are many suggestions for implementing clinical alerts and practice guidelines. However, unless practice behavior changes as a result of the additional information, the IT cannot be considered valuable. This critical link between using the technology and using the information to change behavior has been missing from many early efforts to design successful IT. A recent study demonstrated effective use of clinical workstations in changing physicians' responses to alerts regarding primary care interventions, in reducing admissions (Safran, et al., 1995). Others note that physicians will not be willing to change their minds about using computers in clinical practice until there is evidence of better quality, more time for patient care and more time for themselves (Lunsdon, 1993). These do not necessarily relate to changes in practice on their part.

6. **Organizational Impact** - cost reduction, profits, return on investment, productivity gains, improvements in process efficiencies.

7. **Patient Outcome** - reduced length of hospital stay, reduced medication errors and other "incidents," reduced re-admissions, increased quality of care (as a result of health care professionals having better access to information), patient satisfaction, conformity of patterns of practice to clinical guidelines. Even though the patient is an important stakeholder, few studies directly examine the impact of IT on clinical practice and patient outcomes due to the time lapse between the intervention and resulting health benefits (Rogers, et al., 1982; Blaschke, 1990). In a number of randomized control studies, computerized record summaries have been associated with improved patient outcomes (Rogers, et al., 1982; Rogers and Haring, 1979). The studies assume timely, accurate reports contribute to the goal of "improved quality of care." A comparison of two interpretations of "timeliness of reports" illustrates the difficulty with these measures of impact (Kropf, 1990). In one facility the Radiology Department standard was a twenty-four hour turn-around for reporting results and transmitting the image back to the ordering physician. The physicians however, often did not return to see their patients again within twenty-four hours, so did not find this feature particularly useful. In a second facility only positive results were telephoned to physicians within twenty-four hours and hard copies of all results sent via mail. Therefore, the increased investment in IT to produce more timely information did not effect the action taken by the physicians.

By far the majority of research and practice literature in health care IT assumes an organizational imperative perspective. As mapping to DeLone and McLean's dimensions of success illustrates, organizations expect that attention to system selection and development, user participation and training results in successful system implementation. Research based on this perspective searches for causal relationships between IT, as the independent variable, and organizational change. Survey research is common with resulting "prescriptions" for successful implementation and use of IT.

There is an increasing realization that introduction of IT is more than just another technology because information "plays a distinctively social, interpersonal role in organizations" (DeSanctis and Poole, 1994). IT also modifies the environment it was intended to support and changes the way individuals carry out their tasks within the organization. These changes may invalidate some of the earlier assumptions about the role of IT in change (Blum and Orthner, 1989) and therefore requires a new perspective for investigation of its impact.

2.4 Socio-Technical Perspective in IT and Change

Information technologies are changing. DeSanctis and Poole (1994, p.1) note that: "The past decade has brought advanced IT such as electronic messaging systems, executive information systems, collaborative systems, group decision support systems and other technologies, that enable multi-party participation in organizational activities through sophisticated information management." The impact of many new information technologies may only become evident as they are integrated into organizations, where their effects are less a function of the technologies themselves than of how people use them. For this reason, actual behavior in the context of advanced technologies frequently differs from the "intended" impacts. Assuming a socio-technical perspective for IT and change moves investigations of impact away from single measures of productivity or usefulness, to the relationship between the users and use of the technology and how they change over time. Leavitt (1965) proposed four factors that were important in organizational change. His paradigm, illustrated in Figure 2.6, is a useful representation of the dynamic relationship found in a socio-technical perspective of IT and change.

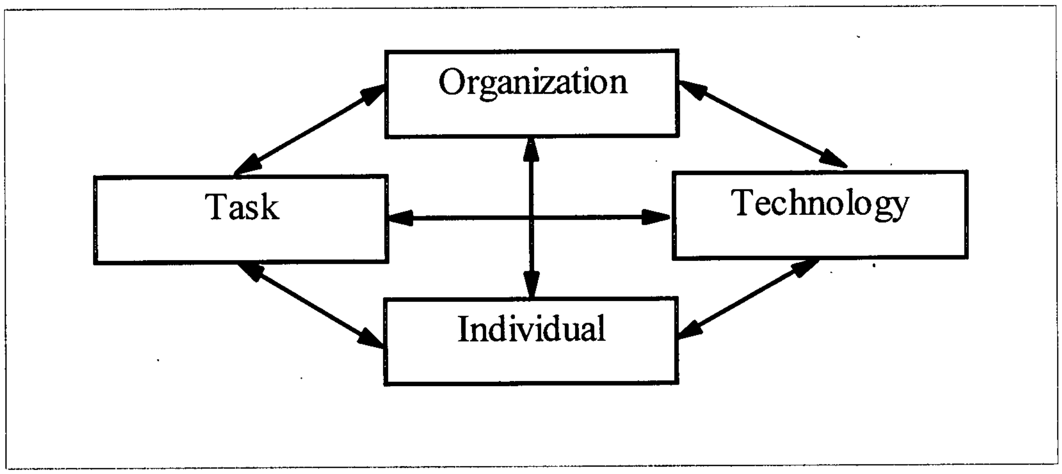

Figure 2.6 - Socio-Technical Perspective of IT (Leavitt, 1965, p. 1145)

The current changes in technology are accompanied by new directions in health care delivery. Moving toward an integrated, community-based health care system simultaneously increases the challenges for information and access to that information. It is impossible to provide seamless access to care without also providing seamless access to information, because patients cannot be directed to the most appropriate location of care unless relevant information about the patient is available there (Metzger, 1995). Opportunities for spending continue to increase as resources decline and the contribution of each expenditure to improved patient outcomes must be evaluated. "Opportunity costs" will be determined on a community-wide basis, rather than by individual institutions. These pressures are major forces behind the current interest in patient-care information systems and the development of a computer-based patient record, with direct clinician entry. As the IOM pointed out five years ago, the major limitations for moving in this direction are not in the technology.

In the 1990's the role of automated Health Information Systems is "generally believed to have been expanded to provide decision-support information to manage patient care more effectively both from a quality and cost perspective" (Huesing, 1992, p. 167). However, Huesing suggests these changes are more a result of economics related to capping hospital-based acute care funding, the care demanded by a more educated consumer, and the cost advances in medical technology. No economic relief is expected through political means. The only viable alternative is to change the behaviour of those who initiate care (and induce the costs) by providing information to the caregiver at the time of treatment decisions (such as can be done through a CPR), rather than retrospectively (as is the case with the paper chart).

Integrated information systems also facilitate the sharing of information across departmental boundaries that can be used to produce patient- and provider-specific costing information.[3] This information provides opportunities for closer scrutiny of resource utilization and variations in practice patterns. As well, it introduces dilemmas for health care practitioners, some who argue that their role is not to resolve conflicts between controlling costs and providing services.

The impact of computer-based information systems is related to the integration and mutual adaptation of the technological aspects of IT as well as the social aspects of organizations (Walton, 1989; Zuboff, 1988; Iacovou, et al., 1995). In health services this may be pervasive because IT has the potential to affect both social organization and delivery of medical care through the restructuring of work tasks (Aydin, 1994). This imposes new methods and routines on the performance of work (Aydin, 1989) as well as changes in organizational procedures and responsibilities (Gerdin-Jelger and Peterson, 1985; Peterson,

1985) creating shifts in power, status and possibly conflict. The delivery of health care requires coordination and cooperation between numerous different occupations and departments. Changes in how these groups perform their work and interact with one another can have important consequences for the organization as a whole.

The impact of IT is perceived differently by different professional groups (Kjerulff and Counte, 1988; Fischer, et al., 1987) or different specialties within a single department (Kaplan and Duchon, 1988). Reactions to the same system can range from increased job satisfaction to dislike of the system because it interferes with the job. Research on the use of IT indicates that physicians and nurses do not resist the concept of computers. However, very few studies investigate the type of computer support needed, functions nurses and physicians find most beneficial to automate, and where current systems fall short (Drazen, 1995). For example, one empirical study of physicians and nurses using order entry in a hospital demonstrates their different perceptions of benefits in the same system: physicians valued off-floor accessibility the most and nurses valued legibility and accuracy of orders (Lee, et al., 1996).

The interaction of users, task and technology within a certain environment produces social impacts of computing on work, particularly for knowledge workers. This is illustrated in Kaplan's (1995b) study of three clinical systems where she investigated individuals' understanding of their work, as well as the relationship between an information system and work it is intended to support. It is this interaction that ultimately will have the greatest impact on worklife for health care professionals. Kraemer and Danziger (1990) identify six dimensions of worklife that IT use may impact:

1. decision making - the capacity to formulate alternatives, estimate effects, and make choices;
2. control - the power relations between different actors;
3. productivity - the ratio of inputs to outputs in the production of goods and services;
4. social interaction - the frequency and quality of interpersonal relationships among co-workers;
5. job enhancement - the skill variety and job domain; and
6. work environment - the affective and evaluative orientations of the worker toward the setting of work.

Given the conditions of professional interdependence and a complex environment in health care, a socio-technical perspective is useful in understanding the impact of new, integrated information systems. The computer-based patient record (CPR) is an example of a complex, integrated set of systems which health care organizations currently aspire to and illustrates the appropriateness of this new perspective. A CPR is built around a common patient database and draws information from many areas, including:

- clinical systems in the Laboratory, Radiology, and Pharmacy;
- transaction processing systems to order tests or drugs and receive results;
- documentation systems to record clinical notes, patient observations and treatment interventions; and
- communication systems that include remote access capabilities.

Anderson, et al. (1995, p. 767) point out these complex systems cross traditional boundaries and have important differences from previous systems:

> While most of the technological barriers to the development of CPR's have been overcome, patient records are also social systems that use information technology. The implementation of such systems does more than enhance our ability to deliver health care. It also affects practice patterns and professional relations among individuals and groups within the organization. The ultimate success of any system depends upon integrating it into a complex organizational environment and ensuring that it is used effectively by the individuals for whom it was designed.

Although the literature suggests computerized records are accepted by physicians, they improve access to information, facilitate patient management and research, and provide educational opportunities,[4] it remains unclear what the consequences for other user groups and patients are. Rogers (1983; 1995) points out that most research on the consequences of adopting innovations has a distinct "pro-innovation" bias. Innovations can cause both desirable and undesirable consequences, many of which cannot be separated. An innovation may be more functional for some individuals than for others. Therefore, certain positive consequences may occur for some members of a group at the expense of others, which is likely the case for advanced IT. For example, physician order entry is considered by some as essential to the success of the CPR. This has lead to prescriptive articles and empirical studies related to how this could be facilitated. Kaplan (1994) indicates that physicians have long been ambivalent with respect to the use of CPR's and particularly direct order entry by physicians. She discusses implementation strategies for enhancing benefits and reducing barriers or disincentives to physician order entry. A survey to evaluate users' overall satisfaction with physician order entry also identifies factors associated with satisfaction and dissatisfaction, users' perceptions about frequency of specific features used and usefulness of those features (Lee, et al., 1996).

As Anderson, et al. (1995) point out, organizations are social systems that are affected by the introduction of IT. However, little has been written about the effect CPR's will have on the organization, interactions between health care professional groups or these professionals and their patients. For example, one report of physician order entry that contributes to efficient drug distribution, benefits both pharmacists and patients (Hubbell, 1994). However, there is no indication how patients perceived the reduced time they spent with the pharmacist. In another setting, nurses experienced changes in their perceived role as integrators of patient information as a result of CPR's (Lorenzi and Riley, 1995). They felt their role in the overall care process had been diminished.

In the context of changing IT and health care delivery, the effect of IT on patient outcome is becoming increasingly more important. Unlike DeLone and McLean's (1992) success factors that include individual and organizational impact, the interdependent roles of health care professionals in achieving "quality care" are a more salient focus for this study of impact in health care. Donabedian's (1965, 1980, 1982, 1988) well-known model for assessing quality of patient care provides a framework for evaluating the impact of IT in this way (Hebert, 1995). Donabedian describes three attributes of care in his model: structure, process and outcome. He suggests the most direct way to evaluate the quality of care is to examine the process of that care. Two less direct approaches to use are the assessment of structure and outcome. A more detailed discussion of these concepts and their relationship to one another provides the context for their use as indicators of IT impact in health care.

The assessment of "structure" is one indirect approach to evaluating quality of patient care. In this case, the term "structure" is used in a way that differs from other disciplines, such as organizational behavior. Donabedian (1980, p. 81) defines structure to mean "the relatively stable characteristics of the providers of care, of the tools and resources they have at their disposal, and of the physical and organizational settings in which they work." This concept of structure includes the human, physical and financial resources that are necessary to provide medical care. Using structure as an indirect measure of the quality of care depends on the nature of its influence on care. Donabedian suggests structure is relevant to quality in that it increases or decreases the probability of good performance. The usefulness of structure as an indicator of the quality of care may be limited by insufficient knowledge about the relationships between structure and performance.

The "process of care" is a set of activities that goes on between practitioners and patients. The quality of that process may be determined by either direct observation or reviewing documentation of the process. Donabedian (1980. p. 79) notes:

> While "process" is the primary object of assessment, the "basis" for the judgment of quality is what is known about the relationship between the characteristics of the medical care process and their consequences to the health and welfare of individuals and society.

Standards for quality of the process of care are normative. They are derived from the science of medicine as well as the ethics and values of society.

The study of "outcomes" is another indirect approach to assessing the quality of care. Donabedian (1980, p.83) uses outcome to mean "a change in a patient's current and future health status that can be attributed to antecedent health care." From his broad definition of health, improvements may be found in the psychological, physical and physiological aspects of patient performance. In an extension of this definition, he includes patient attitudes (including satisfaction), health-related knowledge acquired by the patient, and health-related behavioral change that may be components of current health or contributions to future health.

Figure 2.7 illustrates the fundamental relationship among the three elements that is important in understanding this three-fold approach to quality assessment. This relationship suggests the structural characteristics of the settings where care takes place influence the process of care. Similarly, changes in the process of care influence the effect of health care on health status, or outcome.

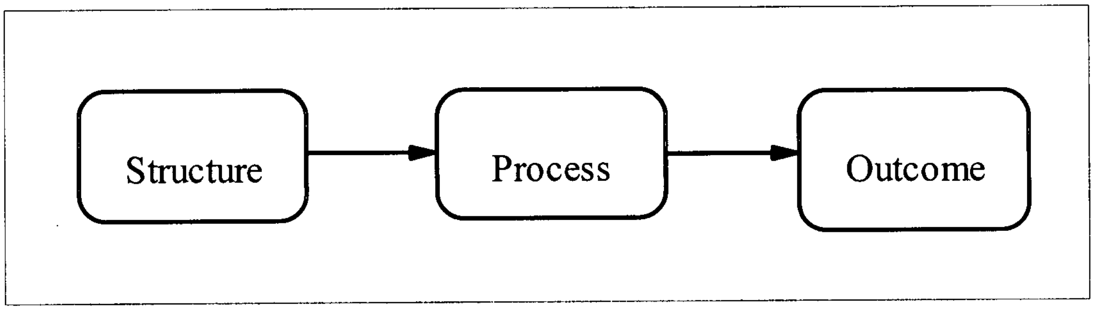

Figure 2.7 - Donabedian's Approach to Quality (Donabedian, 1992)

Donabedian (1980) notes that although his formulation of these elements is based on basic relationships of theoretical and operational significance, many ambiguities remain when one tries to classify specific phenomena exclusively under one of the three headings. This is because "the three-part division is a somewhat arbitrary abstraction from what is, in reality, a succession of less clearly differentiated, but causally related, elements in a chain that probably has many branches. In such a chain, each element is, at least to some extent, a cause of the element that follows, while it is itself caused by the elements that precede it" (Donabedian, 1980, p. 84). The "structure-process-outcome" paradigm is a highly simplified presentation of a complex reality, as Figure 2.8 illustrates.

There are chains of events and even interrelated chains, so as Donabedian (1992, p. 357) points out, it is to some degree arbitrary where one stops and says, "This is an outcome." Sometimes it is not easy to say, "Here structure ends and process begins or process ends and outcome begins." He suggests asking the key question, "In what way have individuals or groups become different?" to help reduce the ambiguity.

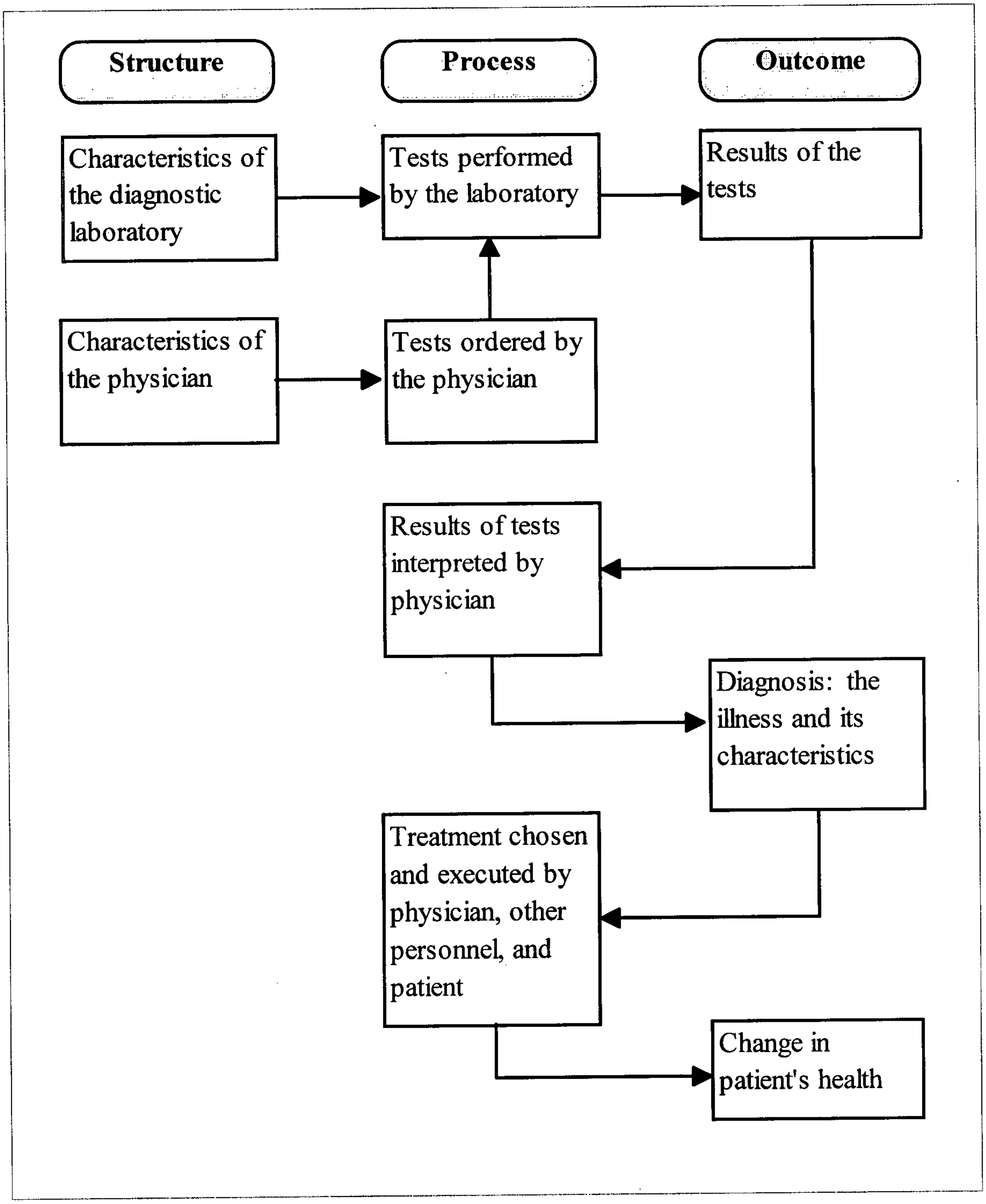

Figure 2.8 - Elements of Structure - Process - Outcome in Diagnosis and Treatment (Donabedian, 1992, p. 358)

Overall, IT is expected to have an impact on the quality of care, but as discussed earlier in this chapter, it is often implemented with disappointing results. Perhaps not surprisingly, a literature review by van der Loo, et al. (1995) revealed that most of the evaluation studies of automated information systems dealt with structure measures and only 15 of 91 studies investigated effects on the outcome of care process. They describe the effect of IT on each of Donabedian's approaches to quality:

a) Structure is the relatively stable characteristics of the settings in which care occurs. The effect of IT on structure may be measured by job satisfaction, user satisfaction, IT performance (that is, previous x-ray films are available), time consumption for personnel and processes.

b) Process is the set of activities that go on within and between health care practitioners and patients (for example, what is actually done in giving and receiving care). Effect of an IT on process may be measured through changes in the user's performance (that is, does the system change the physician's diagnosis?), change in volume of services ordered, number of times the IT has been consulted (in other words, database use).

c) Outcome is the effects of care on the health status of patients and populations, including behavioural changes and satisfaction with care. Effect of an IT on outcome may be measured by whether use of the system has an effect on mortality, the patient's satisfaction with the accessibility of care and the waiting time of patients.

From a socio-technical perspective the evolution of technology and environment produce multi-dimensional impacts. These may occur sequentially or simultaneously because each impact may or may not be a precursor to the other. In Grusec's (1986) evaluation of the adoption and diffusion of Office Automation (OA) in government offices, he describes three levels of impact that emerge over several years:

1. Direct substitution - a new way of performing procedures replaces ones previously done in some other way. Traditional efficiency concepts and measures are applicable because the end "products" are essentially the same whether technology is used or not. Most people can easily see substitutive uses in their own work setting.

2. Proceduralization - events previously performed in non-procedural (rule-governed) or semi-procedural ways are transformed into more procedural ones through use of the computer. Almost immediately the "products" may not be equivalent to their manual counterpart and cannot be compared by counting or other simple measures. Simple cost justification models no longer apply. Users have difficulty envisioning proceduralization without hands-on experience in the work setting. It requires examining tasks that require human judgement and action, and recognizing which things may be matched to computer capability.

3. New capabilities - new capabilities may be radically different from the old or may be something that was entirely possible to do before, but was not done because of the inconvenience or high effort required. There are no easily comparable before and after events that make them much harder to see in advance. Some of the new capabilities imply ways of work or goals that were rejected long ago, if ever contemplated, because they were impossible or extremely difficult to do. In the absence of direct, prolonged and active experience with a computer system, enormous mental, creative effort is needed to try to envisage new capabilities.

Rogers' (1995) identifies three levels of technology transfer (replication, innovation and transformation), which are very similar to Grusec's (1986). In contrast, Austin's (1988) suggests levels of impact that reflect three management visions for IT which are roughly equivalent to the levels described by Zuboff (1988):

1. automate - existing manual tasks and procedures;

2. informate - expand and distribute knowledge created by IT through out the organization in order to change behavior;

3. transform - IT used to change the way the organization works and competes (e.g. order entry from physician's office).

Austin's (1988) view of IT performance differs from either Grusec's (1986) or Rogers' (1995) because impact depends on management expectations. This precludes the unpredictable effects of integrated systems, as well as the diffuse nature of IT impact used across occupational groups and organizational divisions. Over time it also limits the movement of users from one "vision" to another. For example, an order entry system initially used to automate the ordering of lab tests, may later be used to determine what tests are ordered and to develop individual physician order sets.

Researchers in a number of disciplines are investigating the interactive relationship created between the innovation, environment and individual user. These relationships change over time (Walton, 1989), fundamentally changing the organization and what people do (Zuboff, 1988). Unlike earlier innovations, empirical evidence suggests adoption of IT can move beyond diffusion and create a situation of organizational transformation (Orlikowski, 1995).

2.5 Analytic Framework

The study of IT impact in health care generally has assumed a technological or organizational imperative perspective. The technology developed from early financial systems, to stand-alone departmental systems, and then to integrated systems sharing a common patient database (such as a PCIS) that later became technically feasible and organizationally desirable. From these two perspectives the effects of IT on individual users and the organization are thought to be either a result of the technology itself or its application to a problem by managers, developers and implementors. Topics of interest have included training, implementation, productivity, efficiency and decision-making.

A final goal in the evolution of these more sophisticated systems is the CPR, which includes the documentation of patient care. Developers and users of these new sophisticated systems hold high hopes for their potential to change traditional organizational design, intelligence, and decision-making for the better. However, DeSanctis and Poole (1994) point out that a number of questions remain unanswered, such as: "What changes do these systems actually bring to the workplace? What technology impacts should we anticipate, and how can we interpret the changes that we observe?"

The impact of complex systems that are integrated across the organization, can no longer be "controlled" through system selection and training. The technology and its use shape both the IT and organizational change. Apart from the direct effect on operations within one's own department, there is very little known about the relationship between changes in one professional group's work and other groups, or patient outcome. Aside from directly measuring quantitative changes such as increased productivity, no theoretical frameworks have developed to provide the basis for determining a broader concept of impact. The investigation of IT impact in health care can benefit from a socio-technical approach that takes into account the interactive nature of development among users, IT and the organization.

The impact of IT on patient outcomes can be conceptualized through Donabedian's (1988) model of the measurement of quality patient care. To accommodate the expected administrative and cost component of care, this model is modified to include output as a measure of cost effectiveness (Hebert, 1995). Use of a socio-technical perspective also emphasizes that impact is not a static concept, but rather one that develops over time as the user, technology and context change. As discussed in the previous section, Grusec's (1988) model of the three levels of impact reflects this dynamism. To guide the analysis of this study, the combination of these two concepts in a theoretical framework reflects the temporal changes of IT contributions to quality patient care (Figure 2.9).

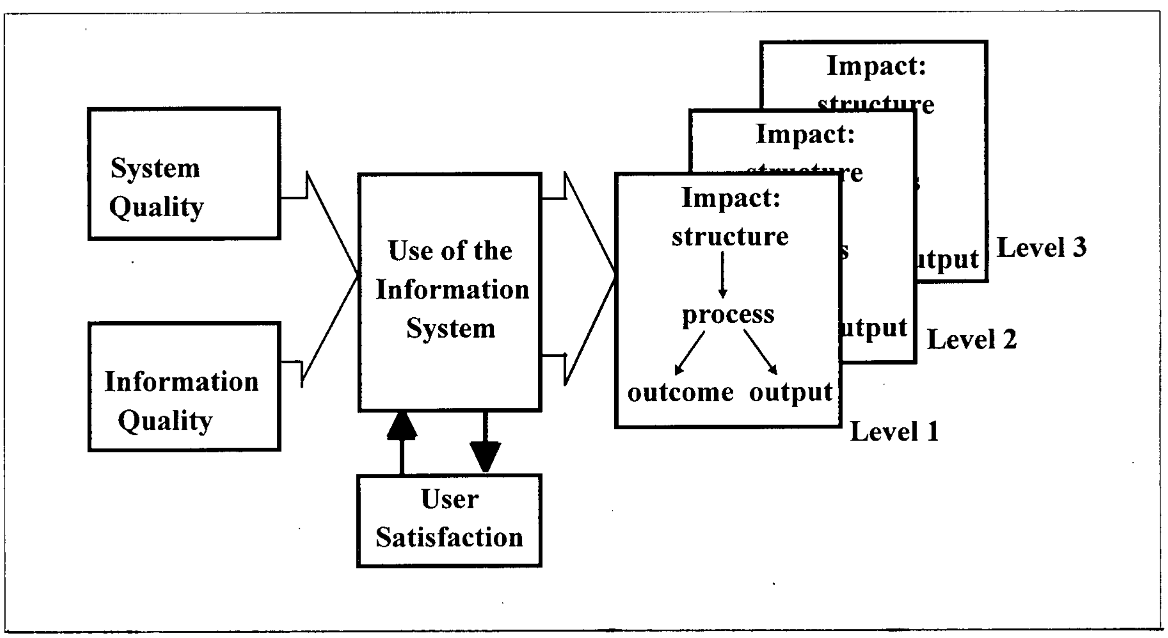

Figure 2.9 - Theoretical Framework (modified from Hebert, 1995, p. 171)

There is ample evidence that DeLone and McLean's success factors are relevant to the study of IT in health care. Very little is known about impact, particularly from a socio-technical perspective. This research study sets out to explore the perceptions of impact of a complex information system held by different health care professional groups. Two specific questions were asked.

Research Questions:

Q1: What, if any, is the perceived difference in impact of PCIS on health care professional groups in hospitals?

Q2: What factors explain such perceived differences in impact between these groups?

The focus of this study is on impact of using IT and not necessarily the factors related to successful systems. Therefore, the analytic framework (Figure 2.10) underlying this investigation is only the portion of the theoretical framework (shown in Figure 2.9) that is directly related to impact.

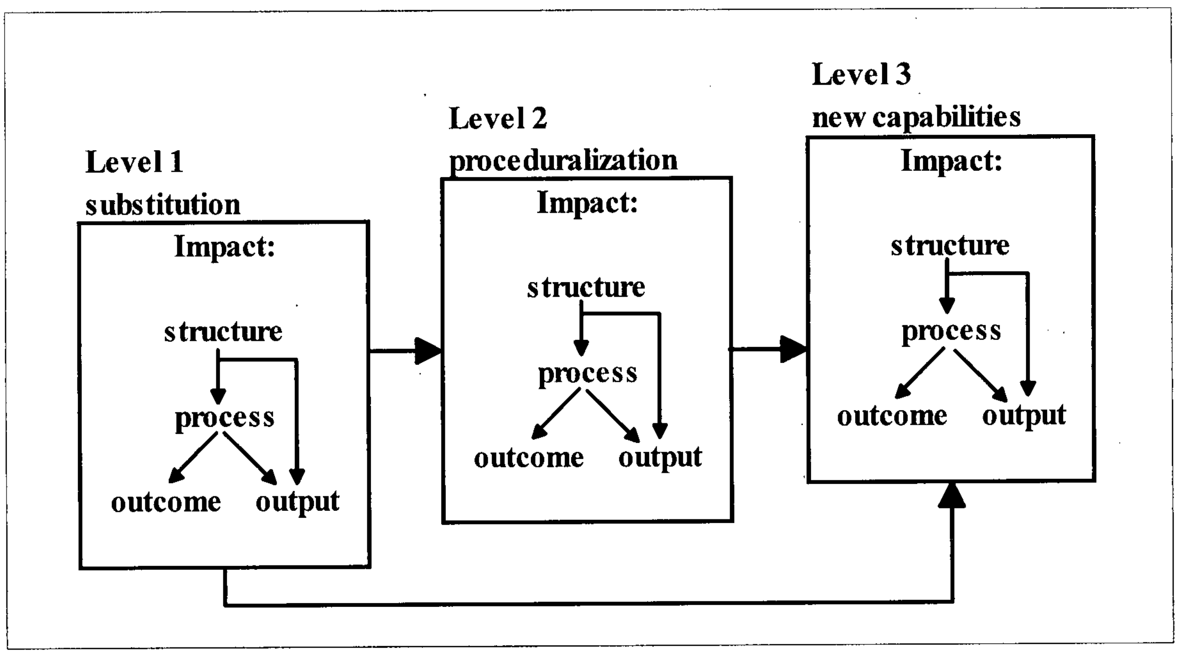

Figure 2.10 - Analytic Framework

The next chapter describes the research methodology, followed by findings for each of the hospitals studied.

Endnotes

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1 The study reported: "Variations in three measures of patient volume were studied: number of patients per month, number of patient days per month, and average length of a patient stay in the hospital. The percentage effects of TMIS on the monthly patient census were separated from the influence of other variables, such as changes in demand conditions, trends in treating patients in hospital outpatient settings, inflationary pressures and controls, and patient diagnostic mix." Original results indicated that nursing services showed a decrease in costs while ancillary services had no significant decline. However, support services showed a significant change in cost and in fact the direction of effect was positive, estimated to be as large as 4.5%. Therefore, to arrive at the reported finding of "decreased cost," nursing and ancillary services were combined under one heading of "medical care departments." It should also be noted that the cost of operating TMIS was excluded from the above analysis and actually was an additional cost to the hospital.

2 See for example: Howell and Higgins (1990); Alavi and Joachimsthaler (1992).

3 Patient specific costing is required for Global Dimension reporting in the MIS Guidelines that were developed as a joint initiative between the Federal and Provincial Ministries of Health and Hospitals. The Guidelines are intended to provide a standardized method to report and compare costs within and across health service facilities.

4 See for example: Lee, et al. (1996); Bolley (1994); Burns (1994); Sheps, Rumanek & Noronha (1994); Massaro (1993); Bergman (1993); Michael, et al. (1990); Peterson, (1990); Siegel, et al. (1987); Young (1987).

Chapter 3 - Research Methodology

3.0 Introduction

The purpose of this study is to investigate how IT affects the worklife of different health care professional groups (including contribution to patient outcomes) and why differences exist. In Chapter 2 a three-level analytical framework is proposed to guide this investigation. Impact is defined in terms of IT's effect on the prime goal of health care, improved patient outcomes. This de-emphasizes expectations of developers and implementors for increased productivity or decreased errors, and focuses on changes in worklife for health care professionals with respect to Donabedian's "quality of care" parameters. A socio-technical perspective is a relatively new approach to IT and change and empirical work is limited. The majority of research and practice based articles report findings related to the implementation process, but do not investigate impact beyond that point.

3.1 The Case Study Approach

The case study approach is used to investigate the research questions. As Yin (1989) points out, this approach contributes uniquely to the knowledge of individual, organizational, social and political phenomena. The rationale for choosing this strategy is inherent in Yin's three conditions that determine research strategy:

- type of research question;
- extent of control an investigator has over actual behavioral events; and

- degree of focus on contemporary versus historical events.

Each research strategy can be used for all three purposes: exploratory, descriptive and explanatory. Questions related to "how" and "why" are more explanatory and lead to the use of case studies, historical studies or experiments as illustrated in Table 3.1. (Surveys and archival analysis are more suited to questions which answer who, what, where, how many and how much.)

Research Strategy	**Control Over Behavioral Events**	**Focus on Contemporary Events**
Case Study	no	yes
History	no	no
Experiment	yes	yes

Table 3.1 - Choice of Research Strategy (Modified from Yin, 1989, p. 17)

A case study approach is preferred in examining contemporary events when relevant behaviors cannot be manipulated. Of equal importance in choosing a case study approach is that the phenomenon and context cannot be clearly separated.

3.2 Case Selection

Researchers often think about "sampling" logic where subjects are randomly selected from a specified population and then results statistically generalized to that population. Multiple case studies use a "replication" logic, where each case is analogous to a single experiment (Yin, 1989). Yin suggests that cases must be carefully selected to either predict similar results (called literal replication), or to produce contrary results, but for predictable reasons (called theoretical replication). The second strategy was chosen for reasons explained below.

Given time and funding limitations, case selection was restricted to British Columbia. A survey conducted by the Ministry of Health in 1993 was used to identify eighteen community-based, acute care hospitals with patient care related computer applications (listed in Appendix A). Extended and continuing care facilities were excluded because their information needs, funding and patient-mix differ substantially from acute care facilities. Teaching hospitals were also excluded from the study because they are relatively few in number, and differ substantially from community hospitals in their size, complexity and access to funding.

The study identified seven hospitals that had invested in a single vendor, hospital-wide integrated system.[1] These hospitals were asked to participate in the study because they provided an opportunity to control for a large proportion of variability that is associated with vendor and system. Five hospitals consented to participate and their IT experience ranged from highly automated, with many modules implemented, to minimal automation. Including all five of these cases reflects Yin's (1989) strategy of "theoretical" replication. The hospitals are comparable on the variables of IT vendor as well as type and size of facility, however differ significantly on the degree of IT implementation.

Many definitions and acronyms exist for the types of IT in health care. A Patient Care Information System (PCIS) is generally considered a subset of a Hospital Information System (HIS). A PCIS includes Patient Care Systems and Clinical Systems as shown in Figure 3.1. The broader classification of HIS includes a variety of financial systems, materiels management and payroll/personnel modules. Only their order of implementation with respect to PCIS are of interest in this study.

Each hospital started investing in IT at different times, but in all cases financial systems were in place before any decision was made to automate patient-care functions. This does not come as a surprise given that health care systems in Canada have been maintained through funding schemes tied directly to the number of "patient days," leading to financial systems being foremost in IT development and implementation. Payroll systems replace expensive outsourcing contracts and can be justified because they reduce outside agency expenses. They are not far behind the financial systems.

Hospitals generally implement Central Patient Index (CPI) and Health Records abstracting systems next. They support the maintenance of accurate patient record information including demographics, admission and discharge dates, diagnosis and procedures. Clinical systems in the Lab, Pharmacy, Radiology and others follow, with order entry, results reporting and patient inquiry implemented last.

The hospitals are arranged on a continuum from highest (1) to lowest (5) degree of PCIS implementation. Each hospital is assigned a number to indicate their relative order with respect to implementation. This ordering is not intended to imply their absolute positions. For example, Hospital 2 is not twice as automated as Hospital 4. The hospitals are referred to by their number through out the rest of this document to remind the reader of the context of their level of implementation as well as to protect the identity of the hospital.

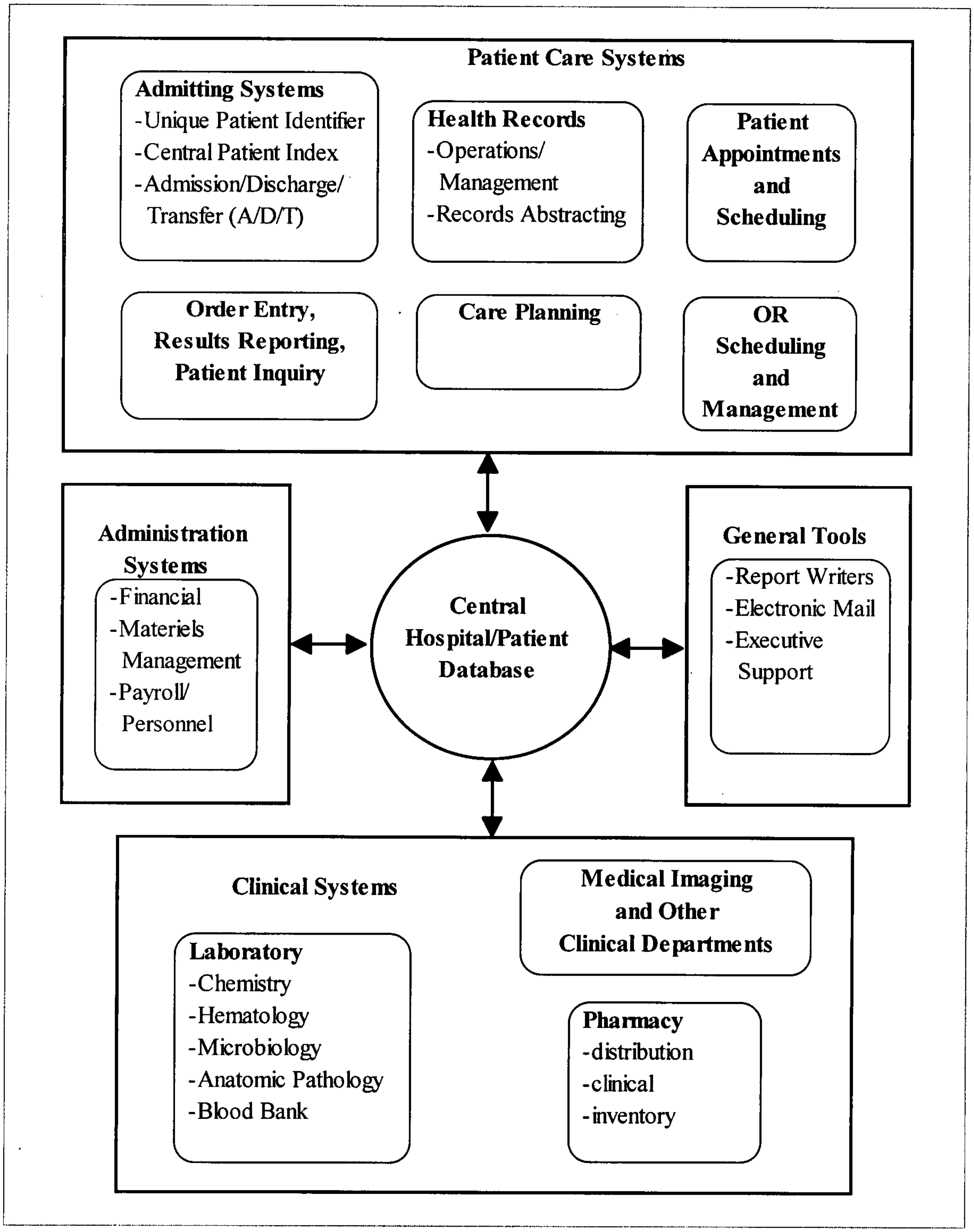

Figure 3.1 - Hospital Information System[2]

Hospital 1 has six years IT experience and the most highly automated PCIS. Hospital 5 is at the other end of the spectrum with the fewest number of integrated systems in place. Table 3.2 summarizes the history of automation in each hospital and generally shows a five year difference between Hospital 1 and Hospital 5. Although Hospitals 2 and 3 began implementing IT before Hospital 1, they introduced XTECH later. (A more detailed description of the IT implementation history at each site is provided in Appendix G.)

3.3 Unit of Analysis

Previous studies focus on a single view of impact from one of the stakeholder groups. This has a narrow scope if all groups are expected to use, and will be affected by, the integrated system. Four groups of health care professionals who are high users and producers of patient information were selected to participate in the study, including laboratory technologists, pharmacists, nurses and physicians. In each hospital these groups were the unit of analysis, although the context of their experience was also important and analyses take individual hospital circumstances into account. In this way each group was a mini-case study embedded within a larger case, which is the hospital.

3.4 Data Collection

In an effort to validate findings, three sources of data were used in the study: multiple interviews with participants, written archival data and observations of IT use.

3.4.1 Participant Selection

Initially the study included five participant groups: four health care professional groups and managers, with four representatives from each group. The managers represented the management perspective in each professional group. Early into the interviews the interviewer discovered responses from the managers with respect to impact of PCIS were better grouped with their respective professional groups.

Participants from each of the four professional groups were selected to represent a range of experience using the PCIS. Criteria for selection in each group included the computer liaison person, a manager and three other people who had a range of experience using the IT (i.e. most, moderate and least). The contact person at each hospital (usually the Manager or Director of the HIS Department) attempted to locate participants who matched these criteria. However, because there was an attempt to schedule all the interviews at each hospital within a single block of time, this meant several potential participants were unavailable. The expectation was that participants had a range of experience, and this was achieved. Appendix E identifies the distribution of participants for each of these categories. In addition, the manager of the HIS Department and/or administrator were included to provide a hospital perspective on the history of PCIS and expectations for impact. Table 3.3 summarizes the numbers of participants in each group.

	Hospitals				
Applications/Modules	**1**	**2**	**3**	**4**	**5**
Administrative Support					
Finance (AR/AP, GL)	1985	1984,1994	1994	199?*	1990
Payroll/Personnel	1987	1994	1994		1990
Payroll/Budgeting	1994				
Materiels Management	1991	1984,1994	1984,1994		
Executive Support System	1992				
Communications					
Internal E-mail/Office Auto.	1990,1995	1994	1994	199?*	1990
External (community links)					1994
Direct Remote Link					1994
Physician Registry	1986	1986,1994		199?*	1994
Patient Care Systems					
Admissions/ADT	1985	1985,1992	1984,1994	199?*	1990
Central Patient Index	1985			199?*	1990
Order Entry	1989	1995		1994	
Results Reporting/inquiry	1994	1993			
Health Records/Abstracting	1989	1986,1992	1984,1994		1990
Medical Dictation	1993				
Booking/Scheduling	1992	1986,1992		1993	1990
Clinical Systems					
Laboratory	1988,1995	1993	1984,1994	1994	
Radiology	1991	1993			
Pharmacy	1988	1992	1984,1994	1985	1984
Dietary		1986	1984		
Documentation/Decision Support					
nurses' notes					
care planning					
patient assessment					1994
physicians' notes					
workload monitoring	1996				
report writer	1987				

Table 3.2 - Summary - IT Implementation in the Study Hospitals by Year
(*Hospital 4 was unable to confirm the exact date of these implementations)

Hospital/ Group	1	2	3	4	5	Total
Nursing	8	4	4	5	4	**25**
Pharmacy	4	3	3	4	3	**17**
Laboratory	4	3	5	4	4	**20**
Medical Staff	3	3	3	3	2	**14**
IS/Others	1	4	3	1	1	**10**
Total	**20**	**17**	**18**	**17**	**14**	**86**

Table 3.3 - Numbers of Participants by Hospital and Group

3.4.2 Interview Guide Development

Semi-structured questions were developed for each of the six success factors identified by DeLone and McLean (1992). Individual impact was expanded to include the six social dimensions related to worklife outlined by Kraemer and Danziger (1990). Further questions were added during the interview to follow up on ideas expressed by the participants. The clarity and face validity of the interview questions were assessed by IT experts in the field from each professional group. These experts were identified through the professional associations for each group and their qualifications are briefly described in Appendix C. With input from these experts the questions were revised and then assessed again through a pilot study with several interviews. A sample interview guide is presented in Appendix D.

3.4.3 Interviews

The author of this thesis conducted eighty-six interviews between February and June of 1995. Each interview lasted approximately one hour and was audio-taped for later transcription. Participants signed a "Consent to Participate" before beginning the interview and were given the option of reviewing the interview transcript. The number of health care professionals in the province is relatively small. It is relatively easy to identify specific individuals given the case selection from community hospitals in British Columbia that have chosen single vendor systems. Participants wanted to be guaranteed their comments would be anonymous within the report for their hospital. For this reason, no specific job titles are used in identifying quotations used in the case descriptions nor are the hospitals referred to by name.

3.4.4 Written Archival Data

Over the course of time that scheduled interviews took place, written documentation and archival material relevant to the adoption and use of the PCIS was reviewed. Appendix F lists the specific documents reviewed. Activities during system selection and up to the present time were included in the time frame examined. This represented different lengths of time for each hospital as they varied in the number of applications in use. A review of these documents proved to be instructive in a number of ways:

- requests for proposals (RFP's) to IT vendors and internal proposals provided information about benefits that different professional groups were expecting from a PCIS.
- minutes of meetings, particularly task forces and steering committees that were struck to manage the PCIS selection and implementation. The membership of these committees represented the initial organizational focus on benefits.
- strategic IS plan review and/or development was usually conducted by outside consultants who all recommended a single vendor strategy.
- hospital newsletters illustrated the degree of IT integration into hospital operations as represented by information about upcoming changes that were reported.

- external correspondence, particularly with the Ministry of Health provided insight into provincial funding limitations and priorities that emphasized cost benefits analysis and financial management.

One set of documents did not provide any additional information. Job descriptions for the three health care professional groups who were employees of the hospital were sought out. They were intended to provide information on one dimension of social impact that is associated with job enhancement, including skill variety and job domain (Kraemer and Danziger, 1990). In four out of the five hospitals, job descriptions had not been updated since before implementation of their PCIS. Most participants indicated the content of their jobs had not changed, but only the method of doing them. Hospital 5 however, had recently undergone significant changes in their organization of work when they moved from a departmental to a program approach. This had major implications for changes in work that were reflected in new job descriptions. While their PCIS supported some of these changes, the job descriptions did not change due to IT implementation.

3.4.5 Observations

Activities and interactions with respect to use of the PCIS were observed over the course of time that interviews were conducted. Notes of each observation were recorded. Observations took place in the departments where the system was being used. This was true for every group except physicians, who were only observed when someone happened to be working at a terminal in the nursing station. In every hospital one participant from each group provided a tour of their work area and made comments about the terminals and their locations. These often related to ease of use and accessibility issues. For example, where terminals had been introduced into an existing work area without ergonomic considerations, a number of problems were created with respect to overcrowding and uncomfortable seating. Overall, IT was difficult to integrate into the workplace due to physical limitations, budget restrictions to make the necessary changes and lack of experience on the part of the users to determine what changes would be needed. On Nursing Units, it was usually relatively easy to install one terminal and printer for the unit secretary to use. As additional system capabilities become available, larger numbers of nurses, physicians and other health care professionals are expected to access terminals in the nursing station. Hand held terminals are being investigated to resolve this to some degree. For the Lab, implementation of PCIS often means having their analyzers on-line. However, in some cases this also means trying to fit an extra terminal on the bench in-between Bunsen burners and other tools. Physicians had the least access in the hospitals, with few terminals and printers (usually in the Doctors' Lounge) that were often poorly maintained. This problem is partly resolved through remote access to the PCIS from their offices and homes.

3.5 Data Analysis

3.5.0 Introduction

The data were analyzed using an interpretative approach (Miles and Huberman, 1994; Denzin and Lincoln, 1994; Yin, 1989). Issues and topics for further investigation were identified through iterative analyses of interviews, transcripts, observation notes and documentation (Orlikowski, 1995a). The initial topics were reviewed and aggregated to arrive at a set of recurring themes. (This process was facilitated through use of a software package, FolioVIEWS®, that is described below.) The data were re-examined and an integrated summary for each group, in all five hospitals, is constructed along the delineated themes. Selected quotations serve to illustrate specific points. An introduction and summary for each hospital provides the context for the analysis. The analytic framework introduced in Chapter 2 is then used to analyze the effect of IT for each group and hospital.

3.5.1 Use of FolioVIEWS®

A textbase manager called FolioVIEWS® 3.1 for Windows was used initially to assist in analysis of the qualitative data, particularly in the process of data reduction. In order to identify participants' perceptions of each topic, the researcher identified a strategy to search the data. FolioVIEWS® automatically indexes every word in the document and this list is available for review. Variations in spelling (such as turn around or turnaround) and derivations of individual search words (such as train, training, trained) can then easily be included in a search.

Keywords in the interview questions were used to develop lists of search words. These lists were expanded to include additional keywords found in participants' responses to the interview questions. For example, when participants were asked whether computers control their work, many equated the concept of control with being better organized. Under the category of Individual Impact, "organize" and "tool" were included in the search for the word "control." Once particular words were located, FolioVIEWS'® hypertext feature for creating jump links between ideas was used to facilitate examination of similarities and differences among transcripts. Segments of interviews containing the search word were then tagged and saved in files for further examination. "Pop-up" windows allowed annotations and memos to be added to the data where needed and document pointers to indicate connections to archival data. Table 3.4 lists the keywords used with FolioVIEWS® software to search the transcripts.

3.6 Issues in Reliability and Validity

Criteria for judging the quality of case study research include aspects of research design (internal and external validity), related to generalizability of the study and measurement issues (validity and reliability), related to whether the instruments and their use capture what they are intended to. (Internal validity is a relevant measure only for explanatory or causal designs.) Steps taken to increase the validity and reliability of this study are discussed below.

3.6.1 External Validity

External validity relates to the analytical generalizability of case study findings, or generalizing particular results to some broader theory (Yin, 1989). This is in contrast to the statistical generalization expected with survey research. Yin's recommendation for a research design based on replication logic, with multiple-case studies, is used in this study to support external validity. It strengthens the precision, validity and stability of the findings (Miles and Huberman, 1994). A range of users in each group across the five hospitals also supports generalization of the findings to other similar user groups in community hospitals.

Information System Quality (themes*)	Information Quality	Use/Usefulness
access, accessible	accurate	acceptance
accessibility	depend (on), dependable	adoption
available, availability	quality	change (use for change sake vs. being useful)
easy to use	time savings	impact (related to use)
simple, simple enough	timeliness	implement, implementation
system selection	timely	learn (to use the computer)
terminal location	turn around time	orientation, password
user friendly		satisfaction, satisfied (with the computer system)
user participation, input, involvement, interests represented		support; train, training;* usage, use, using
		use (technology vs. information)
		usefulness
Individual Impact	**Organizational Impact**	**Patient Benefit/ Care**
accountability*	attitude	allergies
audits	communicate	bed days
benefits (for user)	communication, electronic*	benefits
clinical guidelines	cost, costs	confidentiality
control/organize/tool*	culture	convenience
decisions, decision making*	e-mail, electronic mail*	community
efficiency*	fax	discharge
interaction, social	MIS Guidelines	errors
interpersonal relationships	money	length of stay (LOS)
job content	optical disk, health record	outcome, outcomes
job satisfaction	recruitment, retention	preferences
performance	resource use	safety, safer
productivity*	savings	security
social interaction	success (e.g. administration, HIS support)	waiting time
standards of patient care	support	
standards of practice	utilization	
workload measurement	vision	

Table 3.4 - Keywords Used to Search Transcripts With FolioVIEWS®

Three factors may limit the generalizability of findings in this study:

- The study participants were in community hospitals. This may limit generalizability of the theoretical framework to types of facilities initially eliminated from the study, such as long term care facilities and teaching hospitals;
- The participating hospitals chose a single vendor, integrated IT strategy. Generalizing results of this study to other implementation strategies would be unsupported;
- The organizations participated voluntarily and were more likely to share information about successful change efforts. However, this was balanced by a range of successes in their IT implementation efforts. As well, the two organizations that chose not to participate also demonstrated similar variability in their IT efforts.

3.6.2 Construct Validity

Construct validity is concerned with establishing correct operational measures for the concepts being studied (Yin, 1989). Yin suggests two tactics in case study design that help ensure construct validity: using multiple sources of evidence in a manner that encourages convergent lines of inquiry and having key informants review draft case study reports. Triangulation was used in this study to find convergence among sources of information and different methods of data collection. Three different data collection methods were used, including interviews, documentation review and observation. As well, three or four participants provided multiple sources of information for each group, at each hospital.

A second strategy included eliciting feedback from the participants. They received copies of the original transcripts, as well as draft case study reports. Participants were invited to comment or provide feedback to the researcher by fax, e-mail or telephone. The comments received generally related to inaccuracy of information reported, and these were subsequently corrected. Another strategy used to strengthen construct validity was to have the interview questions reviewed by "content experts." These were representatives from each professional group who were recognized by their peers as having IT expertise in their own professional area.

3.6.3 Reliability

Reliability issues relate to the ability of other investigators to replicate the study. Increasing a study's reliability helps ensure that if later investigators follow the same procedures and conduct the same case study again, they will arrive at the same findings as the original investigator (Miles and Huberman, 1994). Strategies to help ensure this is possible include documenting the procedures used (through a protocol) and data collected (through a database) in the case study (Yin, 1989).

An overall protocol for the multiple-case study design was outlined in the study proposal. A more detailed protocol for data collection was then determined (see section 3.4), and included the development of the interview guide, the process of participant selection and interviews, as well as archival data collection.

A database of the documents examined also assists in replicating the study. An index of document "types" was created before the site visits and documents collected were catalogued accordingly. These are summarized in Appendix F. As well, all interview transcripts were coded and filed by participant and hospital, as the table in Appendix E illustrates.

Creswell (1994) also suggests that the chances of successfully replicating the study are partly related to biases and values of the researcher. In this case the researcher has over twenty years experience in health care IT, management and teaching. This has an indirect, but positive influence on reliability.

3.7 Potential Contribution of the Research Methodology

There are many research approaches that have the potential to shed light on the question of impact of PCIS in health care. The multiple-case study approach is appropriate when the behavioral event cannot be controlled and for new, sophisticated technologies where the impact cannot be predicted. This approach also lends itself to a socio-technical assumption of interactive development between users and technology. A small sample of homogeneous units, coupled with a comprehensive data collection protocol, produced several insights:

- Interviewing participants from four different groups about their use of an integrated system presents a unique opportunity to identify and analyze how the perspectives surrounding the impact of a single information system differ. This goes beyond previous studies that focus on individual users or groups, implementation issues, or impact defined by developers and implementors.
- The value of a multiple-case study approach was demonstrated. While each participant described his or her own unique "story" with respect to impact, similarities among members of a group, and differences among groups, were delineated through analyses of multiple sites.

- Collecting data from several sources including interviews, documentation and observations provided a more complete understanding of impact and the context in which it occurs.

Detailed findings from each case are presented in the next five chapters. Each chapter begins with a brief history of implementation at the hospital, followed by a discussion of the findings for each group and concludes with an overall hospital summary.

Endnotes

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1 Identifying the name of the vendor and their system immediately identifies the hospitals that participated and to some extent, the individual participants. For this reason, the system and vendor are referred to by a pseudonym, XTECH.

2 This illustration is a composite that draws from a variety of XTECH documents.

Chapter 4 - Comparison of Impact Across Groups Within Hospital 1

4.0 Introduction

Twenty interviews were conducted at Hospital 1 from February 22 to 24, 1995 with eight representatives from Nursing, four from Pharmacy, four from the Lab, three from the Medical Staff and one from Hospital Information Services (HIS). They embarked on this integrated information system project in 1985 with a hospital president who was very supportive. Many participants indicate that the vision, knowledge and understanding of the HIS Director enabled them to set a direction and achievable goals for this project. They point to "success after success after success" as important in why they continue to succeed. It has been so contagious that both hospital administration and staff expect IT projects will succeed, both on time and operational. (See Appendix G for more detail on the implementation schedule.) The system is reliable with only occasional unplanned down times.

Potential users in clinical areas were unable to be actively involved in the IT selection process in 1985 because they were not very knowledgeable about the technology. However, they did have opportunities to see vendor demonstrations. XTECH was selected from the limited choices for integrated systems at that time. System selection was initially based on financial needs and finding "a good information system," then later they moved into clinical areas. One benefit of their integrated system is that interpersonal relationships between departments have improved because departments are working on a common project, as this participant explains:

> *I think it's really improved. Personally, I didn't know very many people in other departments, whereas now I know a lot of people in a lot of departments. We have an HIS users' group that is composed of my*

counterparts in all the other modules. So there's Finance, there's Admitting, there's Radiology, Pharmacy, Medical Records, Materials Management, Lab and Nursing.

With respect to the PCIS portion of the project, the Clinical Information Systems (CIS) Coordinator has been instrumental in system development, training and on-going problem solving for the clinical areas such as Nursing, Pharmacy, Laboratory, Radiology and Dietary Services. This role is expanding in a new direction with a project to link community information systems with the hospital system. Physicians also seek out the CIS Coordinator for advice and teaching as there is no official liaison position in Medicine.

Many of the XTECH functions can be performed with four arrow keys, so it is very easy to use and as one user described it: "all you need is one finger and one eye." There is very little typing required and most of the responses can be built in advance so it is simply a matter of selecting the correct response from a list of possible choices. For example, when a patient is being discharged, the user can answer the question, "Discharge To?" by selecting one of the destinations listed in the pop-up window. The fixed choices prevent errors, provide better quality information and all the necessary statistical reports can easily be generated from the data entered.

The current messaging system is also easy to use, once the user understands it. However, they are gearing up for significant changes in their registry system and office automation. Notices are prevalent through-out the organization and trainers have completed their own preparation. They feel the new messaging system they are installing soon is so intuitive that "you could sit someone down and they could almost figure it out for themselves, with look-ups, keys and the entire manual on-line."

4.1 Impact on Laboratory Technologists - Hospital 1

4.1.1 Introduction and History of Computerization in the Laboratory

The Laboratory Information System (LIS) Coordinator was hired in 1988 when they began computerizing the Laboratory. The first lab module included Chemistry and Hematology, two sections of the Lab where the Coordinator had clinical experience. In cooperation with the section heads in these areas, she developed the system dictionaries, which are customer definitions for data, such as patient location, names of tests and ranges for normal results. She was also responsible for training, writing system documentation and developing downtime procedures.

Initially training was conducted in a small computer training room set up outside of the Lab, but it was difficult for people to leave their work stations because everyone was busy. Ongoing training is also important in keeping up with the system changes and to ensure XTECH is being used to its fullest potential. Training is now conducted at work stations in the department during day shift. Evening and night staff come in for a few hours before or after their shifts to learn about new changes and the LIS Coordinator trains them in her office.

Training is important in system success. For the Lab in particular, given the volume and complexity of information to be handled, transferring skills from training into practice was also important. In addition, participants point out that experience using the system is essential. However, sometimes the time required to gain this experience is at a premium because new employees are needed on the job quickly. A perception of "limited training" is related to many of these and other issues, as this lab tech describes:

> *I found the training very limited. We had perhaps an hour, and we're expected to be proficient in it after that hour. The set up here is not a good one. We have a test system and a live system. When we get a new module we go into test system and play with it. The test system does not mimic what you're going to have in live, so you're kind of practicing something you're never going to use. You're practicing baseball and you're going to be playing hockey, you know.*

Initially when the laboratory system was installed, Nursing continued to send manual requisitions to the Lab and these were entered into the computer by Lab personnel. Results were available on-line soon after that. About a year later, order entry became available from the Nursing Units, and the LIS Coordinator worked in conjunction with the CIS Coordinator to train the nurses. Initially the Lab generated "Activity Reports" (one day's results for each patient) and delivered them to the Nursing Units. This quickly proved to be too cumbersome, so the Nursing Units were given the ability to generate these reports themselves, which required additional training.

There has been a constant cycle of change since the initial implementation. New versions of their modules arrive annually that require a couple months of testing, plus updates to the documentation and staff training, before they can be implemented. Changes in the Lab such as their controls (used to standardize the analyzers), normal values (used in reporting results), admitting procedures or financial reporting requirements, also require updating in the system. The Lab is planning to implement three new modules this spring and summer: Histopathology, Microbiology and Blood Bank. They expect this to be a large project. The LIS Coordinator has less clinical experience in these areas, so the section heads will take the XTECH training course and participate more in building the dictionaries and implementation.

In the meantime, until the Histopathology module is implemented, other capabilities of XTECH have been used to routinize the collection and reporting of data in that area.[1]

4.1.2 Use and Impact of PCIS

The laboratory system is easy to use, partly due to local contributions in developing the system. As well, additional information and instructions are available on-line if needed. Every prompt that requires an answer is accompanied by a lookup that lists all the possible answers to choose from. This contributes to results being reported in a consistent way, as this example illustrates:

> *For most of the tests in Chemistry, if it's a non numeric result like an RA or urinalysis, you can actually put in the results they can choose from and so it's really made consistency in reporting. Urine micro is a good example because where you trained determined how you reported epithelials, white cells, red cells or bacteria. You knew what you meant, but you could get five people to do the same urine and they'd all report it slightly different because of the terminology they were used to using. Now it's all consistent because they only have a choice of so many things, so I think that's a good feature.*

However, the feeling that there are too many choices and the questions are repetitive can have the opposite effect of annoying the user and producing information overload, as this participant indicates:

> *There are some things that I don't find particularly easy to use. I think there's too many choices sometimes [on] the menu. When you start on your menu and you've got, I don't know how many categories to choose from and then you go into sub-menus and you've got X number of categories. I think they could hone it down a little bit and give people fewer choices.*

They expected many benefits from the PCIS, particularly in automating manual tasks to increase efficiency and reduce errors (level 1). The Accessioning section of the Lab is responsible for many of these tasks, such as handling specimens and requisitions, and saw implementation of the PCIS introduce many changes into their work. Workload has gone up, rather than down, in one area of Accessioning where additional clerical duties are required to admit outpatients to the PCIS. The information is now more detailed and includes who is responsible for paying the bill.

Prior to the Nursing Units sending orders electronically, paper requisitions were sent to the Lab. The Lab sorted them by unit to organize their specimen collections. When analyses were complete, results were transcribed onto the multi-part requisitions by the lab techs. These were sent back to Accessioning to be separated. Copies were filed and sent to the Nursing Units or doctors' offices. The manual system for ordering lab tests and reporting results is illustrated in Figure 4.1.

With XTECH, Accessioning now prints worksheets and labels for their routine collections at 5:00 and 10:00 a.m. and again at 1:00 p.m. (level 2). The computer organizes the lab tech's work so they do not have to worry about forgetting or missing something because it is on their worksheets. Nursing Units telephone stat and urgent requests to the Lab, and the collection labels print immediately in the Lab when they are ordered. After techs collect the specimens, they are "received" by Accessioning and entered into the computer. The specimens are then distributed to the appropriate sections in the Lab for analysis. The automated process for sending orders to the Lab and receiving results on the Nursing Units is illustrated in Figure 4.2.

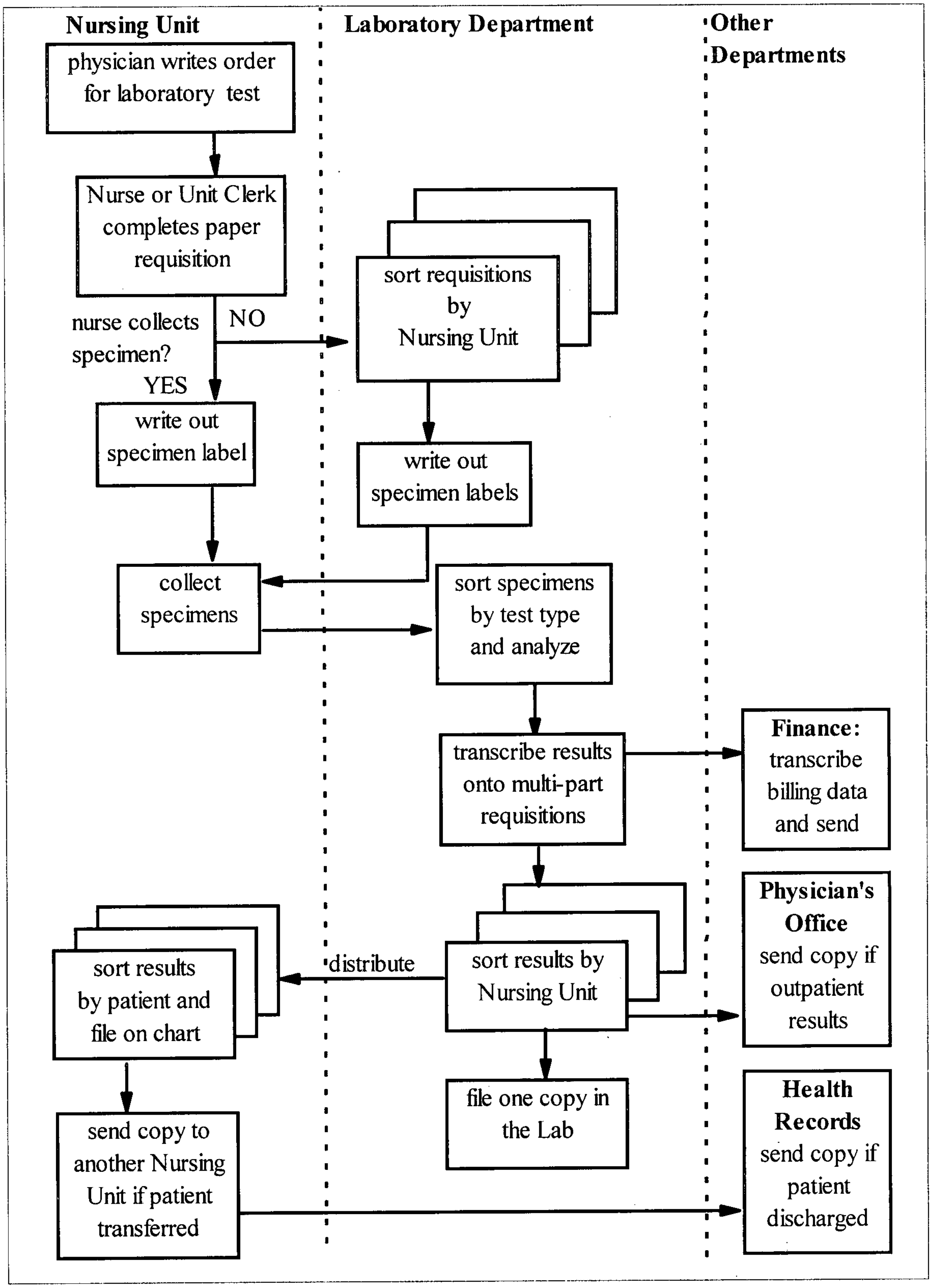
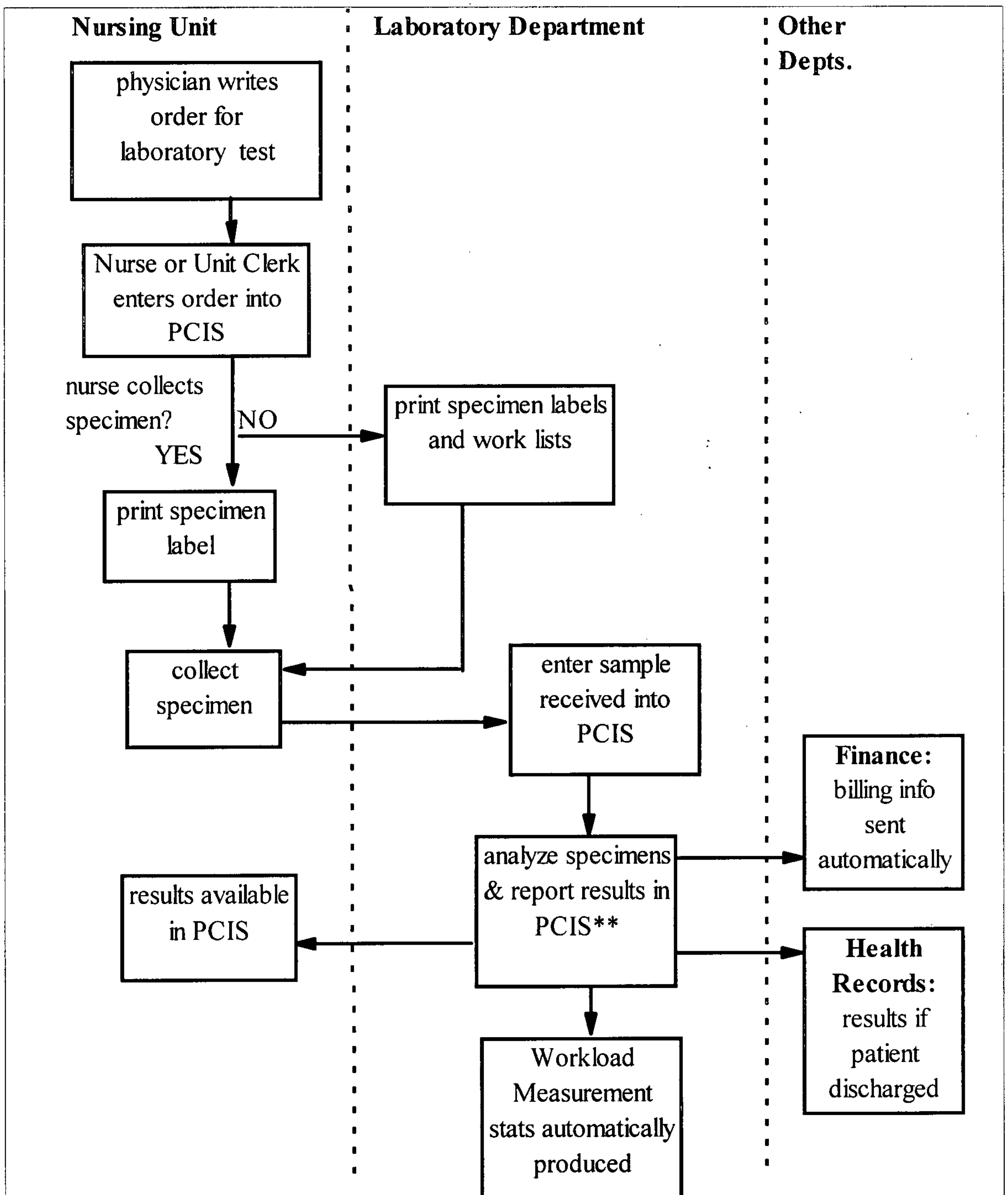


Figure 4.1 - Manual System for Ordering Lab Tests and Reporting Results



Notes:

*Stat & urgent requests print immediately. Accessioning checks these lists to determine if other tests were done earlier and the current test can be added on, or duplicate tests were ordered by mistake.

**this is done directly if the analyzers are on-line

Figure 4.2 - Automated System for Ordering Lab Tests and Reporting Results

The Lab expected many efficiencies as they automated tasks. In the manual system multiple copies of each report had to be separated and sent out, resulting in delays in reporting results. The PCIS is more efficient because as soon as stats and urgents are verified, they automatically print out wherever the patient is. A big advantage is that even if patients happen to be in a temporary location, such as in the Operating Room instead of on the Nursing Unit, it will print in both locations.

Prior to using the PCIS, the Lab was deluged with calls from the Nursing Units asking for information on the status of lab results. The calls were distracting and interrupted the technologists' work, particularly on week-ends. Nursing now has on-line access to this information, which eliminates the calls and improves efficiency in the Lab.. As well, an inquiry feature in the system allows the user some flexibility in choosing one or more test results to trend, over what time period, and whether or not to graph the results. Split screens are also available to examine two sets of results simultaneously.

Accessioning continues to be responsible for keeping track of tests ordered for outpatients, inpatient tests being sent to outside Laboratories for analyses and reporting results to the ordering physician. A disadvantage of their increased efficiency in handling these specimens is the reduced time available for technologists to spend with each patient, as this technologist explains:

> *Because [the computer produces the labels] we don't have to write the names on the tubes, and we have a little bit less time spent with the patient. That's not necessarily good for the patient because as an outpatient, you don't want that patient walking out before you're sure that arm has stopped bleeding. In those few extra moments that it took to write the name on a tube, we'd have a bit of conversation, make that person feel comfortable.*

Other disadvantages of increasing efficiency through the use of IT is the speed work is expected to take place and the resulting effects on job satisfaction. In other industries this is likened to creating an "intellectual assembly line" that results from increased efficiencies, and therefore increased output. Two participants explain this feeling:

> *...It's really hard, but some days I know they feel like a machine. It's like an assembly line. You're just pumping out results. You can't control how much is coming in and how fast it has to go out. It has to go out and it has to be right, so there's that pressure.*

> *...you know it is busier, the machines can put out results faster, bar coding has made things faster. It seems the faster [the machines] work, the faster you work. Plus, when the machines work faster, it means you have extra time so you start doing more specialized things. You're always busy... So every time you speed something up, you just get more work.*

This is related to bar coding specimens that contributes to efficiency and a faster pace of work. Using them may create a distance between users of the IT and the source of their information, the patient. This distance from "reality" is felt when specimens "flip by" and the lab techs lose touch with patients as people, as described here:

> *The only negative thing I've heard about is that before every specimen had a name, whereas now every specimen has a number, so you've sort of lost the personal side of it a little bit. You had John Smith today, and you had John Smith yesterday, and you had John Smith the day before, now you don't even look at names. You're basically interested in the specimen number and the bar code number, so it's sort of dehumanized the system a little bit.*

Aside from the advantages and disadvantages of increased efficiencies, automating tasks is expected to contribute to decreased errors in a number of ways. Manually reporting results introduces the possibility of transcription errors. These are immediately eliminated when the lab instruments are directly interfaced with the computer system. For those instruments not yet interfaced, the results are printed out and must be manually re-entered into the computer.

A false sense of security may be created in thinking that automation eliminates all errors. Errors do not totally disappear, but they expect a decrease in transcription and calculation. There is little data to make comparisons before and after the PCIS, particularly since the types of errors change. Data accuracy remains related to the initial data entry, such as correctly identifying the patient when collecting a specimen, as well as selecting the right patient and the right order from the computer screen. However, some data entry "rules" can be built into the system to ensure the user enters more complete and accurate information. For example, when a blood drug level is ordered the user must enter the time of the last drug dose before the order is sent. (This was also a requirement in the manual system, but users could send the requisition without completing it.)

There is no way of knowing whether errors in reporting occur (such as the wrong test ordered) unless the physician picks it up. Other types of errors, such as those occuring through omission, are reduced through automatically flagging abnormal results (level 2) in the PCIS, and reporting the normal reference range (sex and age adjusted) with each result. In the manual system the lab technologist had to know the normal ranges, or compare the results against standard charts. In addition, delta checks are built into the system so that results are automatically compared to previous results to check for significant differences (level 2). To help assess whether the abnormal results are significant, lab techs have on-line access to results from other lab tests, medication profiles, demographic and diagnostic information. This saves both time and money in the investigation when tests are not repeated unnecessarily.

The PCIS also flags critical values that are outside of the reference range (i.e. abnormal), and also potentially life threatening. The Lab has established a protocol for actions to be taken with these results. It includes repeating the test and phoning the results to the physician (for outpatients), or to the Nursing Unit (for inpatients) and documenting these steps in the computer. The number of such occurrences can be checked through an "Exception Report," which indicates how many results in the last twenty four hours were outside of the normal values and what action was taken, creating a new "visible" accountability for lab techs (level 2).

"Visible" accountability which is created by using the PCIS can also be "short-circuited," by working around the computer requirements. These actions may negate some of the accountability as well as safety features of the system, as this comment illustrates:

> *The computer can be erroneous in that it will say the specimen was collected at such and such a time and received at such and such a time. But sometimes things are pre-received before they're collected, which should be a no-no, but it isn't. ... You have to go by what's in there and that's why it's very important to make sure you put what you actually did rather than what you wished it would be.*

There are a number of examples of "visible" accountability which extend to other professional groups as a result of the changing role of lab technologists. As the computer takes over some of the checking functions which were described earlier, accountability shifts to the originator of the order for ensuring the right tests are ordered, and ordered correctly, as this tech explains:

> *I think that [manual checking] has been the role of the Lab throughout, even before we had the computer system. It was always the Lab who seemed to do*

> *the troubleshooting, to catch the [cases of], "we don't have to do this test because it's already been done," or "I think this looks different, we should talk to somebody about it." I think that the computer system has taken some of that and put it back to the person who originates the order. At least now you can find out who put the order in and actually track that person down. Whereas before they would say there was an order and then an order never came, or "Well, it's in here so you lost it," so it's our fault. But now if it's not in the computer, you didn't put it in. So I think some of that has gotten pushed back to the nursing people, they have a responsibility. It doesn't always just fall to the Lab to pick up the slack or figure out problems.*

"Visible" accountability extends to physicians as well. In the manual system the Lab recorded critical values in a book and situations out of the ordinary were not always easy to see. With the PCIS, lab techs are more aware of clinical decisions because of the availability of information, and therefore physicians' practices become more "visible," as this tech describes:

> *Another benefit I found is that you can look up certain individuals and ask why they are having all these tests done, day after day after day. We're bleeding them dry. With the computer system you can just look and say, "Maybe we'll get a pathologist." Not that we have that kind of clout, but you can get a pathologist involved and pull up the data on that patient and say, "Maybe you can look at this" or "His glucose has been running abnormal for seven days and nothing seems to be [happening] in his treatment. Could you maybe get involved in this?" and I think sometimes we can be beneficial to [the patient's] treatment.*

Aside from "visible" accountability, implementing an integrated PCIS has proven to be both beneficial and detrimental for the Lab. The relationship between Nursing and the Lab has historically not been very positive with each blaming the other for problems. Integration has provided an opportunity to improve relationships between these two departments, with the audit trail providing specific information on where problems occur so these can be addressed directly with the individuals involved.

An integrated system is complex and support from the XTECH vendor has been good. However, major changes take a long time and the company representative seems to be very busy with many clients. Until recently there were some inconsistencies between modules in XTECH, such as keys on the keyboard being defined differently in different modules, which caused problems in the Lab when they were accessing information from other areas such as Pharmacy and Radiology where they were still using an "old programming language" from an earlier version of XTECH. Another related disadvantage of an integrated system is that the combination of old and updated modules may not be the same in any two given hospitals. This means new modules are not tested under all possible conditions, sometimes creating unanticipated problems during implementation.

Integration is also related to issues of confidentiality which are important as more users have access to more information. In the manual system, confidentiality relied on professional ethics and physical evidence of inappropriate access, such as looking through a patient chart. With the PCIS, confidentiality becomes more formally linked to accountability because inappropriate access to information can be monitored electronically through an audit trail. These issues have lead Hospital 1 to recently re-examine their confidentiality policies and the consequences for breaching them.

Issues of efficiency, productivity and integration are related to workload and its measurement. The Laboratory uses a national workload system with a long standing history. When new IT and instrument automation is introduced, the national unit values change (i.e. the time allocated to each task), but these may not always be in synchronization with individual hospital changes. Overall, staff are more productive because they are able to complete additional work with the same number of people. For example, over the last ten years with automation and computerization, there have been no increases in Chemistry and Hematology staff. This has been in spite of the fact that they estimate the number of specimens they are processing has probably doubled, or more, in that time.

Workload statistics are generated monthly per bench, or work station. An average workload per technologist is calculated, but information on individual techs is not available. Individual workload is monitored in a general way through the "outstanding specimen list," which is generated at the end of the day (level 2) to determine what work has not been completed. Questions can then be asked if particular technologists routinely have incomplete work (resulting in another "visible" accountability).

Another activity affecting workload is the Lab technologists' responsibility for monitoring the quality of their testing through ensuring the reliability of their analyzers. Quality Control (QC) measures are established to ensure all the instruments, analyzers and manual methods are working within specified limits. For example, some analyzers are set up to do the necessary calculations (level 2), but initially when they start using those instruments, the calculations are all manually double checked. Abnormal quality control results are flagged for the user who must document in the system if corrective action was taken (creating another new "visible" accountability).

Collecting the data and generating QC graphs has some value in keeping the user closer to the data. In the manual system, QC results were plotted by hand on graphs posted on a big bulletin board, where they could see the results "at a glance." QC was more an integral part of the Lab when everyone was reminded of quality scores, however computer generated reports remove these visual cues and sense of ownership from the environment. The QC reports and graphs are now filed in a binder, making them less accessible, but the lab techs still look up specific information when they work on a particular bench and the QC summaries are posted.

4.1.3 Use and Impact of Electronic Communication

Lab techs had few comments about the use of electronic communication. In situations where communication was "not at it's best," e-mail reduced it even more. They find it is so much easier to just type something in the PCIS, then it is to try and get hold of people by phone. However, the responsibility for reading and responding to the message rests with its receiver, as this participant indicates:

> *And then again, it's there. You let them know. Whether or not they read it is their concern. So that's a weakness of the system, I think. You can use the system too much rather than having some interpersonal skills. [laugh]*

4.1.4 Summary

The impact of PCIS on laboratory technologists at Hospital 1 is summarized in Figure 4.3. It was difficult for lab technologists to have input into the initial decision to select XTECH. However, sections that are implementing their systems now (like Bacteriology and Histopathology) have the benefit of the collective experience of other areas when making decisions. As well, because they are using an integrated system, there are many similarities between the modules.

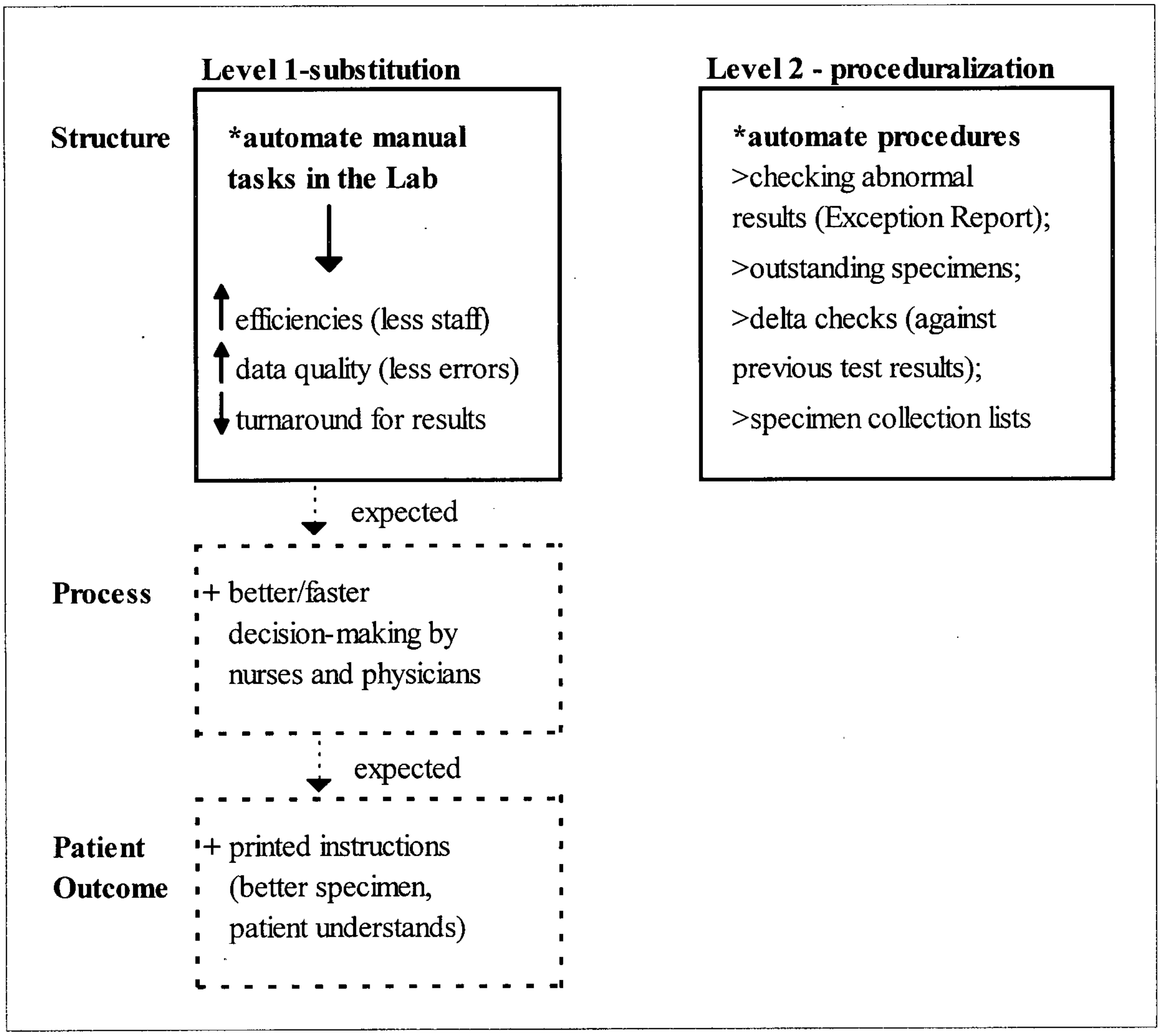


Figure 4.3 - Impact of PCIS on Laboratory Technologists at Hospital 1

Lab techs benefit primarily through automation of manual clerical tasks which result in increased efficiencies (they can do more with less staff), improved data quality through less transcription errors and reduced turnaround of results. The Lab also benefits from the automatic generation of many reports and flagging of abnormal results rather than depending on individual techs identifying the abnormalities. Increased efficiencies can also have negative effects for the Lab such as the increasing pace of work plus creating a distance between the system user and patient.

Lab techs expect physicians, nurses and patients to benefit in a number of ways. Patients should receive better care when physicians can get accurate results the minute they are verified without having to go through a number of phone calls. As well, patients benefit through having instructions print out when certain tests are ordered. These provide details of the test, what to expect and instructions to follow, which help prepare the patient and ensure a better specimen is collected. Lab Manuals which provided information on specimen collection have always been available on the Nursing Units, but were not necessarily easy to access. In the PCIS, all the information is available on-line and can be accessed before preparations are made to collect the specimen, which benefits the patients, nurses and lab techs. Prior to the PCIS being introduced, the Lab estimated that twenty-five percent of the requisitions were erroneous in some way. Since that time they have reduced the error rate to two percent.

4.2 Impact on Nurses - Hospital 1

4.2.1 Introduction and History of Computerization in Nursing

Implementation of XTECH in Nursing has occurred in stages over the last six years. It began with the Admitting module and order entry to the Lab. Electronic communication of orders expanded to other departments such as Dietary, Radiology and Human Resources as they came on-line. All orders, except medications, are entered into the computer. Medication orders continue to be faxed to pharmacy, but they are aware nurses enter orders to pharmacy in a similar hospital using XTECH. Nurses at Hospital 1 have not wanted to start doing this primarily because ward clerks already enter the other orders.

As noted in the hospital introduction, the Clinical Systems Coordinator (CSC) was responsible for PCIS implementation in a number of clinical areas including Nursing. In conjunction with an implementation committee, she organized training and provided active support which was important in the system's success in Nursing. Additional training was provided for key people on the Nursing Units such as head nurses, assistant head nurses and ward clerks, who became the trainers for their own areas. From a Nursing perspective, the PCIS project has been supported by the HIS Department as well as all levels in Nursing. Allocation of money for training and commitment to having staff leave the Nursing Unit for training sessions is indicative of this kind of support from Nursing Administration.

Training began as a specialized task for the Clinical Systems Coordinator, who is located in the HIS Department, but as use of the computer became integrated into operations of the organization, its use became an expectation for employment. Using the computer has become incorporated into hospital orientation and new users receive two four-hour blocks of training time. They come away with a checklist to help them identify where they need additional computer time.

Training has evolved from simply learning to use the computer, to integrating it into the workplace, as this comment illustrates:

> *We put a lot of effort [into training] and we still have special sessions for our ward clerks. We bring them all together [and ask]: "What kinds of things bug you? What kinds of things are you doing that take a lot of time?" because maybe they didn't know there was a different way to do it. We have meetings and on-line minutes are shared with all of them in a [computer] cabinet. I think it's just giving them a little sense of respect... and they love to being able to criticize and say, "I don't like this, and what can we do to make this better?" Having very open and direct lines for communication [is important].*

A "train the trainer" concept has always been used, but with the move toward more specific Nursing applications, more of this responsibility will be taken on by a new Nursing informatics position, assisted by the clinical instructors in Nursing.

4.2.2 Use and Impact of PCIS

Nursing uses the PCIS extensively, and their dependence on the computer is summed up by this statement:

> *"I would say that if a nurse didn't have a password, the nurse would not be able to work because everything the nurse does for ordering is done by computer. So, all of their orders, all their referrals, if a patient's side rail on the bed need to be fixed, it's put into the computer. They don't phone anyone, so any of the phone calls they used to make, it's all done by computer now."*

But not all nurses were keen to use the system at first, as this participant points out:

> *It works a lot better than I thought it would. I was probably just as pessimistic as everybody else when we started. I loved bedside nursing and I was doing general duty when it came in. I sort of resented going to computer school. Like I thought, "Well, the system is fine. What's the problem?" But, now I think it's wonderful and if I went to a hospital that didn't have a system as good, I think I would really miss it.*

Several benefits were expected for Nursing, including improved communication between nursing staff working different shifts, between nurses and physicians and generally in keeping in touch with what is happening. They also expected to spend less time on time consuming, tedious, duplication of handwritten requisitions (level 1). This included elimination of daily recopying of medications on the medication profile and diet orders.

A third benefit was access to on-line information which facilitates efficiency in retrieving results. Stat test results can be returned quickly, in fifteen to twenty minutes. In the OR for example, a frozen section can be sent down to the Lab during surgery, and the results returned before the surgery is complete. Activities on any Nursing Unit are often influenced by many outside variables, such as the Operating Room schedule, and therefore increasing elements of "control" over their environment increases job satisfaction. For example, rather than waiting for the Lab to call with results, the nurse can check on-line for results and avoid delays in getting the patient to the OR.

Another benefit for both patients and nurses is the ability to store allergy information and have it available on subsequent admissions. Eventually a full electronic chart is envisioned as a tool which will provide access to all stored information and eliminate the time spent searching for old charts and information they contain. The electronic chart is close to being a reality now, but it is projected to be another three years before Nursing is computerized and their documentation on-line. They will be able to achieve benefits directly related to nursing care then, as this participant explains:

> *I'm convinced that if we can get through the next three years and get nursing documentation on-line it will be very, very important for the care that we're giving. Right now in Nursing you'll see lots of frustration because everything is still handwritten, whereas if you went into Radiology, they don't pick up a pencil all day long. .... It's all done on-line. Patient checks in, they do what they need to, patient checks out, they've got another patient in there. It does all their finance, billing, statistics, everything. They don't have to do any notes or keep track of anything manually.*

The time freed up through these efficiencies is generally expected to benefit patients because nurses can spend more time at the bedside. But Patient Care Coordinators point to the fact that nurses cannot be found at their nursing stations now because they are busy with patients. Whether this is related to using XTECH, or because of the kind of nurses they are, is not clear. Participants suggest that while the system may free up time, whether that time is spent on patient care is really dependent on the nurse, and those who want to spend extra time with their patients already do. Use of IT does not change a "poor nurse" into a "good one" as these two comments indicate:

> *I've often felt that although they've perhaps intended to save time, I'm not convinced that they do....I mean one could be just as productive in less time but in some ways, and particularly in psychiatry, there is a certain dynamic that actually having the terminal in the nursing station kind of defines and makes that being in there legitimate... so sometimes I wonder whether less time is actually spent with the patient, to be honest.*

> *...logically you would think [that computers free up time to spend with patients] but I think there's a whole other factor. When you have staff that are motivated to spend time with patients, it's because of their own beliefs and just freeing up unmotivated staff doesn't change their motivation.*

Automating clerical tasks through communication of information and requests via computer also creates a new "visible" accountability for completing the request correctly. In the manual system there were many instances of requisitions going astray, being incomplete or in error. It was nearly impossible to follow-up on these problems, resulting in sometimes tense relationships between Nursing and other departments. Now a complete audit trail means the errors can be detected and followed up as this participant describes:

> *I can go back to the days when Nursing was blamed for doing things incorrectly and the whole ward was blamed. For example, "ICU nurses, you're always screwing up when you do things. You're always making mistakes." Whereas now, if one nurse in ICU doesn't understand how to use the tool and that person is having a problem, we can sit down with that person or send them a little note, "Did you know when you do this, this is the problem it causes in the Lab?" So, in a way, it's a quality assurance issue. Then that person learns how to do it properly. Often I would even get a little thank you note back from that person saying, "I didn't know that. Thanks for letting me know." So, it's really building a sense of respect for one another, instead of blaming a whole group of people.*

This "visible" accountability is also stressed in the training for new staff who are told that the system is complex and there will be follow-up on any of these kinds of issues.

The computer is seen as a tool that provides access to information, but making decisions is still the nurse's responsibility. In some ways decision-making may have improved, but a more serious concern was the "data-rich, information-poor" or DRIP syndrome. One nursing manager described her decision-making as "probably better" only because she knew where to find information in the system and was able to retrieve it with the help of reports set up by HIS. Decision-making is also supported through many standardized patient teaching materials which are used to remind nurses of procedures and define standards of care. Participants describe several examples where they have developed systems on XTECH which print these information sheets automatically in response to orders being entered[2,3] (level 2).

The overall lack of computerization in their area is a concern to Nursing. The response from other departments or administrators has been, "Why should we spend $600,000 for a Nursing System?" and IT investment is difficult to sell when returns cannot be measured in dollars saved or revenue generated. This is expected to change with a nursing administrative position now responsible for spearheading IT projects. She is developing proposals to convince senior administrators of the "worth" of these expenditures. The following comment illustrates these issues:

> *Now I find it fascinating that we don't have any qualms about computerizing other departments. Nursing traditionally is always last. Nurses don't even know we're not computerized in the Nursing department. We feed into other modules like Lab and Radiology, but we don't document on the computer system. I think that Nursing is punished usually because it's going to cost more when you're training 900 staff. That's where your big costs are, the training costs. But if you compared that [to other departments]... if it cost you $60,000 to do Radiology and you have 30 staff, what is that per person compared to $600,000 for 900 staff, it's probably about the same. So I think that often we come under a more critical eye because of the dollars attached to it. But on the other hand the Nursing Department spends a third of the*

budget. We have a thirty million dollar budget, so we really should try to gain some efficiency. A 5% efficiency in Nursing is a lot more dollars than a 5% efficiency in a department that has a $100,000 budget...

The Nursing Module is the first step in computerizing Nursing and it is expected within a year. Many nurses feel that the computer could be used in ways to support the work that is uniquely Nursing (level 3), as this participant's comment illustrates:

But, there's so many things out there right now that's wrong in Nursing, that nurses are quite disgruntled. I think one of the things we haven't done in the past, is provide nurses with the right kind of tools or systems to do their work. We haven't valued that or seriously looked at that. We've just sort of said, "Go out there and do it." Nursing seems very task oriented to me right now. We need to step back and look at the big picture, look at the patient as a whole, what's the most appropriate thing to do for the patient instead of getting our cart and starting down the hallway...

There are many decisions to be made with respect to implementing computer programs for Nursing due to the highly integrated nature of the information they use as illustrated in Figure 4.4. Demonstrations of automated versus manual charting have highlighted the expected reduction in errors, which is an appealing feature to these prospective users.

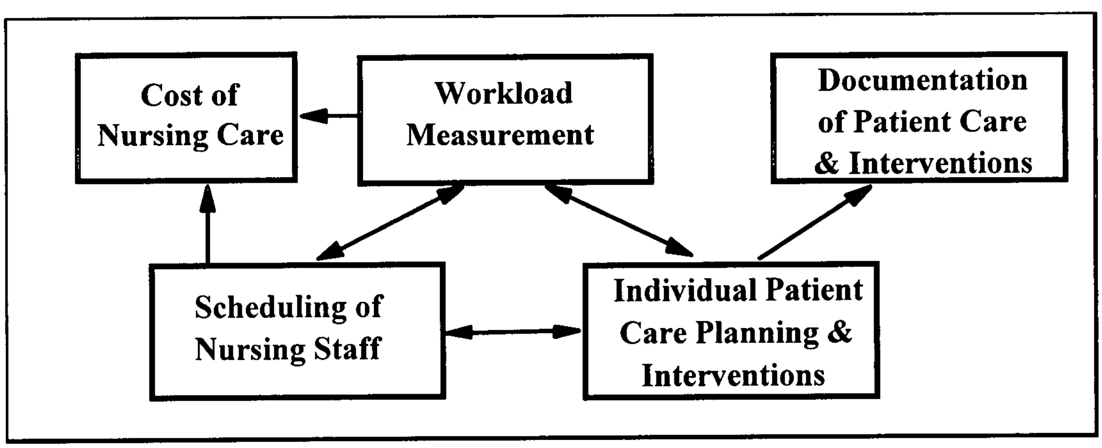


Figure 4.4 - Relationship of Information Systems in Nursing

Documenting nursing care using bedside terminals is another consideration in implementing the Nursing Module. As with many technologies, it is easy to focus on where the terminals will be located, their size, convenience and user friendliness without having clear expectations as to how their use will affect patient care or patient outcomes. Bedside terminals are expected to provide nurses the opportunity to enter their documentation at the bedside as activities and tasks are completed, rather than waiting until the end of the shift and documenting care from notes kept on slips of paper. Anecdotal evidence from managers suggests that staff report staying overtime to finish charting, which is expected to be eliminated with bedside charting. However, many factors contribute to documentation being left until the end of the shift, for example, inefficiencies during the shift, staffing levels and unexpected events, which bedside terminals will not affect.

In preparation for documenting care on-line, the Nursing Department has started revising their manual documentation system in order to streamline it and facilitate transition to automation. While it is difficult to document changes in time spent on documentation, a "before-and-after" study was done to evaluate how the revisions changed the content of the documentation. They found the information to be more relevant and concise.

On-line documentation also opens up other possibilities for multidisciplinary charting. The single, physical location of the paper chart limits the success of this concept in a manual system. For example, a changing program focus in psychiatry from inpatient to outpatient, coupled with no regular ward clerks, provided an incentive for this area to develop an on-line chart. In this case, the patient and nurse establish goals which are recorded on-line and then are accessible to the social workers and physicians. At this time physicians' orders are not recorded directly on this chart.

Nursing is about to purchase a Workload Measurement System which will interface with the Nursing Module. The automated scheduling system already in place is a stand alone system, but there is some potential to link workload with scheduling. Both nurses and managers benefit through another related ability to enter human resources information into the computer. Nurses can make requests for leaves, overtime pay or vacation time, which are authorized by the manager. All the departments that need to be notified, such as payroll and scheduling, are automatically notified at one time.

The nursing managers use the system extensively for writing reports, determining trends in data (such as comparing budgets, supplies and patient census in materials management) and program analysis (comparing patient census, patient populations and diagnosis). Simply automating the recording of data previously kept in log books makes it easier to search for information and identify trends. For example, every surgical case was recorded in the OR log book. Now they are entered once into a database, and the information used multiple times from there. However, they still experience a few problems with the flexibility of XTECH in being able to collect the statistics to generate the necessary reports. This stems, in part, from the fact that the vendor is American, and the reports required for the provincial government use different patient classifications than those available in XTECH.

4.2.3 Use and Impact of Electronic Communication

Many nurses use electronic mail (e-mail) extensively and check their messages daily when they are working. Patient Care Coordinators take advantage of this by communicating changes on their units to all staff, as well as routinely forwarding policy and procedure changes. While the computer manuals are on-line, Nursing is just beginning to use the XTECH capabilities for accessing their many other manuals electronically (level 2).

With shift work and the large number of employees each nursing manager is responsible for, sometimes they do not see each other for long periods of time. In spite of that, decision-making can become more participatory because all staff can easily be contacted for their input. In the same way, Patient Care Educators are able to develop more materials quickly and inexpensively using XTECH, as well as work collaboratively with staff, physicians and managers to develop them. E-mail also makes it easy to follow-up on potential problems, as this manager comments:

> *You can say to somebody, "I understand you had a problem last night on your shift. Can you leave me a message about the details of Mrs. So and So's care?" or whatever instead of trying to wait and find out when you next can connect with them. You can already start some data gathering or whatever you want to be doing on this particular problem.*

A change noted with electronic communication is that intended receivers become accountable for reading their message in a very direct way because an "acknowledgment" can be built into the message. When messages were written in the communication book, the onus remained on the sender to retrieve the book and check that everyone had read the message. Now the onus is on the receiver to open the message and acknowledge its receipt. The following comment illustrates this point:

> *One of my coordinators doesn't check in and read her messages which is what normally other people do. So yesterday, for example, she didn't come to the portfolio meeting. She didn't come to the meeting because she did not read her message, but the message I sent was a reminder of the schedule that we set up in December for the next six months and so all along there she's missed the communication.*

There is a concern that e-mail will create a loss of face to face communication, but this is balanced by the efficiency of getting the same information out to such a large group of people. (Problems that need to be addressed on a one-to-one basis can still be handled that way.) Everybody interprets messages differently and this may still happen with e-mail, but at least the message is consistent. This comment extends to positive or negative messages which can be sent out simultaneously to a much wider audience. As one participant points out, the effect of positive comments such as, "you are doing a great job" may not balance the effect of wide spread negative comments. Electronic communication likely reinforces previous communication patterns, as this participant indicates:

> *Well, theoretically [the computer would affect social interaction]. But again, it's only as good as what goes in, so if people aren't communicating assertively one to one, they're certainly not going to on the computer either.*

Requests for information or services received via e-mail are seen as higher quality than verbal requests received in the hallway or cafeteria. The added information often provided electronically saves a lot of time in understanding the request. Electronic requests are also seen as superior to voice mail. Although the receiver can listen to the message several times, e-mail offers the opportunity to see it in writing, take a hard copy if necessary and mull it over before responding. Another added advantage of using e-mail is the reduction in filing cabinets needed. As users have become more sophisticated in their use of the system, they no longer need to keep printed copies of everything, "it's just in the computer."

4.2.4 Summary

The impact of PCIS on nurses at Hospital 1 is summarized in Figure 4.5. Nursing's coordination role means many of their communication tasks have been computerized in order to facilitate systems in other departments. For example, the clerical tasks of sending orders and receiving results is well developed. Within the last year Nursing has begun to realize how far behind in automation they are with respect to the rest of the hospital. They expect changes in this direction through their plans for implementing a Nursing System and hiring a nursing systems coordinator.

With integrated systems, Nursing is at the centre of many systems and must manage expectations in a new way. So many new ways of doing things are possible, but may not be practical or feasible. They have to learn to assess the cost in time and effort for developing new applications and training to use the technology in a new way. This is highlighted in a physician's request to have Nursing print forms for special types of assessments, which would mean 900 nurses would need to learn how to do this - an exercise not practical or cost effective.

The shift to working with the community is a new area which was not initially anticipated for development by the HIS Department (level 3). Historically hospital nurses think primarily about care within the walls of the hospital. Although they are aware of the need for public and mental health services, these seem to be completely separate from acute care. Extending the PCIS into the community opens up that window to see "we're only just a little piece of someone's life and they need a whole continuum of care. When somebody drops into the hospital for a week, two weeks, three weeks, a month, there is still an entire continuum out there." Linkages with the community may become easier and perhaps more effective with the extension of their PCIS (one of their current projects), and provide an opportunity to look more globally at coordination of care.

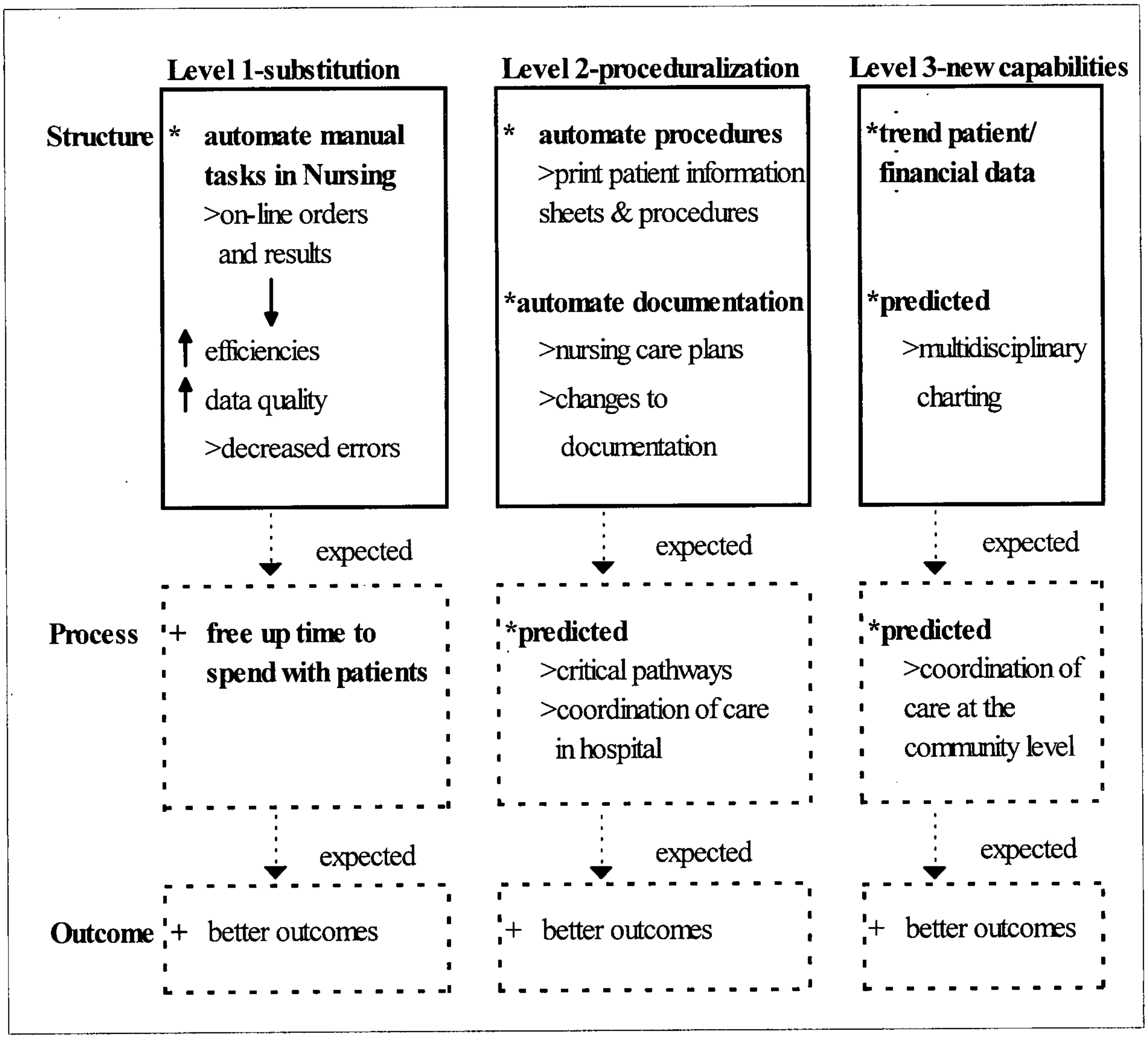


Figure 4.5 - Impact of PCIS on Nurses at Hospital 1

4.3 Impact on Pharmacists - Hospital 1

4.3.1 Introduction and History of Computerization in Pharmacy

It seemed to pharmacists that the selection of XTECH was based on decisions for IT in non-clinical areas, as this pharmacist points out:

> *I think the decision was made for what system we would go to based mostly on financials, medical records and admitting. I think the [HIS Director] was part of the group who made that decision, but I don't think the clinical*

components were as important in making the decision as the financial component, especially at that time.

A supervisor in Pharmacy was responsible for implementing the computer system in their department, a process that began in May 1988. Initially they automated the dispensary and that was the focus of attention for two weeks while the "bugs were ironed out." They soon realized if they did not enter orders correctly, the computer did not handle them correctly. Intravenous solutions (IV's) were added next and they went a lot faster because there were not as many exceptions. In August of that same year they began implementing the inventory portion of the system.

One pharmacist describes XTECH as "usable, flexible and continuously seeing improvements," although this view is not shared by all participants. The system is easy to use, but pharmacists require a little bit of training in order to enter the orders correctly. New pharmacists receive a four week orientation, most of which is spent learning how the Pharmacy Department operates. This includes a day and a half orientation to using the computer that they spread out over the four weeks. Training is a little bit frustrating for people who come with experience using different systems because they have to re-learn their keystrokes. For all users, the hardest part of learning to use the system is understanding how what pharmacists enter affects administration of medications by nurses. If orders are not entered correctly, they print on the Medication Administration Record (MAR) in a way that nurses have trouble understanding them. Ongoing training continues to be available and staff are notified electronically when these sessions are being offered.

XTECH is used extensively in Pharmacy, with approximately twelve terminals and four printers available. Terminals are conveniently located in the dispensary, an overflow work room, offices (two supervisors, the director and a drug utilization specialist), technicians' work area, IV room and clinical area. Pharmacists can also access the information they need from any terminal located on the Nursing Units.

One frustration with XTECH that pharmacists have identified is the difficulty in getting changes made to the system. Areas Pharmacy identifies as needing improvements take a lot of time and money to change. A majority of the pharmacy module users in hospitals across Canada and the United States must agree to any major changes and then it takes another two or three years before these changes actually become part of the system. Unlike other hospitals that have modified the XTECH system "beyond recognition," the Pharmacy Department has only made minor changes in order to avoid additional problems created when they implement system upgrades.

4.3.2 Use and Impact of PCIS

Pharmacists expected the system to provide benefits in automating many of their manual tasks such as producing labels, resulting in less errors and higher productivity. In addition, they expected to be relieved of tedious tasks such as calculating workload statistics (that requires counting the number of IV's and dispensary items processed), as well as producing reports on drug usage. These changes were expected to result in better quality of medication therapy.

Pharmacy could not go back to the manual system because their workload has increased dramatically over the last few years. They have also gotten involved in more programs and services, many of which could not be done manually (level 3). A computer downtime for more than several hours quickly makes them realize how dependent they are on the computer, as this comment about increasing volumes of work indicates:

> *We did IV admixture before we had the computer, but the work on it has increased tremendously. What we could cope with under a manual system, we couldn't cope with now without a computer system. Manually we used to do maybe 100, 150 IV's a day. Well right now, we're in the area of between 400 and 500 IV's a day. So, if you had to sit down and manually start keeping track of that, preparing all the labels, you wouldn't be able to cope.*

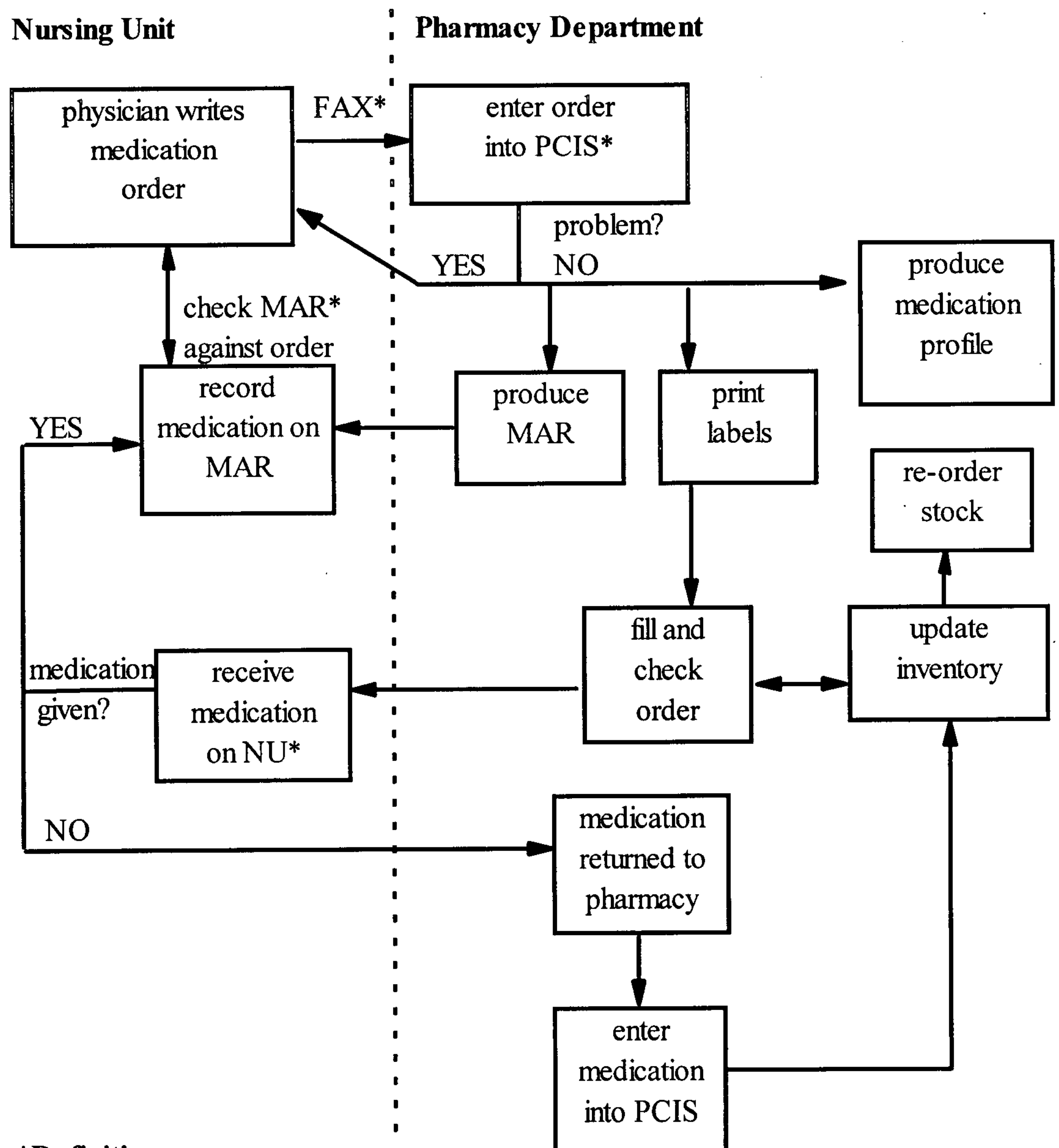
In the manual system Pharmacy primarily kept track of the medication orders they were responsible for dispensing. With introduction of the pharmacy module, they made the decision to enter all medication orders into the system, whether Pharmacy dispensed them or not. Initially this required an increased number of staff. Since then staffing levels have stayed the same, although the computer enables them to operate additional programs, such as IV admixture and unit dose. For example, the IV Admixture Program was also started early in 1988, and Pharmacy staff began to fill intravenous (IV) drug orders based on information supplied by Nursing. Relieved of this duty, nurses were expected to have more time for patients, and pharmacists could focus more on drug therapy. In addition, IV drug orders were filled under sterile conditions and underwent several checks, eliminating up to seventy-five percent of potential errors.

In the October (1992) Hospital Newsletter, the introduction of a unit dose drug distribution system was announced. The Pharmacy Director commented on how the computer supported these types of initiatives that reflected a new era in Pharmacy. They expected many of the same benefits the IV Admixture service demonstrated. Because the computer system was already in place, they were able to identify features of a unit dose system that would be beneficial and then how XTECH could support these. This increased automation of the dispensing process was also expected to allow pharmacists to increase their presence on the wards in order to consult with physicians, attend patient care rounds and enter orders directly into the computer.

Automating tasks is expected to provide benefits through increasing efficiencies and productivity. However, the nature of these increases is not easy to evaluate as a number of changes have occurred through out the distribution process. This process is illustrated in Figure 4.6. In the manual system, technicians typed up labels for drugs to be dispensed. Pharmacists decanted the drugs and checked their labels against the original order. Information typed on the labels was simple and allergy checks were made if the medication order sheet listed allergies. Their automated system (in combination with unit dose drug distribution) is more time consuming and elaborate, but they also have more information available. This has produced changes in the work of both pharmacists and technicians, as this pharmacist explains:

> *We [pharmacists] do all the order entry. The technicians also use it for their ATC machine. ... They go in the computer and they do all their debiting and crediting and run their lists. So they use it quite often as well, to do labels and... But, you'll see a pharmacist at the computer probably more often, like we just sit there and basically type all day long.*

One benefit for pharmacists when they enter all the orders is that they automatically receive information back on drug allergies, drug interactions or orders for drugs in the same drug class. Technicians use the computer to run a list of medications due. They use the ATC machine[4] to produce strips of medications needed for twenty four hours for most of the orders and collect the remainder by hand. Initially pharmacists check the medications against the original order and on subsequent refills they check them against the medication profile. Any doses not used on the Nursing Units are returned to Pharmacy and technicians enter them back into the computer as “credits.



***Definitions**
PCIS = Patient Care Information System
MAR = Medication Administration Record
NU = Nursing Unit
FAX = facsimile transmission

Figure 4.6 - Medication Order and Distribution Process

In this system more information is entered, but to their advantage, the same information can be accurately reproduced in a variety of formats for different users. For example, medication orders are used to produce MAR's which are used by nurses; pharmacy technicians use the same information to prepare their unit dose lists; and pharmacists use the information for their patient medication profiles and medication lists for patient teaching purposes.

Another benefit for Pharmacy is the increased quality of medication therapy, including appropriateness of drugs ordered. However, it is difficult to make comparsions with the manual system because they cannot determine the number of drug interactions that occurred because the pharmacist was unaware the patient was on a particular medication. With XTECH, drug interactions are displayed during order entry and the pharmacist decides if they are significant for that patient, then either responds to the warning or overrides it. Pharmacy does not specifically keep track of how often this happens, or the consequences of pharmacists' decisions in this area.

Increased quality also includes reduced medication errors that were expected as a result of both unit dose and computer order entry. One year after unit dose was introduced, an article in the Hospital Newsletter (October 1993) noted that errors and drug wastage were substantially reduced. The decrease is also related to the use of an integrated hospital system because Pharmacy has access to the most up-to-date information with respect to patient location and lab results.[5] Consistent information also helps to reduce errors, such as entering allergies once and displaying them whenever medications are entered. There are also less transcription errors and interpretation of handwriting when using computer generated labels and worksheets. However, Pharmacy still depends on the prompt action of Nursing Units in faxing down the original orders, which may result in errors related to delays in processing.

Errors decreased initially, but Nursing has recently expressed a concern that too many errors in order entry are again occurring and translating into administration errors on the Nursing Unit. Pharmacy is currently monitoring the accuracy of order entry and the consequences of errors. Nurses are also expected to take responsibility for accuracy by double checking the MAR's at midnight to ensure medications have been entered correctly. However, the "visible" accountability remains with Pharmacy.

The quality of medication therapy is related to the clinical role of pharmacists. Although Pharmacy does not have a formalized clinical program at Hospital 1, they are in the process of making changes in the department to free up pharmacists' time so they are able to be on the Nursing Units more, interacting with nurses and physicians. Pharmacists' clinical decision-making is facilitated by having a lot more information at their fingertips and having more confidence in that information. However, quality of the information retrieved is only as good as what is entered, as well as the individual user's ability to organize their material in the computer. If the information is not readily available from the pharmacy module, two report writers in the system provide enough flexibility to retrieve what is needed. Many pharmacists are quick to point out, however, that decision-making is still dependent on the pharmacist's individual skills and knowledge.

Reports that facilitate clinical decision-making for pharmacists can now be generated automatically or on demand. For example, one clinical program that is now possible is the "IV to Oral Stepdown Therapy." Pharmacists monitor at least four different drugs that were chosen because of their cost or possible toxicity. After three days of IV therapy with any of these drugs, Pharmacy runs a report to determine whether physicians have made this change. They generate other reports including chemotherapy patients who are not registered with the Cancer Agency and patients taking drugs which could potentially cause problems like renal failure or need dosage adjustments such as Gentamycin.

This type of reporting capability is useful in other areas such as drug utilization review. One pharmacist is designated this responsibility and he routinely generates reports that identify the top number of drugs purchased, their costs, comparisons to previous year, and drugs ordered by physician. Outside of making an "educated guess," it was difficult to retrospectively collect this information in the manual system. The new information produced creates a "visible" accountability for physicians that did not exist before. It can be used in a general way to educate them about costs of different therapies as well as to modify individual ordering practices. The can also recommend lower cost alternatives to physicians who are using expensive drugs.

Pharmacy is evaluating a new "satellite" approach to providing clinical services by having pharmacists assigned to specific Nursing Units. They make rounds to those units and enter medication orders directly into the system, the label prints in Pharmacy and the drug is sent up to the Nursing Unit. Use of a PCIS makes this concept feasible (level 3), as this pharmacist describes:

> *It's a concept in Pharmacy that we would prefer to see, where the pharmacists are out in the satellites. They have more direct contact with who our customers are - the nursing staff, the physicians, the patients, our fellow staff members. I think being right there in one-to-one contact is sort of the intent of moving to the satellites. The computer system in itself happens to be flexible enough to accommodate that.*

One of the other clinical duties that pharmacists are engaged in is patient teaching. They provide patients with information about their medications while they are in hospital as well as producing customized patient teaching materials to assist patients in safely taking their medications at home (level 1).

The very characteristics of computers that provide benefits of increased productivity and data quality, decision-support and access to information are the ones that also contribute to dissatisfaction, particularly for knowledge workers who are used to "relying on their brains." Pharmacists feel they are not required to think about activities and information entered because the computer does that for them by providing drug interaction and allergy checks, as these comments indicate:

> *It's just the volume of work and you can process it twice as quick. But then it's got it's drawbacks too, because that's all you do is just processing. It's just like a cashier at the grocery store. You just push the products right through and sometimes that's all you feel like you're doing. You're not really using, quote/unquote your brains. Although you're still looking at the profile and checking for interactions, but you can't know the whole story by sitting at the computer...*
>
> *I enjoy having interactions with nurses and patients and doctors. You're kind of limited when you're the one person who is designated to sit in front of the computer and answer the phone. But, I think that's just a combination of the volume, the work and... The computer does it all for you so you don't need to go out and do all these things, which is convenient. But at the same time you probably miss out on it a little bit.*

Productivity increases in the sense that more orders can be processed with fewer staff. This happens partly because efficiency is accomplished by separating and streamlining tasks, thereby reducing the flexibility in each job. In other industries this is called "an intellectual assembly line." It can have a negative effect on job satisfaction as pharmacists see themselves sitting behind a computer terminal all day. The separation of tasks also moves pharmacists away from the reality of patients, as the pharmacist entering orders may identify specific concerns, but another person is responsible for following them up.

The effect of computer use on job satisfaction varies depending on the emphasis pharmacists place on the dispensing, distribution or clinical aspects of their jobs. Some pharmacists feel their prime responsibility is in dispensing and distribution functions, in other words, "to get the right drug to the right patient at the right time." Therefore, if patients do not receive the right drug, there is no point in conducting clinical investigations to determine whether or not their kidney functions will be affected by the drug. However, other pharmacists feel their focus should be on clinical work, and expect technicians to be responsible for distribution. For these pharmacists, use of the computer, and an increased emphasis on order entry, may decrease job satisfaction. Since pharmacists rotate through all the duty areas, such as dispensary, IV preparation and clinical follow-up, job satisfaction on any one day may be more reflective of the match between philosophy and the task at hand, than use of the computer to do the task.

Use of an integrated system introduces structure into the workday that is sometimes seen as the computer system "controlling their work." For example, certain tasks must be done at specified times, such as running the refill list and dispensing schedules, as this pharmacist explains:

> *If it's 3:30 in the afternoon you have to be aware of the time and know there's a refill list that has to be run. You have to be a little bit more cognizant of the time of day and the things that the computer needs to have done in order to make the system work.... If you don't run that list by 3:30, then you get the next day's workload coming off. ... This causes problems for the people who are working in that area the next day because the list is not up to date.*

4.3.3 Use and Impact of Electronic Communication

The messaging system is used extensively in Pharmacy. Communication has been a key system benefit because staff pharmacists and technicians work extended schedules and may be away for up to five days at a time. They are able to leave messages for someone they will not see for four or five days, which helps provide continuity in their patient follow-up or programs. While it takes away from personal communication, it is a little more reliable than messages passed by word of mouth. They also send messages to the entire group, which is also beneficial when staff work shifts. Pharmacists see benefits in using electronic communication between their department and Nursing Units because IT reduces phone calls that cause distractions and interruptions in their work.

4.3.4 Summary

Impact of PCIS on pharmacists at Hospital 1 is summarized in Figure 4.7. Medication orders continue to be faxed from the Nursing Unit to Pharmacy, creating increased legibility problems, a time lag between when orders are written and processed and the potential for misdirected or lost faxes. This method of communication bypasses an accountability loop because there is no "paper trail" with respect to who sent and received the order, time it was sent, received or filled. Their trial of satellite pharmacies may alleviate some of this because pharmacists enter orders directly from the original order on the Nursing Unit. They expect to benefit primarily from the efficiencies gained through automating clerical tasks (label production, MAR's and medication profiles) resulting in reduced transcription errors, more legible and complete records.

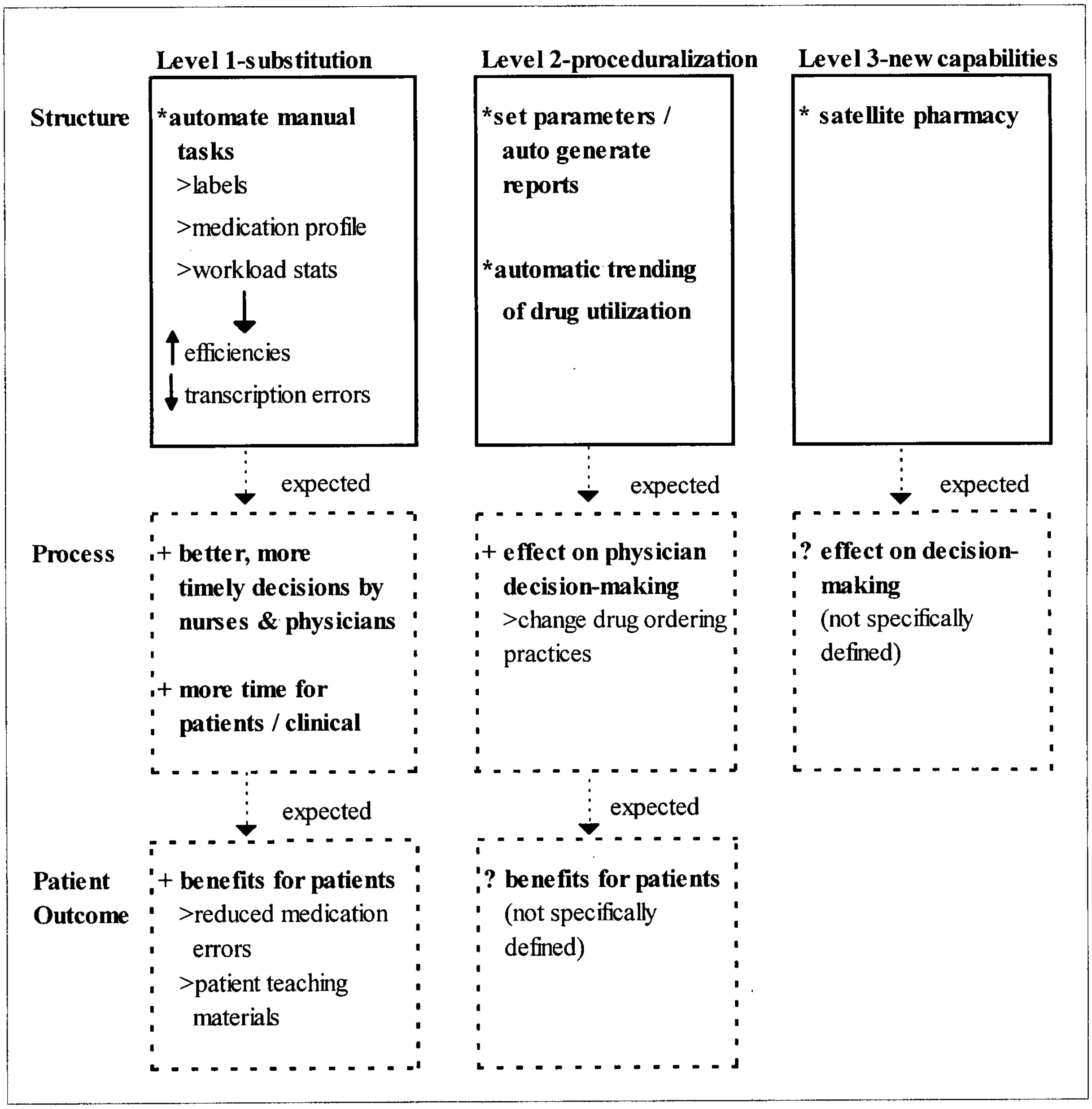


Figure 4.7 - Impact of PCIS on Pharmacists at Hospital 1

They expect these changes to benefit physicians in their decision-making and nurses in administration of medications. Patients should also benefit through decreased medication errors and complete, accurate patient education material. There are many expectations for reduced medication errors, partly based on the number of potential errors that could occur. Reductions may be more significant if many errors occurred before the system was installed.

Other than serious errors, there seems to be little in the way of documentation, but participants speculate that many errors occurred that were never detected.

Integration of systems provides pharmacists with more information "at their fingertips." They are able to set parameters in a number of areas (such as drug use versus lab tests) and automatically generate reports that were too labor intensive and less systematic in a manual system. Patients are expected to benefit through avoidance of drug related renal problems, although the extent of this is unknown. Within pharmacy, having access to patient information, drug orders and associated costs provides opportunities to analyze drug use in new ways. A positive effect on physicians' ordering practices is expected to occur.

The impact of behavior in one department on other departments is now more evident. The informal processes for dealing with inaccuracies or uncertainty are no longer available. Use of an integrated information system introduces formal interactions between departments that do not occur in a manual system. For example, when a nurse enters "drug allergies," these affect the pharmacist's order processing. When the pharmacist is unusre that an allergy exists and feels the patient's symptoms are an adverse reaction, he or she must stop the order process to verify this or override the warning. In other words, they can no longer ignore "errors" on the part of Nursing users and must come to some agreement on the meaning of the terms "allergy" versus "adverse reaction."

The very nature of the expected benefits contributes to dissatisfaction for pharmacists. In many ways electronic communication between Pharmacy and other departments, as well as within the department has many benefits. The reduced phone calls decreases interruptions and distractions. There is increased accuracy and reliability in the information being entered once and used by many different groups. It is produced in easy to read computer print. Efficiencies are gained by dividing up tasks and having one pharmacist assigned to entering orders while others follow up on problems. The downside of these benefits is that entering orders becomes very routinized "like the scanner at the grocery store." The follow up to problems becomes separated from identification of problems creating a "distance from reality." There is less face-to-face communication, although very efficient, is also very isolating.

Differences between training and learning are evident in the expectation that quality of information is dependent in part on the individual user's ability to organize what is entered into the computer. "Just in time" training was recommended by pharmacists several years earlier, so computer training is broken up and matched with orientation for specific areas in the Pharmacy. Users discover new ways to use the system as they gain experience with it.

4.4 Impact on Physicians - Hospital 1

4.4.1 Introduction and History of Computerization in Medicine

One physician, along with hospital Board Members, Administration and the Director of HIS, were involved in the early deliberations to replace a previous Accounting System, which was "at the end of its useful life." This committee also determined expectations for the replacement system and selected XTECH. Although it took awhile to achieve their original goals, use of the system has now gone beyond what they envisioned. They expect the next changes will be "quantum leaps," and include introduction of an electronic chart (level 3). Advantages in cost savings and efficiency are anticipated, as well as benefits from a medical/legal point of view. Advice offered to physicians in other hospitals is to become involved early on, as this candid comment illustrates:

> *I pointed this out to colleagues of mine who complain their computer systems aren't helpful to them, and their hospitals don't seem to have any interest in physicians. They have to get involved early in the process. Even though some of these committee meetings are pretty technical, financially oriented and boring, you need a physician in there to remind them physicians have to be involved. There has to be something in it for the physicians if it's going to work.*

There is no designated physician liaison for the medical staff, although this role is filled to a certain degree by the Clinical Information Systems Coordinator (who has a strong clinical background), as well as other HIS staff who provide training and support. The HIS department initiated training classes and "physicians were invited to come along." The physicians who were interested came to the early classes, and those who were not interested eventually came because they found they were not able to do their work without using the computer. A training program provided by the HIS staff is now available for new physicians coming on staff and provides a one hour introduction to the system. However, this may not be the answer to training as one physician remarked: "You get better use out of the system if somebody sits down with you and shows you some of the finer points of what it can do."

Physicians expressed resistance to using the system in a number of ways. Initially some unique reasons were offered for why physicians should not use the system, as this humorous example illustrates:

> *Some physicians are somewhat conservative. [laughing] It was amusing ... to get our messages before we had the computer system, when we came to the hospital there was a little old black telephone that you would dial in your code. My code was 28, I think. So, in the morning when I came in I would dial two, eight. If there was a message waiting for me at switchboard, a little light would flash. I would pick up the phone and say, "It's Dr. Bildoff." They would go through their scraps of papers and say, "Oh yes, you've had*

somebody admitted." That was fine, but with the new system, you type in your password and it gives you the message. So, some physicians counted the strokes that were needed. In other words, you only had to do 2, 8 and lift before; now you have to do B-I-L-D-Return. That's five, and therefore a backwards move. That was the sort of [laughing] resistance that there was, but that changed gradually.

From the physicians' point of view, resistance also relates to the "opportunity costs" of spending money on computers versus clinical programs or equipment, as these two examples illustrate:

For as long as I've been in this hospital, there have always been budgetary restraints. It's just a way of life in hospitals. Administration is saying you have to cut back and from our point of view, money always seems to be cut from clinical programs. If you're a cynical physician sitting there, and you see HIS spending another million dollars and another five million dollars on their computer, you might really wonder whether that money [could be] better spent in the best interest of your patients. So, that is probably part of where the resistance comes from.

I remember going to an MAC [Medical Advisory Committee] meeting and trying to defend the initial investment in the system. At the time, I think we were trying to get our first CT Body Scanner. That was the question somebody asked: "Should we spend money on the computer or should we get a CT scanner?" So I expected resistance, but no more or no less than we got.

4.4.2 Use and Impact of PCIS

Up to this point, physicians have been able to sign in and out, retrieve a current listing of their patients and receive consultation requests without using a password. Major changes in the messaging system are being implemented in the near future, and a new hospital policy goes into effect, which will require use of their passwords for everything, including electronic mail.

Physicians use the PCIS inquiry function primarily for accessing patient information such as lab and radiology results (which has always required a password). Several months prior to the interviews, a two week audit trail revealed only about thirty-five to forty percent of physicians were accessing the PCIS daily for the patient information they needed (seventy to eighty out of over two hundred physicians). Results of a new audit received by this author approximately nine months after the interviews show this has increased to fifty-five percent (one hundred and ten out of two hundred) of physicians who are using their passwords routinely to access their own patient information.

The effect of the computer on how physicians practice medicine seems to vary depending on the type of practice. It introduced minimal changes for General Practitioners. In areas where patient turnaround time is very quick, such as Short Stay, Same Day Admission and Day Care, physicians were also not as likely to use the system as those whose patients had a longer stay. Specialists began to get their consultation requests through the computer, which was expected to speed up this communication process. The descriptions of how two physicians start their day illustrate the range of systems use. These two participants could be described as a high user (a specialist) and a moderate user (a General Practitioner):

> *We have the XTECH package and it allows us to highlight certain clinical parameters that we want to follow* (level 2). *My day usually starts by printing the computer generated patient list and then going through each individual patient, looking at their clinical highlights. That's before I make any patient contact in the wards or with any of my consultations, or what have you. I find it the most efficient and fastest way to get right on top of what's going on, at least from a laboratory sense. The computer is quite good at flagging new things that have been done as well, so if my patients have had investigations ordered by other physicians, I'm usually on top of that.*

> *In the hospital I use it every morning, as everybody does I think. When I come in I sign on, get all my messages (level 1) and that tells me any patients that have been admitted. Sometimes there are requests from nursing stations about my patients and they want me to do something particular or tell me something about the patient. That's on a daily basis. Frequently, but not necessarily daily, I use it to access lab results, X-ray results. I also use it for E-mail to other physicians and other non-physicians in the hospital.*

Most of the medical staff continue to go to the Doctors' Lounge to pick up their patient lists which have been printed for them during the night; a practice which has a long standing history. Many physicians find their patient lists are useful tools for billing purposes as they can annotate the procedures done and give the list to their secretaries. Since physicians are able to use the system and print their own lists, changing this practice could be considered. However, given that a majority of physicians arrive at the hospital at the same time every morning, increased access to PCIS would have to occur either from home or in the hospital. Both choices would require active participation of physicians in learning how to use the system.

Although the hospital has offered the necessary software to physicians at no cost, physicians identify "medical culture" as playing a larger role in the decision to use this technology. A modicum of support for the system seems apparent, given an estimated one third of the medical staff who have modems in their offices. However, many of the physicians who have modems do not use the system directly, but have office staff who do. There is also "a vocal minority who think that too much patient care money is being directed to this new fangled technology, and they're not shy about expressing their opinion."

Access to terminals is important for users to make full use of the system. Physicians potentially have access to all the terminals on the Nursing Units. This has some practical drawbacks in that they are not always easily accessible at the peak times of the day, particularly when physicians are doing rounds in the morning. Given the limited number of physician users, this has not been too much of a problem yet. Terminals and printers designated specifically for physician use in the hospital do not seem to promote easy access:

Well, it's funny you should mention that [terminal location]. The terminals that are in the physicians' lounge are used by two secretaries who have been sort of relegated to working in the physician lounge because there is no other place for them to work. There is one computer terminal in the physicians' library and that's there just exclusively for physician use. It's in crappy shape and doesn't seem to be getting the preventive maintenance that a lot of the other machines in the place get. I mean the screen is fuzzy and there's pieces of plastic falling off it and it's just crappy. Most of the computer work I do is done on work terminals on the wards, which work fine.

A physician's perception of "user friendliness" is another important factor in his or her decision to use the system. One physician described his experience with a system which required the user to scroll through many pages to get to the screen he was looking for. If he accidentally scrolled one page too far, he could not scroll back, but would have to start at the beginning again. In comparison, he describes XTECH as very easy to use because it is menu driven and arrow keys can be used to move through the modules so there is very little keyboard entry.

In addition to accessibility and user friendliness, other "theories" are advanced to explain why more physicians do not use the PCIS. These include issues around training and physicians not knowing how to use the technology and not making the time to learn to use it. Being apprehensive about learning how to use it is also a barier and some feel they may do something wrong and "crash the system or have everyone think you are an idiot because you don't know how to use the computer." Even though HIS is very flexible with training times, one physician thought perhaps these sessions were not publicized enough. Since attendance at training sessions costs physicians both time and money in lost income, this may also have an influence. Another explanation suggests that the preferred learning style of physicians may not fit with the style of presentation often used for computer classes, as this comment illustrates:

> *Perhaps, the one thing that I'll mention about the training is that it's tedious, in the sense that they do it very slowly, to make sure that the stragglers have the idea, but those of us who get the idea are waiting to move on to the next thing. So, I think one to one training works better than classroom style training. Certainly a lot of things about the computer that I've picked up, just by going up to HIS and talking with them for five minutes, rather than sitting down for a half morning training session.*

Physicians expect a number of benefits from the system. One key area is improvements in data quality, which should be better than in the manual system, otherwise "there's no point spending all this money." Benefits also include efficiencies in data retrieval, resulting in both time savings and labor reduction. This allows physicians to manage the data for large numbers of patients, particularly if they are practicing in a specialty that uses lab or radiology tests intensively. In some of the specialized areas such as the hemodialysis unit, order sets have been established (level 2), which benefit both the patient and physician. However, of the physicians who use the system, only a small number of those use it to the extent that these gains would be significant. This physician's description illustrates how efficiencies can be gained:

> *I have adapted my pattern of practice around the computer that is available. I can't imagine what someone would have done with this volume of patients if the computer system wasn't here. It just would be impossible. It's been a true labor saver, in the sense that it allows me to put all of my information together really in a very efficient way and deal with it. If the computer wasn't here, I'd be spending probably 60 to 90 minutes a day going through charts, trying to extract the same type of information that I can pick up in 15 minutes going through the computer screen.*

Effect of the PCIS on physicians' decision-making is related to whether they are more knowledgeable about what is happening with patients when they use it. Decisions can be made quickly and efficiently when information is more up-to-date, accurate and accessible. The information is not necessarily new, it may just be retrievable in a different format that makes it more useful. In this way, some physicians believe their decision-making may be enhanced by the way information can be organized and presented on the computer. There are new opportunities for correlating information from two different departments, such as lab results and medications. However, not all physicians agree that decision-making has changed, but many predict it will change as they move into using guidelines and protocols.

Patients, particularly if they are long term or have chronic illnesses, can also benefit from the physician's ability to present information to them graphically. One physician describes the advantages this way:

> *One thing that the computer does easily, which the chart cannot do, is it can give you a visual sense of the way that things have changed over time. You can see when something has changed by looking at a graph. So I think it makes some of the decision making even sharper than just pouring through the chart and seeing a test has this value today and it was like this last week, or whatever. I really don't think that the paper chart facilitates good decision making the same way that the computer record does. In the computer record the ability to browse from place to place quickly, I think really sharpens the ability to make correct decisions.*

Use of the system is also expected to affect patient care and reduce wastage in re-ordering tests, especially in cases where previously results were unavailable or it was unclear whether the test was done.

Not all information which would assist with decision making is available in the system yet. For example, access to microbiology information is expected in July 1995, but it has been requested as far back as 1992. As well, information on drugs that were ordered is available on-line, but equally important is information about drugs that were actually taken by the patient. The paper Medication Administration Record, where nurses record drug administration, provides this information, but it is kept separate from the patient chart for twenty-four hours, then a new one is printed and the old one filed. Hand held input devices that the nurses could take from room to room and record drug administration on-line might solve this problem, but as one physician remarked, "the will to look at solutions is not within the hospital."

One disadvantage of having all of this information so easily accessible from the terminal is that a distance from "reality," or source of the data (the patient), may be created (an undesirable move to level 3), as this physician explains:

> *One of the detriments, and I say it rather sheepishly, is that the computer is so good at providing the information that sometimes I don't have to go and see the patient. So, in that way it's detrimental to the patient contact, in that I'm able to abstract all this information and make treatment decisions on the basis of data. It cuts the patient out of the loop sometimes. I would like to think it's not the majority of the time that that happens, but it certainly happens. There's no question, it happens.*

Physician order entry has been considered for a long time. Information from the international meetings of XTECH indicate that this is happening in very few hospitals. One physician who practices at Hospital 1's extended care facility enters orders directly because it seemed easier to her to enter requests and provide the relevant details than to explain it all in writing, then have someone else interpret and enter it. While physicians are retrieving results at the present time using the inquiry module, it is not really suitable for physician order entry because it requires a lot of other detail besides the order itself (such as mode of transportation to X-ray). In the fall XTECH is introducing a new routine to the inquiry module called "Physician Orders" which will be more simplified and may make use of standing orders or

Clinical Practice Guidelines (level 2). The legal aspects of electronic orders still need to be addressed as well.

Physicians who are becoming more involved in management aspects of health care, such as managing a program, are also interested in financial information, such as that provided in XTECH's Executive Support System.

4.4.3 Use and Impact of Electronic Communication

Surprisingly, e-mail is used internally far more than anyone thought it would be. When they began using XTECH, e-mail was not very widely used anywhere. Now, for many people, it is probably the preferred method of communication within the hospital. This may be because e-mail is so easy to use, it is timely and is now used widely throughout industry. Electronic messaging has also enhanced communication because physicians automatically get their messages when they sign in and out at the front door.

Physicians want to be kept informed of problems or issues with their patients. They benefit from up-to-date patient lists and messages about the conditions of their patients, for example if a patient has expired during the night. These benefits are extending out into the community because Continuing Care nursing staff at the Health Unit are also communicating with the doctors electronically when they go on a house visit or a patient has been referred to them.

E-mail also serves as a good bulletin board. If there is a medical association meeting or a meeting that needs to be called on short notice, the whole medical staff can simultaneously be sent a message, with reasonably good turn out. Informal communication still occurs in the lounges and over lunch, while the computer conveniently and efficiently supports other aspects of professional communication.

4.4.4 Summary

The impact of PCIS on physicians at Hospital 1 is summarized in Figure 4.8.

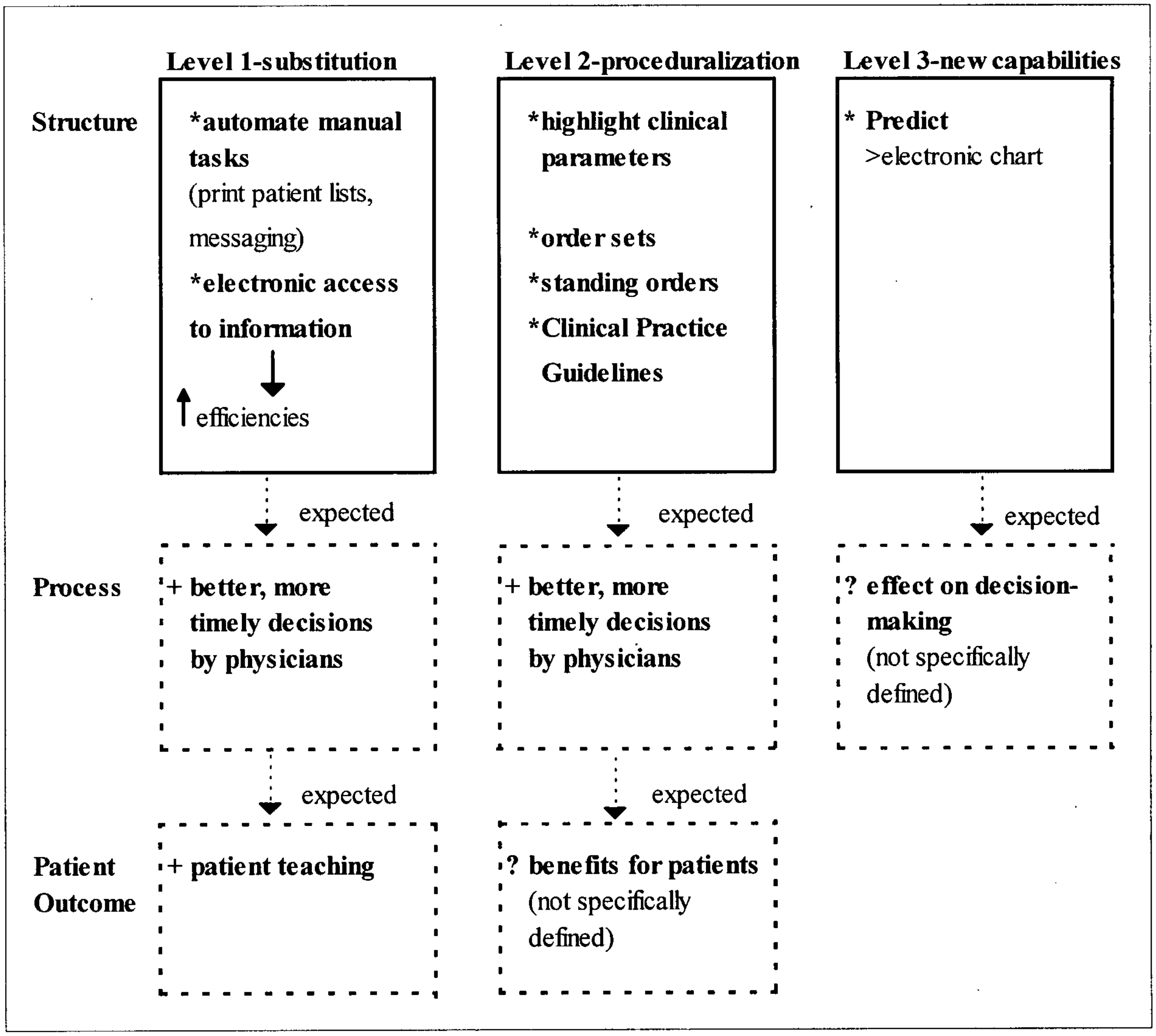


Figure 4.8 - Impact of PCIS on Physicians at Hospital 1

In spite of good planning with respect to the system, implementation and expected benefits, advancements in software and hardware have meant the system is capable of going beyond what was anticipated. (This supports Grusec's notion that levels 2 and 3 are not often predictable. Not only does the user become more sophisticated, so does the IT.)

The PCIS primarily supports automation of clerical and communication tasks for physicians. These include producing patient lists, electronic messaging and on-line retrieval of test results. Many participants outside of medicine anticipate these changes in support (or structure) in the hospital system will lead to changes in physicians' decision-making. However, there is little evidence this happens, and in fact physicians identify many other factors unrelated to PCIS which affect decision-making.

Approximately half of the physicians use the PCIS, although there is still not enough incentive for the rest of their colleagues to use it. Training efforts may need to take into account the profiles of physicians who are, and are not, using the system and why. Training might be presented, not as an opportunity to learn how to use the technology, but as one to learn to use the information to improve one's practice. If there is not a perceived need to change practice this may have to precede computer training. For the physician group, a "just in time" training strategy might be more effective where fifteen minute sessions are offered at lunch or before patient rounds in the morning.

Better information, in a more timely fashion, is expected to contribute to better patient outcome, and therefore provide some rationale for implementing systems. Impact of physician use on patient outcome is an important consideration, but a difficult one to measure. One physician suggests that systems which affect patient care should also be assessed from a financial perspective. If system costs can be reduced because of automation, and patient care does not get worse, in other words the outcome is at least the same, that would be another acceptable reason for investing in IT.

4.5 Summary - Hospital 1

4.5.1 Introduction and History of Computerization in Hospital 1

Introduction of the XTECH system was only one of many changes at Hospital 1 over the last ten years. (In the last year alone, they opened sixty new beds and established a pre-admission clinic, which freed up additional inpatient beds.) The criteria used to select initial financial and admitting systems may not apply equally well to later clinical components. However, high involvement in the international XTECH users' organization provides an opportunity to shape the system in ways that are beneficial for the hospital. The downside of choosing this integrated system is the reduced flexibility and responsiveness of the system. It is costly to make changes and the extended time lag between change requests and implementation of those changes is frustrating for the users. XTECH is a very reliable system, and unlike some systems that have daily scheduled downtime to do backups, Hospital 1 has limited downtime, which is rarely unscheduled.

The hospital culture demonstrates integrated use of the computer system and support at many levels of the organization. Initial training is helpful in getting users started, but support also includes such things as a hospital-wide program that enables staff to buy their own home computers at a reasonable price. The thinking around centralized training has been changing, which means this responsibility is moving away from the HIS department and out to the people who regularly provide education. In other words, the computer is becoming integrated into roles and responsibilities and not seen as "an extra duty," a situation that supports impact at levels two (proceduralization) and three (new capabilities).

The general training philosophy has been, and still is, that follow-up with users is critical to continually improve the system and relationships between departments. This works well for three of the four groups. Not having an official liaison position for physicians creates a dilemma when follow-up with individuals in this group is required.

4.5.2 Use and Impact of PCIS

The hospital expects all nurses, pharmacists and laboratory technologists to use the PCIS. Physician use of the system remains optional, but the relatively high number who use the PCIS daily is one indication of the system's integration into hospital operations. While a fifty percent use rate is very high compared to most other hospitals, which physicians not participating, and why, is not clear. It may be a case of the "eighty-twenty rule" where physicians using the system are the ones who carry the heaviest patient loads, or their types of patients have the heaviest demand on hospital services. For example, specialists are often consulted by other physicians, frequently order lab tests and use the computer extensively. It would be instructive to know how non-users manage their work without accessing the system directly, and what practices in the hospital support non-use. For example, Admitting prints patient lists for the physicians rather than physicians printing their own.

Automation of manual clerical tasks (level 1) produces a large impact in the Laboratory and Pharmacy. In particular, given the daily volume of orders processed, electronic communication of lab orders provides direct benefits for lab techs, nurses and patients. These include increased efficiencies, reduced transcription errors and an audit trail that makes it easy to follow-up requests as well as reduces phone calls between departments. However, these changes in structure have minimal impact on decisions of nurses and physicians, which relate to the process of care and therefore patient outcomes.

The ability to "proceduralize" many tasks offers benefits to all four groups, but particularly for the Laboratory and Pharmacy at the present time. Much of the proceduralization relates to formalizing the processes for checking results or drug orders to identify cases that require follow-up. In a manual system this is often difficult to accomplish due to the labor intensity and complexity of the checks. For example, pharmacists can identify patients who are on Gentamycin at the time an order is received. However, follow-up on the related lab results must be done on each patient through a phone-call to the Nursing Unit or review of the patient's chart. Similarly, in a manual Lab system the lab tech may be alerted to compare current lab results with previous ones only if the result was sufficiently abnormal. The downside of being able to identify many more cases is the difficulty in setting parameters for follow-up.

The hospital has overcome some of the perceived difficulties in using a keyboard, and many people now prefer word processing to handwriting. Some professional groups, such as Social Workers (referrals and notes) and Discharge Planners, complete their documentation on-line, which benefits themselves as well as other system users. Nursing is in the process of revising their manual documentation system in preparation for implementation of the Nursing module and on-line documentation. A small number of physicians are also considering writing progress notes on-line. Not only are illegibility and crossed out entries eliminated, but professionals can easily share the information, and access it from multiple locations.

Roles and responsibilities also change with changing access to information. For example, changes in access to drug information affect both pharmacists and physicians. One role of pharmacists is to watch for potential problems with drug therapy, as indicated by their follow-up on patients with renal insufficiency who are taking potentially toxic drugs. In the manual system pharmacists identified the need for follow-up on an ad hoc basis, then retrieved additional information from the chart or by calling the Nursing Unit. Implementing the PCIS (level 1) immediately provided access to a broader range of information (lab results, demographic data, diagnoses). The investigations became more systematic, with reports automatically generated (level 2), which alert pharmacists to where follow-up should occur. In addition, physicians can directly examine data trends or compare multiple sources of data on-line (such as drug levels from the Lab and dosages from Pharmacy which previously only pharmacists were able to do (level 3). The extent to which physicians take advantage of this capability versus continuing to rely on pharmacists was unknown by the study participants, but likely depends on the individual user.

Another similar example is the changing relationship between nursing and physicians as physicians have more direct access to test results and do not have to depend on nursing to retrieve them. The responsibilities of pharmacists and nurses also change with the automated production of Medication Administration Record's (MAR's). Handwriting these records has traditionally been a nursing responsibility, and completing them on the Nursing Unit allows a degree of freedom in scheduling medication administration times. However, when producing MAR's as a by-product of the pharmacy system, they become more rule-based and under the direction of the pharmacist entering orders.

Changing workload is an area of concern for many participants. Staffing levels have not changed significantly in the Lab although workload has due to increased efficiencies and resulting changes in workflow. While lab reports are no longer detained in the Lab while they are separated, sorted and delivered, some of this workload was transferred to the Nursing Units where these reports are now generated. Pharmacy has also experienced changes in workload, with an increasing number of programs and consistent number of staff. Increases in efficiency have negative consequences for job satisfaction in both Lab and Pharmacy. As their jobs become more specialized and fragmented, a distance is created between the users and their data source - the patient.

The confidentiality of patient information is important to all professional groups, a concern that the hospital has recently addressed in a study by an outside consultant. Access must balance security of information and in that balance people still need to have the access necessary do their jobs. One of the unique advantages of an electronic system is the ability to monitor who has had access to information.

As the consultant recommended, they are considering Health Records and HIS Departments generate random audits on hospital staff use of XTECH four times a year. More frequent monitoring of those areas where access to patient information cannot be limited by user location will likely be needed. The consequences of a breach of confidentiality will be made known well in advance. While the hospital cannot "legislate" attitude toward confidentiality, monitoring behavior with respect to access and use of information is essential.

4.5.3 Use of Electronic Communication

The inaugural Hospital Newsletter in November 1990 highlights electronic communication in a very positive way. They highlighted three ways that acute care employees were able to communicate electronically: through Registry, Nurse Order Entry and Office Automation. One of the most exciting benefits that Hospital 1 has encountered is the opportunities for electronic communication within the hospital as well as with the community.

Communication has improved through the use of "shared cabinets" on the system that allow multiple users to have easy, convenient and timely access to common information such as committee meeting minutes. It also reduces the time spent copying and distributing minutes, as well as each committee member filing them. E-mail also contributes to increased productivity through the distribution and "discussion" of documents before meetings.

Communication between levels in the organization has also improved because it is easy "to keep your superiors informed as to where you're going and the direction you're heading." It also expands employees' access to other employees across the organization and conveys a sense of open communication. Appropriate use of e-mail is always a potential concern, for example, an individual sending e-mail to the president about local departmental issues, but this has not been a problem. Electronic communication may also be a double edged sword, because individuals become more accountable when communication is documented "in writing" with a date and time sent as well as promises of action to be taken.

4.5.4 Summary

Figure 4.9 summarizes the impacts of PCIS on all groups at Hospital 1. Many participants identified expectations for system benefits, however finding evidence that these changes occur is more difficult. While the Lab and Pharmacy have benefited from automating clerical tasks and proceduralizing others, future changes at levels 2 and 3 are predicted to benefit nurses and physicians.

One of the most powerful statements made by participants is that "the system has lived up to the expectations set out during implementation." This not only confirms the history of system success enjoyed by this hospital, but also the tremendous opportunity to influence future users during the implementation process. Individual users may not see impact or potential impact, but depend on the "experts" and trainers to tell them what these will be.

Projects are moving more slowly than users would like, but can only proceed when funds are available. Interesting changes happen to planning and priorities when the money is slow in coming. People have to constantly re-assess how operations have changed and whether the requests for programs or systems continue to be appropriate.

This organization illustrates two different phases of adoption. The first phase involves an enormous cultural change in moving from manual to automated systems. The second phase is ongoing and more subtle. It deals with subsequent changes in the organization, IT, users and resulting changes in worklife.

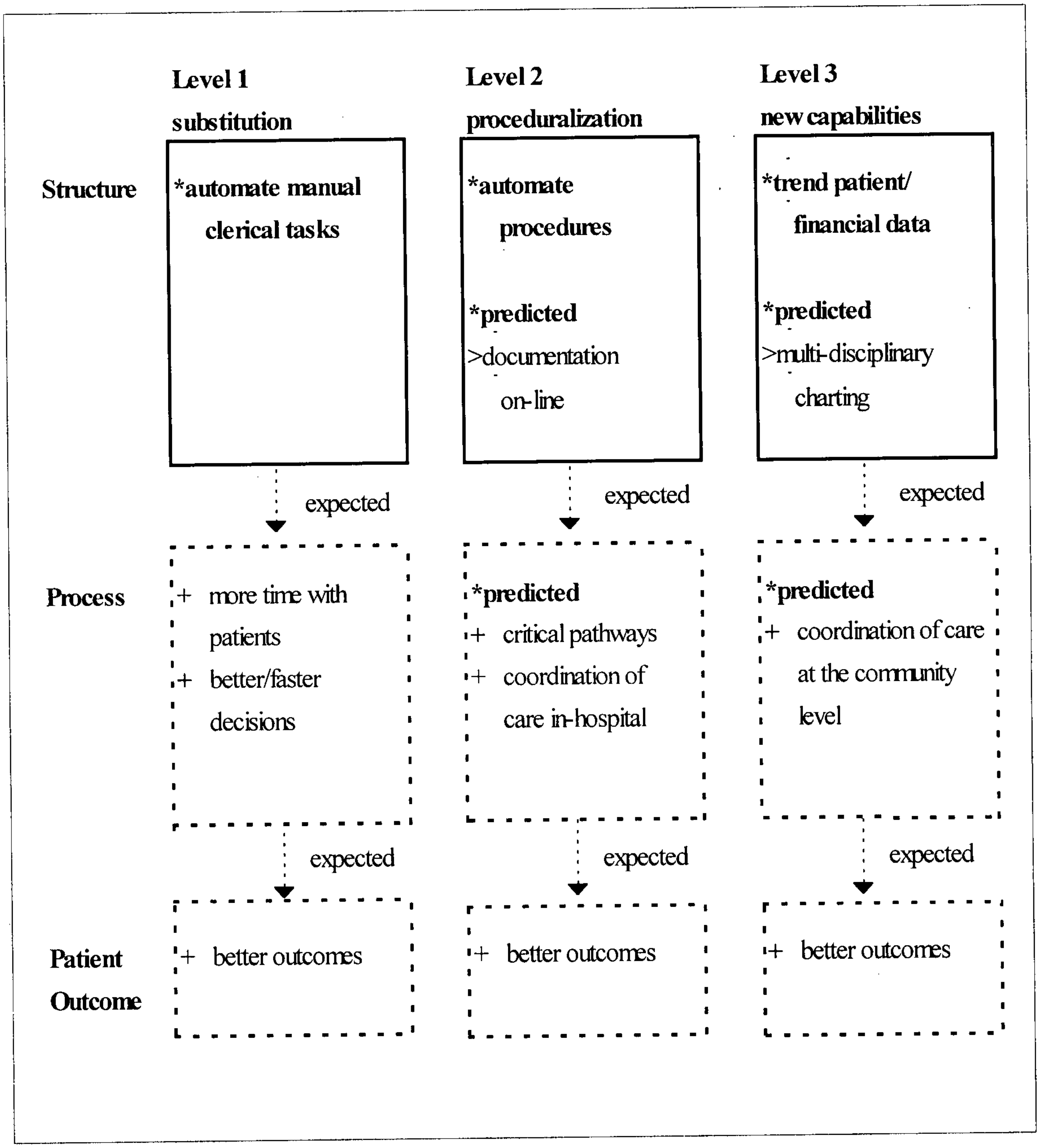


Figure 4.9 - Impact of PCIS on All Groups at Hospital 1

Endnotes

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1 For example, the LIS Coordinator automated the collection of their WLM calculations (level 2) by listing all the procedures done in Pathology. Every day they enter how many of each procedure they have done and at the end of the month their workload units are calculated for them, a job which used to take them several days every month. As well, Pathology used to report their narrative results using typewriters and five part forms. Using the Office Automation (OA) module of XTECH, the LIS Coordinator developed "canned text" for all the reports they routinely do (level 2). These provide a template for the report with "fill in the blanks" for each patient which are then printed on five part NCR paper and only need to be signed once.

They embed codes in these reports so they can search for particular diagnostic groups. There are two limitations to this temporary solution. Since there is no link with the Admitting module, the patient demographic information must be entered each time, which introduces some margin for transcription error. As well, until the Pathology module becomes available, these reports will not be available on-line.

2 Patient information sheets print automatically when orders are entered (level 2), which is of benefit to both Nursing and patients as illustrated in this example:

> *The head nurse in GI lab used to say to me, "I get so tired of our patients coming down here that haven't any idea which end the tube is gonna be put in, in the GI lab, from the bottom or the top." And she said, "Is there any way we can get some patient information in here so that they know what's going on?" So what we designed and set this up, is that when an order is entered into the computer, whether it be a Bernstein test or endoscopy or whatever, the patient information teaching sheet prints and is given to the patient. It explains in patient's language just exactly what is going to happen to them. We've done that for almost all procedures. So, patient teaching is one of the biggest benefits that you have out of this system.*

3 A similar example occurs in Short Stay Surgery where, using office automation and order entry, a nursing care plan system has been developed. When they enter the procedure name, a care plan of what's appropriate for each procedure for short stay is printed (level 2). These care plans also serve as a standard of care and nurses are accountable for patient care based on these. They have also developed twenty-six patient teaching sheets which can be printed off when needed. The doctor completes the bottom with other specific information for the patient, such as next appointment with the surgeon, and it is given to the patient on discharge (level 2). An added advantage for the unit is the savings in printing and storage. Updating the information on both types of sheets is easy and timely.

4 The "ATC machine" is a unit dose dispensing machine that is computerized and interfaced with XTECH. It dispenses two hundred and twelve of the most commonly used medications, in an individually packaged "unit dose" format. It produces long strips of packets for each patient for a twenty-four hour period. There are other medications the

machine cannot dispense because they are part tablets (i.e. the medication order is for fifty milligrams and the tablets are only available in one hundred milligram tablets) or it is just not commonly used. The technicians generate "pick lists" for these other medications that they collect by hand.

5 For example, this pharmacist describes the value of having access to lab and patient location information.

> *Well, I think to begin with, the fact that we can access information that we want. When we're doing clinical duties and following a patient on Gentamycin, if we want to follow their levels, we can look in the computer and find out what the latest creatinine and renal function measures are. .... If the patient's transferred to another ward, then your computer would say it, which is really nice because you don't have to chase after it. In a manual system it's a real nightmare to have to follow the patients all the time and half the time it never gets to the right ward. This way it's more efficient and less time consuming.*

Chapter 5 - Comparison of Impact Across Groups Within Hospital 2

5.0 Introduction

Seventeen interviews were conducted at Hospital 2 from May 8 to 12, 1995 with four representatives from Nursing, three from Pharmacy, three from the Laboratory, three from the Medical Staff, and four from Health Information Services (HIS) and others.

The hospital has a long history of using IT, beginning with a financial system in 1977. Soon after implementing that system, an internal study identified the need for a data processing department. They have implemented, replaced and upgraded various other systems since that time (see Appendix G for details). In 1989, under the direction of a new HIS Director, they developed a strategic plan and began a five year implementation process. The hospital selected XTECH as their primary vendor for an integrated system. However, in recognizing the limitations of this mainframe system to be as flexible as users would like, they have made some hardware and software decisions to position themselves for future changes. Even though the vendor's system runs on their network, they have a true client-server based information system. Any time the vendor is ready, they can "turn the switch" to create an open systems environment. This will allow the user to extract information from the vendor's system and put it into user friendly tools on the client server.

Six weeks prior to the interviews the hospital implemented order entry and results communication among Nursing Units, the Laboratory, Diagnostic Imaging and Pharmacy through a user-friendly patient inquiry module. A number of other new projects are planned for 1995 and by the end of the year they expect to be eighty-five to ninety percent toward their goal of an Electronic Health Record (EHR). Nurses' notes and communication with some of the smaller departments will still be missing.

5.1 Impact on Laboratory Technologists - Hospital 2

5.1.1 Introduction and History of Computerization in the Laboratory

They implemented several applications of XTECH's laboratory system, including Chemistry, Hematology, Accessioning, Microbiology and Blood Bank. Most instruments are on-line and initially results printed on the Nursing Units when they were available. Later, through the patient inquiry module they were available directly on-line.

Training in the Lab was the responsibility of a Laboratory Information Systems (LIS) Coordinator and a manager, with users spending time in the training room as well as at the bench. For the Laboratory, implementation of a new system was not a great change because their automated instruments have been computerized for years. They tried two different approaches to implementation that incorporated more or less user input during development. Where users were able to participate in the development and work with the system as it evolved, they were much happier with the end product and found it easier to use. Users have adequate access to terminals in the Laboratory because interfaces between systems mean terminals on the workbenches provide access to the lab instruments as well as to XTECH.

5.1.2 Use and Impact of the PCIS

Use of computer systems is not new for the Laboratory, although integration with other systems in the hospital presents new challenges. The Lab has reached a point in the last year and a half where their modules operate very well independently and most of their concerns now occur at the inter-application interfaces. Decisions that affect more than one department can no longer be based solely on departmental impact. Rather, they need to take into consideration the effort required to implement the change (for example, 120 Lab employees versus 800 Nursing employees) and the resulting patient outcomes. There is an additional factor that complicates system changes because individual hospital departments may request system changes through the vendor, without considering the impact on other departments. These changes are not necessarily in the best interest of all departments in the hospital, but are made based on the volume of requests the vendor receives. For example, Admitting may request a change that really upsets the Lab, but through XTECH the Lab is unable to vote on changes in the admission module.

There is an attempt to deal with these conflicts through committees at the local hospital level. All the requests for changes go through a steering committee, and then the logistics of implementing their decisions "kind of filters down." With a high degree of integration, conflicts may also arise between departmental and organizational objectives. The difference between the hospital objective to move toward an electronic patient record, and users in the Lab who are not sure this is the route to go, illustrates this point:

> *You see the hospital is going into a paperless system and I disagreed with that because I don't think it's possible. For the Lab our responsibility ends once we have generated the results. How the hospital wants the results to be available to the rest of the physicians, they have more say than I have in that regard. They are trying to move towards a paperless system. We are trying to hold back on it and say, "Hold it, until we are sure what it is," so that is our expectation. The hospital wide expectation and the Lab expectation are slightly different.*

The biggest changes expected from implementing a PCIS are in the areas of efficiency and productivity that occur through automating manual tasks (level 1). In a manual system, lab technologists spend a good part of their day completing clerical tasks such as handwriting results on requisitions, tearing requisitions, sorting them and sending them to the Nursing Units. They also handle phone calls about results and track specimens sent to outside agencies. Benefits of this automation include being able to do more work without increasing the number of people as well as improvements in data quality.

The Lab expects data quality will improve through faster turnaround of results, increased legibility and reduced transcription errors. More efficient processing of orders and results creates a dramatic difference in the time when results are available for review. For example, when the Lab manually reported results, they were sent out at the end of the day, and would arrive on the Nursing Unit around four in the afternoon. The physician would not see those results until the following morning, compared to the results that are now available at 10:00 a.m. on the same day they were ordered.

From the Lab's point of view, quality of the lab reports has greatly improved. They provide more information about normal ranges for lab values and report results in one of three columns, which at a glance indicate whether they are low, normal or high. The results are also accumulated, so all the results of a specific test to date are printed on one page. However, from the physician's perspective, there may be too much information presented, as this comment illustrates:

> *Well... there's a lot more information now in the computer and one can argue that it's good and that it's also bad. [laughter] Sometimes we have too darn much information and I think that's the way the doctors feel a lot of the time, "We get too much information thrown at us." So it's a bit overwhelming and often it's hard to find just the piece of information you want because you have to search so many areas to find what you want. That's a bit frustrating when all you want is this little piece here, but you have to go through so many layers of things to get to it.*

They expect reduced transcription errors, but it is very difficult and labor intensive to track and record all possible errors in a manual system. Most respondents indicate there is no baseline with which to compare the occurrence of "fewer errors," although the probability of errors was definitely reduced. One area of guaranteed reduction is in transcription errors when there is direct interfacing of lab instruments with XTECH. Accuracy still partly depends on the initial data entry and selecting the correct patient name or test. For example, one respondent described a situation where a thoracentesis specimen was labeled with the wrong patient's name, which meant they reported positive results for the wrong person. They discovered the error when no results were reported for the patient who originally submitted the specimen and subsequently had to return for another test.

Along with the benefits there are a number of drawbacks to increasing efficiencies. For example, lab technologists end up doing more work because they can, and it becomes difficult to set limits. (Natural "human" limits that occur in manual processes no longer exist.) Standardization in tasks achieves increases in efficiency and initially people feel "as if the computer is forcing them to do things in an order they don't like." The standardization means work occurs at an intense pace, requiring a more focused concentration, and resulting in the work becoming more tedious, as this tech describes:

> *Because of the fact that people have to really concentrate on what they're doing, productivity is seriously affected by interruptions.* In the manual system...*If you got called away, you could see at a glance where you left off because you have blanks on the requisition...* In the automated system... *you come back and you don't know if someone else has sat down and used that computer screen while you've been gone, so you have to be constantly re-tracing your steps and checking, "Now where was I? So there's a bit of productivity lost there.*

Efficiencies result from having increased information available on the terminal and not having to search for it in previous reports or on the patient chart. However, this is also a drawback because it creates a distance between the user and the data source - the patient. In the Lab the use of barcodes contributes to efficiencies and to this "distance from reality" as well. Although the technologists are familiar with using barcodes, they continue to use the patient's name on specimens for an additional safety measure and to keep in touch with what is happening to patients.

Increased efficiencies may or may not result in reduced FTE's and "documented" workload in the Lab has not been as serious a factor in budget considerations as it is now. With productivity increases, workload goes up, yet departments may still be able to reduce FTE's in spite of what the workload measurement tool indicates. For example, workload increased by almost nine percent in one section of the Lab, and yet they were able to maintain their level of service even with a reduction of six tenths of an FTE.

Computerization is only one factor contributing to changes in efficiencies. Timeliness of communication, turnaround time in processing requests, and increased production are still highly dependent on other factors such as the number of specimens ordered, the resources available (such as people and equipment) and other operational limitations. Among these are the presence or absence of automated and interfaced lab instruments, which are key factors in their operations. Although requests to the Lab and completed results are now communicated more quickly, operational constraints within the Lab still dictate how soon specimens can be collected and analyzed. In this Laboratory, as in most others, specific work benches only operate a couple of times a week, so turnaround time remains related to this restriction. Community hospitals generally schedule only one person per machine, and so they are limited in the number of FTE's they can eliminate without decreasing the number and type of tests ordered.

Laboratory technologists have always been accountable for the quality of their work as an expectation of the job. Computerization has not caused this to increase, but has made accountability for the work become more "visible." In a manual reporting system it is not easy to identify who reported the result. Having technologists' names attached to the results they are processing serves as a reminder that they are personally responsible for the results and makes them more conscientious of their work.

This is a tremendous change from their previous lab system, where a supervisor checked results before they were released to ensure they were within normal range and were consistent with one another. This resulted in work flow being slowed up and increased turnaround time. For example, results on an analyzer at eleven o'clock in the morning may not be checked until one or two in the afternoon. In the current system it is the lab technologist's individual responsibility for ensuring results are accurate, creating a high level of anxiety initially when the new system was implemented. A system generated "exception report" takes the place of the supervisor checking all handwritten reports (level 2).

A new aspect of "visible" accountability occurs with integrated systems because the Lab can now determine who initiated the requests and follow-up on problems. Data in the analyzers can be used to generate a variety of reports, which no longer depend on people noting workload in logs and manually reviewing them. For example, the number of orders for particular tests can be reported by shift, elapsed time period, physician or Nursing Unit, which potentially introduces a new "visible" accountability for physicians as well.

A prime expectation for automation is that when information is available on-line, paper will disappear. The irony is that paper production initially goes up and active intervention is needed to curb it. To change work habits requires a conscious effort, as people are very reluctant to throw paper away, apparently finding some comfort in hanging onto it as a safety net. The Lab's approach is to avoid generating paper in the first place and they have scheduled their first "Paper Meeting" to deal with this issue.

5.1.3 Use and Impact of Electronic Communication

Electronic mail (e-mail) is particularly useful in the Lab where staff work a variety of shifts. Initially users feared that e-mail may potentially reduce social interaction. In spite of these misgivings, it has provided a very beneficial link for people on shift work who feel "cut off from day shift where most things happen." It also offers an opportunity for them to communicate with their boss or other colleagues. They know exactly what messages they have, or have not, read and can save what they need. For this reason, e-mail can be particularly beneficial in notifying staff of procedure changes. Most people have memorized the procedures and do not go to the manual every time and therefore might otherwise miss the changes.

Electronic transfer of information is both prompt and complete with time and date stamp, which unexpectedly also contributes to a "visible" accountability for information provided and action promised. People generally depend on verbal promises being honored or information to be accurate, but now a printed audit trail can be used to substantiate a communication.

Inappropriate use of e-mail presents a downside to electronic communication. Many e-mail messages are widely distributed when it is not necessary, resulting in time costs to open, read and delete. For example, a lab technologist is likely not interested in the news that someone from another department will be away on vacation. They did not have this information in the past and have no use for it now. Over use is equally as frustrating as this tech explains:

> *E-mail is, I don't know, it's kind of another thing pulling at you, another string pulling for some of your time. You have to go and read it and you have to do something with it. It's really difficult when you're gone for a few days. I was gone for a four day weekend and when I came back I had 45 e-mails. Well, my God, it's really only a Monday and Friday I was off. Saturday and Sunday are my regular days off. Give me a break here. I have to spend at least 45 minutes reading those messages and a lot of them I have to respond to, so this takes a huge chunk of time.*

Inappropriate use of e-mail also extends to communication about more sensitive issues, or where the "spirit of the message" is overshadowed by its content. For example, one tech describes this type of situation:

> *Yes, [loss of social interaction] is one of the things that I really don't like actually. I feel that it's unfortunate and it means that the job is less satisfying than it was before in that so much of communication, particularly administrative kinds of communications, are done through e-mail. It's a very cold, impersonal kind of way to do things. It also results in communication problems because you have no opportunity to clarify when you get an e-mail saying, "I need you to do this." You have no opportunity to ask a question about, "Well, I know you said to do this, but do you want me to do it this way or that way?"*

5.1.4 Summary

The impact of PCIS on laboratory techs at Hospital 2 is summarized in Figure 5.1. The automation of many manual clerical and data handling tasks (level 1) is expected to benefit laboratory technologists. Direct results of automation include increased efficiencies (accomplish more work with fewer people) and increased data quality (less transcription errors, increased legibility). Indirectly, more accurate and timely reporting of results are expected to contribute to "better" and faster decision-making by physicians and nurses. As well, lab technologists become more "visibly" accountable through audit trails of the original order entered, processed and results reported.

The lab techs also benefit from proceduralizing a series of tasks required to produce exception reports and specimen collection lists, as well as check for abnormal results. These produce an accurate review of results that provides a consistent basis for determining whether they need to take further action.

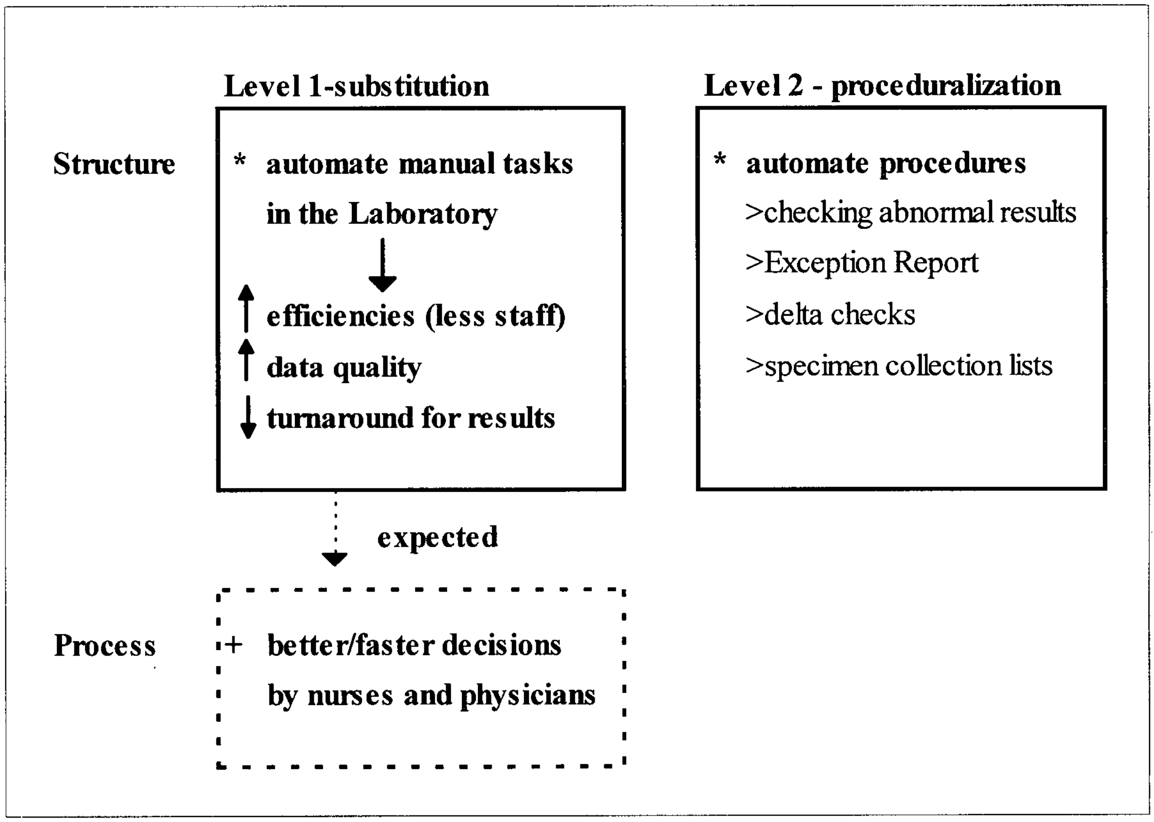


Figure 5.1 - Impact of PCIS on Laboratory Technologists at Hospital 2

5.2 Impact on Nurses - Hospital 2

5.2.1 Introduction and History of Computerization in Nursing

Six weeks prior to the interviews nurses began sending orders electronically to ancillary departments (including Laboratory, Radiology, Food Services) and viewing results on-line. Training and implementation on Nursing Units were spearheaded by a clinical liaison person who was hired late in the XTECH implementation process.

Training for nursing staff was the most structured of all groups in the hospital primarily because of the logistics and effort involved in training such a large group of people (approximately 800). Against the advice of the vendor who suggested training should start far in advance of implementation, they introduced a "just in time" training strategy. During the last week of February eight-hour training sessions were started for the Head Nurses and Unit Clerks who were going to be the major users for Nursing. They were provided with resource manuals and immediate access to the test system. With a team of Head Nurses as trainers, nursing staff training began in March. They scheduled four four-hour classes a day in order to complete the training of two hundred nurses per week. The nature of an integrated system meant "Nursing not only had to learn how the other people thought, but they also had to learn a computer skill." Training introduced the notion of an integrated system and that order entry was only one "piece of the pie."

Some of the nursing staff were unfamiliar with keyboards and computers, which left them unprepared for the training sessions. New strategies were introduced to familiarize them with the basic skills. In spite of this small set back, "reviews" were generally positive and related to the fact that the trainers were nurses themselves, as this comment indicates:

> *The training's been excellent. I think the last team, especially for order entry was excellent. These were people that really understood, they were from Nursing, so they were building the screens from a Nursing perspective and then going out to train, hands on. They were there with lots of reassurance, which was really helpful.*

Following training, and prior to implementation, nursing staff had the opportunity to become comfortable with the system by "playing games," using a mouse and Windows® environment. They discussed the benefits and drawbacks of a phased-in approach to implementation. This would mean introducing electronic communication between Nursing and only one ancillary department at a time. They decided to proceed in a "slam dunk" fashion with order entry to Laboratory, Radiology and Dietary from all Nursing Units, initiated at the same time. This approach was expected to be "a little bit more painful initially," but six weeks later users are quite comfortable with the system.

On-going training continues to be important and has become a module in orientation. For staff who may continue to have problems on the Nursing Unit, trainers follow up with time spent "one-on-one." One area where users felt training was not sufficient, was in the use of office automation tools. When "clerical" tasks (such as typing letters, preparing documents and spreadsheets) become automated, managers are expected to complete them with diminishing clerical assistance. Managers require additional training in this area, and while some of them have taught themselves to use the computer for these tasks, they felt this method of learning was an inefficient use of their time.

Nursing considered adequate access to PCIS was a priority and allocated approximately four terminals per Nursing Unit. This roughly translates into one terminal per nurse on day shift, but does not take into account potential users from other departments, like Occupational and Physiotherapists, who may need access on the Nursing Unit. At the time of the interviews they had not installed all of these terminals.

Access to information can be a powerful equalizer or divider and participants suggested that "some people have more access than others." This concern is evident along two lines: gender and position. In typically female-dominated departments, like Nursing, with large budgets and large groups of employees, they felt there was less access to the technology and support enjoyed by other departments. In addition, not all positions in the Nursing Department have equal access to IT. This decision was based on past practice where nurse aides did not access the patient chart in the manual system. A "two tiered" system is then created within Nursing when electronic messages are distributed through-out the hospital and someone must transcribe them into a communication book. Nurse aides also have to access on-line manuals through a second person.

5.2.2 Use and Impact of the PCIS

Nursing interacts with many departments and introduction of an integrated information system has affected them in many ways. One benefit of integration is that the modules operate consistently from the users' perspective, in other words, after Nurses learn how to send orders to the Lab, orders to Radiology are handled in a similar fashion. Once users have basic keyboarding skills, they have found the system easy to use. Frequency of use is also a factor, especially for Nursing Units with fewer orders to process, where they do not get the same amount of concentrated practice.

Successful systems integration depends on users having an understanding of the whole system and their part in it. Integration also means the ability to produce more information in a number of different ways, which requires potential users, as well as producers, of the information to carefully evaluate its usefulness. This translates into a new negotiated balance between what is required to do an individual's job versus what is required for the overall "good" of the patient and organization. For example, Nursing has to notify Pharmacy that a drug has been discontinued, although it is of no consequence to Nursing, in other words, "...it's just a waste of paper as far as Nursing is concerned." For Pharmacy on the other hand, this information is important in determining drug usage for particular diseases, physicians ordering patterns and inventory levels.

In a manual system the flow of information is loosely managed and the receiver generally understands the intent of the sender, even if the verbatim request does not match the intent of the request. In an automated, integrated system, "rules" that govern decisions and actions are no longer hidden, or known only to one department. Informal interpretations or corrections that were automatically made to compensate for other departments not knowing these rules, no longer occur. Two descriptions of "rules" and their interpretation illustrate this:

> *For instance, we haven't had cross-matches for six years and yet Nursing or physicians still ordered cross-matches. When it went down to the Lab in the manual system they said, "Oh, they want a group and screen." I thought one of the benefits that we were going to see was that everybody would be talking the same language, number one. It would make processing much quicker. There wouldn't be as many phone calls and verification back and forth. For a long time these people gave Nursing what we wanted, not what we asked for, they did the interpreting for us. One of the things that I saw as being a benefit is that we'd bring Nursing on board with everybody else and what was happening in Radiology and Lab and these various areas.*

> *Lab would change ordering rules... they would have an automatic cut-off, for example, if the specimen wasn't in by 2:00 in the afternoon, it didn't get processed until the next day if it was routine. It waited until the 7:00 run. Lab didn't think to tell Nursing, that was just an in-house rule that they had. Nursing comes along and places these orders thinking that now with the computer system the orders are down there and something was going to be done about them... You know those decisions were always made by another person on the other side. Here we are putting them into a computerized system that doesn't make the decisions for us and we have to tell the system what we want, so it's been a tremendous learning curve for Nursing.*

There are "over 952 orderable tests or exams in the system." Automation of manual clerical tasks (level 1) to order tests and retrieve results on-line from Laboratory and Radiology, is immediately expected to provide some benefit in reducing the time and effort required for these activities. As well, a manual system of sending requests to ancillary departments is complex and invites individual idiosyncrasies to develop. One of the efficiencies achieved through automating these manual tasks is consistently handling orders, which also improves data quality through increased legibility and reduced errors. Nursing spends less time "tracking down" results through phone calls to Lab or Radiology because there are fewer opportunities for the information to go astray. Tests can also be scheduled more quickly because the request is received promptly. Output also becomes more standardized, but perceptions of the quality of output, such as the lab reports, are mixed. The Lab provides more information by including normal ranges for lab values and cumulative results. However, the increase in information also makes it difficult to interpret the reports.

Use of the PCIS to automate patient care documentation (level 3) is another manual task improvement Nursing expects will have great benefits for patient care. Impediments to achieving these promises might be inherent in the linear thinking that occurs with paper based systems. Trying to make their documentation the "best process possible" before embarking on automation may detract Nursing from thinking about what data they want to collect and how to look at it in new ways. Apart from expected time savings and more time with the patient, it is too early for Nursing users to envision how simply automating the present documentation system could be useful or what other alternatives there might be.

Automating some processes gives them a greater chance to succeed and there may be no comparison in the manual system. For example, they are thinking about introducing interdisciplinary, automated charting (level 3) and clinical pathways (level 2) which may be more successful when the chart is accessible from multiple, interdisciplinary locations. Nursing believes that moving documentation to the bedside (in other words, at the point of care) also provides an important benefit. It is difficult to implement in a manual system because many people need access to the chart at the same time. It may be difficult for people to envision how these changes to traditional practices might succeed as this comment illustrates:

> *Now physicians have said that they would never be able to have one sheet where everyone could chart. Down the road I certainly see that perhaps happening, but we haven't been able to convince them yet.*

Workload measurement systems (WLM) are used to record the type and amount of work completed. Therefore, they should reflect automation of tasks and resulting changes in efficiencies and productivity. There is some debate in Nursing at this hospital as to whether WLM are useful tools at all because, in effect, they measure quantity and not quality of care. Automating the data collection simply makes it less time consuming and faster, but not necessarily a better tool for decision-making as this nurse manager explains:

> *We have had GRASP here for a long time. Probably have to tell you that I don't know if workload measurement is really a helpful tool. First of all it doesn't measure quality, it only measures quantity and I don't know that you can measure if that's appropriate for Nursing. I think it's appropriate for factories and widgets. I think that a lot of times measurement systems have been developed to talk to accountants rather than have accountants learn to talk to us, so we're just converting what we do into accountant language. I don't know that that's always appropriate. So that's my personal bias. I still have not been convinced that you can measure workload appropriately or accurately.*

One aspect of nurses' work that is difficult to assess is decision-making and whether on-line information affects decision-making processes is unclear. Nurses using the patient care inquiry function to look at results on-line may simply be replacing the manual system if patient care decisions and activities do not change as a result of this new capability. Because results are available so much quicker, the expectation is that better decisions are made in a more timely fashion. How this is determined is unclear. Some participants do point out however, that information required to make decisions has always been available and if not, they found it. In as much as the information has not changed, the decision-making would not be any different, perhaps just faster. As well, decisions are based on a range of data sources including the patient, so lab and x-ray results are only a part of the information needed.

5.2.3 Use and Impact of Electronic Communication

Nurses are using electronic mail (e-mail) to communicate with each other, both within and between units. They use it to send information to the Unit Manager or Clinical Nurse Educator as well as to request information, sign up for a continuing education class or ask for advice. They are just beginning to use it to contact other members of the health care team, such as the pharmacist or social worker. The consistency of messages forwarded electronically to all staff is a definite advantage over handwriting them in communication books. Using electronic communication also allows Nursing Managers to get the "work related" communication efficiently out of the way. There is less delay in receiving and responding to messages. Informal issues are not lost because when they meet they have time to talk about them.

Nursing staff need access to many reference manuals. Cross-referencing all of these manuals on-line, with access through key words or phrases, is expected to have a positive impact (level 2). As well, given the interdisciplinary nature of health care delivery, there are many decisions, procedures and policies that must be made "by committee." There is tremendous potential for working on shared documents and proposals on-line, which changes the way new information is created, expands the input sources and improves the timeliness of production. There is also immediate feedback as to whether people have completed their contributions to the project. Managers and educators involved in committee work are looking forward to this feature, as this nurse describes:

> *We don't have any shared open cabinets in our group yet. ...I'll be presenting this Convalescent Care Program at Nursing Management on Thursday and I'm actually typing the document in here. I'm going to put it in the library (on the system) so anybody can read the proposal. ...The other thing is I'm able to mail it to any physician I want. If I've got a patient of his that I'm going to assess who I think should be on this and he says, "Well I know nothing about this Convalescent Care Program," I can just mail him the whole document, what the criteria are and how this came about*

5.2.4 Summary

The impact of PCIS on nurses at Hospital 2 is summarized in Figure 5.2. When selecting XTECH, "neophyte" users in Nursing were not able to identify what the system could do for them, but they were expected to participate in system selection decisions and predict potential desirable and undesirable consequences. Some respondents formed a better idea of the benefits once they became aware of the interactive nature of the system, and their ability to communicate with various players.

The role of a skilled clinical liaison person is valuable as an interpreter between clinical users and technical support. This is important when automating manual tasks, but becomes even more so when identifying potential ways the PCIS could support Nursing activities. This requires the ability to visualize how to revise processes, as well as recognize new capabilities in Nursing.

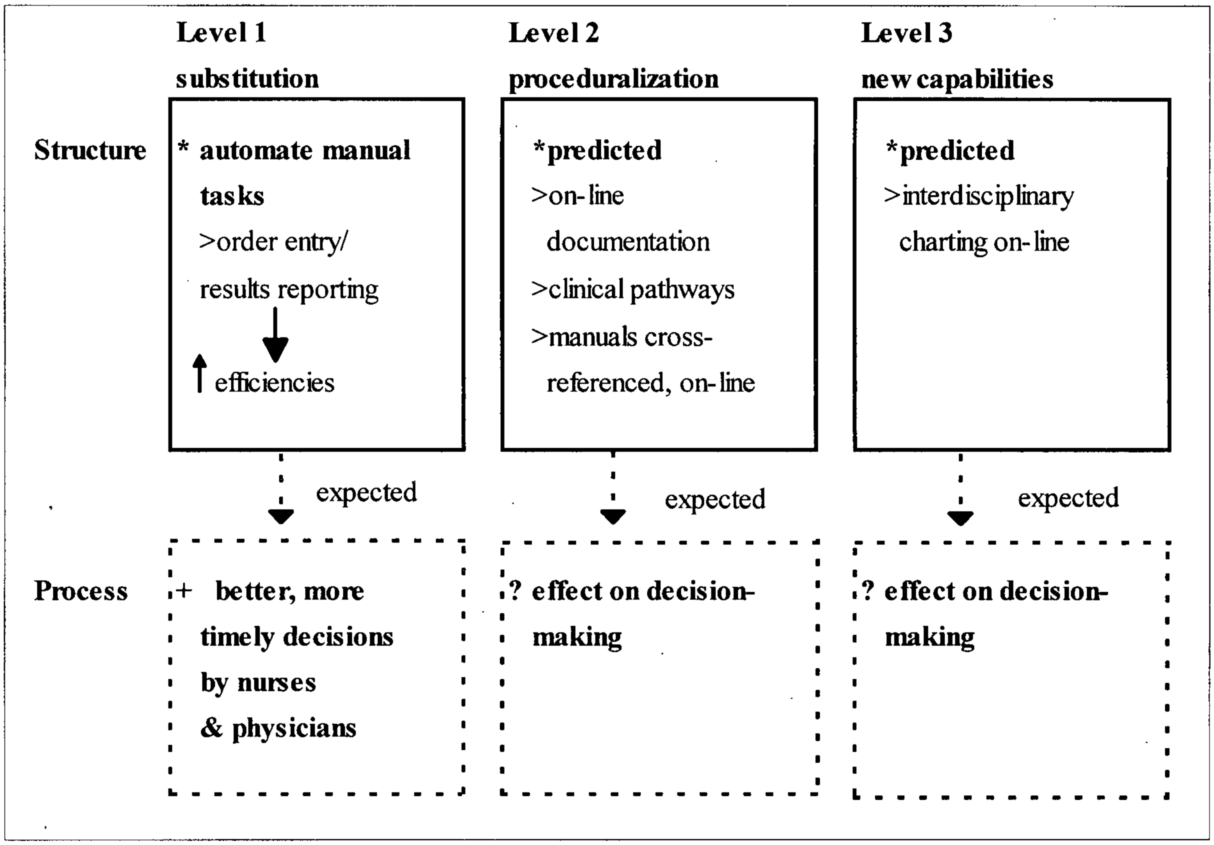


Figure 5.2 - Impact of PCIS on Nurses at Hospital 2

Nursing expects to benefit from more efficient processing of orders and on-line results reporting because they have faster access to better information and improved communication with other departments. Nurses and physicians are also expected to make better and more timely decisions, although participants were unclear what would constitute as evidence that these occurred. Future plans include documentation, manuals and clinical pathways on-line, which will provide opportunities to consolidate a number of tasks into single computer processes. Other than expecting patient outcomes to improve in some way, participants had not yet determined the effect of these changes. Interdisciplinary charting is difficult to accomplish in a manual system due to the limitations of a single chart located on the Nursing Unit. Having all disciplines chart on-line is technically feasible, but in practical terms will not be accomplished until sometime in the future.

5.3 Impact on Pharmacists - Hospital 2

5.3.1 Introduction and History of Computerization in Pharmacy

In 1992, Pharmacy replaced their stand-alone, PC-based (Personal Computer) system, with an older version of the XTECH pharmacy module that was available at the time. They are expecting a newer version of XTECH in approximately one year. The Pharmacy Department dedicated a full-time pharmacist to implementing the computer system and coordinating computer activities. Now that the system is up and running, they still require about half of a pharmacist's position dedicated to maintaining the system and evaluating new programs. In order to make the pharmacy system easy to use, the computer person must understand both the clinical and technical needs of the department, as this participant explains:

> *It's quite easy to use... I think we're really lucky because we had people that put in the information that knew our jobs ... he was one of the pharmacists, so he knew. Whereas other places I know they've had computer people coming in that don't know the job, ... they just know the computer. They have to get all the information second hand and it's hard for people to remember to tell them everything.*

5.3.2 Use and Impact of the PCIS

One of Pharmacy's prime responsibilities is to ensure drug distribution occurs as ordered. This process was not affected when they changed computer systems and continues today. When the physician writes a medication order on a multi-part paper form, the Nursing Unit faxes it to Pharmacy where they key the order into the pharmacy system (level 1). This leaves an opportunity for errors related to both legibility and transcription. Time constraints also mean they have to process more orders within a certain amount of time. Establishing fixed choices in drug names and dosages, assists in improving accuracy because users do not have to depend on memory.

Automation of manual tasks (level 1) is generally expected to result in increased efficiencies and productivity. However, for Pharmacy there is some difficulty in comparing overall pre- and post-productivity measures when they exchange one type of task for another. For example, they no longer have to individually type multiple copies of labels. However, whether Pharmacy dispenses the medications or not, they must enter all of them into the computer. There are also more data fields to complete so the users end up "doing more" as this description illustrates:

> *We're able to do more, we get more information out so I guess we're able to hopefully make better decisions, but we're not more efficient. The computer system doesn't make you more efficient, I wouldn't say. You can't bring in a computer system and eliminate positions. That's not been our experience because you end up doing more, inputting more information. You have to go through a lot more information to get things done.*

One of the drawbacks to increasing efficiencies is the standardization of routines such as order entry, which creates boredom, and a distance between the user and "reality" (or the source of the data). Standardized "warnings" are also built into the program which the user may override. This allows some flexibility in the process, but invites errors to occur. Users can "find ways to get around doing it the right way," which presents a problem for inventory management. It also highlights the new "visible" accountability that did not exist before, as these comments illustrate:

> *Well, I know that people can by-pass the computer a lot. I'm an old stickler for details, and I would say, "That wasn't right, you know. I can tell by the*

computer." In the old days I'm sure people did the same thing but there was no way you could tell. So it doesn't really control us, but it keeps control on what we do, you can say it that way. ...There's evidence (of what you did), but it doesn't really stop people from just doing what they want anyway. ... Sometimes here it doesn't say zero, but it's all used. I don't think people are stealing it, it's just that they don't go through all the different steps.

Yes, it's much more accurate if you do it correctly, but you can trick it so it looks correct too. As far as inventory and that kind of stuff, you can pick the wrong drug and the strength and whatever form is so close that you might pick the wrong one and it looks fairly right.

Pharmacy has experienced a number of changes with their move from a stand-alone system to an integrated PCIS. Historically in the manual system there was a loose integration between departments, but each department was free to operate somewhat independently. Departments relied on informal interpretations and responses to their requests. For example, a physician's failure to renew a prescription order was simply absorbed by the system. Nursing went ahead and ordered drugs due for re-order, Pharmacy sent them, and the patient continued to receive them. An order was eventually written and sent down to Pharmacy, indicating whether to continue with, or discontinue, the medication. Now the "computer system" does not allow the Pharmacy to dispense additional doses until the written order is received in the department. Similarly, a change to ward stock items on the Nursing Unit previously required just a telephone call and Pharmacy dispensed the medication. Now a more formalized requisition process must be followed as a result of the automated inventory systems.

The effect of integration is also evident in changes to information access. In the past only Pharmacy had access to the patient's full medication profile. Currently they are in a transition period of converting a manual medication profiling system to a computer profiling system, which only some Nursing Units have completed. Having all the information on the computer means it is easier to make decisions on therapy. They can produce a copy of the profile for interdisciplinary patient care rounds, providing all team members with the total picture. Participants predict on-line review and real time updating of orders will be effective ways to use this information in the future (level 3).

There are other opportunities to use integrated information with the PCIS system. They are limited in conducting some studies because information reflecting nursing care (such as nurses' notes, care plans, vital signs and medication administration records) is currently not available. Availability of complete information affects decision-making from Pharmacy's perspective, as this example illustrates:

> *We started getting into cardiology but we have none of the patient care vital signs or nursing monitoring, so it's hard to tell what's going on. For calcium channel blockers, which are a very expensive drug class, it would be nice to look at efficacy in terms of BP control and heart rate, but I don't have the [numbers]*

One such opportunity created when using an integrated PCIS, is that they can establish a combination of parameters for data collection from different areas and automatically generate reports (level 2). This information plays an important role in managing inventory as well as supporting clinical activities. For example, pharmacists can identify patients on medications whose dosage requires adjustments for renal impairment. Within that list, they note patients whose lab tests suggest renal impairment and follow-up with them. Making this information available to physicians also has a potential effect on their decision-making. For example, pharmacists have played a role in presenting information related to lab culture results, sensitivities and drug costs to physicians. They see a positive influence on behavior demonstrated when pharmacists show physicians data on their colleagues' ordering patterns and compare their individual practices to this benchmark. This participant explains:

> *Most physicians genuinely want to do the best thing for the patient. If you present an argument where efficacy and toxicity are not being compromised and it comes down to cost, most of them are very persuaded on that. They want to do the best plus maintain cost in the system because they know that every dollar wasted is one less for patient care somewhere else.*

In addition, the marketing strategies of pharmaceutical companies influence physicians' decisions related to drug prescriptions, and pharmacists have an opportunity to mitigate that. Access to a broad information base with respect to drug benefits presents Drug Utilization Evaluation pharmacists with the opportunity to move away from retrospective analysis of drug usage, to pro-actively establishing guidelines for use before the drug is introduced into the hospital (level 2). However, the ability to carry out this new activity is in part limited by the flexibility of XTECH. Pharmacy sees itself as a rapidly changing discipline with new ideas, new ways of doing things and new programs. They are frustrated with a vendor who is very slow to respond to requests for changes in their product. They also have an older version of the software and expect improvements in the next version.

Some users are concerned about the future liability of having access to all this information, the difficulty in setting priorities and not being able to respond to all the situations that they can now identify. In the future, Decision Support Systems may provide some relief in assisting to determine priorities for action. In the meantime, pharmacists sometimes feel that using the technology may be setting them up for information overload and less effective practice. Without evidence-based decision making, there is difficulty in setting reasonable limits for expectations. In a manual system some of these are set naturally by the labor intensive nature of the tasks. A pharmacist describes this dilemma in this way:

> *Well, that's kind of a 'win lose' situation though, because I can identify more problems with patients and end up working harder. You see more patients and you accomplish more, which is good, but I find that with all the data hitting you now you're overwhelmed. ... Before we used to target just the antibiotics like Gentamycin and that was a full day service. Now we're getting all these other things, we have to prioritize everything and I can't see all the allergy assessments, I can do maybe three a day. I can't get to everybody, so I feel more guilty. ... As long as you go home and you've hurt no one, I feel safe going home. Could I have done more? Well, you can stay longer and do more. I get job satisfaction knowing I've turned these patients around faster, the system wins because length of stay and drug costs have decreased.*

5.3.3 Use and Impact of Electronic Communication

Pharmacists have found e-mail to be useful in sharing information throughout the hospital. In particular, managers can easily forward a message to all staff that they have received. However, the effect of this on decreasing social interaction is a concern, as expressed by this pharmacist:

> *Decreased social interaction? Big time. You don't see some people anymore. You don't talk to them on the phone, you get e-mail back and forth and it's fine, I still know who they are but there is less social interaction now. The saving grace for me is that when I go into the wards, I'll see them. ... I can go see the patient, talk to them, I can tell them there's a pharmacist involved with their care. ...*

Using e-mail to communicate clinical information to physicians has not proven to be too successful. A lab result can quickly and easily be sent to the physician with a message attached. Where discussion of this information needs to occur, rather than a single, one-way communication, it has not been effective.

5.3.4 Summary

The impact of PCIS on pharmacists at Hospital 2 is summarized in Figure 5.3. Approximately three years ago Pharmacy moved from a stand-alone system to the XTECH module. The hospital is now in Phase 4 of five phases of their PCIS implementation, and pharmacists can see the benefits of an integrated system. However, they have an older version of the pharmacy module that is awkward to use and does not meet their present needs. They feel they input a lot more information now, but it is difficult to get it out in ways that are useful. They are looking forward to the new version that is expected to be more flexible, user friendly and programmable.

Pharmacists benefit from using the PCIS in a number of ways, such as time savings when processing renewal orders in the dispensary. XTECH is slower than their previous stand-alone system, which was dedicated to Pharmacy. One of the reasons is there are more data fields to complete because they are collecting more information. For example, maintenance of a perpetual inventory saves money by reducing the amount of inventory kept on hand. However, there are time and personnel costs to maintaining inventory numbers because they must enter information regarding all dispensed and returned drugs.

As part of the pharmacist's clinical duties, they interview patients with drug allergies and enter the information into the PCIS where it is permanently stored. Automatic flags prevent errors in dispensing drugs the patient is allergic to, as well as the information being available on future admissions. Pharmacists predict that information contained in medication profiles may also be available on-line in the future to assist with multi-disciplinary discussions of patient care.

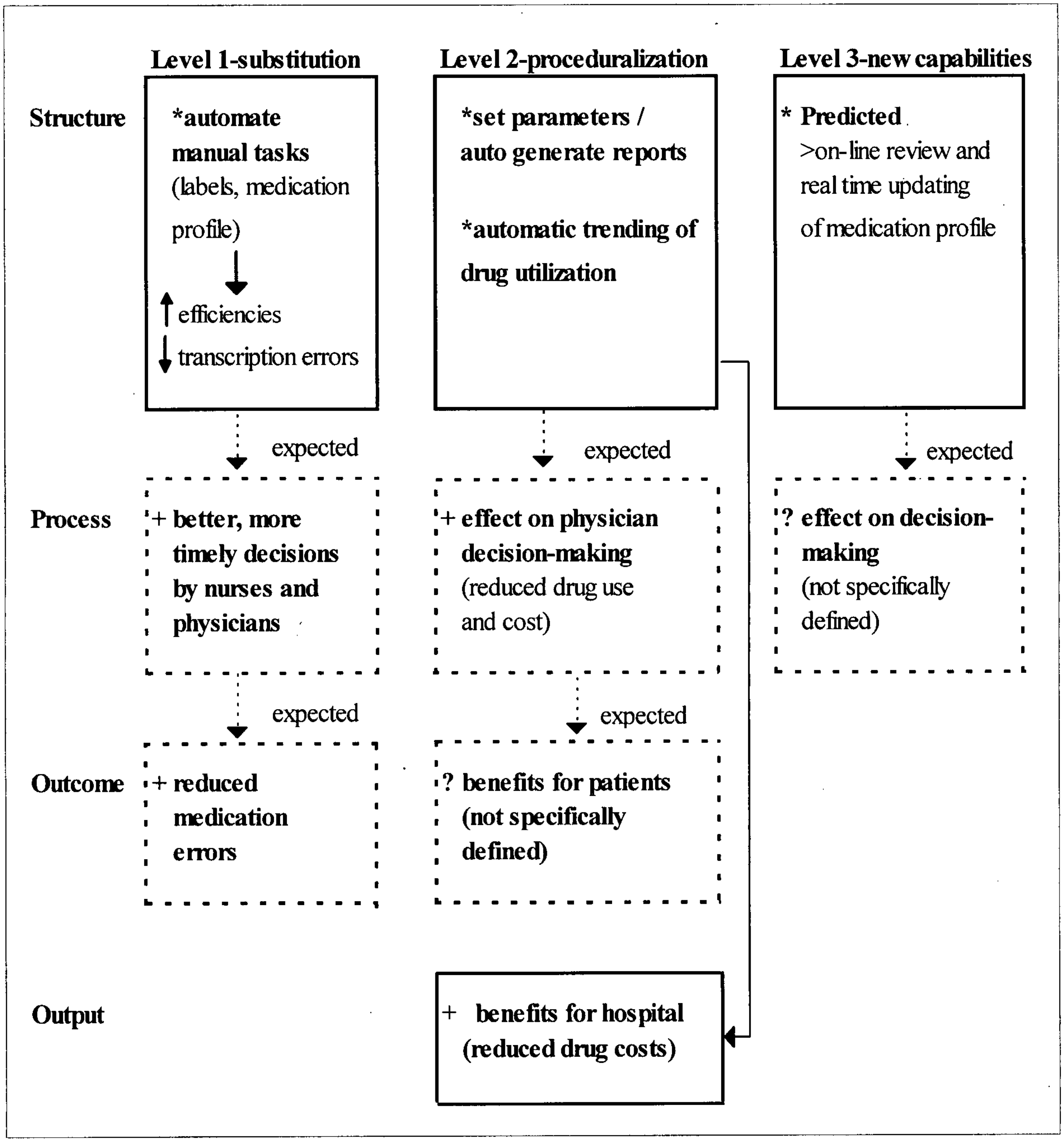


Figure 5.3 - Impact of PCIS on Pharmacists at Hospital 2

Access to information from other departments facilitates Drug Usage Evaluation and automatic reporting of conditions exceeding pre-set parameters. Providing this information to physicians has successfully influenced changes in their drug ordering patterns, which are also expected to benefit the patient and the hospital. It is not clear whether patient outcomes change by reducing the number of doses of medication or using less costly brands. The activities at level 2 imply benefits to patients arise from changes in physician behavior, but what these are specifically has not yet been determined.

5.4 Impact on Physicians - Hospital 2

5.4.1 Introduction and History of Computerization in Medicine

Physicians' Registry (for signing in and out of the hospital) and patient lists through the Admitting system have been available through a previous information system for many years. These functions became available through XTECH in 1992. Only very recently have physicians had remote and on-site access to patient orders. Operative reports and discharge summaries have also been made available on-line recently when Health Records began their Electronic Health Record project.

While physicians have participated in some of the system development activities, the clinical liaison role has been absent. Training for physicians has not been too successful yet as the costs and benefits of physicians using the system are not clear. Many other user groups have expectations for changes in physicians' practices, without strong incentives or support for these to occur.

System access is through two kinds of terminals. Five terminals of one type are available throughout the hospital for signing-in. Physicians can access patient information at XTECH terminals on every Nursing Unit, and also use them to sign-in. Off-site, or remote, access for physicians is available, but implementation is both a cost-benefits issue and business decision. They have to weigh the costs of IT purchase and implementation (not only financial, but degree of disruption, effort to change and the learning curve involved) against the benefits of increased access to information. As a pilot project, one clinic with eight physicians invested in remote access and demonstrates what they consider to be fairly heavy use, as this description illustrates:

> *...On any given week day they have upwards of about 72 accesses to the system. So these physicians are constantly clicking in and pulling up results and looking at all kinds of things and following up with their patients. We were really pleasantly surprised at the amount of time they were spending on the system.. But it comes down to dollars. Who's going to pay for the computer? Who's going to pay for the ISDM line? Right now people are very dollar conscious ... and it comes down to, I guess, the political will.*

5.4.2 Use and Impact of the PCIS

Although there is a range of users within the group, physician use is generally minimal. Most physicians are able to sign on and get their patient list without much difficulty. A few individuals and one clinic are achieving benefits with their access, although others are eager to begin when the resources become available, as these comments indicate:

> *I generally start at home by phoning in. I have the remote software that plugs in and I get my patient list (on screen). I also use something called patient care inquiry to get any new laboratory results. Then of course one would come in here and sign in, then use it to generate your patient list, which you can get as a print out copy.*

> *We sometimes laugh that there are still a few using quill pens out there. [laughter] There are some who are already pushing us quite a lot to get on the system and get using it and we're already trying to do that. We have limitations in finance and time and people to sort of plug everyone into the system. But we have one of the clinics that has full hook-up already and is using that. We have umpteen more who want to do that and quite a few of the individual physicians who say they want to do that when they can.*

Other professional groups expect that physicians' decision-making will change with the introduction of a PCIS. However, many physician participants note that decisions still reside with the practitioner and providing information in a more timely manner is only one element in this decision-making process. As well, one physician suggested that the effect on decision-making would be difficult to detect, as this comment illustrates:

> *It's a bit of a leap of faith to say that it's affecting decision making very much yet. We would like to think that it's setting up a situation where patients can be assessed and perhaps discharges occur a bit earlier and some of those things happen. I don't know how we're going to measure the extent or impact of that...*

The presentation of data is important in the decision-making process, however perceptions of the quality of output, such as the lab reports, are mixed. The Lab provides more information, such as the normal ranges for lab values and cumulative results, but the increase in information also makes it difficult to interpret the report. Another concern for physicians is the inflexibility of XTECH and both the difficulty and cost, of making changes to the report. A number of these issues are related to acceptance and impact of XTECH, as this participant explains:

> *Previously it was handwritten so now it's in a more readable form. But unfortunately it's very limited in the forms that we can use, the size or the highlighting of certain areas that we cannot change. When you look at a computer generated report it's very easy to read in the sense that it's not hand transcribed, but there's just too much information on the page that it overwhelms the reader. Even though it's easy to read and clearly written, it doesn't hit you in the eye. You cannot just look at the page and hone in on that particular spot. ... Because of that a lot of physicians are up in arms about [lab] reports and it's very difficult for them to express why they don't like it. They know they don't like it. In the past, although the handwriting is bad at least they can get the information out very fast. Now they have to hunt for all that information.*

A number of physicians note benefits through increased efficiency and productivity in managing records, filing and retrieving information. This is of particular importance for managing the paper work in a general practice setting. As well, "with a few keystrokes" they can efficiently retrieve patient information from previous visits rather than searching though old files.

Participants identified several drawbacks to increasing efficiencies. In part the added efficiency comes through increased information accessible from any terminal. However, easy access to all the information needed, rather than having to go to the source of the information, creates a distance from "reality." As they become more productive physicians may also become busier than they want to be. They end up doing more work because they can, and it becomes more difficult to set limits.

While benefits to the organization and individual depend on use, the reverse is also true: use of the system will be minimal if expected benefits are not evident. For example, if the system does not support work related to patient contact and is seen as intrusive rather than supportive, it has minimal usefulness. Physicians may also be reluctant to use the system if they are not comfortable using the tools, have other time pressures related to seeing patients and terminals are not easy access, as this physician explains:

> *...As far as physicians having electronic records, usually what they're doing is just dictating and someone else is putting it in the system again. It's the time and disruption to sit down at a keyboard and do your entering that I think is still a hurdle - a bit like practicing medicine the way the reservations' clerk at the airline counter does. I mean, they talk and they type simultaneously and to me it's a little bit more difficult to do that. You need your hands on the patient's pulse or something rather than on a keyboard so there's a bit of a mechanical issue there. ... I'm sure there are some who are doing it and there's been some interesting articles in the literature about it, but it's far from being the norm.*

A variation of this is the chauffeured use[1] of information systems that develops in a manual system as an efficiency measure in response to geographic and time related barriers. For example, the physician calls the Nursing Unit for lab results they recorded on paper and sent to the Nursing Unit. While these barriers are removed in the automated system, many of the same practices continue in use of the PCIS, such as physicians calling for results rather than accessing them directly. Because physicians have moved to electronic submission of claims to the Medical Services Plan, this is sometimes assumed to mean they use computers and are computer literate. However, several participants suggested that in many cases physicians delegate automated billing procedures to the office secretary or service companies, much the same as it was in the manual system.

Related to this is the controversy surrounding direct order entry by physicians and a number of issues to consider in deciding whether the benefits are worth the costs. Automating order entry that is currently handled by unit secretaries simply requires automating a manual process. However, introducing a system where physicians enter their own orders becomes a whole new process, one that is much more difficult to implement, but is a cornerstone of the Electronic Health Record (EHR).

There is considerable disagreement on the value and approach to an EHR, which stems in part from how it is defined. Several years prior to these interviews, the Health Records Department embarked on a project to radically change how they managed health records. Physicians had always been responsible for signing-off their patients' charts, a responsibility that most of them fulfilled without reminder. Health Records personnel also maintained a follow-up system to ensure the sign-off occurred. A survey of several hundred charts revealed that the majority of physicians promptly signed off their charts and this "safety net" was really not necessary. Accountability for signing off their patients' charts was officially returned to the physicians.

At this time Health Records personnel began optically scanning all documents in the patient record, making storage less costly and electronic retrieval at a later time more efficient. A disadvantage of this system is that access is limited to terminals where the CD-ROM can be read. This version of the EHR is not in its most useful form for practitioners to "flip" through the chart looking for information. The definition of EHR from an HIS perspective is having all the information entered directly on the PCIS, with no intervening paper step. This version has the added advantage of being accessible from wherever an XTECH terminal is located or through remote access to XTECH.

The drawbacks of an EHR are related to the benefits and use issues discussed earlier. The physician gains a holistic picture of the patient and his/her complaints through analysis of information from many sources: the patient chart, the patient and family, other health care professionals. There is a fear that an EHR may limit this process through being able to see only one screen at a time and the concentration of information, as described by this physician:

> *[The EHR] is not going to work. It's going to affect patient care because computers are still very limited in a sense. All over they talk about multi-tasking and all that, but compared to the human brain it's still not as efficient. A physician can look at a chart and immediately his mind starts processing. He forms several opinions on the patient just by looking at the chart. If it's very thick then he knows the patient has been here before or for a long time with a lot of complications. A computer will really just show you one screen at a time and you just don't get that feeling of looking at the physical thing. When you look at a page, you don't just look at one result, you immediately look at the whole page of results and begin forming several opinions.*

5.4.3 Use and Impact of Electronic Communication

Physicians practice medicine in institutions and offices located through-out the community. They are coming and going all the time and e-mail provides them a way to communicate more easily. It also proves to be an advantage for communication between medical administration and physicians. In both cases, messages are handled more promptly and efficiently, and there is less time spent chasing each other down by telephone. Not all physicians are sold on using e-mail and one obvious reason is the need to be able to type. This means not all of the medical staff are using the system, resulting in the need to maintain duplicate systems in order to send out messages.

Electronic communication with community agencies presents opportunities to use e-mail in a new way (Level 3). While this is not operational yet, some users could envision these opportunities, as this comment illustrates:

> *We use it for e-mail within the hospital and there'll be other groups that will be involved in our net coming along... The health department is sort of hooked up, but I'm not sure where that is at. We can now send faxes out of the system. If you have a message and you want to fax it to yourself or somebody else, you can do that or you can send it to external e-mail carriers. That's also possible.*

5.4.4 Summary

The impact of PCIS on physicians at Hospital 2 is summarized in Figure 5.4. The automation of tasks in Pharmacy and the Lab that influence production of information is expected to affect physicians' decision-making, particularly in reducing length of hospital stay and associated costs. However, physicians note that decisions still reside with the clinician and these will not likely change dramatically. They have only recently acquired on-line access to orders and reports, so this may change over time. Physicians also benefit from automation of documentation in patient charts and referral letters (in the office), retrieving billing information and production of patient lists (particularly when they are on call).

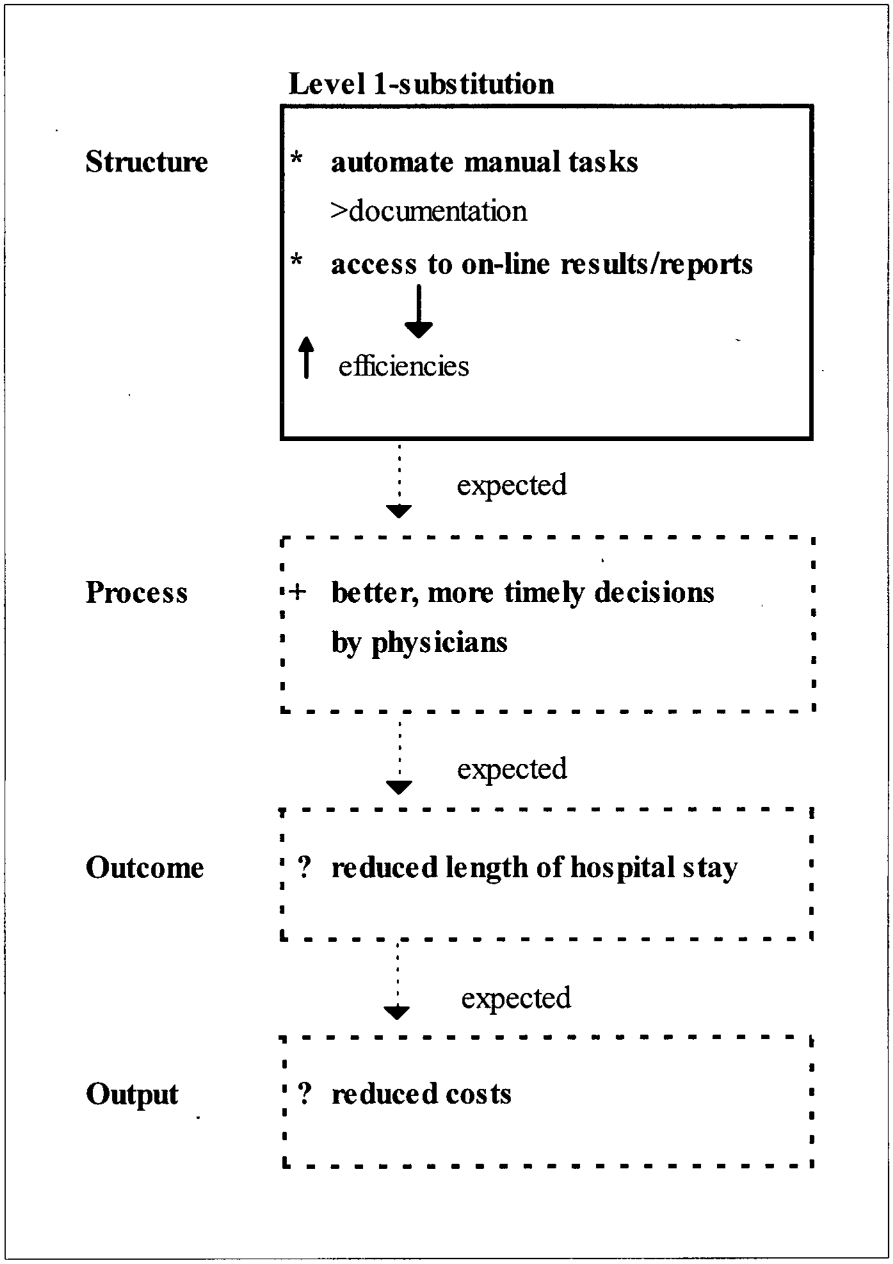


Figure 5.4 - Impact of PCIS on Physicians at Hospital 2

Other information intensive industries are not based on the same kind of relationship that medicine has between vendor and client. Efficiency and effectiveness gains achieved through talking and typing simultaneously do not balance their intrusiveness to the clinician - patient relationship and decision-making process. Many clinical assessments are complex and contain subjective as well as objective information about the patient. For this reason, physicians feel uncertain whether use of computers will transfer well into clinical medicine or whether they will be used in a constructive, effective way.

This uncertainty relates to the increased efficiencies the organization expects when physicians enter their orders into XTECH. Physicians identify potential drawbacks to this idea that include an implied reduction in flexibility when writing orders and use of a keyboard, which slows down data entry. As well, "Administration" may exercise an element of control through the system design.

Because physicians practice independently from the hospital, there are costs associated with having remote access to XTECH, which they have to decide is worth their time, effort and money. The costs and incentives are also related to the number of physicians that share the office.

5.5 Summary - Hospital 2

5.5.1 Introduction and History of Computerization

The degree of system and operational integration is an indication of success in other multi-user systems such as electronic data interchange (EDI). It may be a factor where a single vendor, integrated system is the goal. The integrated approach to information management at Hospital 2 includes sharing a common patient data base and offers benefits to the organization through smoother transition between departments, reduced duplication of work and increased accuracy. Patient benefits such as scheduling across the system, reduced repetition and faster communication of results are expected to flow from that.

A strong, stable HIS department, senior administrative support and a history of positive implementation experiences have developed confidence in the users. Designating application coordinators and then supporting these people has built a foundation of strong clinical and technical knowledge for each department. Departments also benefit from their previous experience with systems, such as in the Laboratory and Pharmacy. This was evident when Nursing and the organization saw benefits with the "big bang" approach to implementation, rather than a slower approach of mixing manual and automated systems.

5.5.2 Use and Impact of PCIS

Achieving maximum benefits from XTECH depend in part on the degree of system integration and its full use. There are some inherent difficulties in achieving this with a mix of mandatory and voluntary users. As in most hospitals, use of the PCIS is a job requirement for all professional employees. Physicians, on the other hand, are not employees of the hospital, but have privileges to practice in the facility and therefore do not fall under the same mandate. Although there is a range of users, physician use is generally minimal.

Nursing is most aware of integration in terms of learning how to interact with other departments in new ways. However, what other departments like Lab and Pharmacy are more concerned about is the effect on operational decisions. In a manual system, changes within a department could be made easily and more independently, without affecting other departments. With integrated systems, all departments have to take more active roles in knowing how their decisions will affect other departments. This requires new flexibility in operations and communication because changes in one department may not necessarily be favorable for another. Individual users are also beginning to realize the interplay with other departments and how a change in one has an impact on others, resulting in more dialogue between departments.

Participants identified several drawbacks of integration. The first drawback is a lack of agreement between the department and organization's expectations for the system. If they do not agree on the benefits or direction to take, the nature of integration suggests that organizational needs must take precedence over departmental ones. A second downside to a single vendor, integrated approach is the system's limited flexibility and their slowness in making changes to the system.

Study participants expect implementation of XTECH to impact them primarily in two areas: automating manual clerical tasks (for Lab and Pharmacy) and decision-making (for Nursing and Physicians). In Nursing, automating clerical tasks affect the Unit Secretary more directly than the Nurses. The automation of tasks is expected to result in increased efficiencies and reduced errors.

Expected savings through reduction and reassignment of FTE's, as well as better use of resources, has already occurred in non-clinical areas. In clinical areas "micro" time savings in many activities do not necessarily translate into savings of FTE's. When manual tasks are automated (level 1), there is a definite increase in the efficiency of data entry for orders. This is easily reflected in the work of the Unit Secretaries who enter, on average, about 500 lab tests a day. This translates into the number of results that are processed by lab technologists. The number of tests ordered would not necessarily increase or decrease as a result of an information system, but continues to depend on physician orders.

However, one participant suggested that benefits for professional staff such as efficiency, time savings and convenience are really taken for granted. In other words, they are obvious and agreed upon gains and therefore not worth the time and effort to measure them. They are considered almost "spin-offs" because even if they do not produce the savings expected, the hospital is not going to remove the system due to financial gains in other areas. There seems to be little incentive to determine changes in process of care or patient outcome that result from using the PCIS, unless a direct cost or saving can be assigned.

Increased efficiencies and productivity have a downside as well. Standardization in tasks increases efficiency, but does so by making the work more tedious and narrowly focusing concentration on the task. In other industries this has been likened to creating an "intellectual assembly line." Better access to information also supports efficiencies because most of what is needed is available at the computer terminal, rather than having to go to the data source - the patient. Users note that this begins to create a gap between themselves and "reality."

Increased standardization and reduced data handling are intended to decrease errors. However, two factors get in the way of demonstrating that this occurs. In manual systems it is often difficult, if not impossible, to track all possible errors. The benchmark that departments are comparing their "reduction of errors" to may not be reflective of the actual number of errors that occur. Some participants describe situations where potential errors were caught and corrected in the manual system, but these were never officially documented. The other factor is that errors, or potential errors, become more "visible" with the automatic "surveillance" inherent in computer technology. This means the documenting of errors may increase, not necessarily the number of errors.

Although participants expect decisions to change for the better in some way, it is difficult for them to identify how decision-making might be different. In the case of hospital utilization management, managers expect that having information available sooner (that is, quarterly rather than two years old), will assist them in making more timely decisions. However, one participant also pointed out there are several trends in health care that are occurring irrespective of the computer. One trend is reducing lengths of stay as a result of different drugs and therapies and another is increasing hospital efficiencies because they must. Nurses, pharmacists, and lab techs more frequently predict changes in physician decision-making behavior than do the physicians themselves. For example, faster turnaround for lab results (two hours versus twelve) is expected to impact decision-making related to utilization of resources, such as reducing length of hospital stay. Timeliness of results, new report format, more information and less errors are all expected to benefit nurses and physicians, and through their decisions, the patient.

Use of the PCIS has contributed to some financial savings in clinical areas, such as the drug utilization studies done by the Pharmacy Department. Pharmacy has been able to reduce inventory, although it is not clear whether the IT has contributed to that or simply made it easier to see. The pharmacy mandate is to decrease costs and save money, given the most effective and efficacious drugs available. Information provided through the PCIS enables pharmacists to encourage physicians to change their patients sooner from more expensive intravenous drugs to less expensive oral medications. This activity contributes to

Pharmacy's mandate (level 2), but it remains the physician's responsibility to change the orders, discharge the patient sooner and translate the medication changes into savings through reduced length of stay.

5.5.3 Use and Impact of Electronic Communication

Electronic communication (e-mail) has provided tremendous, sometimes unexpected benefits. It is particularly useful in organizations like hospitals, where one or more parties are not physically present due to geographic or time separations, and large numbers of people are involved. Where e-mail has replaced manual communication systems such as memo's, communication books and telephone messages, participants report that both the quality and quantity of communication have increased (level 1). In spite of fears that e-mail may potentially reduce social interaction, it has proved to be a very beneficial link for people on shift work. For some users, e-mail does not decrease or replace the amount of social interaction, but rather they see it as an expanded, electronic contact.

Participants identified several drawbacks of using e-mail. Because it is so easy to use and so immediate, users seem to be encouraged to send a larger volume of messages than usual and to "forward" problems rather than solving them. Users find it difficult to judge the importance or urgency of messages without opening them, creating a problem compounded by "junk mail," such as vacation notices or lost mugs in the cafeteria. Not everyone in the organization uses e-mail regularly so the system is not as effective as it might be. Both of these situations incur hidden organizational costs. Users must maintain duplicate manual systems to support effective communication when everyone is not using the system. They also require additional time to process messages that are not useful or relevant to their jobs.

Electronic communication of minutes, agendas, and on-line manuals has effectively extended the notion of "e-mail." In a manual system, updating the many policy and procedure manuals is a monumental task that includes making changes, distributing copies and filing them hospital wide. The hospital must also ensure that employees who use the manuals are aware of the changes, and can use them to quickly locate information when needed. When the time came for revisions several years ago, the hospital took the opportunity to put all the manuals on XTECH to begin making this information available electronically.

5.5.4 Summary

Impact of PCIS on all groups at Hospital 2 is summarized in Figure 5.5. The most powerful impact of XTECH in the four study groups is the automation of manual clerical tasks (level 1). These structure changes are expected to affect decision-making for nurses and physicians. However, participants generally could not specify how decisions might change except that they would be better decisions in some way and made more quickly because information would be available faster.

The nature of many reporting and checking tasks in the Lab and Pharmacy lend themselves to proceduralization (level 2), for example, matching results against a standard to check for errors or abnormalities, checking for drug interactions between new orders and previous ones, dangerous drug/disease combinations and drug utilization evaluation. Changes in drug therapy decisions demonstrate the most specific, measurable linkage between structure and process. For example, determining which patients continue to receive intravenous therapy after three days and reminding their physicians to reduce the treatment to oral therapy. This is not only cost effective, but patients benefit as well. In some cases Pharmacy reduces costs directly by using information in the PCIS to make choices in limiting the drug alternatives available to physicians.

Patients are expected to benefit in other ways. For example, participants expect better information will support better decision-making and reduce errors. As described earlier in this chapter, there are a number of difficulties in measuring changes in this area pre- and post-implementation of XTECH, and there is little incentive for determining what these changes are. Financial benefits achieved through using XTECH in non-clinical areas are significant and far outweigh any immediate demonstrable savings in the clinical areas.

Participants identified a number of new capabilities that are planned for the future. In some cases, such as interdisciplinary charting, the idea is not new, but becomes much more feasible with the PCIS. Other ideas, such as electronic communication with community agencies is possible through expansion of system capabilities that are new.

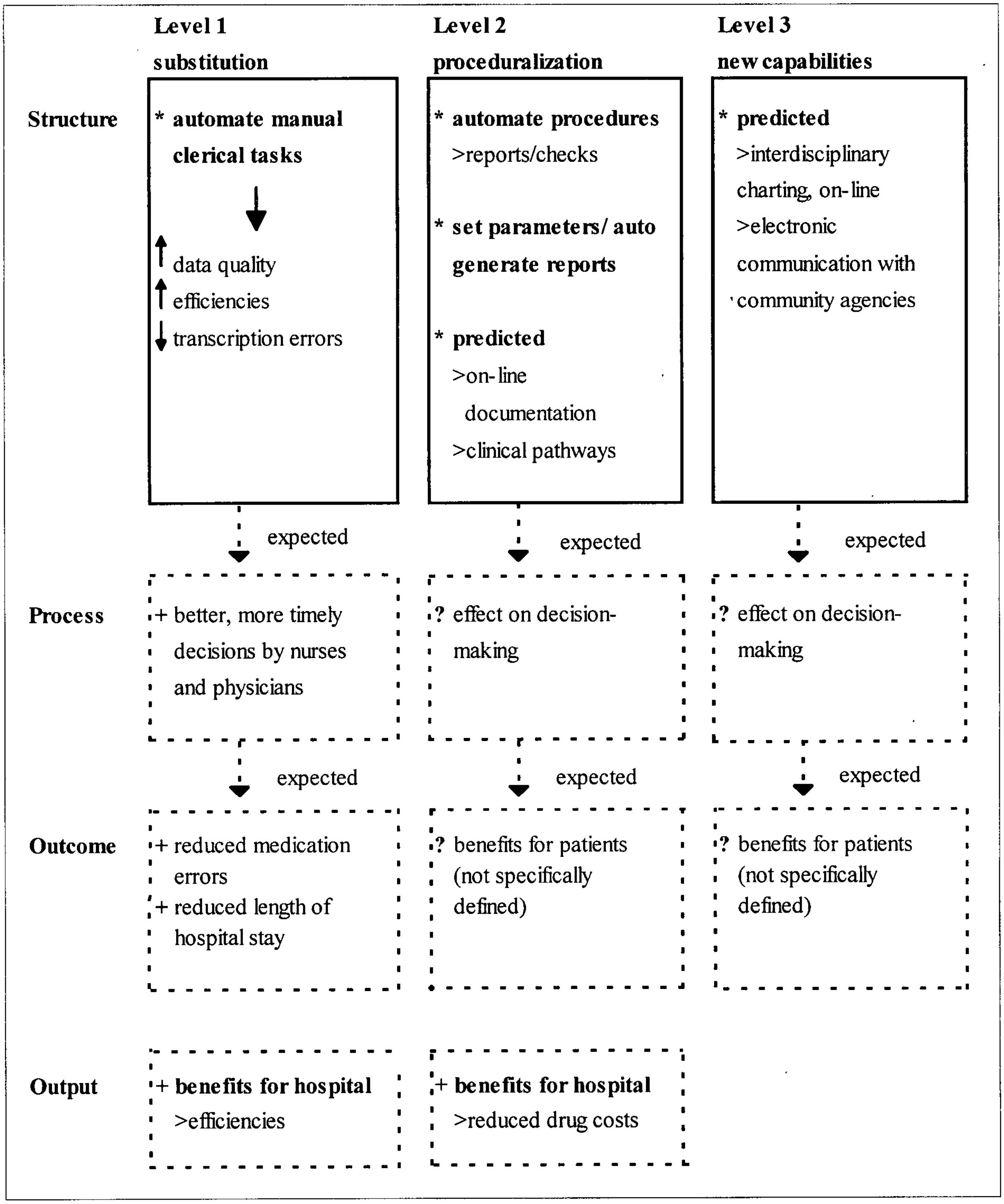


Figure 5.5 - Impact of PCIS on All Groups at Hospital 2

Endnotes

1 Delegated or "chauffeured" use occurs when the person who uses the information doesn't use the system to enter or retrieve it.

Chapter 6 - Comparison of Impact Across Groups Within Hospital 3

6.0 Introduction

Eighteen interviews were conducted at Hospital 3 from May 15 to 18, 1995 with four representatives from Nursing, three from Pharmacy, five from Laboratory, three from the Medical staff, and three from Information Services (HIS). The number of beds in the hospital has been reduced dramatically over the last several years (from 400 to 270), causing a lot of turmoil with respect to potential reduction in services and jobs. "Computers" have become a prime target for accusations of overspending.

Hospital 3 has a long history of computerization which began over ten years ago. An integrated PCIS was selected in 1985 and many of the modules were purchased. The Information Services Department was small, but attempted to provide comprehensive services hospital wide. The hospital soon outgrew the system hardware, which had to be upgraded. After implementing only a few modules, the PCIS was difficult to maintain and unreliable with frequent unscheduled downtimes. Given these circumstances, the hospital decided to select a new PCIS rather than pursue further development of their current system.

One year prior to the interviews, Hospital 3 moved to an integrated systems approach with XTECH. Previous systems were replaced first and these included Admitting, Pharmacy, Laboratory, Health Records and some of the Financial applications. PC's have been installed through-out the organization on a Local Area Network which require boot-up disks specific to each terminal. In the event of a power outage or not powering down terminals before a scheduled downtime, new boot disks must be issued by the HIS Department to each user, which causes frustration and delays on both sides.

6.1 Impact on Laboratory Technologists - Hospital 3

6.1.1 Introduction and History of Computerization in the Laboratory

The Laboratory at Hospital 3 employs approximately ninety people in seventy positions, and is divided into five traditional functional areas: Chemistry, Hematology, Pathology, Microbiology, and Blood Bank. The Lab has a long history of computerization with their first system installed in 1977. In approximately 1982, this stand-alone system was replaced with another which was eventually intended to become part of a hospital wide system. Before this could take place, a number of problems with system reliability and its limited potential for expansion convinced Hospital 3 to begin looking for a new system.

Generally, the Lab expected the new system to have a better response time than their previous system which they had outgrown and had "crashed a lot." Other than that, they had been fairly satisfied with their second system. They were looking for additional flexibility such as being able to access both lab work and word processing from a single terminal and "user friendliness" in the new system. The Lab also expected improvements in their software used for quality control, workload and management information. Representatives from the Lab participated in the selection process through development of a Request for Proposal (RFP), site visits and vendor demonstrations. XTECH was selected as a single vendor, hospital wide, integrated system and the stand-alone lab system was replaced in August 1994.

All lab modules except Microbiology, Anatomical Pathology and Blood Bank were initially implemented.

One person was responsible for overall coordination of computerization in the Lab with senior technologists responsible for their own individual areas. Most users in the Lab are quite computer literate. They found XTECH easy to use because the system is menu driven and most of the menus are tailored to what users need. A training room with ten terminals was set up, although much of the training took place in short sessions at the bench when there was time available. Their past training experience taught them that "bombarding" people with information makes them confused, so they tried to keep the training very basic. Total training time varied, but was anywhere up to a day and a half overall. For some areas this involved "breaking old habits" because the previous system had been in place for a long time and they were used to working a certain way. In this sense the computer was felt to be somewhat controlling at first, as this lab tech explains:

> *Learning to use a computer you have to do what the computer wants you to do. There's not a lot of variation there. And so when you're using the computer you have to understand how it thinks and sometimes to us it's not always logical [laughter] but it's just an adjustment you have to make.*

However, when Microbiology was implemented several months later, they did not have a history of computerization and so expected to spend more time initially just getting used to the system. The Lab ran parallel systems, live (in the old computer) and test (in the new computer), for a month before actually switching over to the new system.

Accessibility differs by functional area and need for access. In Chemistry there is almost one terminal per workstation so they were easily accessible, but in Microbiology only the results from four tests are being entered and five to eight technologists share two terminals.

6.1.2 Use and Impact of the PCIS on Laboratory Technologists

The Lab expects productivity, as both a function of using automated instruments (which run the tests faster) and the computer system (which helps report the results faster), to increase. For some areas, productivity definitely improved with the initial computerization, but they expected no additional changes with the new system. Large instruments in Chemistry are on-line so everything goes back and forth between them and the host computer automatically, making it very easy for the person operating it to monitor everything.

In Microbiology however, it is debatable whether more computerization would mean they could process specimens more quickly. Most of their testing is time dependent, such as incubation which may be forty-eight to seventy-two hours. Productivity is expected to decrease initially in this area as technologists in this area get used to knowing where to look for the information. As more instruments go on-line, they expect to reduce the turnaround time for reporting results.

Relaying the order from the Nursing Units to the Lab remains a manual process, as illustrated in Figure 6.1. Physicians write orders for lab tests which are transcribed onto appropriate requisitions on the Nursing Unit.[1] These are sent to the Lab where they enter the request into the computer, collect the sample and conduct the test. A computer generated report is printed in the Lab and sent back to the nursing unit when the test is completed (which is the same as with the previous system). Four exceptions are the Intensive Care Unit and Intensive Care Nursery, which have terminals and Emergency and the OR which have printers so results can be printed directly on the nursing unit. Nursing has become more actively involved in the design of lab reports in view of the integrated nature of this new system and their imminent involvement in entering orders directly. Microbiology is somewhat different because they have a few automated instruments (e.g. antibiotic susceptibilities), but many of their tests are still done manually. Eventually more instruments will be interfaced and report directly through the computer. Until that time, results from only four tests are entered into the computer and the remainder are reported back on the paper requisition.

The Lab automatically achieves a number of benefits when their instruments are on-line. Elimination of transcription alone has a large impact in both reducing errors as well as increasing productivity, as this lab tech describes:

> *We save time. For example, I know when we put this system up we also got an interface for the Clinitec, which is our urinalysis analyzer. We didn't have that before and we used to transcribe, oh I think it was anywhere from 10 to 15 results per urine and we do something like 70 urines a day so the minute that was interfaced all that [transcription] stopped.*

The use of bar codes also contributes to the reduction of errors,[2] whether the numbers are keyed in or the codes are read directly by the computer. However, in Microbiology specimens are still written into a log book and assigned a number. That number is re-copied onto the requisition, culture plates and results report, creating many opportunities for transcription errors which the computer does not affect.

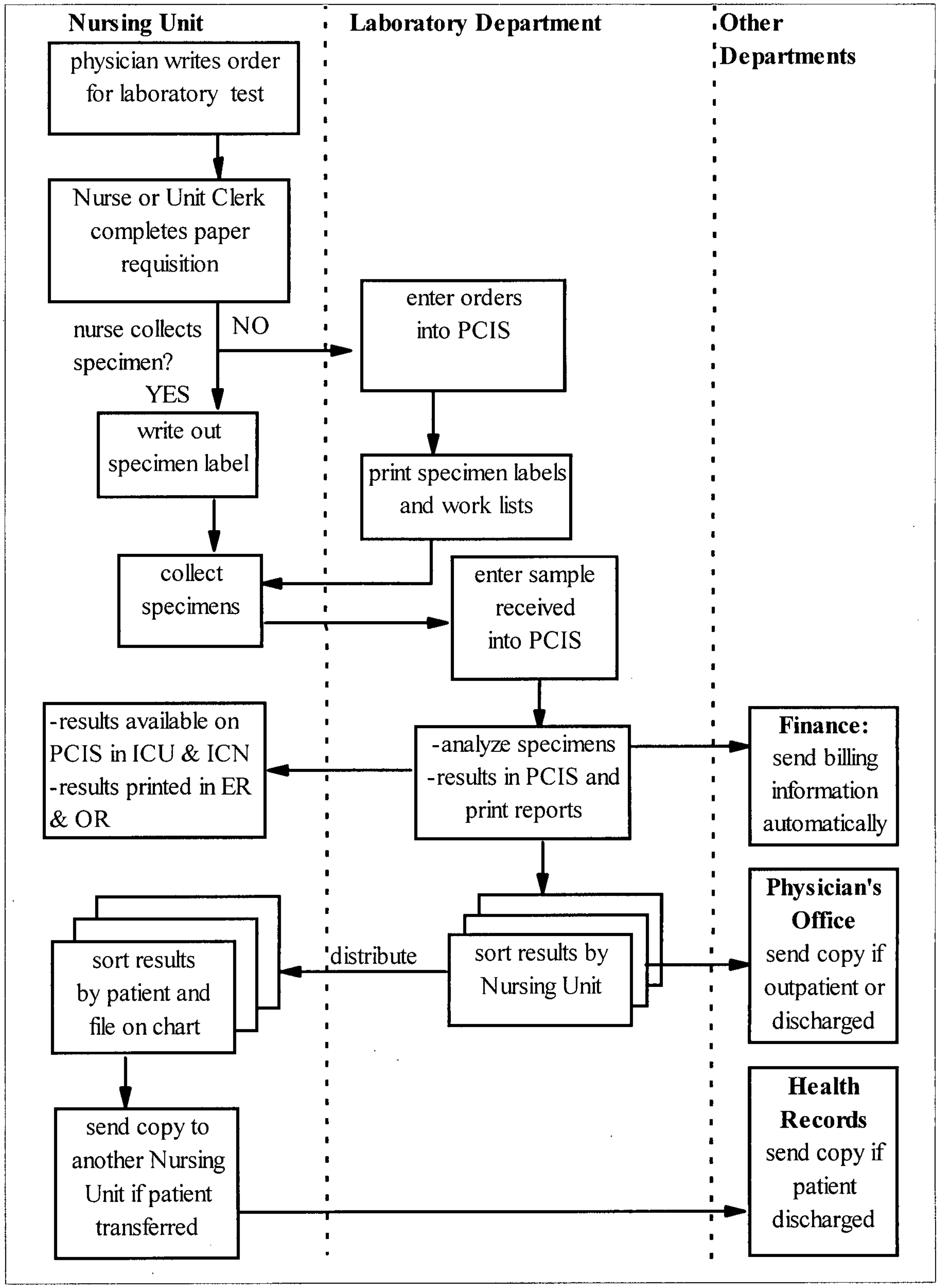


Figure 6.1 - Automated Lab System

The computer assists the technologists to organize their work by producing lists of patients in the order that the computer wants them. Any stat or urgent requests appear first on the list, versus the old system which organized the tests by accession number. They note that with the current number of people it would be impossible to manually complete all of the work they do now (level 1).

Access to current test requests and previous results are benefits many areas in the Lab have grown to expect. Microbiology still receives frequent requests for information about the condition of a culture and what stage it is at, which requires looking through the back copies of requisitions. In order to analyze current results, the technologist may also want to know if previous specimens were taken and what their results were. A major benefit Microbiology is expecting is the ability to retrieve this information for their own use, as well as to answer inquiries faster and easier. While it is an advantage to look at previous results, patient inquiry is very cumbersome with the current system. The user can only retrieve only one encounter with each search, whereas with their previous system they could look at several encounters at the same time.

Integration with systems in other departments is a major change for the Lab that has a long history of stand-alone systems. Prior to this implementation, each department in the hospital who provided services to patients had their own method of entering and collecting patient demographic data. Initially differences between Admitting and the Lab with respect to admitting patients into the PCIS had to be resolved. The lab technologists now have access to Admitting and Health Records information and do not have to re-enter patient demographic information. Lab technologists have access to the clinical diagnosis and previous test results which assists in interpreting the results. Better access to previous results is also a benefit for patients in reducing the number of tests that are repeated because information is not available. Although Pharmacy is on the same system, they have a different version, so they can look at lab results but the Lab cannot look at pharmacy information. Lab technologists feel the PCIS may be more beneficial to some areas of the hospital than others because some modules, like in the Lab, were introduced by XTECH many years ago and have not been updated very much.

Integration also enhances efficiency gains for the Lab by printing information directly in the appropriate areas. For example, rather than printing in the Lab, being sorted and re-distributed, discharge reports print automatically in Health Records and billing information goes directly to Finance. Efficiency gains are also expected through improved communication with other departments which results in less phone calls and interruptions.

The work of laboratory technologists becomes more "visible" to other users of an integrated system - both inside and outside the department. The technologists initially set up parameters for situations they want the computer to flag, for example, results outside of normal range, in "panic range" (i.e., critical values) or significant change from previous results (Level 2). When an abnormal result is detected, the technologist immediately receives a message that the result must be phoned, his or her name is automatically attached to the message sent and the name of the person or unit receiving the message must be entered. This information is also manually recorded to assist in following-up any questions that results were relayed.

"Visible" accountability will extend to other health care professionals as evidence of practice becomes easier to see. Where concerns are raised about physicians' practice, several clinical liaison positions, such as the microbiologist and pathologist, present Laboratory concerns to physicians on behalf of the Lab as this technologist describes:

> *In cases where we see a trend of results when it seems like the doctor is not doing anything about it and we feel uncomfortable [then we follow-up]. For example, if we've been repeating a test three days in a row and still the results are really high. It's not really up to us to phone up the wards and say, "Is the doctor treating this patient?" [laughter] so we would get our supervisor or a pathologist to follow up from that point of view.*

Individual technologists are responsible for ensuring the right information has been entered (including the right patient, date and specimen number), before sending it to the computer. If the instrument is not automated, the results are written on a piece of paper and then entered into the computer. Only students have their work checked by another technologist. The capabilities exist in XTECH, as in their previous system, to print Exception Reports or Abnormal Results Reports, but the Lab did not find them particularly useful unless a pathologist or charge technologist was available to review them.

Lab techs are responsible for making sure a particular set of results looks reasonable and is reportable. The computer assists in this role by automatically conducting "delta checks" to compare current results against previous test results (Level 2). The content of the lab technologist's job is changing partly because automation and computerization allows them to process a number of tests without much intervention on their part. This also frees them up to do more specialized tests like electrophoresis. The lab aide position is affected in an opposite way. A lab aide provides operational support in the department by answering phone inquiries, sending reports and taking calls for stat collections. However, this position may become redundant when orders are entered directly from the nursing units and results are available on-line.

The Lab expects patient outcomes to be positively affected with implementation of the XTECH system because physicians can more easily monitor patients' results with the new lab reports. The Lab put a lot of effort into organizing the reports so physicians could scan through them and look for trends. Associated results are reported together in order to make it easier to make connections between them, rather than having them all on separate pieces of paper. A specialist in the Lab can also make comments right on the report.

Turnaround time for reporting results has also been reduced, particularly for lab work referred in from other sites. Previously the work would arrive at 5 p.m., but the physician would not receive the results for forty-eight hours. With increased productivity and computerization, they are now testing that work the same day it is collected and sending a report out so the doctor has it available the next morning. Currently they place results in physicians' mailboxes, but one physician is doing a pilot project with a printer in his office. Patients also benefit because the Lab forwards copies of test results to the physicians that they receive after the patient has been discharged. The Lab was not able to do this before and the results went to Health Records (Level 2).

Workload in the Lab is changing because the same tests are being done in different ways. For example, Microbiology has changed from manually reading plates to an automated system where a card is inoculated, then put into a reader and incubator, and the computer produces the results seventy-eight hours later. Workload is also increasing in this Lab because they are now analyzing different tests for the Provincial Laboratory.

The workload measures themselves (as determined by the lab system) may not be accurate if the system is not used as it was intended. This occurs if users attempt to use a new system the way the old system worked or develop strategies to "work around" system procedures. Workload measurement data to determine workload changes may not be entirely reliable, as the actual amount of work may stay the same but the workload appears to be decreasing because unit values change. As well, projects like learning to use and implementing a new system are not factored in.

Workload measurement was an area that functioned quite nicely in the previous system, so the Lab wanted something at least as good. There is a major problem however because their previous vendor who was Canadian, understood Canadian standards. The new vendor is American, and although they have promised to meet Canadian requirements, at the time of interview the Lab was testing out a new software update that was supposed to give them the desired improvements.

The Lab also has a number of concerns with the XTECH vendor, including their ability to meet Canadian standards and their lack of flexibility. Hospital 3 is a large referral centre which is required to report separately for inpatients, outpatients and patients referred in from other hospitals. XTECH is from an American vendor, which has created some problems in meeting the Canadian government reporting requirements for billing and workload reporting. The system allows the user to write some rules for billing, but a lot of the rules that the Lab wants to write to conform to Medical Services Plan billing requirements are not possible.

This lack of flexibility extends to users not being able to directly access the information they need, particularly when standard reports do not meet their needs. A report writing facility is available but requires the person using it to take a programming course. This creates a catch-22 situation where the more reports a person writes, the higher the demand for custom reports. The danger of tying up too much energy in producing customized reports is that when system upgrades are issued, all these reports have to be checked to ensure they still run and the information is correct. This problem becomes more serious as the degree of integration between departments increases and more requests come in, as this lab tech explains:

> *What you find is that as soon as you start, you re-write a report for somebody and they say, "Geez this looks really good. Would you be able to do anything with this report?" and it grows. As you get one finished, you end up collecting three or four more that you know somebody would like to have done just to address what we perceive as deficiencies.*

Clinically-based professions have a responsibility to participate in training students "on the job," and instructors in this Lab have found ways to harness XTECH to help them in teaching and record keeping. Teaching lab technology students is changing to reflect the increased automation in the job. Participants expressed concern that students place greater trust in "printed results, which must be right." In this sense they are not developing skills in "real, basic manual methods to fall back on for troubleshooting." Because the technologists have other duties outside of teaching, the computer system has been used as a flexible tool to present information and manage testing. Tutorials are available on-line and can be completed at the student's convenience. A comment facility added to the lessons allows the student to type "notes" on the screens where particular material gives them problems. These are followed up later at the instructor's convenience (level 3). Quizzes are also available, which the students take whenever they are ready. They receive immediate feedback on each question, as well as their final mark (level 2).

6.1.3 Use and Impact of Electronic Communication

E-mail is used to communicate between members of the department who work a variety of shifts, twenty-four hours a day, seven days a week. Not all areas use it extensively, and in Microbiology for instance, there are a number of factors contributing to this. The group of people working there is relatively small, their hours of work are not as spread out as in some of the other areas and they are using XTECH much less frequently than many of their counterparts. Because e-mail is not used consistently by all areas yet, communication books are still being kept and in some cases copies of e-mail messages are posted in them.

An advantage of using e-mail in XTECH is that it is more developed than their previous system and documents can be pulled into word processing, or saved in cabinets, files and drawers, rather than on little slips of paper. This can also be a drawback when there is a lot of information put into e-mail libraries and the user forgets about them. Unlike their old system, the new system does not alert the user that there is a new message waiting. When people are busy trying to complete their work, they do not routinely look.

E-mail also opens up communication with people in other parts of the hospital, but this is limited until more terminals are available. For example, using e-mail facilitates communication with Nursing Unit managers and supervisors, as well as saves time when people are hard to contact. Monthly reports have also been completed and efficiently sent via e-mail to the Vice President (level 2). Electronic communcation produces a more permanent record of the transaction, which creates a more "visible" accountability. Once the Nursing Units are ordering lab tests on-line and people are using their terminals more regularly, the Lab anticipates e-mail will become more beneficial to them.

6.1.4 Summary

The impact of PCIS on laboratory technologists at Hospital 3 is summarized in Figure 6.2. Laboratory technologists experience the greatest changes when they move from manual testing to automated instruments. The impact of the new PCIS has been minimal and primarily in areas where this system differs from their previous one, such as integration and on-line reporting. For Microbiology, using the computer to report results imposes a new structure that was not present before and may be felt as a kind of "control" over their jobs.

A serious concern was expressed with respect to moving to a paperless system and managing operations during downtime. Currently they can still fall back on paper work lists and requisitions, but wonder how they will manage if this paper is totally eliminated. This is of particular concern because new graduates and some new employees have only ever worked on automated systems.

The Lab has taken care in developing their new automated reports. They expect the additional information will benefit physicians in their decision-making. Environmental cues used in decision-making have been reduced and enhanced. For the technologists, abnormal results are flagged with colored messages which bring them to the technologist's attention. On the other hand, printed results have changed in many ways that reduce the cues formerly associated with them, such as color and font changes as well as phone messages.

The Lab uses a number of opportunities to automate procedures around checking for abnormal results and delta checks. They have chosen not to use exception reports which identify when abnormals were reported, deciding instead to assign responsibility to each technologists for his or her own work. The students in the lab benefit from having their quizzes on-line and receiving automatic feedback on their test results. The Lab instructor has taken this one step farther and used the PCIS to develop tutorials which allow the students to interact with the material in a new way.

The Lab expects they and the hospital will benefit with electronic communication to other facilities in the region. Patients will also benefit in much the same way as they do in the hospital, but on a larger scale. However, a move in this direction also heightens concerns about security and unauthorized access to patient data via the Internet.

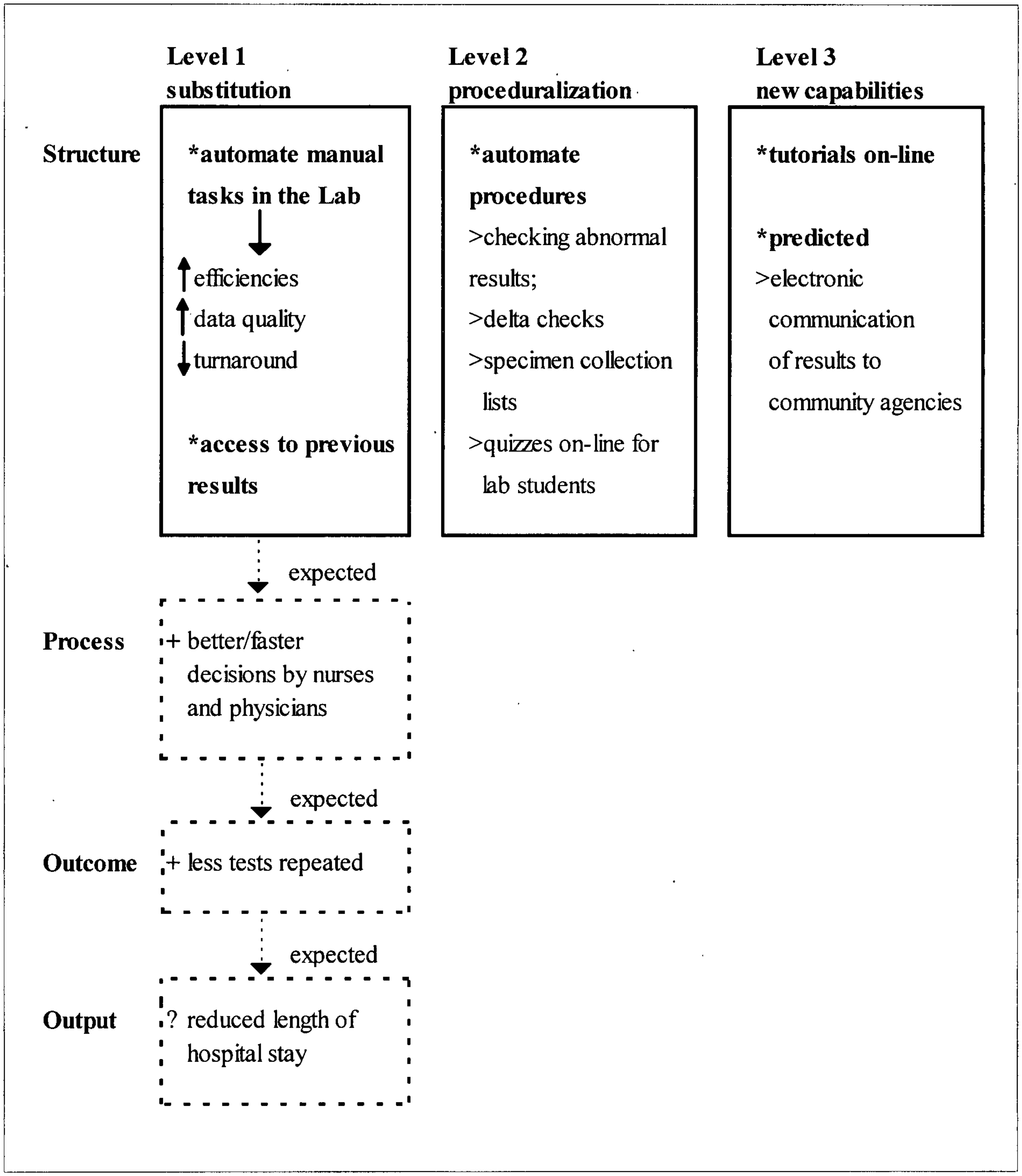


Figure 6.2 - Impact of PCIS on Laboratory Technologists at Hospital 3

6.2 Impact on Nurses - Hospital 3

6.2.1 Introduction and History of Computerization for Nursing

Nursing users did not feel a true sense of participation in the selection process and felt the decision had already been made before the process began. However, when the hospital selected XTECH, they could understand why: the system is very structured and XTECH does not make a lot of changes, but they implement the system fully and on time.

Nurses felt "ease of use" was an important factor in system selection and looked for as many "point and click" features as possible to minimize use of the keyboard. Nurses expect keyboarding to be an issue in moving to on-line documentation, as this nurse describes:

> *There are a lot of nurses who just don't type. If you're a busy nurse and you've to put your charting on-line, but first you have to learn how to type, that's still a big demand. That's an added stress. Those are the nurses who are unhappy and would like assistance in doing that. So I was looking for graphical user interfaces, really quick ways to grab things and get in and out. I don't actually know that we got that with the system we chose. I think that would have been more important for Nursing and to get nurses on-line.*

The hospital implementation strategy for XTECH was to replace all the previous systems first, before beginning on any new projects. For nurses, however, this created a situation of continual upgrading for the oldest systems, and some users never getting their systems implemented. This creates a dilemma for nurses: inexperienced users find it difficult to participate in the selection process and make informed decisions, but the only way to gain that experience is to implement a system, learn how it works and move on from there.

There is no official nursing liaison role, although the clinical resource coordinators who are responsible for teaching, orientation and assisting staff with procedures unofficially fill this position. The nurses filling these positions also have a personal interest in providing the computer orientation.

Order entry and results inquiry are already available in critical care areas: Operating Room, Intensive Care Unit, Emergency, Intensive Care Nursery. The Nursing Department intends to have terminals on all Nursing Units, but has not established a definite number of terminals or timeline for their installation. This decision partly depends on whether physicians will be entering their own orders. Nursing may have to consider five terminals per Unit if this is the case. One general Nursing Unit is currently pilot testing the patient care inquiry module and training takes place when there is time on the Unit. The trainer uses a one-to-one or sometimes one-to-two approach. This depends on the learners' abilities and previous computer experience, because some nurses are unfamiliar with keyboard basics. There is no formal training plan, except to try to incorporate it into hospital orientation. This lack of coordinated training plans is of some concern, as this nurse notes:

> *We generate way too much paper out of the system because we're not putting enough time into the training. I think the end benefit is proportional to the time and money you are willing to spend on training. Even with our current e-mail system there are tons of functions that people are not using because they don't know how to use them yet.*

6.2.2 Use and Impact of PCIS on Nurses

Use of a computer system is not a single binary concept and there is a range of users in every professional group. Staff nurses use the PCIS minimally and there is some question whether use of computers is a benefit to Nursing overall. This reflects the "high-touch versus 'high technology" kind of argument often found in Nursing, as described by this nurse:

> *I think it has to do with nurses and bedside nursing and their belief that those [caring] things are over here, the technical things over there. The caring and the nursing components are here at the bedside, the hands-on, the touchy feely*

stuff. They don't necessarily equate the benefits in time savings from improving the clerical side through automation, or even the documentation and the tracking of histories with what nurses value the most; the touchy, feely, hands-on types of things. The documentation and clerical sides of it have always been the necessary evils.

As well, managers are not convinced of the system's merits because they do not find it easy to retrieve monthly reports where they exceed target expenditures. The standard reports are long, cumbersome and hard to read, so the benefits are not there yet. The reports also lack historical reference points because data in the new system is not categorized in the same way as in the old one. This means it is difficult to compare past and present information.

Early benefits of integration and ease of using the PCIS are not apparent to nurses either. There are many steps or layers in the system to go through to get into and out of an area. They hope this will be reduced when more pieces of the system are available. The integration of systems between departments presents new challenges in the level of trust required, which takes some time to develop. Nursing staff on the pilot unit quickly found the computer-generated lab information was accurate, however they found it frustrating that the paper level did not decrease. The Lab continues to print interim reports, but users recognize once everyone is using the system, this will likely cease. In a month's time following the interviews they are planning to conduct a trial of automated MAR's. They felt this might be a good test of faith, in other words, that nurses would feel comfortable with the system's accuracy.

Historically, physicians generate the orders and nurses are responsible for sending the orders to the appropriate departments. During the peak times, such as day shift, Nursing generally delegates the communication of these orders to unit secretaries. For this reason, automation of order entry and many of the accompanying efficiency benefits are achieved by the unit secretaries, not by the nursing staff per se. Nurses anticipate achieving benefits when they are able to simultaneously send requests to multiple locations and have a better method of tracking orders.

Nurses expect to benefit with on-line documentation (level 2), which will include nurses' notes, vital signs and medication administration. Using the nursing workload measurement (WLM) system, they have calculated the amount of time currently spent charting. By reducing this amount of time, they expect to free up more time for patient care. This is particularly true if nurses can complete their documentation at the bedside so they do not have to write their notes on a piece of paper and later recopy them onto the chart. If the documentation system is easy to use and reduces redundancies in charting, automating this process should result in efficiencies. They have mixed feelings whether these efficiencies actually translate into more time to spend with patients, but consensus leans toward, "it depends on the nurse," as this participant explains:

> *I guess I don't know for sure that this extra time will translate into more time for patient care. I can only go on my gut feeling, although I know some people, if you give them more time they'll go and have another coffee or they'll sit at the desk and talk about last week's party. I only know now that that's not what I see if there's any down time at all. What I see is nurses taking someone for an extra walk around the hall or talking to patients. They feel so guilty about that now because in an acute care setting there's no time any more to sometimes just counsel or listen...*

Generally, nurses do not expect decision-making to change because the information that is available remains unchanged. However, this information will be easier to find and reminders through automatic flags will be helpful, but these do not change how nurses process information. They must continue to think through the available information and make decisions. Providing the "automatic reminders" as decision support may also have detrimental effects such as reducing individual creativity and innovativeness in problem solving. They may interfere with individuals developing the ability to think through a problem and reduce collegial sharing of knowledge, as this participant describes:

> *From a personal perspective I think it takes away control and it worries me a little bit because it might make [nurses] think less. If they cannot think it through themselves and the information is there in a decision package, they may be more tempted to use that package than to problem solve. It might decrease the amount of colleague support you get. Right now the inexperienced nurse would go to the experienced nurse and say, "Come and look at this foot with me, I've got some troubles here." I wouldn't want to see the computer replace that either. I think it might take away some of the innovation, and I think that is what it hasn't been good for.*

On the positive side, nurses suggest decision support may play an important role in continuing education outside the time the nurse is providing clinical care. In this case it is not used to help make decisions, but rather to increase the user's repertoire of "scientific facts" that he or she can then use in practice, as this example illustrates:

> *I would hope once we get into actual nursing stuff, which are care planning and documentation on-line, there might be some decision support involved in that. A less experienced nurse might actually be able to call up some symptoms and get a decision tree on say, "I've got a blue foot and toes here. What are my possibilities?"*

Nurses anticipate some role changes will occur when physicians have direct on-line access to patient information. The advantages are that less nursing time will be spent in phoning results and waiting for orders. Physicians are able to look up results themselves and they can enter the orders directly. They do not know whether physicians will take on this challenge, but they expect system use will vary as widely as other clinical practices. Nurses have not considered the actual dynamics of how this might, or might not, work although they have consulted other hospitals on their experiences, as this participant describes:

> *One of the hospitals I toured is having a major battle to get their physicians to even input their own orders and we'll have the same thing here. Some won't touch it and some will do really well. Those ones are the ones that are accountable now. Those are the ones you don't have to phone because they make 5:00 p.m. rounds. They have their 8:00 a.m. lab results and put in their orders. They're the ones who will be motivated to get on-line. The others will just ignore the whole system and pretend it's our problem because the nurses are supposed to be handling orders.*

Role changes also occur as nurses transfer some of their tasks to trained technical staff. For example, Operating Room (OR) nurses make decisions with respect to surgeon's preference cards needed for each procedure. However, Aides in Central Supply have been trained to use those cards to select the appropriate supplies. In addition, with the OR Booking and Scheduling system, a booking clerk will replace each surgeon's idiosyncratic procedure names with standard ICD-9 Codes (level 2). Booking, preparation and billing will all be based on this same code. Nursing decisions will no longer be necessary as all the information required to set up for the procedure will be built into the system through these standard codes. This creates a new potential for follow-up on "surgery statistics," as well as how closely billing matches the procedures done (thereby increasing the "visible" accountability for physicians).

Nurses have always been accountable for their professional practice and expect to take responsibility for what they do. They estimate accountability will not change because someone can track these activities a lot easier, but will become more "visible." As one nurse points out, being able to automate the auditing process will not necessarily change the behavior being monitored:

> *You know, I think the nurses take responsibility now for what they do. It'll be the same when it's automated. I think for the ones that don't stop to think about it, the system won't actually change their behaviors. Now maybe we'll find them faster and we'll be able to do better education. That might change it, but that will take time. I don't think that knowing it's automated and we can audit it, will by itself change their behavior. I think only the follow-up by whoever's doing the auditing, will make a change in their behavior.*

Nurses anticipate patients will benefit in several ways, but in particular from more nursing time spent at the bedside. They expect to make better care decisions if they have additional, faster information. Patients also benefit from quieter nursing stations that result from using the computer instead of the noisy pneumatic tube system. However, nurses also identified a number of caveats to achieving these benefits:

- "If the documentation gives us more time and we spend that time at the bedside..."
- "If the decision packages are good and the nurses make better decisions based on that..." and
- "If they are able to find the information more quickly and get information off the system..."

Patients are also expected to benefit through decreased redundancies in questions being asked by different care givers, as well as consistent teaching information. Realizing any of these benefits depends on having a system that is relatively easy to use, adequate access to terminals (which may or may not be at the bedside) and integration of system use into daily operations.

Patients and the hospital benefit from using the PCIS as a "non-partisan" reporter of information that can be used to make sensitive evaluation decisions (level 2). Decisions can be reviewed more frequently because the data is automatically and continuously collected.

This draws attention to measuring changes in patient outcomes as an active process. Excerpts from a nurse's description of the start-up of a new program illustrate this:

> *A new surgical program was initially started with the patients staying 48 hours post-op because of a fear of too many potential complications. The equipment was purchased with the understanding that after 6 months they would assess whether stay could be reduced to 24 hours. IS could play a role in removing the "politics" of decision-making in this case. In six months time the computer could automatically generate a report on the variables related to complications, which could then be brought to the attention of all the parties involved in the decision.*

6.2.3 Use and Impact of Electronic Communication

Currently limited access to terminals and training affects the use and impact of electronic mail (e-mail). E-mail can potentially have great impact in departments where employees work rotating shifts and managers are responsible for areas located in geographically separate parts of the hospital, as many of the Nursing Managers are. Managers from all departments seem to have been automatically included in the first group to use e-mail. However, the Nursing Department has the largest group of employees who work shifts and week-ends and they still depend on handwritten communication books. This has created a situation where nursing managers receive e-mail from other departments and must relay the messages to their staff. While this reduces the work for other departments in typing up, photocopying and sending out notices, it increases the work of nursing managers who must print, photocopy and distribute messages. Terminals are also not accessible in all areas so managers may be unable to respond to messages promptly.

Nurses express a concern that use of electronic communication will reduce the face-to-face communication that now occurs. As Nursing begins to use e-mail on a regular basis, nursing groups will likely build in other mechanisms, such as weekly meetings and "help" messages to co-workers, to replace the regular human contact.

In much the same way that people suspect decision support systems encourage "laziness" on the part of decision makers, e-mail also creates situations where people seem less likely to solve their own problems. It becomes easier and faster to "forward" a problem for someone else to make a decision on or take action, than it was in the past. Often by the time the receiver could deal with the problem, it has already been resolved. In addition to that aspect of e-mail, it has unexpectedly been an effective tool in encouraging accountability for responses to requests for information or action. In the case where there is a feeling that a miscommunication has occurred or promises for action are not followed through, a hard copy of the "evidence" can be presented to support one's case.

Nursing is inundated with policy and procedure manuals. This creates issues related to information access, as well as reliability and liability when there is no guarantee that information is up-to-date or can be located. Productivity is also an issue because a tremendous amount of time is invested in updating all the different manuals through out the hospital. Nurses envision having all manuals on-line and cross-referenced (level 2) as this nurse describes:

> *We have a policy manual, a procedure manual, a lab manual, an infection control manual - you know, all of those manuals. It's hard sometimes to remember which manual has what piece of information. I think the benefit will be if you can search by topic and then drill down even further if you need more [information]. An example this morning was the question, "How long is a consent good for?" Well, [the answer] is actually in the QA Guidelines for consent, but she said, "Now if I didn't know where to look for that, what would I do?" We thought it would be a good benefit if you could actually search by consent, time frame, and that kind of stuff.*

6.2.4 Summary

The impact of PCIS on nurses at Hospital 3 is summarized in Figure 6.3. Nurses are using the PCIS minimally and have experienced few benefits, although order entry increases efficiency for the unit secretaries. From their perspective, other departments have installed two systems while Nursing is still waiting for benefits. Nurses predict expanded system use will include order entry and results reporting by all areas, as well as on-line documentation and manuals. These changes are expected to free up more nursing time to spend with patients, although it is not clear whether this will happen.

Nursing expects benefits from documenting care on-line, but emphasize this would require the system to be more user-friendly than it is and rely less on typing skills. There is a perceived dichotomy between nursing practice (associated with hands-on, patient care activities) and use of technology (such as computers, which are associated with number crunching). This debate influences how aggressively they pursue the case for computers in Nursing, and therefore, also affects the benefits achieved.

They also see benefits when some tasks are proceduralized, such as physicians accessing their own results on-line and entering orders directly. The implementation of an OR Scheduling System that uses ICD-9 codes will proceduralize many of the tasks involved. This is expected to result in more efficient scheduling and use of resources, which benefits both patients and the hospital.

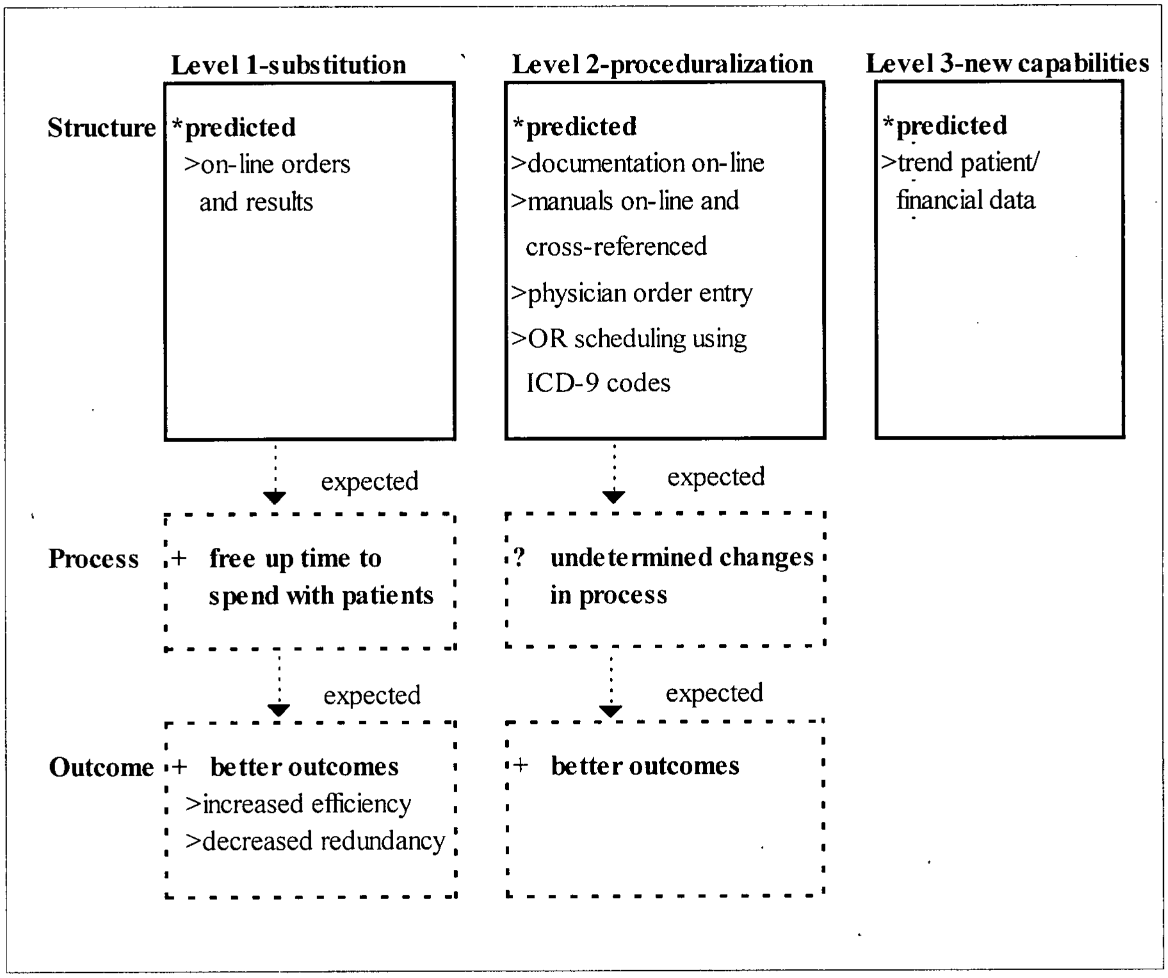


Figure 6.3 - Impact of PCIS on Nurses at Hospital 3

The e-mail system is available for nursing managers, but not for nursing staff, which has shifted the burden of communication from other departments to the nursing managers. The organization is undergoing many transitions with bed closures and administrative changes where employees could benefit from up to date information. E-mail could be a vehicle to communicate these changes quickly and frequently.

6.3 Impact on Pharmacists - Hospital 3

6.3.1 Introduction and History of Computerization in Pharmacy

They replaced the manual system for ordering medications in approximately 1989 with a pharmacy system intended to become part of an integrated, hospital-wide PCIS. Pharmacy then had access to the census information, so they did not have to re-enter patient data and allergy information from previous admissions was available. Overall, they found PCIS to be unreliable as well as difficult to work with and never implemented most of the other modules. The hospital decided to change to another PCIS vendor and initiated a search process.

Pharmacists felt that limited user input had contributed to selection of the wrong system the first time. Site visits and talking to pharmacists in other hospitals helped prepare them to represent their interests in selection of the new PCIS. The pharmacists were familiar with the computer's capabilities, so were looking for a system that was easy to use and would decrease workload in the dispensary. They also considered the available technical support and hardware capacity (such as the printer speed) which they needed to support the speed of operations in the Pharmacy Department.

Hospital 3 selected the XTECH vendor, and although its pharmacy system was not as sophisticated as a stand-alone system, Pharmacy felt that integration throughout the hospital was a positive trade-off. In 1994 they replaced the pharmacy system with the XTECH pharmacy module. Their previous pharmacy system and this one had some similarities (for example, allergy and interaction flags) although initially small differences in how they entered orders slowed down their use and efficiency.

A staff pharmacist filled the liaison role required to coordinate system implementation and provide training. This role continues to provide support in system maintenance and implementing updates. They feel XTECH is a better quality system, but complicated parts require a knowledgeable person to maintain it.

6.3.2 Use and Impact of the PCIS on Pharmacists

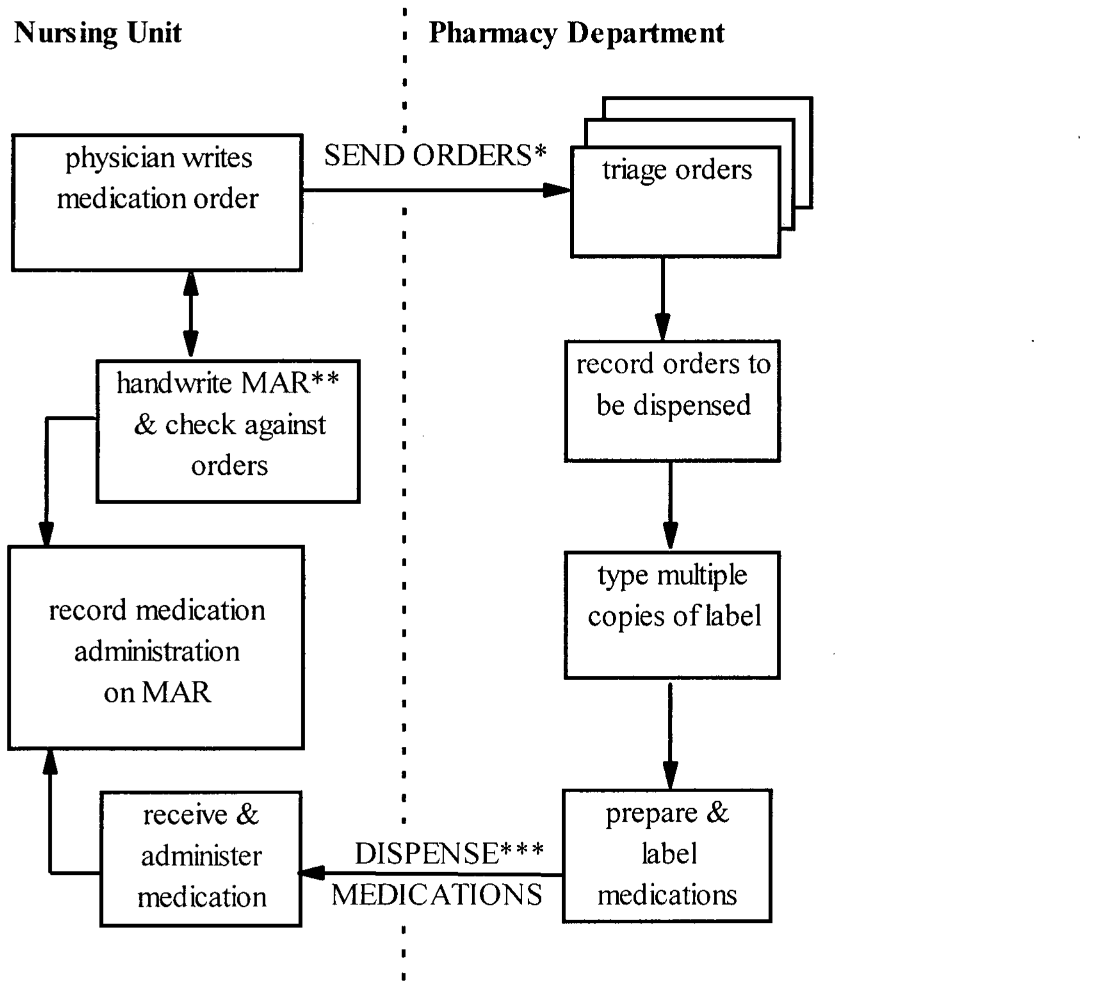
XTECH is generally easy to use, but leaves "a bit to be desired" because of the programming language used. One resulting idiosyncrasy that is particularly frustrating for pharmacists is that if they make a mistake and go on to the next field, they cannot go back to the previous field to correct the mistake. They have to cursor through the whole screen and start it over again. The next version of software is expected to correct this.

Pharmacists have four main functions in the hospital: medication distribution, clinical activities, drug utilization monitoring and inventory control. They use PCIS differently for each of these functions and share responsibilities for all of them through rotating shifts. Pharmacy sees an integrated system as a big benefit. They expect to have access to information from other modules once they are implemented, but at the present time this is limited to admitting information and lab results.

The pharmacist's prime responsibility is ensuring the right medications are distributed to the right patients, at the right time. The Pharmacy Department maintains two different medication distribution systems: six Nursing Units are using ward stock and six are using unit dose.[3] Generating and sending orders to Pharmacy has not changed with XTECH. Physicians write orders for medications on a multi-part form. Nursing Units send one carbon copy to Pharmacy through the pneumatic tube system, personally drop it off or have it picked up by the porter who delivers medications to the Nursing Units every two hours. The orders are "triaged" (or assessed for their urgency) by the technicians and also priorized based on which unit dose exchange carts are going up to the Nursing Units first. The manual system of processing medication orders is illustrated in Figure 6.4.

With the manual system, pharmacists in the dispensary had little information about other medications patients were taking and relied on the Nursing Unit to recopy patients' allergies onto the order sheet for every order. If something did not seem right with the order, the pharmacist would phone the Nursing Unit to clarify it. The technicians typed multiple copies of the labels, which the pharmacists then checked. When the department first became computerized, they experienced a really big change in workload because pharmacists were suddenly responsible for entering, as well as checking, orders.

With XTECH, a pharmacist on the eight hour dispensary shift enters all medication orders into the computer. Intravenous (IV) orders are the exception and these continue to be manually recorded (level 1). The pharmacist is responsible for all written orders and any requests coming to the wicket, as well as answering the telephone, which can be very disruptive. They process the bulk of the orders on day shift, with a back-up person assigned to unit dose coming in to assist on busy days. The automated system for processing medication orders is illustrated in Figure 6.5.



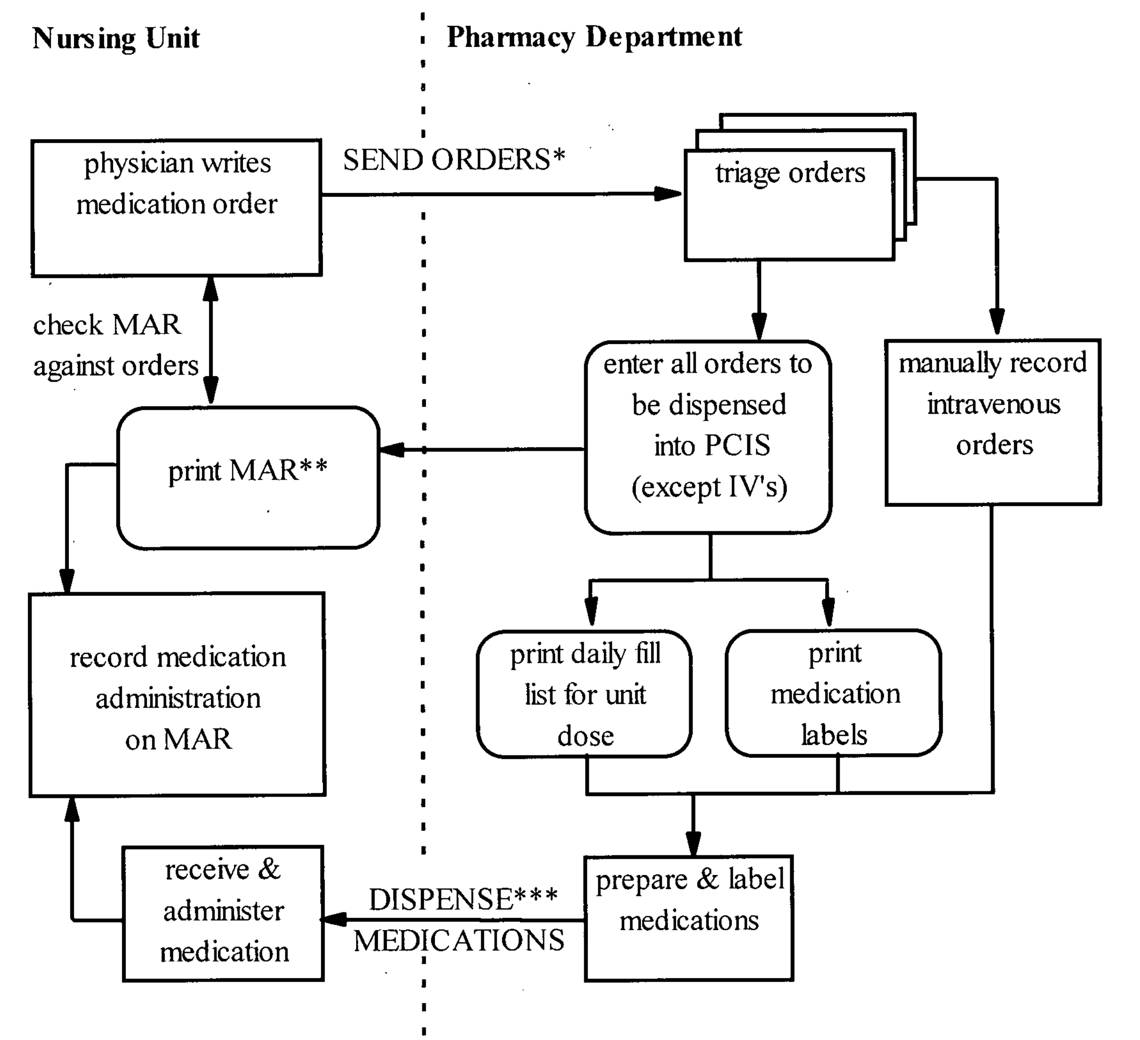
Notes

*medication orders sent via pneumatic tube, personal delivery or porter services

**Medication Administration Record

***frequency and number of medications dispensed depends on type of distribution system

Figure 6.4 - Manual System of Processing Medication Orders



Notes
*medication orders sent via pneumatic tube, personal delivery or porter services
**Medication Administration Record - pilot stage only, otherwise handwritten
***frequency and number of medications dispensed differs according to distribution system

Figure 6.5 - Automated System for Processing Medication Orders

This Pharmacy Department has decided to continue with pharmacists entering orders. They feel it is not efficient to have technicians enter the orders and then pharmacists repeat the same procedures to verify them. As well, if the technician is entering orders, every time an allergy flag or interaction occurs, the pharmacist must evaluate and perhaps override it. This usually means it is more efficient for pharmacists to just enter orders themselves. However, technicians do enter orders under certain circumstances where a pharmacist has entered the original order, such as when a patient requires medications for a short leave from the hospital. This includes orders for patients pre-booked for chemotherapy. Technicians enter these as "unconfirmed" one week prior to the patient's arrival and the pharmacist checks the orders before they are filled.

Productivity increases mean fewer people can accomplish more work. Both the numbers of pharmacists and patients have decreased, but the number of orders to be processed has actually increased over the years, although no additional medications are being dispensed. There is a large difference between the number of orders processed in a manual versus automated system. In the manual system pharmacists only record the medications dispensed, but with an automated system they enter all medication orders. The increased efficiency and speed with which they can process orders sometimes do not translate into time to investigate the additional information available, as this pharmacist describes:

> *I think it takes a couple months before you get efficient at entering [orders] - just [understanding] what it can do for you and not just flipping through the screens really quickly. It's definitely a better system than manual. You have more information available to you, but do you have the time, can you slow down enough and dig out all the information? Sometimes I wonder.*

Unlike the manual system, a certain degree of "visible" accountability is related to productivity. This occurs because Pharmacy is able to monitor the number, speed and accuracy of orders entered by the pharmacists (level 1). Pharmacists have a wide range of abilities, and therefore some people are slower than others at entering orders. Whether this situation relates to typing skills or organizational skills, using the computer focuses attention on it.

Use of XTECH also supports productivity in unit dose distribution. A technician calls up computer-generated fill lists each day, puts the appropriate number of doses into each patient's drawer and then a pharmacist checks the drawers. While checking each drawer, the Pharmacist reviews the medication profile of that patient and flags any orders that he or she wants to check on the Nursing Unit. (They print the profiles daily for each patient. This prescription documentation is kept for two years in accordance with the Pharmacy Act.) Pharmacy is considering having technicians double check technicians. This would free up pharmacists to do more screening of problems from the beginning rather than later in the process.

Using the PCIS presents a catch-22 situation for Pharmacy. While it reduces the pharmacists' workload in some areas, they are potentially able to provide many more services, which requires new priorities to balance their use of resources. The "paperwork" or clerical duties have been reduced, but it is quite a bit more time consuming to maintain the automated system. A prime goal of Pharmacy is accurate and timely distribution of medications. Frequently energy goes into trying new systems for distribution (like the "minibag plus program" or pre-filled syringes), without evaluating whether these are efficient or effective use of time.

Reduced errors are one primary goal for automating many systems in hospitals. For the Nursing Units on unit dose, Pharmacy is aware of a potential error within twenty-four hours when the bin exchange occurs and medications are returned unexpectedly. For the

Nursing Units on ward stock, using the PCIS does not affect error reduction. There are also built-in error checks in the PCIS, but many potential errors such as the wrong medication or a medication labeled incorrectly, are still discovered through "human" error checking. These may never be recorded and the "system isn't really going to keep track of them either."

Pharmacists also expect reduced errors through the automatic monitoring of drug interactions. They use a standard pharmacy reference manual to enter potential drug interactions into the system. The computer recognizes a lot more drug interactions that otherwise pharmacists may overlook if they had to rely only on their memories. Although drug interaction checks, allergy checks and flags provide additional cues for action, pharmacists have been taught not to rely totally on the system, that it is just a secondary check. Not all interactions are serious and the pharmacist may override a warning if, in his or her clinical judgment, it is not a problem for a particular patient.

The integrated nature of the system introduces changes in roles and responsibilities both within and between departments. As technicians take on more of the distribution function, pharmacists feel they could make better use of their comprehensive drug knowledge. They should be more involved on the wards in managing drug therapy, as well as discharge counseling for patients and families. There are more opportunities for pharmacists to be up on the Nursing Units with unit dose distribution systems because they actively review those medication profiles daily. As well, if a pharmacist is on the Nursing Unit, he or she has additional opportunities to develop rapport with physicians, gain their confidence and offer advice on medication therapy. Pharmacists are not in a position to change drug therapy, but can question orders when they may be contributing factors for patients admitted repeatedly (a "visible" accountability for physicians). A "clinical intervention section" on the system is available to communicate patient specific interventions to other pharmacists.

The traditional role of the pharmacist is to deliver the medication as ordered and the nurse is to administer it to the patient. Nurses copy medication orders onto a Medication Administration Record (MAR), which they use to document their administration of medications. Use of the PCIS creates an opportunity for pharmacists to work with nurses in computerizing the MAR's. These are a by-product of the pharmacy distribution system, and are expected to reduce nursing transcription errors. While certain drug classes (like cardiac drugs) have standard administration times, nurses exercise professional judgment in adjusting many of them according to the patient's condition. With automated MAR's, Nursing Units will be able to print new MAR's at their convenience, although Pharmacy will determine the medication administration times. Nurses may interpret this as pharmacists exercising an element of "control" over nursing practice (level 1).[4]

The second role of the pharmacists is clinical work and use of the PCIS supports their decision-making in several ways. They now have more information available including the current medication profile, admitting diagnosis, patient demographics and laboratory results. Because the PCIS is not totally integrated, this information may be enough to answer simple questions at the distribution desk, but may not be enough to answer more complex questions. Not all information is available on-line and pharmacists must still go to the chart for microbiology results (like drug sensitivities), temperature, nursing and physicians' progress notes. Many parameters may have changed since a patient's admission to hospital, so there may also be new diagnoses or complications not reflected in the computer information.

Producing census lists also help pharmacists organize their clinical work by determining which patients are on their assigned units. As well, rather than relying on the pharmacist in distribution to notice if lab values are abnormal, they print lists of patients' serum creatinines and drug levels daily so pharmacists can follow up abnormal results more consistently (level 2). Other decision aids like "dosing ranges" that are based on the patient's weight are potentially available. However, pharmacy does not use them because they are time and labor intensive projects to enter into the computer database.

Pharmacists expect additional benefits in their clinical practice from statistical information available. This includes which patients are taking particular medications, numbers of patients on specific medications and which physicians are ordering what medications. While the new system has many potential capabilities, Pharmacy must commit the resources to sit down and program those things in, which they have not had the time or expertise to do yet. In April one pharmacist completed a course to learn how to make those changes, but until that happens, they end up with a system that is less supportive of their work than their previous one.

Drug Utilization Evaluation (DUE) is the third primary function of pharmacists. Pharmacy monitors trends in the use of medications because they account for a large proportion of the budget. Antibiotics are of particular interest because they make up about twenty-five percent of the drug budget. A number of other areas in the hospital currently assist with DUE in a variety of ways. For example, the Chief Microbiologist in the Lab receives lists of patients taking the more expensive antibiotics in order to monitor their appropriate use. The Respiratory Department receives lists of patients who are using inhalers so they do not miss anyone with their teaching. Along with the Clinical Director of Pharmacy, pharmacists are involved in other departmental studies, such as monitoring the use of pre-op antibiotics or prophylactic post-op usage. They conduct these studies through retrospective chart audits, but pharmacists expect "being computerized to make it a lot easier."

Pharmacists anticipate more involvement in Drug Utilization Evaluation and Review (DUE and DUR) processes, but presently do not have a person specifically assigned to this function. A drawback to conducting these reviews is that they require additional human resources to enter all the necessary data consistently and accurately for statistics and program evaluation. They could use the computer to conduct drug utilization reviews, but it would not be too accurate because they do not credit all returned medications back into the computer. This is not possible with a ward stock distribution system.

While the ordering practices of physicians become more "visible," attempting to modify ordering practices through drug utilization information has only been moderately successful. The information goes to the medical staff through the Pharmacy and Therapeutics Committee, but "there is no compulsion by anybody to change habits."

A number of capabilities in XTECH support the pharmacists' final function, which is inventory control. They plan to use them in the future, but they also require the extra work noted in DUE to count and re-enter all the returned medications. They anticipate computer generated purchase orders will simplify the drug ordering process.

6.3.3 Use and Impact of Electronic Communication

Managers use e-mail regularly to communicate outside the department and internally to communicate policy changes and other information to staff. All pharmacists and technicians have access to e-mail, but it is unclear how much they actually use it. They used e-mail in their previous system, but it was not effective due to the limited number of users in other departments. Pharmacists recognize the potential benefits of using it within their own department because of their functional divisions and shift work, but they currently depend more on their communication book or face-to-face communication. Uneven use of e-mail is evident when people in the department do not respond to their messages because they have not checked their e-mail.

E-mail has been beneficial for interdepartmental projects, such as communication between pharmacists and Nursing Unit managers who are on the MAR Committee. Nursing managers all have access to e-mail and they use it regularly, so this is highly effective. However, communicating with physicians through e-mail has not been a viable option. Pharmacists still telephone urgent messages to physicians and wait for a return telephone call. They relay non-urgent messages through "Doctor Notes" that are attached to the patient's chart. Unfortunately, pharmacists found a lot of physicians did not look at the notes because there were so many other things attached to the chart. They have been investigating the best possible way to communicate problems.

Opportunities to communicate information about meetings with community agencies like public health, have been explored with little success, in part again because the system is not being used consistently (level 3).

6.3.4 Summary

The impact of PCIS on pharmacists at Hospital 3 is summarized in Figure 6.6. The Pharmacy Department has gone through two major changes. The first change was from a manual system to a PCIS that did not reach its potential for integration. They moved to a second PCIS that is also predicted to produce benefits through integration with all patient-care related departments. Of equal, if not greater, consequence for Pharmacy appears to be their combination of distribution systems. They make it impossible to take full advantage of PCIS capabilities and reduce benefits such as DUE and inventory management. Every time they introduce a change, they multiply the effort to make it work for all the systems, as well as introducing more opportunities for error. A computer system does not solve the inherent problems in a manual system and may even exacerbate them as evidenced by the difficulties created when a patient is moved between units with different distribution systems.[5]

In a seemingly paradoxical manner, productivity increases although the number of orders filled remains constant (or goes down because there are fewer patients). This occurs partly because pharmacists are entering all the orders, which they never did in the manual system. The number of pharmacists has stayed more or less the same, slowly increasing to the present number, but this is about to be reduced. Pharmacists do not expect the computer to greatly influence productivity, apart from processing orders.

The minimal integration between the systems in all departments also limits the impact of using PCIS for Pharmacy. For example, orders for respiratory therapies could automatically print in that department rather than waiting for Pharmacy to generate a list. System users do not fully understand how all the departments contribute to the patient record and where information in XTECH originates. For example, it is unclear whether allergies are entered on the patient's admitting profile, come up automatically from a previous admission or have been entered recently by a pharmacist. One pharmacist suggested that the system might automatically tag information shared across departments with the user's initials and department name.

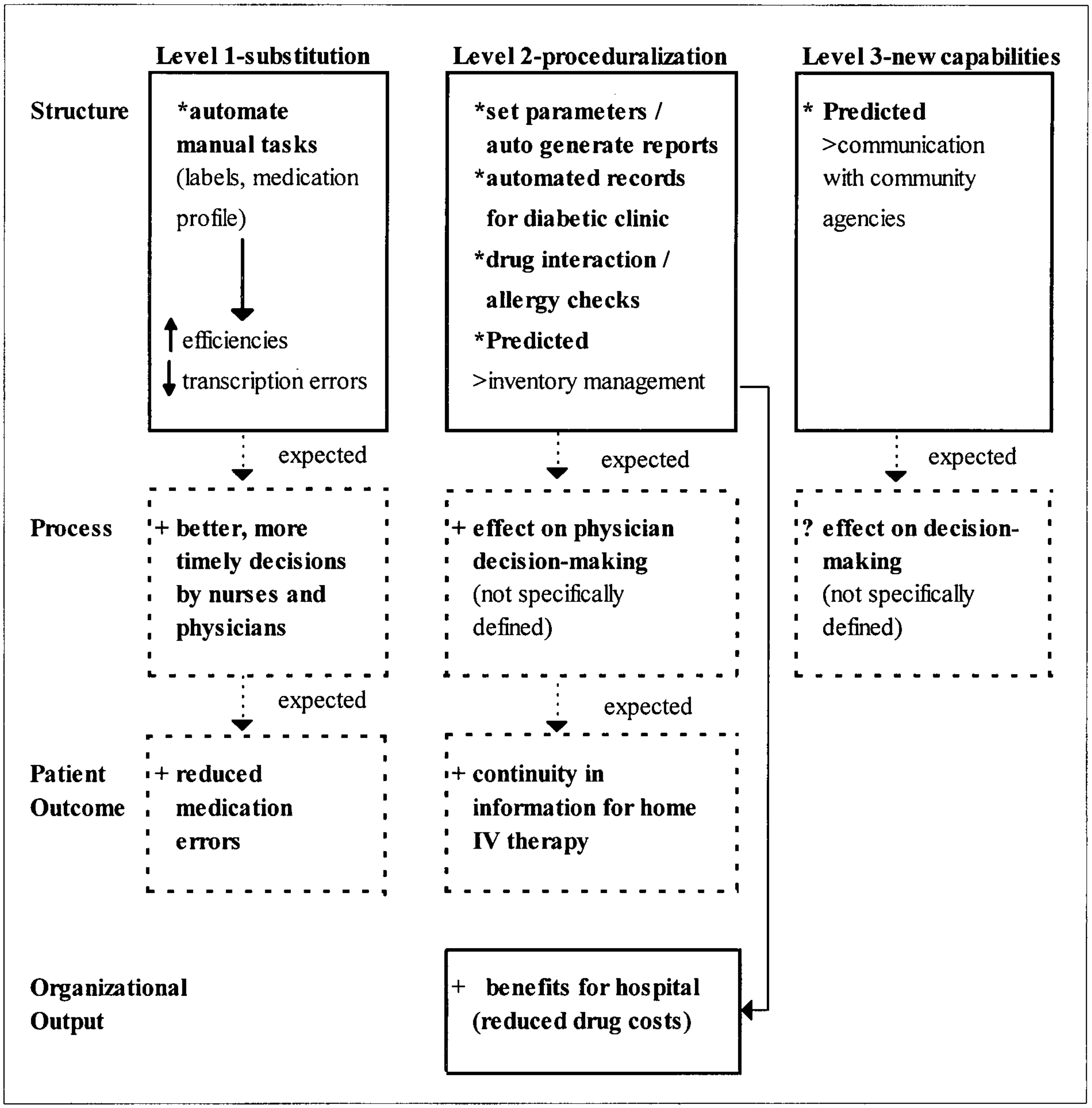


Figure 6.6 - Impact of PCIS on Pharmacists at Hospital 3

Benefits identified for patients include fewer medication errors, but it is difficult to compare this in a "before and after" fashion because the computer system provides a better tracking system. While some errors are easier to identify (for example, wrong drug, dose or patient), some are based on in-house rules and more subject to interpretation. For example, a medication not administered within one hour of its assigned time, regardless if the patient is asleep or away from the unit may be considered an error. It is often also difficult to track down why "errors" have occurred, but in doing so it helps to re-define what an "error" is, given the new kinds of information available.

Pharmacists are better able to protect patients, particularly the elderly, because they can prevent a lot of problems (such as adverse reactions and interactions between medications) before they happen. Patients benefit through better information about the medications they will be taking when they go home. Pharmacists provide printed patient education material to answer commonly asked questions such as side effects, things to watch for, when to call the doctor and what to do about missed doses. Outpatients, such as those on the home IV program, also benefit from the continuity of information on return visits, versus depending on someone remembering that they were on the program. The catch-22 situation is again where to allocate limited resources because these programs often expand beyond initial plans.

The pharmacy system produces a "visible" accountability for both nurses and physicians in several areas. In the unit dose system Pharmacy is immediately aware of a potential error in either medication administration or documentation when Nursing returns medications. Pharmacy must re-enter these into the computer. As well, DUE information brings trends in drug use to the attention of physicians when they are outside the average range or less expensive alternatives exist. Unexpectedly, when pharmacists enter all medication orders into the PCIS, this sets up a "visible" accountability for themselves in terms of productivity. This sets off other dynamics in the department when some pharmacists work faster than others.

Pharmacists are experiencing another catch-22 situation under an assumption that more information is better, without evidence as to how much is enough or too much. They cannot achieve full benefits from an automated system unless they enter all the necessary information. For example, they must enter the detail of all medication orders, whether distributed by Pharmacy or not, and all returned drugs to maintain a complete patient profile and accurate inventory system. The burden of this record keeping falls to the professional staff and may reduce the time that they could otherwise accord to patient related activities. What is not clear to pharmacists is how producing and using all this new information is necessarily helpful in their jobs. Their attempt to establish automated records for an outpatient diabetic group to track problems and interventions, lead them to discover that this system was too labor intensive to set up and maintain for the benefits they gained (level 2).

There also seems to be some "make work projects" occurring because people do not trust the electronic storage of information. They keep computer records of orders and duplicate manual files for two years, creating a huge volume of paper as well as extra work in filing. The College of Pharmacy recommendation to keep the paper copies if possible, may no longer be appropriate if pharmacists are able to note in the PCIS that they checked the medications.

There are a number of potential benefits for pharmacists as use of the PCIS moves out into the Region. Meeting with users in other hospitals provides opportunities to learn from their problems and solutions. It is interesting that each hospital enters and updates common operating information, such as drug interactions. It is expensive to purchase commercial packages so there is a lot of duplication of effort in determining what to enter, entering the information and updating it. If Regional "best practices" were evidence-based, rather than based on history, personal preferences or political expectations, there may be opportunities to share PCIS resources.

6.4 Impact on Physicians - Hospital 3

6.4.1 Introduction and History of Computerization in Medicine

There is no official physician liaison, although one physician is working with the Information Services Department in pilot testing remote access from his office and home. The hospital has not yet established an official training program for physicians.

6.4.2 Use and Impact of PCIS on Physicians

Physicians sign in and out of the hospital through the Registry System on terminals located in four areas. These terminals are different from the ones located on a few nursing units where they can access lab results, send and receive electronic messages and print patient lists. They recognize they will require more terminals in the future to provide the access needed. Currently there is "no dedicated physician terminal to be able to sit at, receive and process unrestricted e-mail," however this is under review.

Physicians also use the lab system for reports and the admitting system for patient census information. Their use of the terminals, and desire to use the terminals, probably constitutes a range much like a bell curve with three groups of people, as one physician describes:

> *There are those people who are semi-ambivalent, but think they're rather useful. There are the people who wouldn't use anything else and there are people who wouldn't use them period. The larger group in the middle will use it if they have to and it is the only way to [get the information they need]. The group at the other end has an active interest [in computers] and like playing with them.*

Physicians suggest their system use is related to several commonly identified issues such as ease of use, usefulness, accessibility and security. One physician's comments illustrate how these issues and their resolution are interrelated:

> *We don't look up lab results on our computer now. We look at the print outs, but I find the detail annoying. I think you only get a summary every week or something like that. The result is you have to look through several pages to find the current results. We don't use the computer screen because we don't have access to them, they're not on the wards. I suspect that when we do have access and terminals are available, I will learn how to use them and I certainly will use them. I'm quite keen for that.*

Ease of use is an important consideration in system selection. In this respect physicians feel that system use is definitely related to typing skills, or at least familiarity with the computer keyboard. There is a learning curve associated with keyboards that requires physicians to sit down and learn how to use them. This is definitely true for electronic mail or word processing, but does not equally apply to clinical information that they can retrieve with the use of arrow keys and menu selection. The small numbers of physicians using the system agree it is easy to use, but comment:

> *You have to gear the interface to the lowest common denominator, to the guy that doesn't know how to backspace or whatever so that he can get the*

information out. If you have only 10% of the physicians using the system, you have a lot of money and time invested in providing 10% with the capability and 90% are ignoring it.

Ease of use extends from using the hardware and software to being able to access information in the system. For example, when it came time to make utilization management decisions, information related to bed occupancy and vacancies in various services was unavailable. A program for developing flow diagrams illustrating Continuous Quality Improvement (CQI) activities was easier and took less time to write than the process to request it through the hospital channels. They expect to retrieve this type of information directly from the new system, as this physician's comment suggests:

It is virtually impossible to manage a hospital this size without better information and we just didn't have good information, we never have. Hopefully with the new system we will have better information. Management decisions tend to be made by a guess and not by information. That is because the information is so hard to get out of the paper system and impossible to get out of our previous computer system.

PCIS usefulness is limited by its ability to support practice. Physicians routinely have their patient lists printed from the census. However, this has not been useful for on-call lists because there is a system limit on the number of physicians it can list for each patient:

...Until very recently you were only allowed to associate two doctors with each patient. If you had a surgical patient, you may have a general practitioner, general surgeon, head surgeon, chest surgeon, an orthopedic surgeon and a urologist. Well, chances are that you wouldn't be number two on that list. So if it was one of my colleague's patients that I needed to see, he or she wouldn't be on the computer list because it doesn't recognize more than two doctors.

Many users expect the PCIS to benefit physicians through decision-making support. An underlying belief related to automation in health care is that additional information flowing faster, will result in more timely and "better" decisions. However, physicians do not place the same emphasis on the importance of decreasing the turnaround time for lab results that nurses and lab technologists do. What is more important for physicians than "information flowing at the speed of electrons," is the accessibility of that information. Access to results from home or office before patient rounds could facilitate the physician's preparation for the decision-making process. Accessible x-ray results are a good example. Films are kept for five years, so the physician has to search through stacks of them. It would be much more efficient to have these images on CD-ROM and physicians access the ones needed, as this physician suggests:

> *A number of times a patient has come to see me [in my office] and they have lost their X-rays or their X-rays were supposed to have been sent over today. Two patients came down from out of town and each of them thought I was supposed to have their X-rays. What happened was they were asked by somebody to collect the X-rays from [hospital C] and bring them in to show me. So a system where I could phone up [hospital C] and they could put their CD-ROM in their reader and I could read it on my screen here would be wonderful. I don't understand why nobody thinks that's important.*

Physicians characterize decision-making as a process that is highly dependent on the practitioner's clinical skills and practice patterns, which in turn are based on his or her training and experience. Many physicians view computers as a tool and, per se, do not affect patient care either adversely or beneficially. They simply provide more information on which to base decisions, but do not play a huge role in making clinical decisions or patient outcomes. However, physicians anticipate graphical representation and trending of data may enhance decision-making. Trending has already been a useful tool in areas that monitor many physiological parameters, such as the Intensive Care Unit or Anesthesiology.

As well, just because the information is available sooner does not always mean users access it any sooner. (The computer may also provide users with too much information that ends up wasting time.) However, many physicians do not see themselves using computers to make decisions soon because the use of computers in medicine continues to have an ill-defined role. Medicine is still seventy-five percent art and twenty-five percent science, and therefore one physician concludes:

> *Computers can help with the 25% of science, but they can't help with 75% of the art and they never will be able to. So my way of looking at it is computers are tools for the garnering of information so you can make decisions. They do not, in and of themselves, aid you in the making of decisions. You can put in safeguard processes where if you set a series of events in place, the computer can monitor those events to ensure that you aren't doing something that is contradictory or inappropriate.*

An important distinction must be made between supporting the physician's decision process through providing faster, more accurate information, and using the computer to assist in decision-making. Algorithms may be beneficial in decision-making and are ideally managed through computerization because the decision trees become too complex to handle manually. However, physicians view the concept of "decision-support systems" with some suspicion because the practitioner needs to understand the underlying algorithm used, that is, the process used to arrive at the decision. Blindly following any algorithm may lead to problems. Sometimes the physician may follow all the prescribed steps, but intuition tells him or her that something else is wrong with the patient, as this physician explains:

> *...To be honest, the process between our ears is more efficient than any electronic process we have. Basic medical training is simply that... supplying algorithms although you don't realize that's what you're doing at the time. To have any memoir available certainly may be helpful, but that doesn't need to be electronic, that can be in book form as well.*

This example also illustrates another role of decision support in education:

> *Dr. DeBombal of Leeds, England devised a Bayesian probability analysis of acute abdominal pain. He compared the success of the surgeons' decisions and of his program and guess what, they both got better. The conclusion was*

that even after the event, even in retrospect, the use of the computer program focused attention on the important points. You didn't sort of worry about how the patient described the pain, let's say, you worried about where the pain was.

Using the computer to implement Clinical Practice Guidelines (level 2) has been suggested as one way to support decision-making. In this case, a group of physician experts determines "best practices" that both minimize use of resources and produce the best outcome for the patient. Physicians express some uneasiness about whether this becomes "cookbook" medicine. However, individual practitioners are still free to override the recommended treatment.

Role changes and shifts in responsibility are often unanticipated and relate to information accessibility, decision-making and power. Some physicians expect they will become increasingly accountable for managing their orders when the hospital implements a system that makes it possible to do so. They anticipate that access from their offices will provide two benefits: they do not have to bother "busy nurses" to retrieve information for them and accessing the results themselves will be much quicker. On the other hand, physicians are not likely to use computer terminals in their offices if the current system works fine, there is not much evidence that an automated information system would improve care, or implementation would involve great time and energy costs as this physician describes:

The actual financial cost of providing the terminal isn't a factor at all. Computer terminals are fairly cheap. It is the amount of time that would need to be invested to get a system up and running. Then it would require converting a system that is working quite well, into a system that could equally work quite well, but is going to require to be tweaked significantly just to make it work for you.

With minimal use and interest in using the system, an important question is how to motivate the large group of ambivalent physicians to become willing and active users. One suggestion was simply to mandate use, much as the government did with the electronic submission of claims to the Medical Services Plan (MSP). There are a number of differences in these two situations, the biggest one being the incentive to change when it is tied to financial payback. Payback is not the only factor, however, because in other cases physicians discarded new technology because it became "just another encumbrance, even if the payback was evident."

The concept of "chauffeured use" is not a new one, but seems to describe the manner in which physicians have historically interacted with the health care system in retrieving information and communicating orders for patients. For example, the office secretary may call the hospital to forward information about a patient's admission. Nurses, lab techs and pharmacists receive requests for information that the physician uses to make decisions and generate further requests. The physician easily communicates these by telephone or on paper. This frees him or her to use the information in decisions and communicate additional requests in the most efficient manner. These practices often extend to automated systems where the only difference is that the medium for exchange of patient or billing information is electronic. For example, one physician pointed out, "an administrative advantage [of using PCIS] is the ability to have your secretary phone in and download patients."

An assumption is often made about physicians' use of computers in the hospital, based on their use of on-line MSP billing. Several physicians noted that it is the clerical staff in their offices who use the computer to do billing. Physicians characterize themselves as generally slow to change, with physicians in this hospital "showing leadership in being the ones that are the slowest to change." There are many independent (versus group) practices, that are reluctant to allow others to "interfere" or "become involved" in their practice. However, they are also beginning to see the advantages of a more efficient system reducing the backlog and waiting lists for their patients.

Physicians expect implementation of terminals and accessing results on-line to be a slow process at this hospital. Out of approximately one hundred and fifty doctors, they estimate approximately ten percent will never be comfortable with the system, and these people are probably within three or four years of retirement.

Physicians express both strong and mixed feelings about the use of an Electronic Health Record (EHR). Issues related to physicians entering their orders and on-line documentation are important. Physicians continue to view entering the requests for tests or results as a clerical task and therefore is not a necessary or economically viable skill for them to acquire. As well, pharmacists already monitor drug interactions, so physicians do not see benefits in ordering drugs from a computer screen.

One of the prime benefits of using an EHR is to improve communication. If the way in which one group documents observations or patient care is not in a format useful to other groups, the computer has the flexibility to present the same information in a variety of user-defined formats. These types of benefits are not measurable in financial savings and so do not receive the same kind of priority. For some physicians it is difficult to see how an EHR would facilitate the process of medical care where the physician reviews a patient chart, goes to the bedside and makes notes. At this time, the advantages do not seem significant enough to warrant the change required. One participant suggests physicians may react positively to the idea of an EHR as long as two things happened:

> *First [it must be] demonstratively superior and the effect in the end is to get a better record. Second, the phase-in of the system must be very, very gradual and very permissive so that if you wanted to scribble notes you still could. You would not have to learn to manipulate the keyboard if you didn't want. There must be some back-up system where your notes or dictation are transcribed into the record. I don't think you could ever get to a situation where people would prefer to use a keyboard rather than write in the chart.*

Physicians are less concerned about the increased "visible" accountability inherent in using a PCIS than they are about being scrutinized without knowing it, as this participant describes:

> *...the physician point of view is we don't want any change, we know the current system, we like it. In particular we don't want anything to come along that will put us under any greater scrutiny. One of our current concerns is that the new systems will allow the performance of doctors to be scrutinized without the doctors ever being told and this we consider to be wrong. It should be written into the system that if you draw a report on my performance, I also get the report. I'm not saying that you shouldn't get this report, but that you should never get them without my knowing.*

Physicians feel less threatened if that someone "looking over their shoulders" is a clinical expert rather than "the computer" being used by non-experts. They feel their autonomy, ability to treat patients and relationship to patients is jeopardized.

6.4.3 Use and Impact of Electronic Communication

Currently limited access to terminals and training affects the use and impact of electronic mail (e-mail). There is only "a dozen or so" physician users, although this is twice as many as three months ago. The difficulties in using e-mail include that some physicians do not respond to their messages, some are not in the hospital very much and most do not yet have access in their offices. However, physicians see e-mail as potentially very useful because they frequently exchange communications. There is often some doubt whether they received or read these messages, and e-mail could eliminate many of these concerns.

In spite of its great potential as a communication tool, the biggest perceived drawback of e-mail is the need for "typing skills." If physicians do not have these skills to make good use of e-mail, they may be deterred from using it and resort to using the telephone instead, as this physician describes:

> *A couple of times a day I go over there and pull up my file, see who's been writing to me and what they want, acknowledge it, delete it or write a response. I'm a slow typer so I don't write many responses to it, or very few. The other thing is often where I could reply, I'll choose not to and pick up the phone because I want a conversation. I know you can get one on here too, but they're not sitting at the computer.*

Physicians identified several other drawbacks to using e-mail. Although e-mail improves efficiency, the fear is that it does so at a cost to social interaction, in other words, "you waste less time, but see people less often." While a user can read e-mail at his or her convenience, for some it also imposes a perceived need to respond immediately and a certain degree of structure in the day that a stack of paper on the desk does not. For other users there is no sense of urgency, but they agree it is easier to deal with the messages promptly by filing or responding to them.

Another problem identified with e-mail is that it can get exceedingly trivial and "junk mail" is not as easy to spot as it is in paper mail. This means it is difficult to distinguish how important e-mail messages are because they all look the same. One physician suggests that the "sender" of the message is a good indicator of its importance:

> *I go on the basis primarily of who sent me the message. You get to know the styles... some people write messages and you tend to discount them when you see "please respond as soon as you can about whether we should have hamburgers next week or not." I mean this [expression] "as soon as you*

can," ordinarily you'd say well this is what people want, then you see the rubbish down below. Other people who are modest in their demands, you'll look at what they're asking you about and normally it's a priority. So I would say that that's the main difference. I don't think that whether it's a computer or piece of paper makes a big difference.

Physicians recommend the introduction of e-mail take a couple of years. They suggest the hospital run a parallel manual process at the same time, until users decide for themselves that the backup system is unnecessary.

6.4.4 Summary

The impact of PCIS on physicians at Hospital 3 is summarized in Figure 6.7. As one physician points out, typically health care is very good at collecting data, but not at using it to change behavior. XTECH has been in use for almost a year and the hospital data is just "coming together." Before this, system data collected from individual departments was not comparable locally, or provincially. Access to utilization information is of practical benefit in decision-making as well as an education tool for medical staff. They can compare individual and group practice within the organization as well as hospitals through out the province.

Physicians have had little opportunity to use the XTECH system and therefore have experienced few benefits. On-line results are expected to facilitate better and faster decision-making. However, physicians point to a number of factors that affect their decisions, of which information is only one. The use of Clinical Practice Guidelines and decision-making algorithms may provide some assistance in decision-making and teaching.

Physicians also see billing advantages to having electronic access to information because "on occasion physicians do not get full remuneration for work they've done because they don't have the data to bill appropriately."

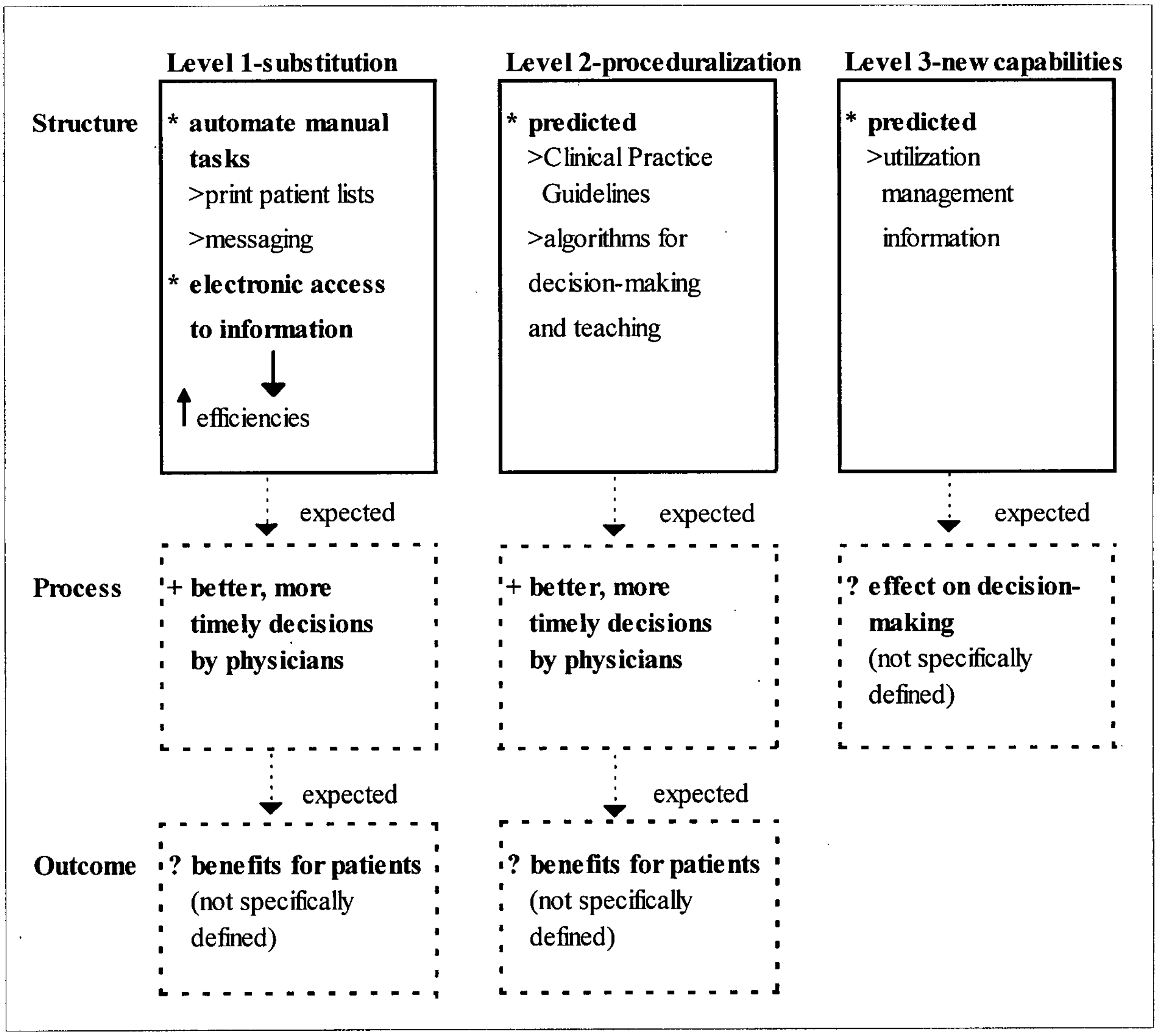


Figure 6.7 - Impact of PCIS on Physicians at Hospital 3

6.5 Summary - Hospital 3

6.5.1 Introduction and History of Computerization in Hospital 3

Hospital 3 has a long history of computerization that includes an unsuccessful previous attempt to implement an integrated PCIS. This was due to a variety of reasons, including an unreliable and limited system as well as lack of resources. The hospital and HIS Department are in the challenging position of replacing this system and changing negative attitudes that have developed around the use of IT.

When the hospital decided to look for an integrated system, there were few vendors on the market to choose from. The number of systems successfully implemented in British Columbia and Canada reduced this number even farther. Although users participated in system selection, they felt strongly that they went through the motions of a selection process, but the decision had already been made. The limited vendor choices may explain why this was partly true. Implementation of XTECH began in 1994 by first replacing those systems already in place.

6.5.2 Use and Impact of PCIS

System use by nurses and physicians is limited at the present time for reasons that have been discussed. Pharmacists and lab technologists are using their respective modules more extensively to automate clerical tasks. In addition, as is the case in all study hospitals, there are two groups of users based on whether their IT use is voluntary or not. Physicians may or may not choose to use the PCIS, while all other professional groups in the study must use the system when it becomes available, as a condition of their continued employment. Physicians may also depend on "chauffeured" system use through office secretaries (who request information and complete electronic claims) and other health care professionals in the hospital. There is also evidence of "chauffeured" use of the PCIS by nurses, as well as doctors, just as there is in the manual system.

The benefits of implementing XTECH may not be evident until there is a critical mass using it, as is the case for e-mail. The success they achieve may be less than the system potential if both automated and manual systems must be maintained (for example, automated MAR's, order entry and results inquiry are only available on a few Nursing Units). Efficiencies derived from order entry are expected for the unit secretary position and the Nursing Department by association. Nurses do not see "order entry" as a direct benefit for Nursing because it is a clerical task. Physicians expect that if the focus of their "real job" is to operate on people, the contribution of the computer to increased productivity is hard to see except in terms of the "paper pushing" activities, such as dictation and retrieving previous results for review.

Environmental cues become embedded in the presentation and interpretation of information. They develop over time and are taken for granted, but become very important when the established system changes. These cues are part of what make the information useful and must be built into electronic systems. For example, when the results are available electronically, Nursing Units or Physicians no longer get a telephone call alerting them of abnormal results. Computer generated lab results are all printed on the same color paper with the same size font. They are efficient to produce, but do not stand out the same as different colors that signify different types of tests. Physicians are concerned that the same problem will occur with electronic health records where all the information looks the same, and this presents a deterrent to using them.

The new Freedom of Information and Privacy Act requires that the organization be able to produce audit trails of access to patient data. This has not been too much of a concern yet because the number of users is limited. However, they predict this may be a problem when the system is used from remote sites. It is a commonly held belief that "you can rely on the professionalism of staff who work at the hospital," but once outside the hospital there is decreased security and confidence in who is using the information and for what purpose. Physician users with personal and pecuniary interests in data protection may exert added influence on organizational decisions regarding the level of security needed.

Interdependent roles between health care professionals often mean that role and responsibility changes in one group influence another group. This also occurs when tasks are moved from professionals to trained technical staff. Integrated information systems may be the catalyst for these changes to occur. For example, under the direction of OR nurses, Aides in Central Supply have been trained to complete some of jobs which OR nurses traditionally did. Eventually, the OR Scheduling System will provide the additional information the Aides received from the OR nurses. Automating manual tasks at level 1 allows them to be done by less skilled people, which may be akin to deskilling if the OR nurses are not freed up to do other more complex tasks.

There is a unique interdependence and hierarchy of roles between nurses and physicians. This must be considered where physicians predict system benefits when they no longer have to bother "busy" nurses to get information, because they can get it themselves.

This effectively cuts the nurse out of the loop of "information gatekeeper" for physicians. One physician saw this as an advantage for both nurses and physicians because, as he says, "You don't have to waste an R.N.'s capabilities to have her phoning around trying to get results." Historically nurses have played the role of knowledge brokers between the support departments like lab and pharmacy, and the physicians. Figure 6.8 illustrates the changes in roles among three order entry systems where orders are written and sent on paper, written on paper and the nurse sends electronically, or the physician both sends orders and receives results electronically.

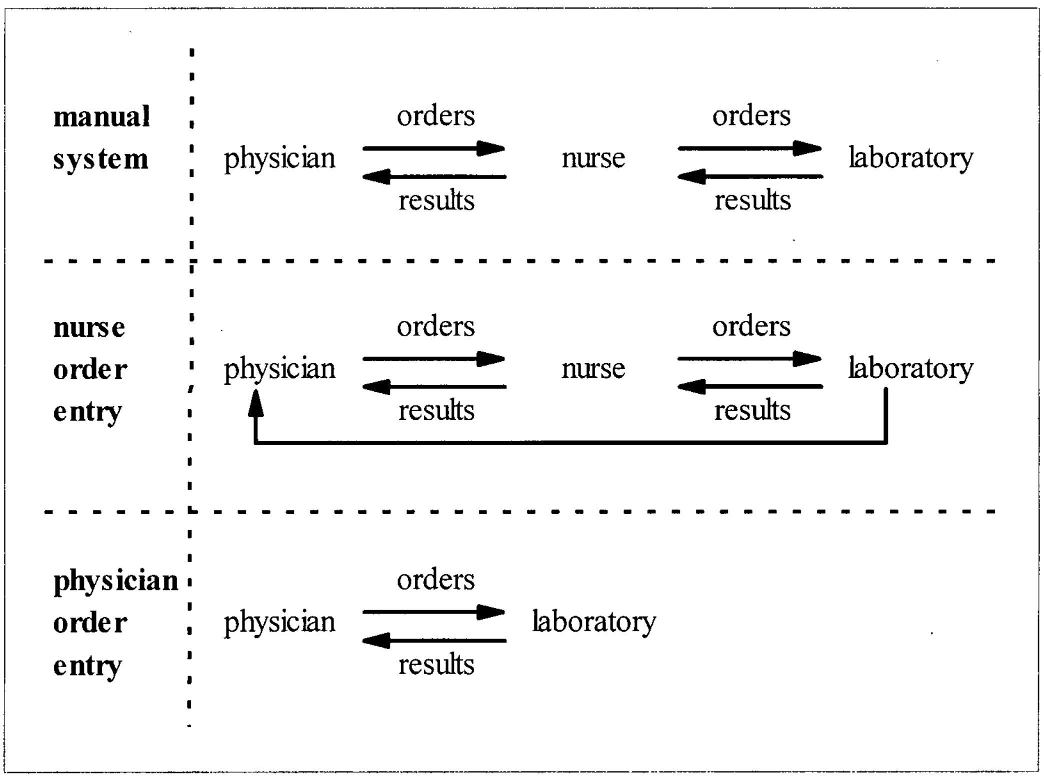


Figure 6.8 - Comparison of Three Order Entry/Results Reporting Systems

The technical requirements for implementing any of these three systems are not difficult. The role and responsibility changes that occur with these changes may be more difficult to predict and manage. It may be useful to establish an interdisciplinary group to examine the changes and develop support strategies for them

6.5.3 Use of Electronic Communication

At this time, use of electronic mail remains voluntary for all users and there is a range of use in every professional group. All groups anticipate a positive impact will occur when there are enough users to make it worthwhile to send messages, and the sender can be more assured of consistent responses.

6.5.4 Summary

The impact of PCIS on all groups at Hospital 3 is summarized in Figure 6.9. The hospital only began implementing their new PCIS in 1994. Nursing has experienced little in the way of benefits as terminals are not widely implemented, and there is no liaison assigned to take the initiative for implementation. They expect limited benefits from order entry and mostly as an efficiency measure for their unit secretaries. It is not clear how these efficiencies will translate into changes in the process or outcome of patient care. Most participants identify generic changes such as "more time with the patient" or "better/faster decisions." Participants were able to identify three specific areas where they expected outcomes to improve: reductions in errors, length of hospital stay and redundant questions patients are asked.

The Lab and Pharmacy have experience using computer systems. As in Hospitals 1 and 2, they have been able to use the systems to automate many procedures, and to set parameters for automatic checking (e.g., abnormal lab tests, drug allergies) and/or generating reports. Some of these procedures now allow the Lab to forward test results to physicians after the patient has been discharged which is expected to result in better decisions and a continuity of therapy.

	Level 1 substitution	Level 2 proceduralization	Level 3 new capabilities
Structure	* **automate manual clerical tasks** >medication orders * **predicted** >lab order entry	* **set parameters/ auto generate reports** * **on-line quizzes** * **predicted** >on-line manuals, documentation >physician order entry	* **predicted** >communication with community agencies * **tutorials for students**
	expected	expected	
Process	+ **more time with patients** + **better/faster decisions**	+ **better decisions** >results available after discharge	
	expected	expected	
Outcome	+ **better outcomes** >reduced errors >LOS, redundancy	+ **better outcomes** >continuity in therapy	

Figure 6.9 - Impact of PCIS on All Groups at Hospital 3

Participants in the Lab have taken the initiative to extend their use of the PCIS to proceduralizing some of their teaching tasks (e.g., quizzes, marking, feedback) and new capabilities in designing interactive tutorials.

Endnotes

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[1] Generally, transcription of lab orders onto requisitions is an activity carried out by unit secretaries, but nurses may also be required to complete them when the unit secretary is off duty.

[2] The bar code is a positive identifier which incorporates a check digit to ensure accuracy as opposed to a number previously assigned by the Lab.

[3] Six Nursing Units have their most commonly prescribed medications distributed in bulk as "ward stock" that are replenished by Pharmacy on a regular basis. Several days supply of medications are decanted from bulk supplies in Pharmacy and sent to the Nursing Unit when the order is filled. Nurses are responsible for again decanting the appropriate dosages from the ward stock or individual patient bottles for administration to the patient.

The other six Nursing Units use a "unit dose" distribution system. Medications are individually wrapped, labeled and distributed in daily amounts for each patient. They estimate that 50% of the medications are pre-packaged. The other half are packaged and labeled by the technicians, then checked by the pharmacists. It took a long time to establish the first six units on the unit dose system, a process they began approximately 15 years ago. For the past 8 years they have maintained two distribution systems because they felt it was difficult to properly support expansion of the unit dose system given their limited resources.

[4] The target date to begin pilot testing the new MAR's was last October, but this has been held up because a computerized chip required by the printers to pre-print the necessary grid work has been unavailable. Pharmacists anticipate that implementation of a hand held computer in Nursing will enable nurses to document medication administration on-line and the MAR's will become redundant. However, there are no definite plans for these devices in the near future.

[5] Due to their combination of drug distribution systems, many changes are required in the computer system when a patient is transferred from one unit using ward stock to another unit on unit dose or vice versa. This is not done automatically through PCIS, and because each unit does not have the same stock medications, the pharmacist has to re-schedule all the medications on the patient's medication profile, ensuring the receiving Nursing Unit has the right medications available.

Chapter 7 - Comparison of Impact Across Groups Within Hospital 4

7.0 Introduction

Seventeen interviews were conducted at Hospital 4 from June 1 to 7, 1995, with five representatives from Nursing, four from Pharmacy, four from the Laboratory, three from the Medical Staff and one from Information Services.

The Hospital Information Services (HIS) Department has had a mixed history with little in the way of stable human resources support (see Appendix G for details of the history). Currently the department has a part-time Manager, who the hospital shares fifty percent of the time with another facility of similar size, a business analyst and half-time electrician (responsible for repairs of the hardware). They plan to add a second business analyst and increase the manager's position to full time in approximately four months.

They implemented XTECH financial and admissions systems in 199?. A recent consultant's report recommended continued IT implementation using an integrated approach. In the summer of 1994 they implemented the XTECH laboratory system, somewhat independently and without real involvement or ownership of the hospital. The Lab decided Nursing should enter the lab orders and took on the training of Nursing staff. Unfortunately, two key members of the project team were injured shortly after "live" date. At the time of the interviews they were just returning after six months leave.

The HIS Department established a rigorous implementation schedule in their projected four year plan. It includes Pharmacy, Radiology, patient scheduling and electronic patient chart systems that incorporate patient care inquiry, order entry systems, cost accounting, executive support and physician access.

The philosophy of the HIS Department is that users are responsible for the projects in their area. The HIS Manager provides project management to ensure they stay on schedule. It is up to each department to assign a department leader who will coordinate the development of their systems, including building dictionaries, establishing procedures and processes, and conducting the necessary training.

7.1 Impact on Laboratory Technologists - Hospital 4

7.1.1 Introduction and History of Computerization in the Laboratory

The Laboratory had been requesting a lab system for as long as they could remember, however their request "just kept being put on hold." The hospital computer person asked the lab manager and section heads what they thought a computer system should do for them, but he did not involve them directly in selection of the current vendor or system. When the Admitting and Finance Departments implemented XTECH, other departments assumed that in the future they would also be using the same system. In December 1993, the Lab was informed they would be installing XTECH, and in January 1994 the implementation process began.

The hospital expected the Lab to carry out implementation and training within existing resources. They do not recommend this strategy to other sites because they constantly felt pressed for time and resources. A five-member team was drawn together, consisting of the Lab manager, three section heads and one lab assistant.[1] One section head agreed to coordinate the implementation effort. They recently hired the section head for Microbiology and although she did not officially begin work until March 1994, she agreed to participate in the implementation process. There was no formal computer department to provide on-site support, which they felt was a big drawback to the project.

The XTECH vendor presented an implementation schedule for the project. However, given the Laboratory's lack of experience with computers, it was difficult for them to evaluate whether XTECH's expectations were realistic or not. The vendor regularly conducts training at their headquarters on the eastern seaboard, and they scheduled all members of the implementation team to attend a session. Given the size of the hospital and Laboratory, they felt having five people away for a week was untenable and alternatively they requested the vendor to bring training to them. They hastily constructed a training room with five terminals and began training for the implementation team on-site. In preparation for implementation in mid-July of 1994, the implementation team had to build all the system dictionaries.[2] They began by identifying all possible XTECH screens and then selecting the ones to customize for their department. Two neighboring hospitals also lent their dictionaries as templates and the Lab modified these for Hospital 4's use.

Implementation included all three sections in the Lab: Hematology, Microbiology and Chemistry.[3] They quickly discovered that receiving orders on paper requisitions meant they would be responsible for re-entering all those orders into XTECH. They negotiated a modified order entry with hospital administration, which meant Nursing would be responsible for entering the orders.[4] The Lab's implementation plans expanded to include installing terminals and printers on the Nursing Units as well as training two hundred nurses and ward clerks. Once the training process began, they sought the assistance of the Education Department to help with scheduling people to be trained, and their replacement staff. Training was done efficiently in two-hour blocks, back-to-back. This was casual staff could sequentially replace more than one person per shift.

Most of the Lab's employees are long term and this was the first computer system they were exposed to. This lack of experience and because the implementation team was "a little short handed," they saw their training as less than successful and in some cases almost non-existent. In retrospect, the implementation team felt Laboratory staff had really suffered because their education efforts were directed elsewhere.

During the implementation process the rapport between the Lab and Nursing Units improved for those involved in implementation because they had better communication and more appreciation for each other's work. They felt system success related to implementation success, as this comment from a lab tech suggests:

> *Your implementation, your training and your team that's putting it in I feel has a whole lot of power to make it simple and workable or totally screw it up [laugh]. It's only as good as the training you've received from XTECH, how well they've gotten through to the team and how much the team buys into it and understands....*

They conducted several weeks of "parallel runs" to ensure the accuracy of the new system in comparison to the old system. However, information quality remains partly related to the accuracy that users enter it. As the lab system stands, they must select a patient name from an alphabetical list of names, and then the correct visit from a list of their encounters with the hospital. Both selections may lead to errors, particularly if the last name is common or there are numerous admissions. At first there was a significant error rate with this input into the system. While this number has decreased, the Lab continues to find the number of errors frustrating.

When they went "live," section heads, a couple of people from another hospital and their XTECH implementation person provided support on all shifts for several weeks. Although the lab techs and assistants felt they did not have adequate training, they struggled with it and eventually adapted well. Section heads initially scheduled their staff for a block of time in each of the areas (Chemistry, Hematology and Microbiology) to assist them in becoming very familiar with the new system. Evening staff were at a bit of a disadvantage at first because they had to become competent in all the areas very quickly.

The Lab did not initially offer physicians training to use the lab module because two members of the implementation team were unexpectedly unavailable. However, this was later resolved when they returned. Over a two week period in March 1995, approximately thirty physicians participated in training sessions of one half, to three quarters, of an hour each.

7.1.2 Use and Impact of the PCIS

Lab techs saw implementation of the PCIS partly as "a move into the '90's" because all of their peer hospitals seemed to be using computer systems. The Lab describes the system as fairly "user-friendly," but they have been disappointed in the XTECH support they received. This may be related to the minimal technical support available on-site that has consisted of only one contract person, who changed frequently. The Lab acknowledges that although XTECH is not the perfect lab system, integration is probably "the way to go for the facility overall." An immediate benefit of the integrated system for the Lab was the availability of admitting information, which they previously had to re-enter.

The Lab expected use of the PCIS to increase their efficiency, particularly with improvements in work flow and reduced paper handling (level 1). In an earlier Continuous Quality Improvement (CQI) project in the manual system, they identified the time the Lab wasted in going to the wrong rooms, to the wrong beds or trying to locate patients to collect blood. The patient may have been discharged the day before and the test not canceled or the patient transferred after Nursing sent the requisition to the Lab. Computer generated worklists provide the lab assistants with more timely and accurate information about what tests have been ordered as well as the patient's location. The computer sorts the list by room and unit so they do not waste time arranging all the requisitions (level 2). They are also able to access the "test dictionary" that provides them with an on-line manual of collection procedures.

Seven instruments now on-line reduces the time they spent transcribing results onto requisitions and filing copies of those results (level 1). The Lab can now handle inquiries from doctors' offices quickly and efficiently because they can retrieve and fax reports directly. These results are also available on-line in the hospital, so they gain efficiencies through the reduction in phone calls from the Nursing Units to the Lab. Blood Bank can benefit through definitively linking the patient to the blood they receive, but they have not automated yet as they have not determined whether the investment is justifiable for a hospital their size.

Another benefit of their improved efficiency is the reduced turnaround time in getting results back to the doctor that they believe supports better patient care. For example, results from blood drawn at 7:00 a.m. are available on-line between 8:00 and 8:30 a.m.. Reports are printed at night and hard copies available on the chart the next morning. Unless there is on-line access to results, there is little difference than the manual system. Advantages over the manual system include having the reference range right on the report, cumulating results and fewer errors in filing results on the wrong patient chart. The Lab can enter the test and automatically produce labels in less time so outpatients benefit because they require less time for tests.

The Lab expected efficiency gains would enable them to reduce their staff, but this has not been the case. They balance what they are saving in billing time and workload unit time with, for example, the increased time required to input results for the Microbiology area who do not have their instruments on-line yet. In more of a cost avoidance rather than cost saving effort, they feel they can do a lot more with the staff they have because of the computer system.

Productivity is also affected by the physical layout of their work area. Of serious concern to the Lab is the lack of attention paid to the ergonomics of terminal, keyboard and printer locations. Workplace design concerns include ensuring terminals and keyboards are at the right height, recessed counters, accessible work space and terminals without excessive twisting, and good lighting. Making the changes themselves is not difficult, however after implementation is complete it is not easy to get the money to make them. In some areas the Lab anticipated these changes, but they have not implemented them yet.

The Lab expects workload measurement (WLM) to reflect productivity changes, but difficulties in this area have been compounded by the fluctuating number of patients and available beds in the hospital. The Lab expected clerical duties associated with measuring workload to be reduced. However, they have had a problem generating workload statistics on the computer. This is partly because they were pressed for time and resources during implementation, but they also did not have a good understanding of it initially. Other problems stem from not being able to capture workload in the same manner as they did in the past and therefore not being able to make historical comparisons.

The lab techs are experiencing role and responsibility changes in several ways. They have always been responsible for checking their work and deciding whether results are abnormal, to repeat tests or notify the Nursing Unit. With the interface between their lab instruments and the PCIS, they still have to review and accept the results before reporting them, but the computer flags results that need a second look (level 2). In Chemistry, for example, when the system detects an abnormally high or low value, it also automatically does a delta check to compare the patient's previous results with current results for that test (level 2). While these flags remove the responsibility for remembering to do the checks, the lab tech's response to the flags can now be monitored (creating a "visible" accountability).

In a sense, having the computer flag highs and lows and conduct delta checks transfers a physician's responsibility to the lab tech. It is a tedious job for lab techs to manually check each result against previous results, but physicians are expected to do this for their individual patients because they already have the information on hand.

In the manual system if requisitions were incomplete, the Lab contacted the Nursing Unit for further information, or completed the work without it. When Nursing staff began sending orders electronically, the Lab built each test order to include the additional information required. In these "customer defined screens" the Lab determines what information users must complete before they advance and what information is discretionary.

Accountability for nurses to correctly order lab tests is now "visible" to lab techs who can follow up errors specifically with the person who entered the order. The Lab is also frustrated with errors in the priority of an order (for example, timed versus routine) which mean they do not draw tests at the appropriate times. The question arises about who should be responsible for following up these errors, the Lab or Nursing, but the Lab does not want to become the "computer police." They try to clear up a problem through phone calls or a "polite, but firm, e-mail message." They also follow-up the occasional serious error with a written incident report.

Use of the PCIS has had a greater impact on the role of the lab assistants than on the lab techs. As more of their time that was previously spent on clerical duties is freed up, the lab assistants take on more of the technologists' jobs. The lab assistants are responsible for blood collection, glucose metering, in-lab duties such as wash-up (most of the equipment is disposable, a few things go down to central stores) and dispensing formalin. There is no Histopathology Department in this Lab, so they also process all the specimens sent to the Regional Lab, making sure they are all documented, sent to the appropriate places and properly packaged. They now type into the computer much of the information that was handwritten. The lab assistants have a high volume of paper to contend with because of the large number of out-patient visits and tests referred out. When the reports are returned, they distribute copies to physicians' offices and hospital mail boxes on a daily basis as well as file them in the department.

From the Lab's point of view, a definite drawback to the system is the incomplete audit trails available. For example, if Nursing places a stat or timed order, a label is supposed to print in the Lab, alerting them to the order. There is no way to confirm in the system whether the label printed, so Nursing staff end up phoning to check. As well, the Lab is unable to determine whether stat results printed (or were held up by a printer being out of paper, jammed or off-line) or reviewed by nurses or physicians. They also have to follow up with a phone call. A more potentially serious example of incomplete audit trails occurs because the system tags only the original order with the user's ID. However there is no indication of any subsequent changes to that order, either in labels printing or ID changes.

Another drawback is the reduction in access to information, which has resulted in some negative, perhaps unintended consequences of "chauffeured use." Where a job has not changed and employees have had access to information in the manual system, limiting access to that information in the PCIS has several consequences:

- employees feel an element of trust is lost;
- employees are unable to complete all aspects of their jobs without asking someone who has access to retrieve the necessary information, creating an interruption on both sides;
- they circumvent security of the system.

The Lab expected quality of the output to improve, as it has, because the printed reports are much easier to read and more legible than the previous handwritten copies. For areas such as Microbiology, reports have become more standardized and less subject to individual variations between technologists. The initial problem with these new reports was that they printed stat results, as well as daily activity reports. The Lab expected Nursing to file these daily on the patient's chart and then replace them with the new results as they were printed. However, this change caused increased workload on the Nursing Units. Physicians were also very unhappy because it meant they had to sift through many pieces of paper to find current results if Nursing did not remove extra "old" reports from the chart. Health Records personnel had the same reaction to this sudden increase in the volume of paper on patient charts. This was probably the Lab's first clear example of the consequences of an integrated system when one department makes a decision that has an impact on many others.

7.1.3 Use and Impact of Electronic Communication

Electronic mail is being used extensively in the Lab and some managers may even "drive their staff crazy" with messages. It is particularly useful for communicating to part-time and casual staff, who provide twenty-four hour coverage in the Lab. This makes it very difficult to get messages to one another in one manual system. Sometimes it is weeks before a section head may talk to someone personally. User defined lists are helpful in directing specific messages to different groups or departments.

Using e-mail is not compulsory in the Lab, although most techs regularly check their messages. However, the Pathologist still prefers to receive handwritten messages. Barring that situation, they still note critical information in a departmental communication book and post internal hospital notices on a bulletin board. E-mail has not been as useful outside the department as there is quite a large group who do not have access yet. The effect of e-mail on social interaction within the department partly depends on the culture that exists irrespective of the computer, as this technologist describes:

> *Everybody in the Lab gets along so well. I don't think the computer or any e-mail would take away the personal touch of the people there. I don't think it could touch it.*

7.1.4 Summary

The impact of PCIS on lab technologists at Hospital 4 is summarized in Figure 7.1. There has not been a sense of commitment from the Lab due to their minimal participation in the hospital's plans to computerize. The implementation of the lab system has been a struggle from the beginning of the project with its limitations in time, resources and on-site computer support. Shortly after they went "live" several of their key people were away from the project for months, leaving many issues unresolved and no closure on the process.

The Lab has been able to increase their productivity through increasing their efficiency in handling orders. They have automated many of their clerical tasks (level 1) and having instruments on-line automatically reduces transcription errors. They expect to facilitate clinical decision-making through reduced turnaround time and printed (versus handwritten) results. As in the previous study hospitals, the Lab has automated several procedures that allow them to monitor abnormal results.

There are no formal mechanisms in place to share PCIS expertise or resources. For example, through the OR Booking System users can apparently check to see if the slate has printed on Nursing Units, but the Lab cannot check to see if stat results have printed. The role of PCIS in job satisfaction is important to note. Recruitment and retention may be an organizational benefit worth capitalizing on because Lab staff would not want to go back to a paper system.

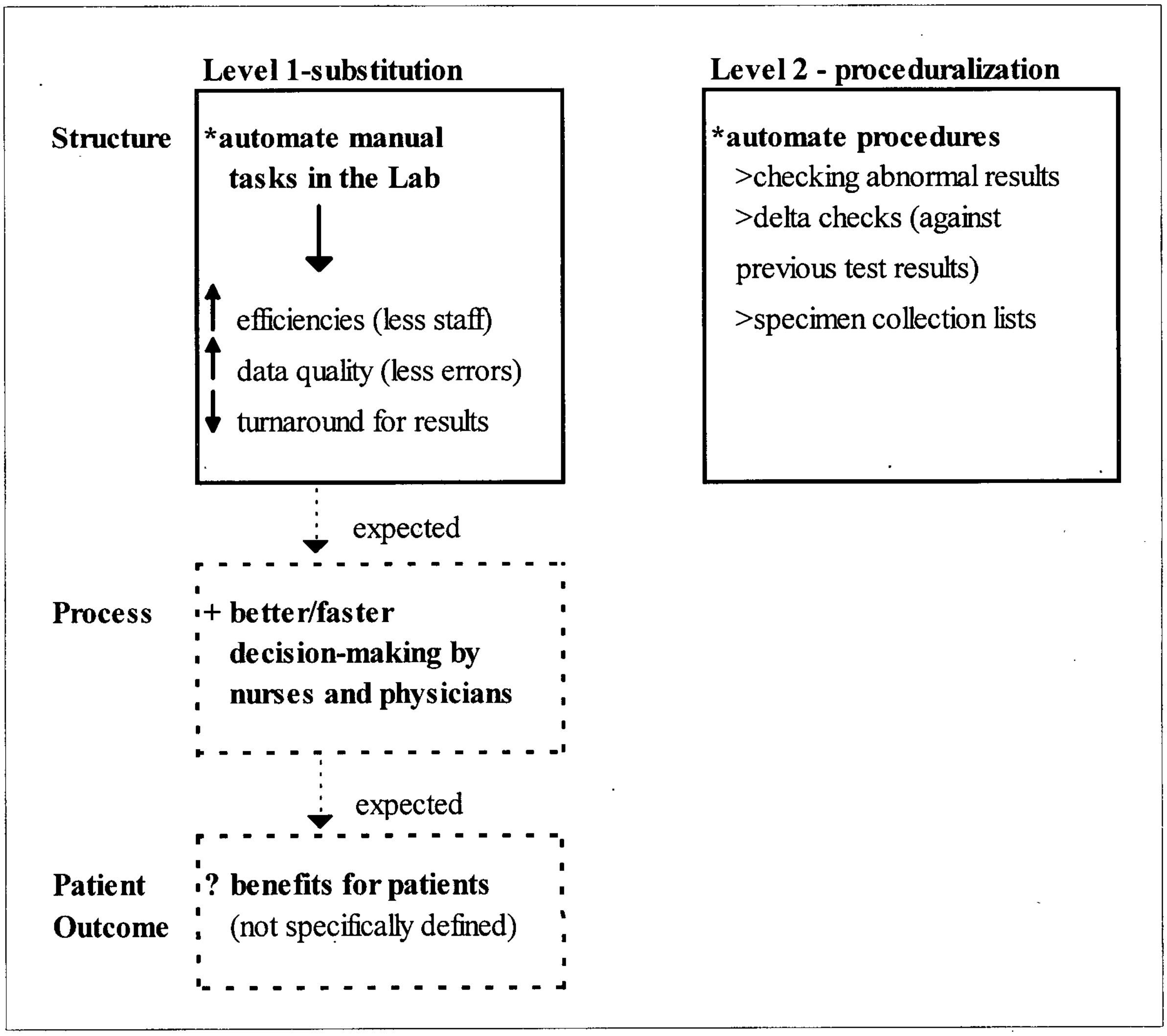

Figure 7.1 - Impact of PCIS on Laboratory Technologists at Hospital 4

7.2 Impact on Nurses - Hospital 4

7.2.1 Introduction and History of Computerization in Nursing

The decision to use XTECH in Admitting and Finance was made some time before the current implementation and set the stage for future system choices. Three different aspects of PCIS are being used by Nursing, including order entry - results reporting, the Admissions program and the OR Booking System. All three of these are important in the Surgical Admissions Program and will be discussed.

Electronic communication of lab orders and results was implemented on the Nursing Units in July 1994. The impetus and momentum for this project came from the Lab who had been directed by the hospital administration to take on the responsibility for setting up the system, communicating about the project and training. The project proceeded without apparent overall leadership or direction from an information systems perspective, as one nurse remarked, "There was one IS person but that person didn't seem to be heading up the implementation." They found the project both exciting and frightening, as this nurse explains:

> *It was a pretty exciting time. We had known for quite a while we were going into this lab information system, but actually bringing a computer into the Nursing Units was pretty exciting for the staff. Some of the unit clerks were pretty frightened [because] they had never had anything to do with computers. Others could hardly wait. They were computer literate and were really frustrated by the lack of access to computers they had in their jobs.*

Nursing was not involved in the system development and from their point of view, "terminals just appeared on the units without warning." They had little time to consider the ergonomic implications of integrating terminals and printers into the Nursing Units. They were unable to make informed choices partly because people on the units did not know enough about how they were going to use this technology. The lack of space on the Nursing Unit continues to be a concern as more terminals are added. In critical care units this situation is compounded by physiological monitoring systems already in place. They contribute to space limitations as well as problems with noise (alarms and telephones ringing) when using the PCIS or teaching someone else how to use it.

Nursing has not determined the optimum number of terminals, but estimate they will need a minimum of three per Nursing Unit. This number partly depends on the direction the hospital takes with respect to order entry. If they choose to implement an Electronic Health Record (EHR) with physicians entering their own orders, they will need more terminals. There are also a number of practical considerations, as this nurse comments:

> *In our hospital, on an average unit between the hours of 8:30 a.m. and 9:00 in the morning, there are probably upwards of fifteen to twenty physicians that go through a unit. They are not going to want to hang around waiting for a computer terminal to be available to them. Whether or not the physicians will be willing to participate at that level and whether we will even be able to support it, in terms of having the number of terminals for very brief periods of time, I don't know. That's a big question mark.*

Training was provided and coordinated through the Lab who established a training room with seven or eight terminals. Initially Nursing Units with high volumes of lab orders, such as critical care, cardiac step-down and surgical units, were targeted for training. The Lab conducted two-hour inservice sessions and nurses were replaced on the units in order to attend. Unit clerks participated in this basic training. They were initially targeted for "super user training," which meant an additional two hours, but this did not materialize. The initial training included only about half of the acute care Nursing staff, but later funds were not available to replace people for training time. Nursing did not target Licensed Practical

Nurses (LPN's) in this initial training because they did not process orders in the manual system. However, since that time they have also expressed an interest in learning how to use the computer.

Responsibility for training shifted from the Lab to the Head Nurses, who were more or less prepared and interested in taking on the challenge. In their roles as managers and clinical experts they were expected to assist staff in clinical problem solving. Becoming the "trainer" for a new IT thrust Head Nurses into a role that some were not comfortable with. It created an unwelcome situation where they were no longer knowledgeable resource people for their staff. Aside from training, the role of nurse managers is also changing with respect to their use of computers. Some managers have computers, but do not have the necessary computer skills that make it worthwhile to use them. They produce "memos and that sort of thing," but still submit most their reports in handwritten form. Managers identify the need for a lot more training and preparation in this area.

The Education Department continued the training efforts through on-going one-hour sessions, which are now included in orientation. Many people were trained on the units by their peers. The hospital intended to issue passwords when training was complete, but this "training on the job" created a problem because passwords became communal property. This made it difficult to follow up errors in entering orders or appropriate access to information.

Sharing passwords has implications both for accreditation and compliance with the Freedom of Information and Privacy Act which requires that audit trails of access to information be available. In light of the discovery that some nurses were using physician's password to access information, it was felt to be important for the organization to make a statement that inappropriate access was not only unacceptable, it would not be tolerated. Mechanisms for monitoring use and consequences of its misuse have not been established. They see this kind of problem as serious because it reflects their organizational culture.

7.2.2 Use and Impact of the PCIS

Nurses felt that learning to use the system presented them with an opportunity to "move into the information age and become computer literate." This not only contributed to job satisfaction, but meant they were "able to keep up with their kids at home." The only component of the PCIS generally available to Nursing is ordering lab tests through a modified order entry in the lab system. When order entry was introduced, they processed orders a little slower initially, but other than that productivity on the units has not been greatly affected. There are less pieces of paper to fill out, but because orders are sent electronically to only one department, there are still many other orders to be manually processed.

Nursing anticipates benefits from reduced paper work when all support departments are on-line, although it is the unit secretaries who will be more affected by this than the nurses. They expect nurses to enter orders when the unit secretary is off duty, but the number of times this occurs varies from unit to unit. Aside from this aspect, it is much easier for nurses to check on the status of orders placed and results received.

Some areas, like the Critical Care Unit, do not have a unit secretary and nurses routinely process the orders. Electronic order entry creates a certain amount of additional stress for these nurses because in emergency situations they must handle the clinical crisis as well as continue to quickly and efficiently communicate orders. Potentially serious errors in patient identification have occurred partly because of the way in which order entry has been modified. The nurses and unit secretaries directly access all patients through the lab system rather than having limited access only to patients currently on the Nursing Unit. This feature is available through an inquiry module of XTECH and they expect to implement it sometime in the future.[5]

Nursing was initially concerned about the quality of the lab system output because stat or abnormal results and daily reports all printed on white paper on the Nursing Unit. The "canned printouts," or standard reports from XTECH were difficult to read and the format hard to modify. Nursing staff were unprepared for this change in their routine tasks. On a daily basis they were expected to remove and discard lab results from the patient charts, and then file the new copies. This was unlike the manual system where the results were reported and filed only once. Duplicate copies of reports often ended up on the chart, creating frustration for the physicians who could not find the results they needed. Health Records personnel were also suddenly faced with an increased volume of paper in the patient charts. The hospital struck a "users' task group" to resolve these early issues and eventually a decision was reached to only print a cumulative report three times a week. The task group also resolved a number of physician complaints through better orientation to the lay-out of the reports.

The PCIS has only had minimal effect on decision-making for nurses and then only in conjunction with other changes. For example, PT and PTT results[6] are available much earlier than before because they are automatically sent to the unit rather than waiting for the nurse to call the Lab. Consequently they can telephone physicians for new anticoagulant orders sooner. The Critical Care Unit also established a new heparin protocol where nurses automatically adjust the anticoagulant order based on the lab results (much like a clinical guideline - level 2).

Users generally expect that either not having the required data, or having the necessary information more quickly affects physicians' decision-making. From Nursing's point of view, the paper system for lab requests was efficient and physicians were informed of critical values in a timely fashion. For this reason, they estimate that physicians' decisions with respect to lab results probably have not changed. Nurses anticipate decision-making will be more affected when diagnostic imaging results are on-line because there is a greater time gap between x-ray orders and results. The feel remote access to results will also be key to changes in decision-making (level 2) because "this is a GP hospital." The General Practitioners (GP's) are at the hospital in the morning until approximately 9:00 o'clock, and then usually go to their offices. The nurses do not see them again until the next morning, unless there is an emergency. Most of the communication between nurses and physicians during that time takes place by telephone. They expect the benefits of remote access will extend to physicians in Vancouver reviewing diagnostic tests like CT scans on-line. This will reduce the number of tests that are repeated because the results were not available (level 3).

The second aspect of the PCIS that affects nurses is the Operating Room (OR) Booking System. It is used by a very small group of people, but has a wide range of impact. For over twenty years a Booking Clerk managed all the OR bookings. During that time she acquired the necessary knowledge and skills to do an increasingly complex job. On her retirement one and a half years ago, the position was changed to OR Booking Coordinator, and filled with a person having OR Nursing experience. Although they purchased the OR Booking System three years ago, the Booking Clerk did not use it. Staff participating in the system selection have since moved on or have forgotten the orientation information.

The OR Booking Coordinator had no previous computer experience. She began with an orientation and ten days of consulting help to set up the system and build a few reports. Initially hardware and software problems were frustrating because there was not a lot of technical support. She has learned to troubleshoot most of the problems now and estimates it takes about one month of orientation for new system users to become comfortable.

A half-time clerk assists with OR booking. They expected this position to be "phased-out" once the Booking Coordinator began to fully use the computer. What they did not take into account was that all the booking cards now have to be entered into the computer and this takes up most of the clerk's time. (The cards are sent from the surgeon's office and patient demographic information must be matched with the Admitting system information before a new patient number is created.)

More complete information that is easier to use, helps ensure the OR is fully booked (level 2). For example, in the manual system OR procedures were written on a sheet of paper with a note: "This takes an hour," or "This takes an hour and a half." The surgeon usually based these estimates on the OR time he or she had historically asked for. When they book cases now, the Booking system automatically averages the total number of cases, as well as the actual time it took the surgeon to complete the last ten cases. This results in a better estimate of the time required, as well as better use of OR resources and surgeon's time. Paradoxically, this has not reduced the surgical waitlist as expected.[7]

The Booking Coordinator now sends the OR slate information electronically to other areas that contribute resources to the OR. This helps them better plan to meet the demands.[8] The Coordinator also produces new reports (such as the number of total hip replacements) that assist the OR to review their resource use over time.[9] They have not designed reports for all the information they would like and are looking forward to having someone on-site who can help them. Use of the Booking System benefits patients because it is much easier to keep track of who is in the queue without continually thumbing through every single booking card (level 1).

The hospital initiated a new program, the Surgical Admissions Program (SAP), two years ago and it takes advantage of the other systems described above. The objectives of the program are to:

- increase the utilization of surgical beds in the hospital by bringing patients in the same day of surgery;
- identify any problems that might delay or cancel their surgery;
- try to provide a more controlled environment for patient education and advocacy; and
- bring a more holistic approach to surgical patient care.

As illustrated in Figure 7.2, there are some areas of duplication in information handling. They are paying particular attention to the role of the Admitting Department because the admissions module is accessible from many areas of the hospital. Parts of this process need to be streamlined, such as how roles of departments like Admitting should change. These roles develop over time to support a particular function and are partly based on access to information. With an integrated PCIS people in program roles may be able to complete the necessary tasks more efficiently (such as the OR Booking and Surgical Admission Program) rather than people in departmental roles (such as Admitting or Nursing).

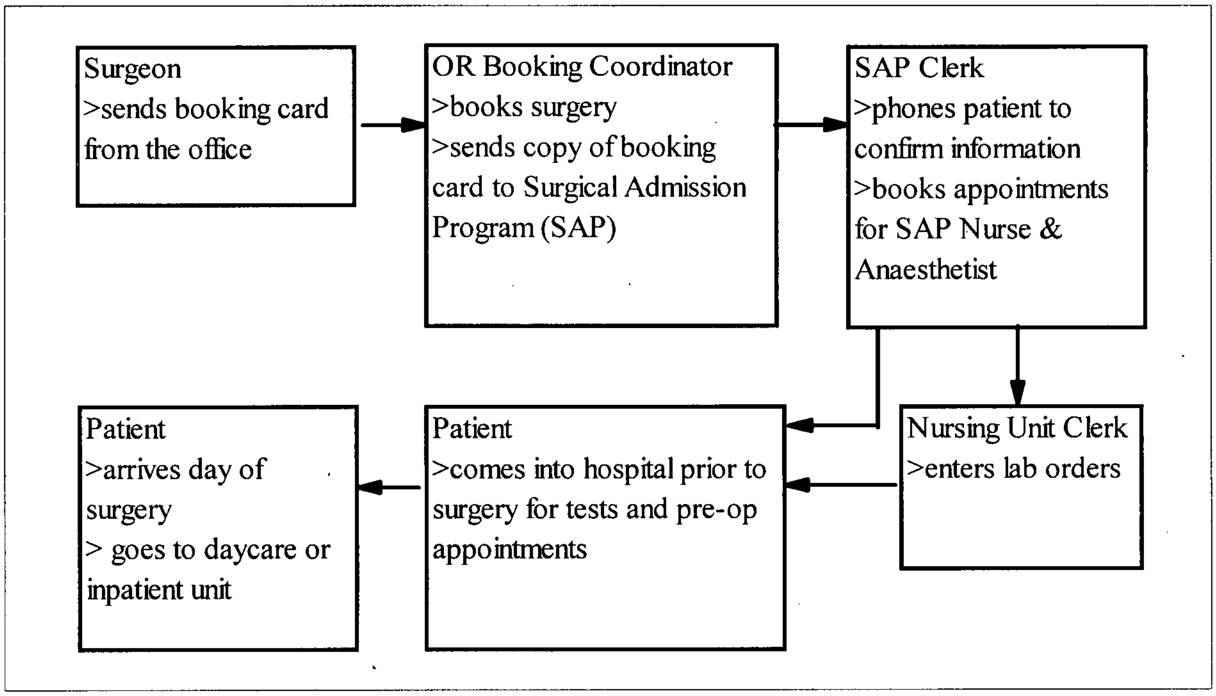

Figure 7.2 - Flow of Information in OR Booking and Surgical Admissions Program

There are benefits both for the patient and hospital with the Surgical Admissions Program. Length of hospital stay (LOS) is reduced immediately for several reasons:

- patients come in the day of surgery rather than one or two days before;
- patients are told what to expect for their hospitalization, including LOS and can begin preparing for discharge before surgery;
- surgical techniques and anaesthetics are changing.

They expect patients to be active and willing partners in their health care. When they come in to see the SAP Coordinator, they have an opportunity to discuss any concerns about the surgery, other health issues or assistance they might need on discharge. The SAP Coordinator has quick and easy access to information. She projects an image of a health care professional who is knowledgeable and able to locate the necessary information to answer questions about OR scheduling time or lab results. Redundant questions and wasted time for employees as well as patients are reduced. This creates a situation where patients are more satisfied, which patient surveys indicate has improved.

Nurses expect other opportunities for change as the hospital plans Phase III of their expansion and upgrade. This includes new space for Nursing Units that can accomodate more terminals. Point-of-care data entry, whether at the bedside or with hand held input devices, appeals to Nursing, particularly where it will support the electronic chart. While they are uncertain what technology will be available when they are ready to use it, they are considering the role of IT in data management in their building plans. When it comes to funding computers however, nurses feel people outside the organization have unrealistic beliefs about their potential benefits. While many areas have demonstrated that computers save time and increase productivity, this may not apply as well to direct patient care activities. This logic continues to be a concern for Nursing as they attempt to demonstrate how the computer provides benefits, but may not necessarily save operating dollars.

Once Pharmacy and Diagnostic Imaging systems are on-line, the Nursing implementation phase is expected to begin. They anticipate being able to streamline documentation and generate workload information as part of normal processes rather than being additional tasks for the nurse (level 2). Hospital-wide on-line scheduling of patients is also being considered as a future endeavor, with a view to extending this to the community (level 3).

7.2.3 Use and Impact of Electronic Communication

Nurses see e-mail as a potentially efficient and effective way to communicate information to large groups of people. This is tempered by the understanding that it is only one type of communication and will never replace one-to-one discussion, particularly if there is a problem. Regular use of e-mail is not an expectation in the organization. Initially nurses were excited about using e-mail, but "that sort of fell off" because there was nowhere to send the e-mail and the few people who had access did not use it routinely. Another difficulty they found with e-mail is the presence of multiple, separate networks in the organization that makes them unreliable for communication.

7.2.4 Summary

The impact of PCIS on nurses at Hospital 4 is summarized in Figure 7.3. While the impetus and momentum for implementing the lab system came from outside Nursing, they ran into some difficulties due to the integrated nature of the system and lack of central hospital planning. As well, because the Lab project was not well supported organizationally, when two key people in the Lab were unavailable, there were serious consequences through out the organization.

Given the organizational philosophy that users take responsibility and ownership of projects, it seems unrealistic, from both Information Services and Administrative perspectives, to expect a project as large and complex as this one to succeed by delegating responsibility for it as an "add on" to people's jobs. As well, if these project managers do not have the experience or expertise, they have to spend some time initially learning about the computer system, its terminology, potential benefits and drawbacks.

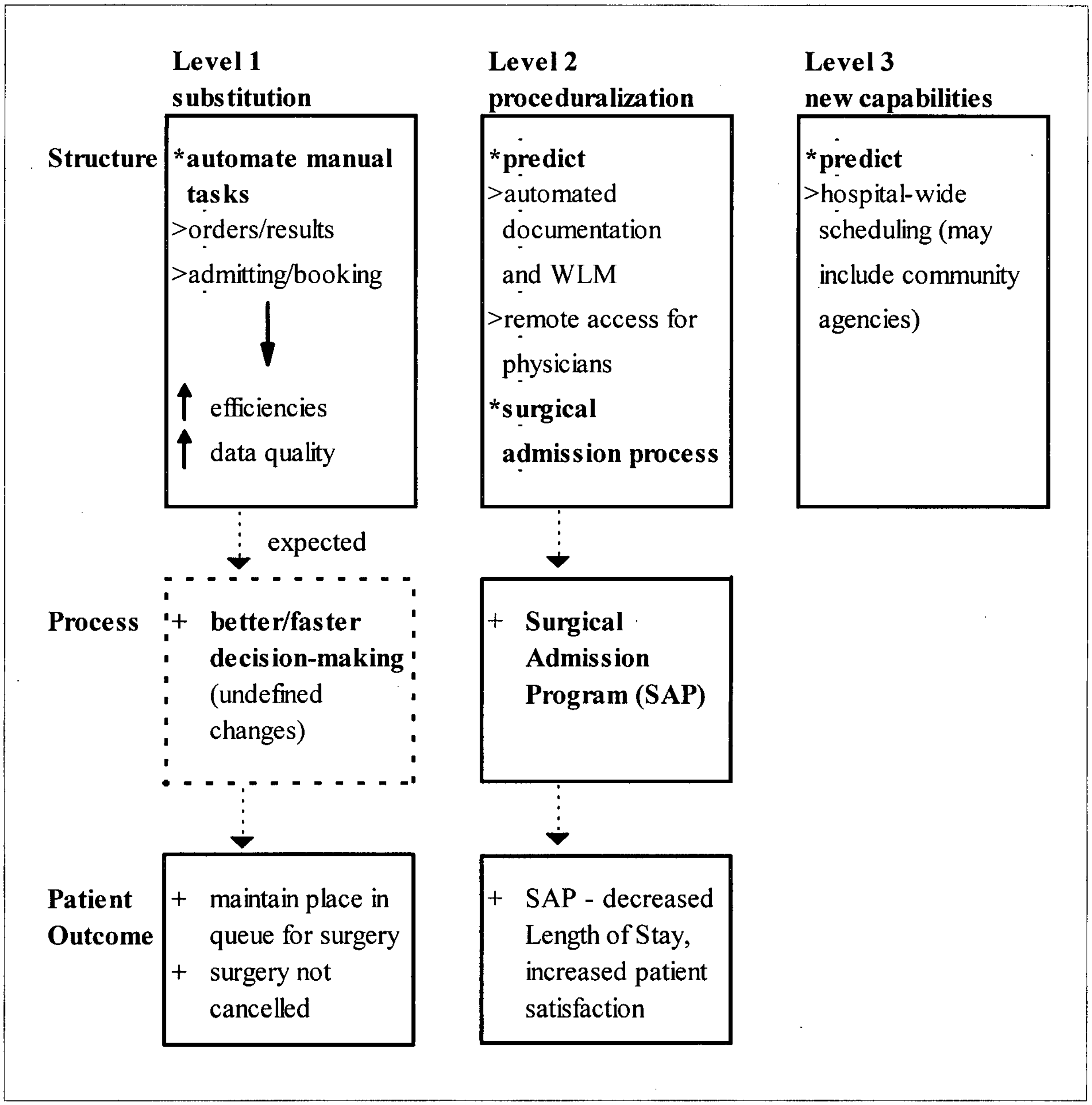

Figure 7.3 - Impact of PCIS on Nurses at Hospital 4

Preparing users for the changes in each department and participating in customizing the system take enormous time and effort. Nurses did not feel they were involved in this major change effort that affects their current work as well as sets the stage for future modules. They were unprepared to make decisions with respect to terminal and printer locations and integration of the technology into their workplace. These early decisions may also affect their flexibility in moving to levels 2 and 3.

The nurses identified important organizational issues around ergonomics and ensuring the workplace supports the work being carried out. If automating tasks becomes less efficient than in the manual system, it creates a negative impact (level 1). This perspective is demonstrated by the volumes of lab results printing on the Nursing Units, that had to be filed and then later removed from the chart. The previous manual system of faxing requisitions to the Lab as well as receiving stat and abnormal results was much more efficient and effective.

Nurses feel a "conceptual awareness" of what computers could do for the facility has been lacking. A few senior managers recognize the need for computers and are becoming computer literate, which brings with it the power force to establish funding and a long term view. The organization was without a leader in the HIS Department for a long time (approximately one and a half years) and that proved to be a detriment in moving ahead. Additional resources have been allocated to improve computer use by providing on-site support for technical issues (programming and maintenance) as well as planning. Establishing a strategic plan is seen as a great step forward. There is no lack of data, so they consider support from a "high level analyst" important in providing direction for the type of reports needed, helping identify what information needs to be "pulled together" and in what format.

As illustrated in Figure 7.4, the integrated use of XTECH systems and programs in Nursing demonstrates the multiple linkages between structure, process and outcome (rather than a singular linear relationship). In the traditional hospital system, efficiencies are gained by delineating and grouping manual tasks. Which department completes each task is determined by their physical location, access to information, skills and knowledge. Admitting patients into the hospital is one example where a group of Admitting clerks were trained and managed this function from one location. This ensured some degree of consistency and accuracy in the information collected. In developing the Surgical Admission Program, they discovered that the separation of structure (admitting a patient into the hospital system) and process (anaesthetic assessment and pre-op teaching) was not the most efficient or effective use of patient or staff resources. An automated information system made it possible to complete the necessary tasks from any location and to structure those tasks to ensure consistency and accuracy by staff who are not trained as admitting clerks. Outcome is directly measured via patient satisfaction surveys which ask the patient for feedback on elements of structure and process.

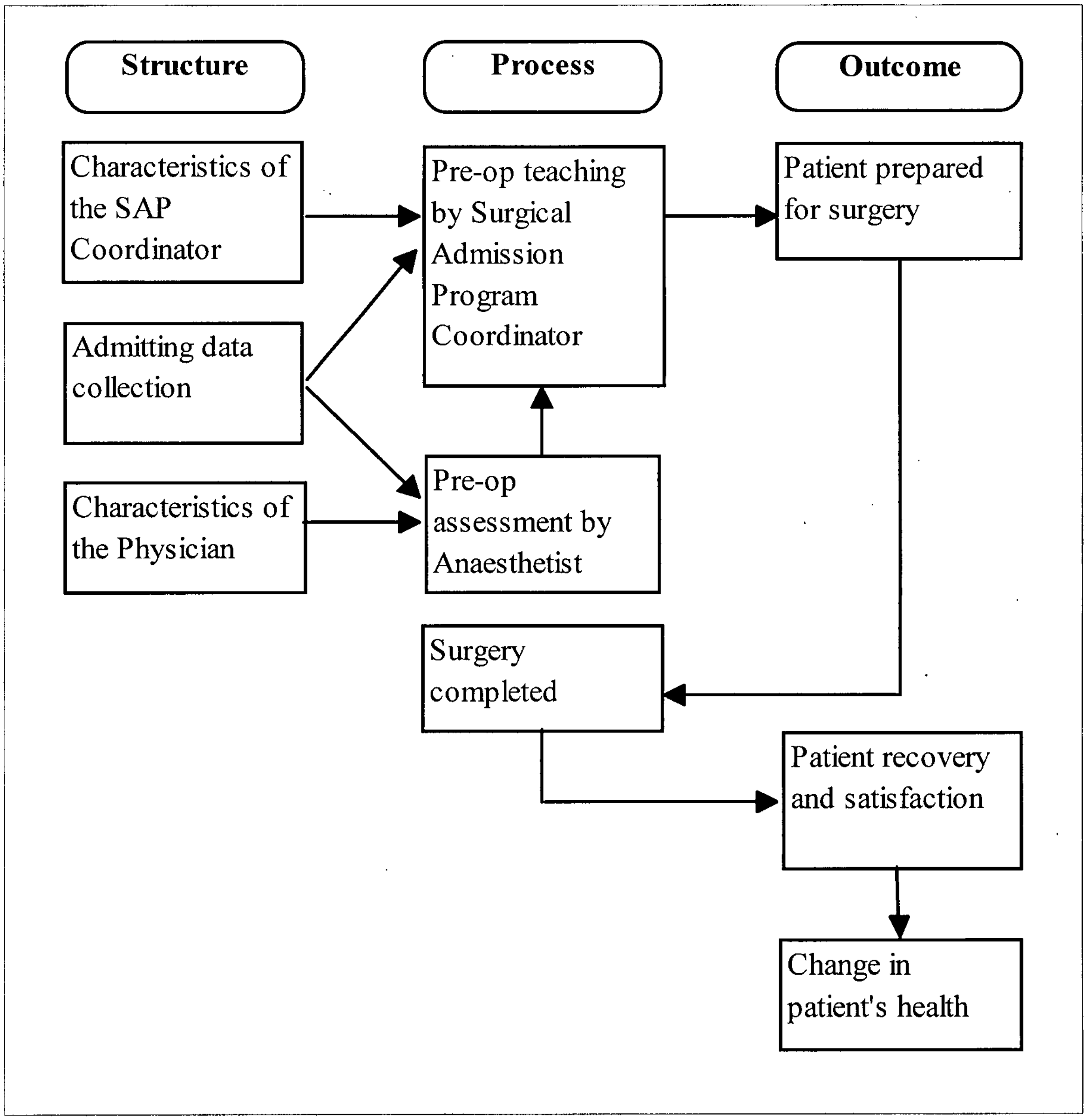

Figure 7.4 - Multiple Linkages Between Structure, Process and Outcome

7.3 Impact on Pharmacists - Hospital 4

7.3.1 Introduction/History of Computerization for Pharmacists

Development of the pharmacy system at Hospital 4 has a unique history. The Director of Pharmacy took an early, active interest when personal computer's (PC's) were introduced and began to investigate how the computer could be harnessed to assist the Pharmacy. At that time there were no hospital pharmacy systems on the market, so the Director and his staff began developing their own system. Over the past ten years they developed this stand-alone system into a marketable product, which they have sold to several hospitals in British Columbia. They expected the system to benefit pharmacists through better record keeping, assistance with calculations and reduced task redundancy, such as label production.

In addition to the pharmacy system, the staff have developed skills in using a variety of PC programs.[10] They are confident using the computer and see it as a valuable tool in their work. In the fall they are slated to implement the XTECH pharmacy system, which has caused mixed feelings. Resistance comes from the change to an unfamiliar system, but also because staff have a vested interest and pride in the system they helped develop.

7.3.2 Use and Impact of the PCIS

The pharmacy system uses micro-computers on a Novell network for order entry, label production and inventory control (which is linked to their materials management and purchasing routines). The pharmacy system is also interfaced with XTECH to retrieve admitting information and microbiology results, but no information flows the other direction. Integration with the other systems in the hospital is a prime incentive for Pharmacy to change to the XTECH system.

The pharmacy system is easy to use partly because they have designed it to meet their needs specifically. Initially new users have to "learn the nomenclature to do with computers and what people are referring to" before they can learn the system specifics. Pharmacy does not conduct separate computer training, but incorporates it into their orientation to the department. Within a day or two of learning how to use the system, staff begin order entry, usually with someone supervising them for another day. Pharmacists and pharmacy technicians become competent users in a couple of weeks, where they can rapidly enter orders. Pneumonic codes that are easy to remember are used for all the drugs and dosages. Alternatively, users can enter full drug names if they have problems remembering the codes.

Pharmacy has established physical security for their system by ensuring that no one is allowed in the department without authorization. Users do not require passwords and the pharmacist or technician use their initials to verify entries. However, the audit trail is incomplete without passwords. In other words, someone can modify an order in the system and that person's identity cannot be traced. This concern will be eliminated when they change to the XTECH pharmacy module.

Pharmacy usually schedules three pharmacists and three technicians on day shift and they have access to five terminals. They designate one terminal for order entry and the other four terminals are used for drug ordering, inventory and project work (such as presentations, committees, teaching materials). Similar to other pharmacies, their routines include entering orders, narcotic distribution, drug deliveries, patient teaching and clinical follow-up.

The duties of pharmacists and technicians are determined according to which shift they are on. Technicians enter orders into the computer. When they began entering all the orders it caused a tremendous increase in order processing time and the number immediately went up by thirty per cent.[11] The computer checks for allergies, drug interactions and duplications in the same drug class. This information is printed on labels along with a new medication profile for each order. A pharmacist checks the medications against this profile before they are dispensed, along with the profiles, to the Nursing Unit. Medications are distributed to the Nursing Units via a modified unit dose system.[12]

Pharmacists are not assigned to specific Nursing Units to provide clinical services, but follow up concerns for specific patients as they are identified. They often conduct discharge teaching for patients on particular types of drugs such as anticoagulants, anti-depressants, anti-psychotics, and those used for treatment of diabetes and cardiac conditions. Rather than produce patient handouts on the computer themselves, they find it much easier to use the American Hospital Formulary because it has a counseling guide they can photocopy. All the basic information is included and it relieves them of having to type it in and update it when there are new drugs.

Record keeping for dispensing and administering medications has historically been done by the areas that carry out the tasks: Pharmacy kept track of the medications dispensed and Nursing kept track of the medications administered. Both areas created medication profiles that chronicled current and discontinued medications. In the past year and a half Pharmacy has started to produce automated medication profiles and Medication Administration Records (MAR's) as by-products of entering orders into the pharmacy system. The profiles are updated every time a medication is added, discontinued or changed and now include "PRN medications" (such as those kept on the Nursing Unit and given for pain when needed). Pharmacy now generates MAR's on admission and replaces them weekly on the Nursing Units.

Their overall productivity has increased because they can physically enter more orders into the computer and process them faster than they could by writing them down (level 1). They also save time because once they enter information, the computer can accurately "copy" it to as many places as needed. For these reasons they are expected to be able to accomplish "more work" with the same number of pharmacists. As well, additional pharmacists' time should be freed up so they can visit the Nursing Units more often to do clinical work.

One advantage of using a computer is that pharmacists see their product as more "professional looking," rather than one with handwritten entries, items crossed out and additions penciled in. It is also easier for the pharmacist to quickly and efficiently find the information when someone phones with a query. The disadvantage of having these automated products is that any errors or additions means the user has to go back, make the change and re-print the document. This may require more work in the end as this pharmacist describes:

> *Sometimes you see a little mistake on there, but it's not just a simple matter of taking your pen and changing it. You have to go in and edit it on the computer, pull new labels and re-label all the cards, pull a new profile, get rid of all the old stuff. In some ways you may think of it as more work because you've got to put out all this new stuff. But then what you end up with is a really professional looking product. Everything is printed properly and nothing's been changed by hand and over written. I think that's positive.*

Pharmacy has been actively involved with Drug Utilization Reviews (DUR) for some time. Their computer expertise has been invaluable in writing programs to extract prescriptions for particular drugs over a given time period (level 2). This information is retrieved from their archives and sorted by ordering physician. From this database they do not know how long individual patients were on antibiotic therapy and therefore use an average length of therapy to calculate cost. They also produce reports by individual physician and sub-grouped by specialty so physicians are able to see, confidentially, where their practice falls in relation to their peers. If Pharmacy identifies a particular problem, they bring it to the attention of the Pharmacy and Therapeutics Committee, as well as use it in physician education.

DUR supports the pharmacists' decisions in both hospital-wide uses of drug groups as well as individual patient therapy. For example, they routinely compare the usage of individual drugs over a given time period to previous years (level 1). They also produce a report that shows the amounts of various drug classes or individual drugs used by each ward. Drugs rising in volumes or costs are of particular concern and are evaluated. Pharmacists are able to base individual patient therapy decisions on more information because it is available, for example, a complete drug profile (level 1) and the automatic checking for drug interactions (level 2). Services like drug dosage calculations (level 2) would likely be impossible without the computer, as this pharmacist describes:

> *Given our level here, we wouldn't be doing things like Gentamycin dosing if we didn't have a computer and a program to do it. I think we're more willing to take into account the different factors that affect the dose because it's there in the program. You can do it in a simplified fashion manually, but we wouldn't be doing it to the detail we do and feel as professional and confident in what we're doing. So it has definitely helped there.*

Pharmacists have the opportunity to note their patient follow-ups, interventions or suggestions for therapy in a comment sections on the computer. They expected this feature to facilitate communication and continuity between pharmacists, but how extensively it is used depends on the individual pharmacist. Unfortunately, with this stand-alone system they are unable to save the additional information from one patient visit to the next, so an element of continuity is lost.

Pharmacists communicate with physicians in several ways about potential changes in drug therapy. They telephone physicians for urgent messages and a pharmacist or nurse makes the appropriate changes on the order sheet as directed. Other less urgent suggestions for change are placed in the chart or written on the doctor's order sheet. Only those messages written on the order sheet are carried forward for future admissions. In these ways their stand-alone system does not offer benefits in communication outside the department or continuity in communication between patient visits.

In spite of all these gains, productivity unexpectedly went down because pharmacists are doing more things because they are able to. This means that some of the routine "maintenance" tasks may go by the wayside. For these reasons, Pharmacy responded with caution to a consultant's recommendation that said: "Opportunity exists to re-engineer the whole drug order process from MD to nurse to Pharmacy, but enabling information technology will likely be part of the solution. This will result in significant staff savings of 1.5 - 3 FTE's or re-allocation to more value-added functions." In reality workload actually increased, as this pharmacist describes:

> *Some of the activities we do are based on utilization, but other activities had to decrease because the system allows us to do more. Our workload has increased just putting the data into the system. Even though systems are designed to save manpower, if you utilize them to their full extent you can actually decrease your available man hours for other functions. A lot of the manual tasks, like the ward inspections (where techs used to go around monthly and check for outdated and extra stock), we only do about once every six months now because we just don't have the staff. That's an example of technology causing a decreased amount of time for other tasks we used to do. People think if you put in a system, you're going to have lots of time, but it isn't the case. I don't think there have been systems put in place that actually*

decrease your workload if you use them properly. I think that's something that's forgotten.

Pharmacy was involved in a Continuous Quality Improvement project about a year and a half ago when they determined the value of inventory and how frequently they ordered drugs. From this information they identified order levels, order quantities and intervals for various vendors. They have tried to establish an optimal inventory level where any amount lower than that would not be worth the additional time spent generating purchase orders and receiving stock. Pharmacy has been experimenting with using Electronic Data Interchange (EDI) for their drug orders. There are some limitations to the kinds of orders they can send electronically or by fax, such as orders for narcotics. Because they have already reduced their inventory levels, they do not expect this EDI project to change what they order, just make the process of ordering easier.

7.3.3 Use and Impact of Electronic Communication

Pharmacy is not using XTECH e-mail for two reasons: there are not enough people using it and they do not routinely log onto XTECH every day so that would be an additional step for people. Pharmacists see the potential value of having a system readily accessible, but it is also difficult for them to see advantages of using e-mail when the fax machine seems to be filling that need. Bulletins are faxed to all the Nursing Units and orders are faxed from the Nursing Units to Pharmacy. They feel e-mail has an added disadvantage because there is no indication a message is waiting (although this feature is available in other hospitals using XTECH).

7.3.4 Summary

The impact of PCIS on pharmacists at Hospital 4 is summarized in Figure 7.5. Pharmacists use the pharmacy system to assist them to more effectively monitor both individual drug therapy and overall drug utilization. The additional information they require comes at a cost. Pharmacists and technicians must now process all medication orders, which has dramatically increased their workload. As well, responsibility for producing complete drug profiles and automated MAR's has shifted from the Nursing Unit to Pharmacy.

Computer systems are expected to increase accuracy and decrease errors, but it is difficult to determine the magnitude of this change for several reasons. More errors are discovered before they are dispensed due to the checks, such as drug interaction or allergy monitoring, in the pharmacy system. There are less chances for transcription errors to occur because entering one order produces all the labels needed. This automatically adds the new information to the medication profile and MAR. However, the order may still be entered incorrectly and dispensed.

With the XTECH system it is technically possible for physicians to enter their medication orders directly, although this is infrequently done at community hospitals. Pharmacists view physician order entry with mixed feelings. Aside from the physicians' attitudes and mechanical access barriers, pharmacists identify other dilemmas with this issue. The pharmacist would still be responsible for checking the order before dispensing the medication, but many of the other services provided by pharmacists could be done by the computer. For example, physicians could directly review messages and reminders that come up on the computer screen, rather than the pharmacist conveying them. Additional information with respect to cost and efficacy could also be available at the time of entering the orders (level 2).

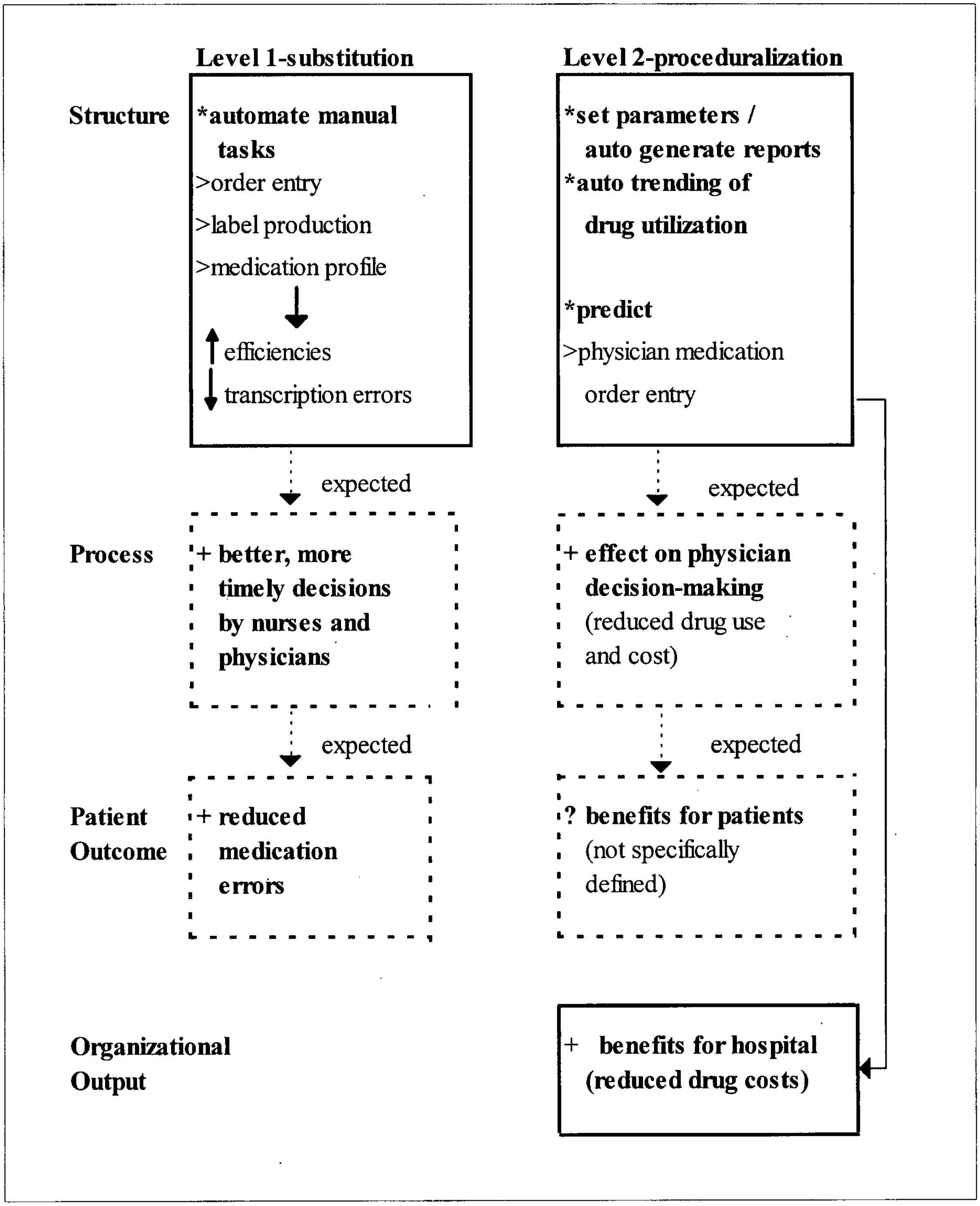

Figure 7.5 - Impact of PCIS on Pharmacists at Hospital 4

As illustrated in Figure 7.6, the lines between structure and process become even more blurred when physicians enter their orders. The role of the pharmacist in providing the elements of structure that facilitate quality care is partly replaced by the error checks performed reliably and consistently by the computer. These include allergy and drug interactions, duplication of orders from the same drug group, therapy suggestions and contraindications. The added advantage is that physicians receive immediate feedback on the orders they have written and are able to modify their orders as needed. When pharmacists are entering the orders and receiving the computer's error checking messages, they decide when to call physicians to request modifications to their orders.

Because they are able to do more things, they are getting more things done. Sometimes this is at the expense of tasks that have not been automated such as checking outdated medications on the Nursing Units. It also means Pharmacists may give up some tasks that can be done by other staff. This continues a change in roles they have been seeing for some time, as this pharmacist describes:

> *I think the profession is shifting to that direction. Twenty or thirty years ago pharmacists just sat inside a Pharmacy and reviewed orders, but now it's changing. We're seeing the pharmacist participate more in decision making for patients because much of the standard order entry can be done by technicians.*

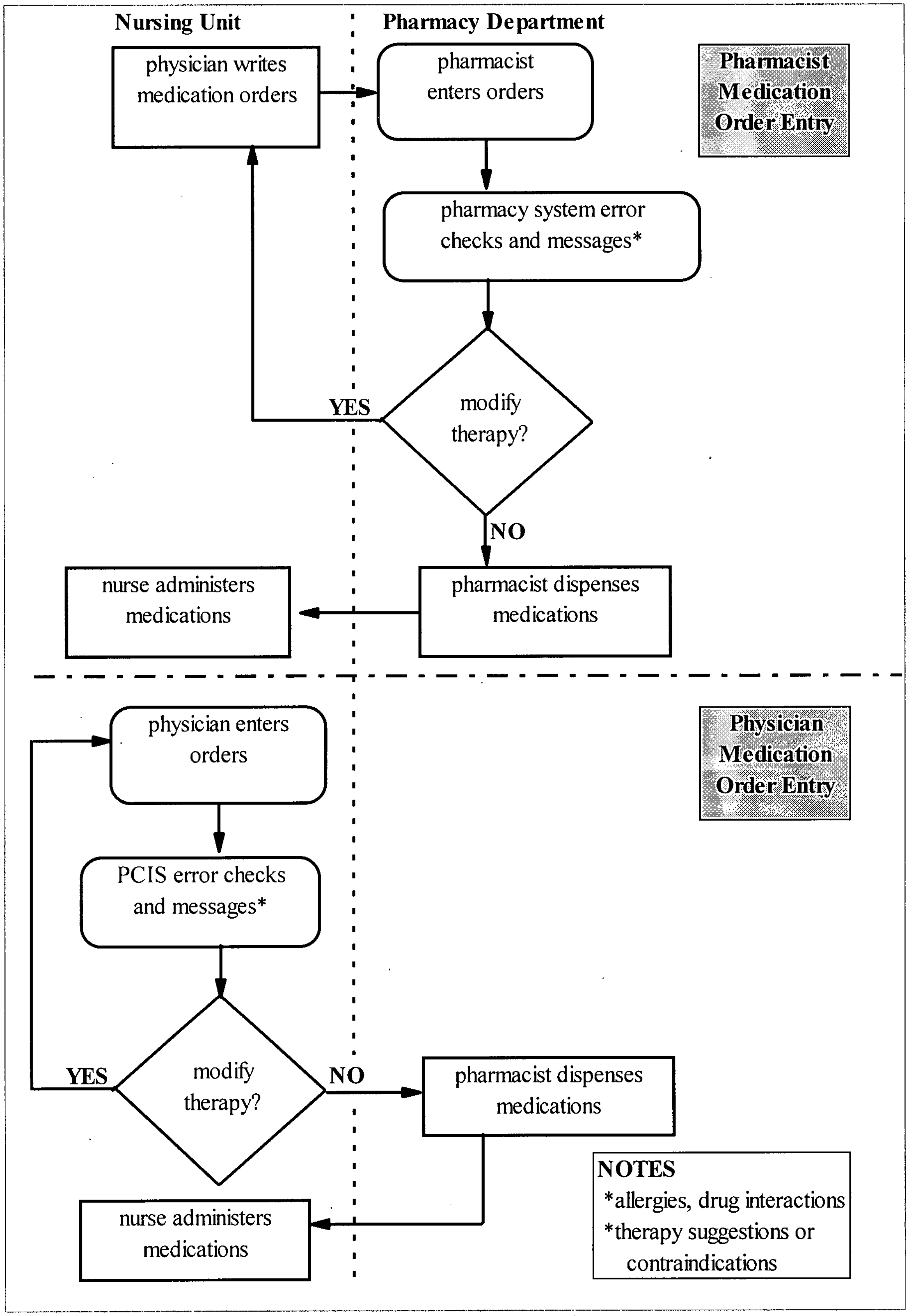

Figure 7.6 - Comparison of Medication Order Entry Systems

Related to the ability to do more is an increased involvement in clinical decisions. The suggestions from Pharmacy and follow-up (or lack of follow-up) by physicians presents an interesting example of "invisible" accountability. Pharmacists may suggest changes to therapy, but physicians are under no obligation to follow them. There is also no permanent record that these suggestions were made unless they are written on the doctors' order sheet. When they implement the XTECH system, these comments become a permanent part of the profile, and increase the "visible" accountability of both pharmacists and physicians.

The Director of Pharmacy has played a large role in developing their system in-house and encourages staff to learn other PC based programs. Changing to the XTECH pharmacy module will be a challenge for this department because they have invested so much time and energy in their current system. Their approach to change has been that the users decide what is needed and they program the computer to provide that assistance. The lack of flexibility and ability to make changes in XTECH may present some new challenges for them. Pharmacy did not identify new capabilities (level 3) for their use of the pharmacy system. This may be due to their experience in building a system to specifically support activities in Pharmacy versus using an integrated system.

7.4 Impact on Physicians - Hospital 4

7.4.1 Introduction and History of Computerization in Medicine

Several physicians provided input into the computer selection process that began approximately ten years earlier. The results of their input have been disappointing because at that time they "talked about physician use of the computers, but it never happened."

Financial and Admitting modules of XTECH were implemented and then funding for additional systems was unavailable some time. The hospital reviewed their strategic IS plan three years ago and reconfirmed their plan to implement XTECH. By this time however, one physician commented, "XTECH is far behind. They are still dealing with 1970's technology." This is similar to many other single vendor systems because that have not been able to change easily with the times. Physicians finally received a computer terminal for their use just within the last year. It is located in the doctors' lounge with word processing and Scientific American on CD-ROM available. In July 1994 the hospital implemented the laboratory system as the first clinical module of XTECH.

7.4.2 Use and Impact of the PCIS

Physicians presently use the PCIS minimally. They use the Admission system to print patient lists that are grouped by Nursing Unit. On the week-ends when one physician takes call for several colleagues, he or she ends up with several lists and must manually integrate them in order to efficiently complete patient rounds in the hospital. Physicians have a long standing request to have the Admitting system automatically integrate these lists by pre-defined groups of physicians.

Physicians felt the Lab was very accommodating in trying to set up training for them. In March 1995, the Lab offered training for the physicians to learn how to inquire on lab results. One difficulty in using the system is the way patient inquiry is set up directly into the lab system as opposed to using an XTECH interface available for this purpose, as this physician describes:

> *The lab system is not a physician's system. They've taken a lab system and tried to expand what it can do to produce reports that are available on the floor. So it's not really a reporting system or a physician inquiry system.*

Physicians do not find the modified order entry easy to use. Only lab results are currently available on-line, so they use the system infrequently. Consequently they forget their passwords, which increases the incentive for not using the system.

Physicians expect access to more accurate and timely information from the lab computer system should result in the patient being discharged from the hospital sooner (level 1). They also anticipate patients will benefit when results are readily available and tests do not have to be repeated (level 1). One physician noted that studies show physicians order fewer tests when they are presented with test results before they order more tests. When physicians enter orders directly they expect fewer mistakes because he or she is immediately alerted when the wrong test is being ordered or the wrong dose prescribed. Where the lab requisition is simply a communication tool, entering the requests directly on the computer alters the tool so the user automatically receives feedback on orders being placed. Currently the feedback is received by Nursing staff who enter the orders and lab technologists who process the orders. Their responses to the feedback and motivation for changing the orders may be different than the physicians'.

Physicians feel the contribution of automated lab orders and results to decision-making is minimal. On general medical/surgical units, they usually write orders in the morning during patient rounds and then go to their offices or the OR for the remainder of the day. The decision to discharge a patient is usually based on a variety of factors and not just a single, last minute lab result. Orchestrating the patient's move back to the community often involves family members and support agencies. In other words, it would be difficult for a physician in his or her office to be advised of a lab result in the middle of the afternoon and then start the discharge process. If results were available on-line, physicians suggest that system prompts would be necessary to indicate results were available.

The focus in these changes is on the practical advantages (structure), as opposed to practice changes (process) they would support, as this participant indicates:

> *Hopefully, as we move to computer charts we will have the computer linked with the physicians' offices. We can just transfer information to their computer instead of printing it, putting it in their mailboxes or mailing it out, which not only costs money, but takes a lot of effort. It also takes a lot of staff and storage is no small benefit. We are having major problems with storing charts now and with computers you can have thousands of charts on a few disks.*

Physicians find output from the lab system more difficult to read than previously because each set of lab results was on a separate piece of paper and color coded for each Lab section (for example, Hematology was pink, Chemistry was green). Instead, results are accumulated and there is a lot more information on one page. The same print is used throughout the report, without font changes to make each section stand out, so physicians have to scan each line. However, abnormal results are typed in bold letters. There are fewer pieces of paper, but physicians have to be extra careful because there are two or three days worth of results on one sheet and they have to be sure they are looking at the right one. They are hoping this situation will improve when they implement physician inquiry.

Although there is minimal use of XTECH, physicians use computers in a variety of contexts outside the hospital and see other benefits. One physician familiar with a keyboard has found typing medical/legal reports in his office is much quicker and more efficient than dictating and reviewing them. Introduction of laser printers means these reports are printed more quickly than with the old dot matrix printers. Physicians also use computers to search for specific information in large databases. For example, billing systems can be extended to produce information that is useful clinically. Although the information is not exactly what they need, it is better than trying to manually search through individual records. For patients with multiple diagnoses, if the billing reflects a different diagnosis on each visit, the physician can build up a more complete profile of his or her patients. Searches of the billing data base produces new information about categories of patients or patients with multiple diagnoses.

A number of physicians also have computers at home, as this participant describes: "They're getting 486's and Pentiums, 500 megabyte hard disks, with 16 or 32 megabytes of RAM." Two educational sessions on how to use the Internet was attended by about thirty physicians which indicates many physicians are interested in becoming computer literate. One physician's comments illustrate how physicians perceptions are changing in this respect:

> *Physicians were resistant when MSP [Medical Services Plan] put in computerization but I don't think now anybody thinks it was a bad thing. It was just the fact they didn't know how to use them. I didn't know. My opinion at that time was our secretaries will deal with it and I'll probably never touch a computer. Now I have one at home, I'm on the Internet, I have a CD-ROM - that's how things change.*

The physician group is uniquely different from the other three professional groups in this study because their relationship to patients has a business aspect to it. They expect any investment in IT to have a financial payoff whereas the other groups use IT that is provided and paid for by their employers. For example, advantages of using electronic records include rapid access to information, as well as savings when paper records are not stored. For physicians these savings must be balanced by the costs of converting and maintaining records, which often requires ongoing additional human resources, as this physician discovered:

> *The ladies in my office liked it a lot better when we weren't computerized because it was much simpler. They made out a little card for each patient. Even with a busy practice, when I saw 75 people in a day, I had one girl in my office. When we got computerized, I had to have two. It hasn't gotten rid of any of the paper because you have to have hard copies of everything for legal purposes for the College and it's an additional expense. If you start getting somebody in to change things, like the networking and that kind of thing at $80 an hour, it doesn't take too many hours to wind up costing you $3,000 or $4,000. So I like computers, but I'm realistic enough to admit that they can give you lots of trouble.*

Participants identified a number of ideas for computers could be beneficial to physicians. These are not new ideas, but have not come to fruition for several reasons. Physicians generally are not "computer phobic," but their use of computers is influenced by three factors: ease of use, added value and accessibility. As with many people who are already pressed for time, if the learning curve is too steep and it takes too large an investment in time to become adept at using the system, physicians will be dissuaded from using them. Terminals must be readily accessible (at the hospital, home and office) and enough information available to make it worth their while to use the system.

Because patients are also customers, physicians are interested in their perceptions of physicians using computers. For some patients the computer is simply a tool no more interesting than the stethoscope. Some physicians felt that having information "at their fingertips" projected a more professional image. Others suggested that keeping good records, whether manually or electronically, benefits physicians and patients. This translates into quickly finding information rather than flipping through many pages. Whether physicians use computers or not is still very much based on individual preferences and perceptions, as this physician point out:

> *What I've heard from various talks with patients is they like it. Some physicians will set things up so the patient will see what's on the screens and they have the opportunity of correcting mistakes or adding comments to what's there. But if the physician is totally focused on the computer and ignoring the patient, they don't like that. If the patient is part of the loop then it seems to be OK.*

Patients are "more than the sum of their lab reports." Elderly patients with multiple ailments and multiple medications are interested in spending more time with their physician. Even if more appointment bookings and lab results could be processed faster, and physicians could see more patients in a day, what the patients want is more of their time.

7.4.3 Use and Impact of Electronic Communication

Physicians do not use e-mail on XTECH because it is not accessible from enough locations yet. However, some physicians do use e-mail with private companies. They have found it useful for communication among colleagues as well as searching for information.

7.4.4 Summary

The impact of PCIS on physicians at Hospital 4 is summarized in Figure 7.7. Currently there is little incentive for physicians to use the system. It is not particularly easy to use and does not provide many benefits because only lab results are available. Remote access has not been discussed and is not realistic until the patient care inquiry module is available. Physicians recognize that given the way many of them practice, making the best use of electronic information may require changes in practice, which they may or may not want to pursue. Of approximately eighty physicians who practice at Hospital 4, one physician estimated there was probably ten percent or less who felt negative about the computer system, but they were much more vocal than the others.

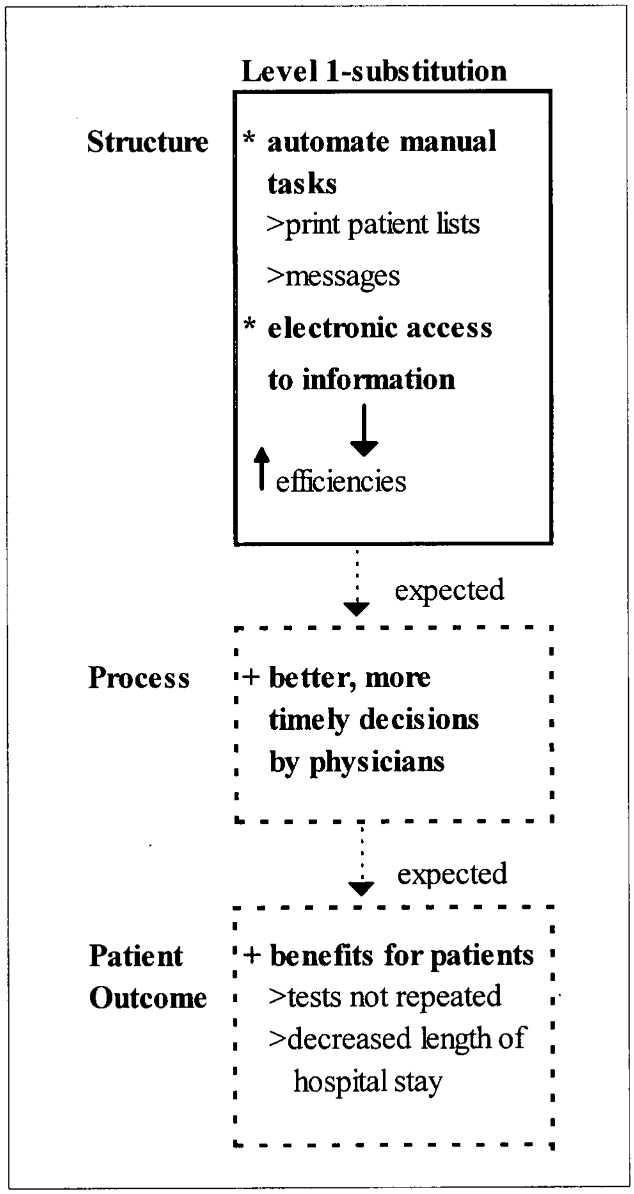

Figure 7.7 - Impact of PCIS on Physicians at Hospital 4

Role changes occurring when information is available to different groups. For example physicians benefit by knowing which of their patients are on certain medications. If those medications are re-called, they can notify their patients. Pharmacists (or even the government) may have moved into this role because this information is now stored in a provincial database (called PharmaNet) that contains all prescriptions filled by commercial pharmacies. Pharmacists can directly notify all patients in the province who are taking a particular medication rather than notifying physicians, who notify their patients.

Training to use the technology often stops at the use of the hardware and software and does not extend into changes in the system or in behavior that must occur to enable the technology to work in everyday practice. For example, the Admissions system produces reports for individual physicians, but the way physicians practice requires lists that can combine patients for several physicians and sorted by Nursing Unit. Altering practice to accommodate the computer system is not only difficult, but does not make sense. Training has to go beyond just using the technology. One physician aptly described the need to learn things that will help change habits. Users have to examine practices that need to change, particularly if they expect the IT to affect the patient care process.

Physicians' habits have been successfully changed through physician order entry. The desired behavior is incorporated into the system as the default action and all the user has to do is press "enter." It takes more effort for the physician to order something different. One participant noted a danger in using this tactic: If physicians feel their behavior is being manipulated with this process, the plan may backfire.

The decision to go ahead with automating the Lab is one thing, but bringing in order entry and new reports based only on the lab system may not have been good choices. Implementing the patient inquiry module at the same time would have reduced errors in order entry, produced better reports and made order inquiry more user friendly. It would also have sent a message that XTECH is a "good investment" for the organization. Instead physicians find a number of these areas are less functional than they were before the lab system was introduced and motivation for using them is low. Physicians do not expect computers to contribute to job satisfaction with respect to patient care, problem solving, diagnosis or treatment. However, their jobs may become less stressful and better organized when clinical information is readily accessible.

7.5 Summary - Hospital 4

7.5.1 Introduction and History of Computerization in Hospital 4

XTECH's Admitting and Financial systems have been in place for several years at Hospital 4. They recently introduced the lab system and modified it to allow Nursing to enter orders. Systems have been introduced in other areas, but they are not fully integrated with the PCIS yet. The pharmacy system has a unique ten year history of on-site development and suits the needs of Pharmacy very well. They are scheduled to replace it with the XTECH pharmacy module in the fall. The pharmacy system, OR Booking System and Surgical Admission Program all use the available Admitting and lab system information. The hospital has achieved limited benefits to date, but as more integrated systems are implemented they expect additional benefits to accrue.

IT implementation has had limited technical and planning support in the organization as positions in the HIS Department have been filled only on temporary bases. Currently the manager is part-time, but is expected to become full time in the near future. The hospital has established an ambitious implementation schedule for many of the remaining XTECH modules and will bring on more HIS staff to assist them. The HIS Department's philosophy is that users are responsible for implementation in their own departments, however, they have established only a small number of knowledgeable users.

7.5.2 Use and Impact of PCIS

The Lab expected immediate benefits from order entry because they did not have to enter orders or transcribe results. However, modifying the lab system to provide order entry features created a number of frustrations on the part of other users. The system is more difficult for them to master, which has discouraged nurses and physicians from "buying into the system" and using it. Nurses, physicians and Health Records personnel were initially unhappy with the format and number of lab results printed.

The Lab gained efficiencies through reduced transcription of results and distribution of reports to Nursing Units and doctors' offices. They also benefit by the reduced telephone calls from Nursing inquiring about results. The Lab expected time savings to translate into reduced FTE's, but these have not "materialized" as increased time is now required in other areas. The cost savings they predicted have become cost avoidance efforts because more work can be done with current staffing levels.

Nursing expected increased efficiencies in entering orders electronically, but these savings applied more to clerical staff than nurses themselves. In some respects the manual system of faxing stat or urgent results to the Nursing Unit was better than printing them because the fax alerted nurses to the waiting results. Unlike the Lab that assigned someone as their project leader and Pharmacy with their many years experience, Nursing has little expertise with IT. They have depended on "volunteers" in the Nursing Department to take the lead in training and implementation.

Physicians use XTECH minimally because it does not yet offer enough functionality for them to invest the time and energy in training. For example, physicians use of patient lists is limited because the lists are not flexible enough to represent the way they take call for other physicians.

Both nursing and physician groups are expected to make better and faster decisions as a result of automating order entry and results reporting processes. The OR Booking System and Surgical Admissions Process benefit patients in defined ways.

"Visible" accountability has been created for lab technologists in a new way because XTECH flags abnormal results that lab techs must respond to. There is also a new visibility of one department's actions to another. For example, any errors made by Nursing in ordering and Lab in reporting is known by the other department.

7.5.3 Use of Electronic Communication

There are pockets of avid e-mail users, but a lack of terminals and training through out the organization limit its effectiveness as a communication tool.

7.5.4 Summary

The impact of PCIS on all groups at Hospital 4 is summarized in Figure 7.8. As in other hospitals, the efficiencies in processing lab orders and reporting results are expected to affect decisions of nurses and physicians. The participants predicted a number of areas they planned to use the PCIS in both proceduralizing tasks and in new capabilities. However, this hospital's Surgical Admission Program (SAP) provides the best example of specific linkages that have been made between changes in structure to changes in process, and from process to outcome. Specific measures of patient satisfaction and length of hospital stay were evidence of effective changes in process supported by the PCIS.

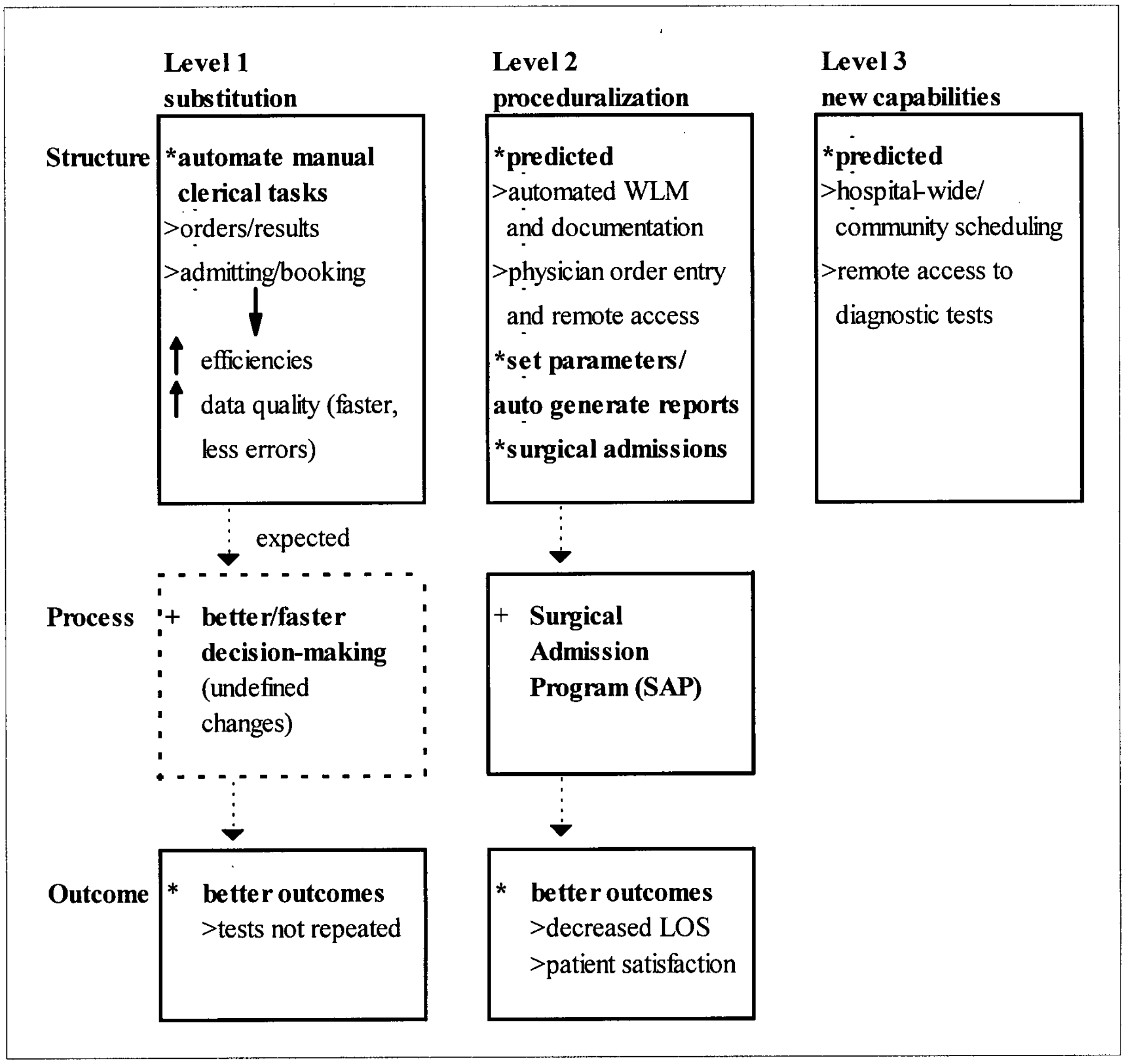

Figure 7.8 - Impact of PCIS on All Groups at Hospital 4

This result is unexpected, and not what was predicted given this hospital's limited IT and IT experience. It appears to be the result of individuals in the organization who had a "vision" about what this program could do, as well as saw opportunities for the PCIS to support their new information needs. One such change was moving the hospital admission process from the Admitting Department to the SAP area, where it could easily be completed because the PCIS "admissions program" became accessible from many areas of the hospital. This was not only less stressful and time consuming for the patient, but also assisted the Program Coordinator to collect more complete patient information as part of the SAP.

Endnotes

1 The Lab has approximately thirty four full-time, part-time and casual employees, with two thirds lab technologists and one third lab assistants.

2 Dictionaries are the internal definitions of each test and procedure which include the normal reference range values and any other abnormal values the user wants to flag.

3 There is no Histopathology section in this Lab so all special, low-volume, high cost tests are sent out to the Regional Lab. A Cardiovascular section of the Lab responsible for ECG's installed a printer and terminal in their department, but their orders and results were not on-line.

4 XTECH allows users to place orders directly into each ancillary system, like Lab or radiology, but this means that the patient's name must be selected from an alphabetical list containing all patients and other visits this patient may have had to the hospital. The user must be careful to select both the right patient and the current visit. An inquiry module is also available to implement in addition to the ancillary modules and it provides a much more "user friendly" interface to the user, in this case nurses and physicians.

5 One example of this was an urgent request for a CBC and cross match for a woman in labor that was ordered on a seventy-five year old man who had been discharged two weeks earlier.

6 PT and PTT tests are done to determine the ability of the blood to coagulate or clot. This is usually measured daily and the anticoagulant dosage adjusted accordingly.

7 The number of people on the waiting list for surgery, as a measure of effectiveness and efficiency of using the OR Booking System, is misleading. The time allocated for each case booked is based on the actual time required to do the last ten cases, allowing more

surgeries to be booked than in the past, which means the waitlist should be decreasing. However, other factors such as a growing community, mean that overall more people require surgery. As well, the process for including patients on the waitlist differs by surgeon. For example, some surgeons keep track of their own lists and then send their cases in as they book them. Others send their cases in ahead of booking them so they are on the list longer.

8 A computerized print-out of the OR slate is sent to the Sterile Supply Department the day prior to surgery so they can assess their level of supplies. They expect that over time, surgeons' preference cards can be entered into the system and supply lists automatically generated for sterile supply. The slates are printed a week ahead for the day care area, the OR scheduling nurse and recovery room so everyone can plan ahead. Previously these were photocopied and hand delivered. Now they are printed in the respective areas and the OR Booking Coordinator can check on-line whether they have actually printed. A Blood Bank Report is sent to the Lab weekly that identifies who is to be cross-matched for blood in the following week.

9 They send a computerized waitlist to the surgeons' offices that lists the patients scheduled and those still waiting for a surgery date. This has been a useful tool in following up where patients have been scheduled and canceled several times. It was difficult to do this in the manual system so when they first started producing these lists they discovered "a lot of really old stuff in there."

10 Windows based software that they use includes Word®, PowerPoint®, Excel®, D-Base®, and Microsoft Publisher®

11 Productivity is a "slippery" issue. A combination of factors since 1992 contribute to changing productivity figures for the department: beds have closed, staff have been decreased, the work week decreased from thirty-seven and a half to thirty-six hours the number of orders entered has increased significantly (in part just due to the change of entering PRN medications as well as medications dispensed).

12 A modified unit dose system uses cards where each medication is individually wrapped in blister packs and labeled. Anywhere from three to twelve days supply is sent at one time. These are refilled on demand and not on a daily basis as is the case in a traditional unit dose system. This system is less time consuming and uses less staff resources.

Chapter 8 - Comparison of Impact Across Groups in Hospital 5

8.0 Introduction

The XTECH system has been developed along departmental lines, with a pharmacy system, laboratory system and others. This works well for the other four hospitals that function along these lines, although the departments still share integrated information. Hospital 5 is unique because they are in the process of changing their organizational structure to operate along program lines rather than traditional department lines such as Nursing, Rehabilitation Therapy, and Admitting (see Figure 8.1). They decentralized functions such as housekeeping, laundry and food services. The hospital created new categories of employees[1] to support this changing structure that focuses on better patient care at less cost. (Their new approach was introduced in September 1993). Management changed as well. For example, the Director of a specific program has all disciplines reporting to him or her, rather than the traditional positions such as Director of Nursing who were only responsible for nurses. Financial information is structured so it is available at both the Nursing Unit and program levels.

XTECH's departmental modules and lack of flexibility for customization, make its implementation in this hospital challenging. They have taken a different approach to setting priorities for implementation. No "official" departments means there are no liaison positions to represent departmental interests of Nursing, Laboratory or Pharmacy, as there are in the other four hospitals. One program director is responsible for computerization as it relates to the programs and so she is on committees where "anything to do with computerization is discussed." Several computer projects are underway; these include the Maternity Program (where they contribute to a National Perinatal Data Base), the Orthopedic Program (where they are developing an evaluation for Total Joint Replacement) and the Psychiatric Program.[2]

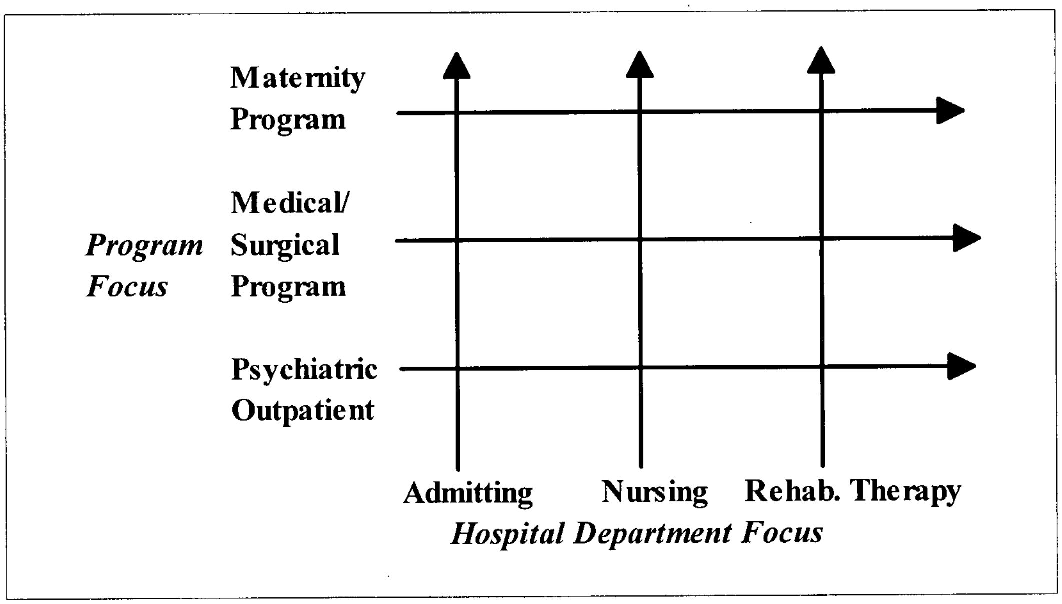

Figure 8.1 - Program versus Hospital Departmental Focus

Initially the hospital implemented the XTECH modules that were expected to have the highest pay-offs: payroll (to avoid high service bureau fees), ADT (Admissions) and finance. These systems contributed early to a cost avoidance when the hospital opened one hundred beds without adding any financial or materiels management resources that would not have been possible without the system in place.

Clinical components of XTECH, such as order entry to the Lab and Radiology, are planned for the future. Funding is a big issue in smaller hospitals like this one that have less "discretionary" funds to finance IT. They have just implemented the health records, abstracting and transcription modules. The next systems planned will be Pharmacy and

Laboratory. Many of the laboratory instruments have their own IT integrated into the instruments. The hospital has to decide whether they "need to get a great big lab system" or whether they "need to work with the instrument interface capability to link to an order entry system in the Lab." (Appendix G provides additional information about the IT history in this hospital.)

It is more difficult to justify purchasing clinical systems because they do not demonstrate the same benefit in cost savings, or cost avoidance, as this manager explains:

> *There is cost associated with bringing up the systems and paying for that software and hardware, but those are one time costs. The clinical pieces become a bit more difficult to bite off in terms of hard-core benefit. You need information in order to manage your organization more effectively and ultimately more efficiently. The only way you get information in a timely fashion is to have that from an automated environment. There is just no other way you can do that. So that's the conundrum and the benefit is to be more knowledgeable about your organization so you can make more effective and efficient management decisions.*

However, the role of information does not change whether the organization is organized around traditional departments or programs:

> *The systems people need to play the same kind of role [as in a traditional organization], and that role is to move out into the user's world. They need to understand the business of the hospital and then translate that into systems and vice versa because it's the hospital, the clinical type, if you will, that really drives hospitals. You need to understand the world of information. You need to be able to articulate what data needs to be collected so it can be turned into information, so the role of systems is exactly the same. Our patient groupings, I suppose or our staff groupings may vary, but the role in terms of changing data into information is exactly the same.*

8.1 Impact on Laboratory Technologists - Hospital 5

8.1.1 Introduction and History of Computerization in the Laboratory

The Lab has thirty-eight employees and they are responsible for all the lab testing for hospital inpatients. Forty percent of their work is for outpatients. There is no single Lab Information System, but they have implemented lab instruments that are computerized and could interface with XTECH. Different sections of the Lab handle information differently and therefore their use and perceptions of IT differ. For example, Chemistry is "very black and white" because they put a specimen on the analyzer and it gives them a number. On the other hand, reporting in Microbiology and Pathology is very subjective and Hematology is a combination of the two. Blood Bank is generally objective, but occasionally unusual specimens require descriptions of antibodies.

The Lab receives orders for lab tests on requisitions, transcribes the results from their instruments onto these requisitions, and sends them back to the Nursing Units. They have report generators off the ViTek® in Microbiology and off the Hitachi® in Chemistry (that use demographic data, but are not interfaced with the XTECH Admissions system). The week of the interviews the Lab was implementing a comprehensive lab system, a TLC®, that interfaces with their cell counter in Hematology. In about three weeks they were expecting to computerize print-outs for Microbiology, Chemistry and Hematology (level 1). The TLC® vendor will set up their system and train the technologists how to use it.

The advantage of implementing the TLC® is that it costs a fraction of the XTECH lab system and was also a component of an analyzer they purchased. Lab techs have not been involved in selecting XTECH because they have not been close enough to funding to engage in this complex process. However, Section Heads have been to other sites to review their systems and are familiar with XTECH.

8.1.2 Use and Impact of the PCIS

Using computer systems is expected to change the content of the lab tech's job, as this participant explains:

> *If you go to a smaller hospital, as a lab technologist you're just using instruments and writing on small requisitions as most places are, I think, in the province. When you get into a computer system, it really changes how you do your work. You have to be familiar with computer lingo and how computer systems work. You have to think in the way of the computer.*

More significant is the change in the Lab's role due to program management. Lab technologists now share blood collection duties with nurses. Other changes include a lab assistant/clerk position, very similar to the Administrative Assistant position on the Nursing Units, who admits outpatients to the system. She also completes the payroll and calls in casual staff. Lab technologists are not assigned to specific hospital programs, but see a new role possibly evolving for themselves, as this manager suggests:

> *We need to start moving more to being consultants on the care maps and having some input into what kind of ordering patterns occur with physicians. We are just on the cusp of getting ready to try and be more a part of the team for that component of looking after the patients.*

They expect benefits from the new computerization through reducing transcription, improved accuracy and reports that are easier for the physicians to read. The time savings are not expected to be significant enough to translate into reducing the number of lab techs. Part of the reason is that their system has been "piecemealed together," resulting in an system that is not streamlined. However, they are hoping it will prevent them from having to add staff in the future.

These savings may be offset because the systems are not necessarily easy to use because they were designed to function with lab instrumentation and are being stretched to produce computerized reports. For example, the ViTek® ID and Susceptibility machine has software that allows them to enter demographics and print out computerized reports. They enter information that might be necessary for the doctor to see on the final report (such as ID numbers, patient names, birth date, diagnosis, allergies). They did not have to do this before and is very time consuming (up to one or two hours a day). The benefits include reports that "look better," are more standardized than handwritten reports, and present information about the recommended drugs for treatment and their cost per twenty-four hour dose.

They have not realized any direct gains from "extra time" being freed up. However, one technologist noted they benefit in other ways: "In a ripple down effect, they can assume some of the responsibilities that were typically under the wing of their seniors and keep forcing down some of those skills to a lower level." The system is not sophisticated enough to track information or conduct utilization studies and consequently change physician ordering patterns. They expect this will change as they add more components to their system.

The accuracy of information in the system depends on users entering the correct data. Potential errors occur in several ways, particularly at the interface between manual and automated systems. On the first encounter the lab assistant admitting outpatients assumes the patient is providing the correct information. If the patient does not have the right Care Card or Personal Health Number, the information will be incorrect from admission on. The lab assistant enters the lab tests requested and the business office converts these into billing codes, which introduces another source of error. The lab assistant also completes the requisitions for patients coming in for pre-operative blood tests, which may be done up to two months prior to their surgery. This information is hand delivered to the OR daily because it routinely gets "lost" when sent via courier. (These activities represent level 2 opportunities for saving time in transcription and reducing errors in automatically generating billing codes or producing summaries of blood tests and results for the OR.) The lab techs enter demographic information into their instruments that do not directly interface with the ADT system. The information they enter is only as good as what is written on the requisition.

Currently the computer system provides little benefits in the area of workload monitoring, which is extremely time consuming and tedious to complete manually. The Service Director uses Excel® spreadsheets for this purpose, but the lab techs collect the data. The individual instruments keep track of the number and types of specimens that have been analyzed.

8.1.3 Use and Impact of Electronic Communication

Electronic mail (e-mail) is accessible to all employees in the Lab. Messages related to procedure changes, or specifically to the lab techs' job, may be written in the communication book. E-mail is a "wonderful tool" for managers to save time in setting up meetings and communicating information. Messages can be sent to everybody - the president, vice president, program directors, section heads and staff. They feel there is a small cost in loss of personal interaction, but are far outweighed by the benefits.

Lab staff meetings and Safety Committee meetings are held monthly and these minutes are sent out electronically. Staff are also able to indicate shift changes and overtime in messages to the lab assistant responsible for payroll. However, any information related to specimens or requisitions that they need right away is requested through a telephone call to the Nursing Unit and not through e-mail.

The number of e-mail messages that are "really important to do your job" may indicate why people may or may not use it One participant was off for four days and had nine messages when she returned. Messages such as "somebody left their lights on" were irrelevant, and few others were important, as she explains:

> *Oh, maybe one was important and I think this was the one. [laughter] Very few are very important. I mean they send it global and they assume that everybody is going to see it. Some of this is to nurses only. Well, I don't really care about that. Funny, some people might find some of this stuff very interesting.*

8.1.4 Summary

The impact of PCIS on laboratory technologists at Hospital 5 is summarized in Figure 8.2. It was difficult for participants to know how patients benefit from reduced transcription errors because they did not know how many errors were made. However, transcription is eliminated with direct transmission of results from the analyzers and results are returned to the Nursing Units more quickly.

Lab techs are accountable for their own work. With the manual system completed multi-part requisitions are usually separated by someone who has not reported them, and he or she checks the results. Initially they will be comparing the computerized report with the working copies of the requisitions (which are kept on file for three years).

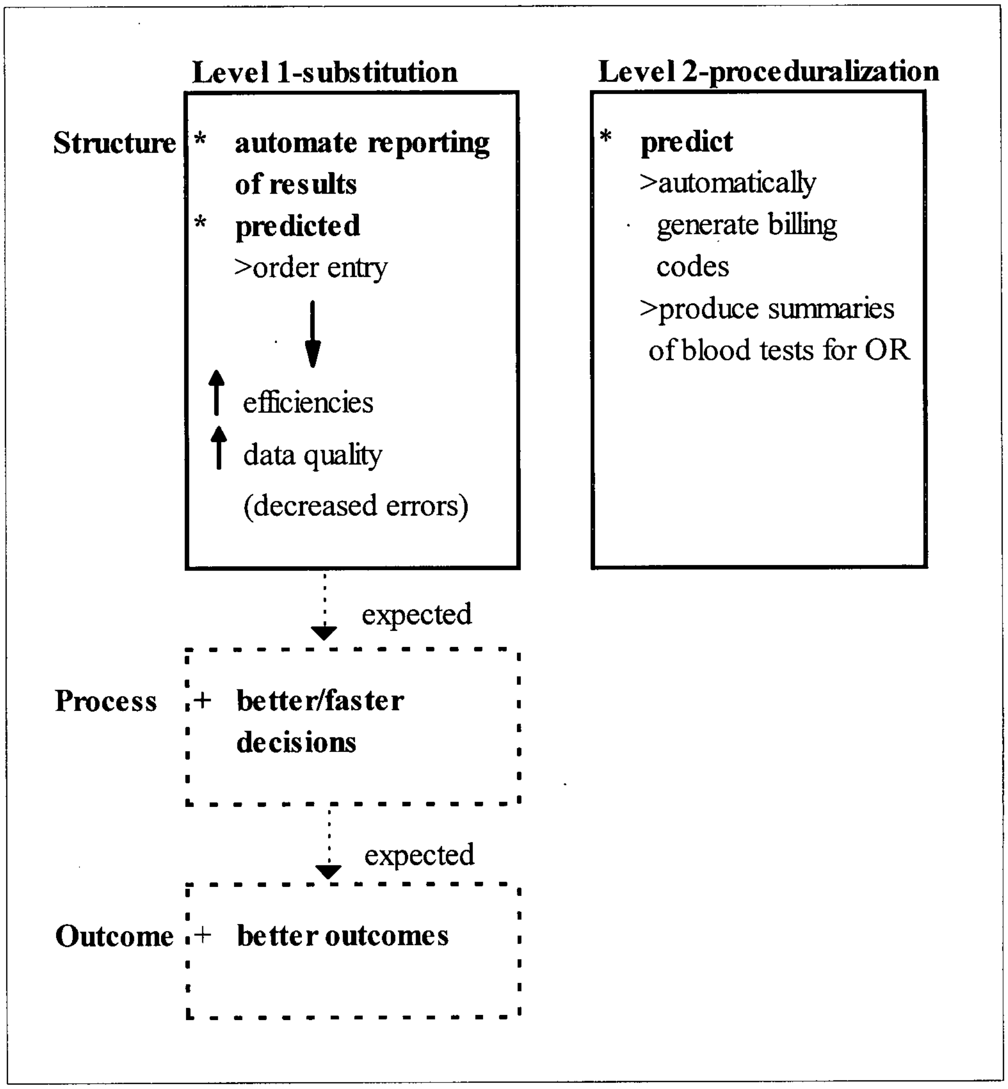

Figure 8.2 - Impact of PCIS on Laboratory Technologists at Hospital 5

Creating "mixtures" of automated and manual systems may solve some of their short term problems, but creates a whole new set of problems, such as patient identification and potential errors with the number of times patient demographics have to be entered. It is not clear to the lab techs how their increased effort (i.e. non-unit producing work) equates to better outcomes for patients. Patients benefit indirectly because physicians are expected to benefit in their interpretation of the reports. A better solution from the lab techs' point of view would be to interface with the main system and download patient demographics.

It is difficult to make "well-informed decisions" based on anecdotal or subjective data and the Lab is looking forward to having more data on utilization and staffing patterns. The potential trap experienced by staff at other hospitals is having too much data available, which gets in the way of making decisions.

8.2 Impact on Nurses - Hospital 5

8.2.1 Introduction and History of Computerization on Nursing Units

Terminals and electronic mail were introduced on the Nursing Units in approximately 1990. The hospital was considered "really forward thinking" when they decided to open the building with terminals on the units. They brought up ADT fairly quickly after that. The philosophy of the HIS Department and Administration at that time was to introduce the terminals and leave them out for people to try, rather than pursue an aggressive training and implementation plan. However, this strategy may, or may not have been perceived by users in the same way. If users are left to learn on their own and the system is not used or integrated into daily activities, little or no impact occurs. Opposing perspectives of this strategy are illustrated by two participants:

> *The nurses were doing admitting and discharge. Part of their whole socialization process to computerization was to have the stuff sitting around and then curiosity would have people start using the keyboards, which is exactly what happened.*

> *I know we got some training last year. Now there is some computer training for e-mail. Before that e-mail was there, but there was no official training so nobody knew how to use it. Nobody ever looked at their messages, so it's been probably a year where everybody's been utilizing it more. But prior to that I don't think... there was never any training in the room with the computers, sort of thing. It must have just been people showing me on the ward.*

Early training consisted of an "inservice with the people that are in the computer department," that introduced users gradually to a few functions such as discharging and transferring patients (a reference manual was also made available on the units). They found XTECH easy to use because it was "very predictable" as this participant describes: "It tells you what the next step is and gives you the choices. You pick the ones you want and move on."

There was a gradual transition from someone on the Nursing Units phoning down to the Switchboard to have them enter changes (patient transfers, expirations or discharges), to making those changes themselves. They expected to benefit through increased accuracy and timeliness of this information. Some nurses felt it gave them better control over this process, and "doing it yourself" had a positive effect on job satisfaction. Others felt the IT was another technology encroaching on their "real job," which is to care for patients.

Patients have traditionally been "admitted" to the hospital exclusively by the Admitting Department. In September 1993, as part of their organizational changes to re-focus on the patient, Administrative Associates on the Nursing Units began admitting patients. They use the admitting module to complete the "long form admissions." The Nurse Clinicians sometimes assist in the process by completing "short form" admissions for patients who have gone through the pre-admission clinic and were pre-admitted before coming in for elective surgery[3]. This usually involves only editing the admitting information for changes or errors.

Nursing may not have considered the ergonomics of computer terminal and keyboard placement as carefully as they might have partly because of their lack of experience with the technology. As they become more knowledgeable about workplace ergonomics and how they will use the system, they are making the appropriate changes to Nursing Units.

8.2.2 Use and Impact of the PCIS

There are no clinical systems up and running, so limited access to one or two terminals and one printer per Nursing Unit, is sufficient at the present time (numbers that vary slightly by unit[4]). Once they move into order entry and results reporting, or if they were to consider recording nurses' notes electronically in the future, they will re-evaluate their numbers of terminals and printers. Hand-held terminals may also be a possibility. However, their use raises concerns about dependence on the technology, as well as being able to function during computer downtime, as this nurse explains:

> *When the system is working well, I could see it would be an excellent thing, but if ever the computer was down for any period of time, that would really throw a cog into the works. ... Then we'd be out of luck. [laughter]*

Selection criteria for systems that benefit nursing may take a different perspective with a change in focus from departmental to a program management, as this nursing manager explains:

> *I think you need to be very selective about your criteria of what you're looking for. I am biased in that I think it's an absolute waste of everybody's time to look at automating nursing care planning, for example. I think that's just a 'make work project' for nurses. I don't think the benefits are there... I think I've always believed in exception care planning. One of the reasons for that is nurses have always been beaten up because we don't have written care plans, or because we do exception care planning and the stuff that we do routinely doesn't need to be written down. So I'm much more in favor of doing patient care planning that talks about interdisciplinary [goals] and again on an exception basis, so that's why the care map notion or critical path or whatever, is what we need to [focus on].*

In this respect, they can also approach "point-of-care" documentation and patient care planning from a multi-disciplinary perspective.

At this point any changes in nurses' decision-making are due more to organizational changes, than to the computer. More decision-making responsibility has been delegated to individual nurses as traditional roles of head nurse and supervisor no longer exist. In much the same way, the computer has had no effect on nurses' productivity. The computer is unlikely to have an effect in the future unless it directly affects patient care, as this nurse describes:

> *As it is now, I don't see that it changes things very much. When we're doing more bed-side charting on the computer, I could see that would be a time when it would have more effect on the job done. You know it's just the way we process information, the way that we receive information. It doesn't really change the actual physical care to the patient.*

For the computer to have an effect on patient outcomes the user must identify how this is expected to happen before the system is implemented.

Increased productivity with future applications is expected to free up nurses' time that they assume will be spent with patients. Nurses may not always spend any "free" time they have now with patients because there are many other tasks that need to be done that they may not have had time to do, such as changing tubing, stocking carts and going through medications. Whether nurses spend extra time with patients is likely an individual decision, as this nurse describes:

> *There's a lot of times I want to sit down and talk to my patient about something that I don't have time for and hopefully if you have that increased time you would spend it that way. I think that's the way most nurses work now. When they have extra time they try and do those extra things. ...I think it would be pretty individual too. Some nurses might also take that opportunity to just chat with each other, or to sit down and relax or take our break, our full break.*

Nurses feel that benefits are limited at the present time and centre around increased computer awareness and faster access to information, as this participant describes:

> *I've heard more complaints than I've heard people praising what it's done for them. I think it's increased nurses' awareness of how things are done, by doing them themselves. Because we've been exposed to them gradually, it's made nurses more aware of computers, as opposed to not knowing anything about them or how they work and hence being frightened of them. Now we can find out some things that we couldn't find out before. For example, if a doctor dictates a report and it goes down to medical records for typing, we can now get that report after it's typed, before it makes its way up to us in the mail.*

They expect other benefits such as entering data once and having it consistently available in as many places as necessary. This would be more efficient, save time and spare the patient from the repetitive questions asked by each health care professional (for example, allergies). This benefit is minimal with ADT (admissions), but is expected to increase when they order tests and receive results on-line. At the present time users have not integrated PCIS into their daily functioning. For example, some participants do not always think to look in the computer for allergies and ask the patient again anyway. Sometimes data is not consistently entered, so the computer is not a reliable source of information, as this participant explains:

> *I don't see where the patient does benefit actually, because we're still asking important things that might be recorded into the computer like, "Do you have any allergies?" So patients are getting asked by four or five different people if they have any allergies. It's such an important thing that we don't want to have a slip-up in the previous steps.*

A number of disadvantages for nurses using computers were identified. There is a feeling a lot of nurses are still afraid to use computers, which produces a negative attitude toward them. Computers also require "extra work" that takes time away from patients, as well as incur a tremendous cost associated with purchasing and implementation. However, a mixture of manual and automated systems creates more work, decreases efficiencies, and increases potential for error, as this nurse describes:

> *I think to automate a hospital you have to automate everything to make sure everything is interfaced. If you have just one thing automated and another thing automated, then it makes more paperwork. [Hospital R.] just got the hand held terminals and I was talking to several nurses from there who have been using them. They're finding there's more paperwork because they're not doing everything on the computer yet. They're still doing some paperwork and so they still have to put things on paper for the physician. They still have a paper chart as well as the computer chart.*

Requests for lab and x-ray tests are handled in a way that is similar to the manual ordering systems used in other four hospitals in the study. Multi-part lab requisitions are completed on the Nursing Unit. Unlike the other hospitals, each nurse at Hospital 5 draws blood for his or her assigned patients as part of their "patient focused care." The vials of blood are sent with the requisitions down to the Lab via messenger pick up. Urgent requests are hand delivered by a nurse or Patient Care Associate. The Lab does not find out what tests need to be done until they arrive in their mailbox. When the tests are completed, the results are recorded and the top copy of the requisition is returned to the Nursing Unit. The adhesive strip is removed and the completed results pasted into the patient chart. If the results are abnormal, they are telephoned to the Nursing Unit as soon as they are available. In a similar way, requests for x-rays are written on a requisition and faxed to the X-ray Department. The original is then sent by interdepartmental mail. X-ray books the time of the test and telephones it to the Nursing Unit.

8.2.3 Use and Impact of Electronic Communication

Nurses identified several advantages of using e-mail. E-mail is a useful tool to communicate information between users about meetings, confirmation of attendance, and minutes. Nurse Clinicians or Program Directors can easily forward information and messages to all staff. They use communication books infrequently now, but important notices of policy and procedure changes, and sometimes minutes of meetings, are still printed and posted. E-mail also provides access to more information, as this nurse describes:

> *I think it's helped us because we're able to get information more easily than we used to. I think we're not missing as many things either because when you go through your mail, you scroll through each one and you can't over look one really because it comes up next. Whereas before, when things were just posted up onto a notice board, it was very easy to overlook that.*

In spite of its benefits, e-mail is not read and used consistently by all users, as these two participants illustrate:

> *No, I don't e-mail the minutes to staff. The reason being is there's a number of people that don't use the e-mail all that consistently and they've got 386 messages waiting for them on their e-mail that they haven't attended to. Because I want people to see them, I'll make copies of it and leave them on the ward so they can find it.*

> *I don't rely on e-mail because there are lots of staff that never use it, and there are some staff who will openly tell you that, but the vast majority of people who don't use e-mail are silent non-users. If I need to send something out for the staff, for example, I will always print one and post it.*

Participants identified one reason for not using e-mail is its inappropriate, for example messages such as, "I lost my coffee mug. If anybody finds it, please send it back." These translate into other costs, as these participants explain:

> *People put all kinds of things on e-mail, like things lost and found. [laugh] A lot of it I think is a waste of money but... they're not important things, people going on holidays, "I'll be away from such and such to such and such"...well*

I'm sure it's a little cheaper to put out a little piece of paper than to store it in e-mail.

[The quality of the information in the system], referring to e-mail, a lot of that is sort of garbage in a way. Some of the things nobody wants to know about. Somebody lost their pet or somebody's getting married, or who cares. It's a waste of hospital money.

Having the available time, as well as the urgency and relevancy of messages, are also factors. When nurses are off duty four out of eight days, messages are often outdated. Nurses may review their e-mail at a quiet moment during the shift, or may not look at them at all in the course of a busy day. On the list of patient care priorities, e-mail is not at the top. On the other hand is considered an "organizational standard" for communication, as these nurses comment:

Actually most times I don't even read them on my day shift. It's usually nights when you have more time once the patients are settled. Depends on the kind of day, but most days you've got your mind on other things. E-mail's the least of my concerns. [laugh]

I would never be supportive of everything being done on e-mail. I mean if you take a look at any kind of teaching principles then you know you need to be able to provide information and teaching strategies in a multiplicity of ways because we all process information differently. So I would never say that we should rely on e-mail. The standard of the organization is that we use e-mail as a means of communicating, so if you tell me that you don't know about something and it has been sent to you on e-mail, then that's not an excuse. You have that access. That's the standard of the organization, right?

The communication book still is used. I think it was supposed to just all go on e-mail, but then I guess some people aren't reading their e-mails. I know I hardly ever look in that communication book but I noticed the other day that there's still people writing things in there occasionally so I guess people still are using it.

Use of e-mail has varied effects on social interaction depending on how it is used as these two participants explain:

I don't use e-mail unless it's a message or a question with a yes/no kind of answer to it. I try to be very careful with anything other than that because I am a great believer in a conversation. I think there are things that are great for e-mail and there are things that aren't so good. With e-mail there is always a big risk that people quit talking to each other and when that happens that's not good from my perspective. I think that's something we suffer from here. I mean, we rely too much on e-mail, and I don't know quite what the answer is. Initially you want everybody to use e-mail, so you don't want to discourage it, but you need to have that face-to-face contact.

I would say that I still deal with people as much [as before]. E-mail would be in addition to talking to someone about something or to line up a time to talk to someone about something, but it doesn't take the place of talking to that person. It might take the place of the telephone in that regard.

Policy and procedure manuals are not available electronically, and there are no immediate plans to put them on the system. However, e-mail is useful to send messages advising nurses that new policies have been issued or keep them updated on trials of new procedures or equipment.

8.2.4 Summary

The impact of PCIS on nurses at Hospital 5 is summarized in Figure 8.3. Nurses seems to have little understanding of the overall PCIS goals, where it is headed, who is using it and for what purpose. Some nurses were unclear about whether physicians are using the system or not, so did not use e-mail to contact them. This is also a good example of the interactive nature of use and usefulness: people do not use the system if they do not see its usefulness. For example, entering transfers and discharges may not be seen as particularly beneficial because it was easier to call Admitting and have them make the changes. However, the system cannot be useful if it is not used.

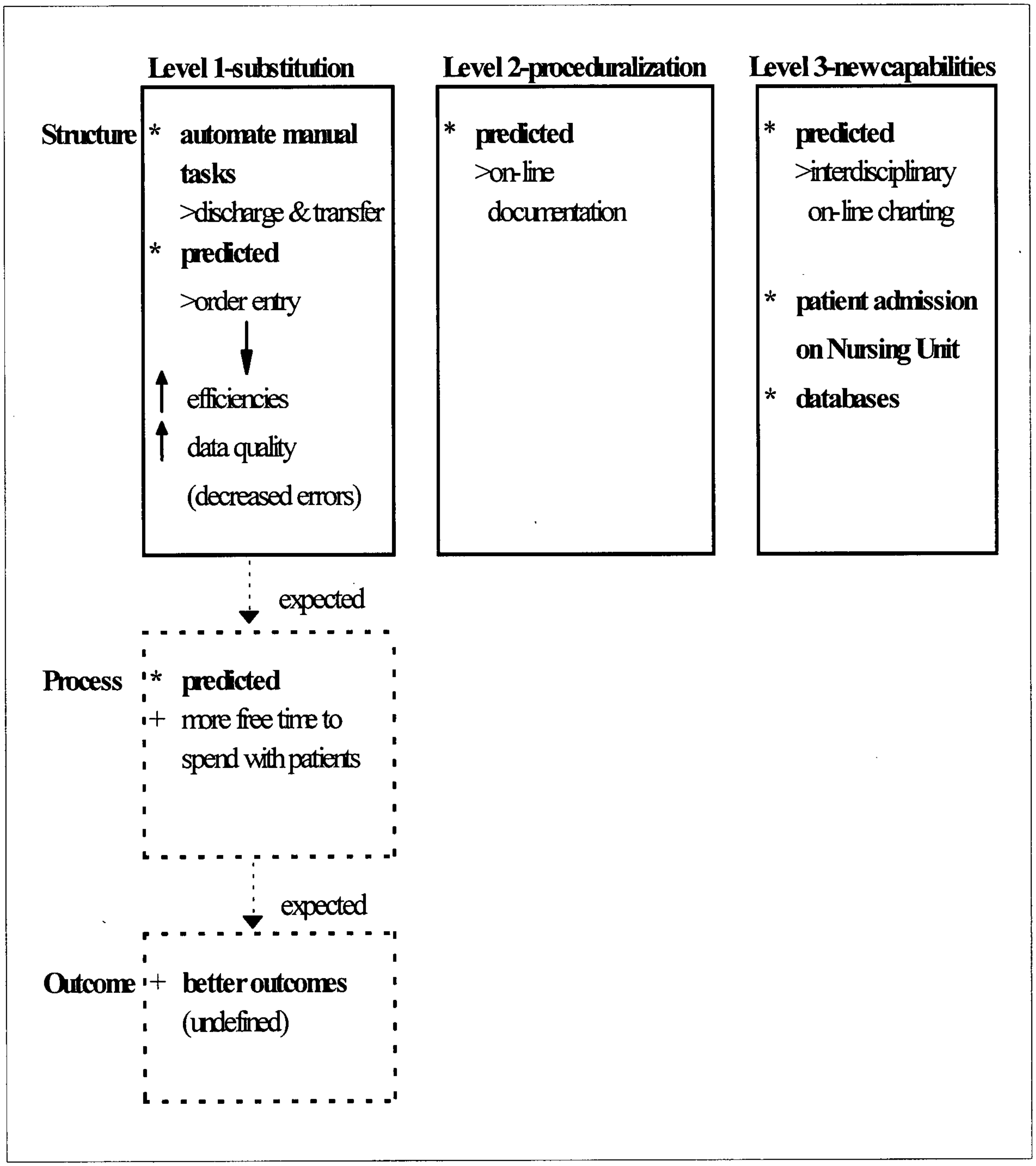

Figure 8.3 - Impact of PCIS on Nurses at Hospital 5

Increased efficiency may not be beneficial from an individual nurse's perspective because it increases the ratio of patients to nurses and therefore fuels resentment that money spent on computers is not being spent wisely.

"Visible" accountability can be seen as a double-edged sword, with control being on the other side. For example, when medications are scheduled for certain times, the reality is that they cannot always be given at those times. If nurses are forced to be accountable for giving them at exactly those times even when that is not practical or therapeutic, they will find ways to circumvent the system, such as scanning the medications at the right time, but not actually give them to the patient until it is convenient.

Increased availability of information is beneficial. One nurse points to being able to look up patients' admissions to hospital and their diagnoses each time, but noted this did not present any additional difficulties with confidentiality. However, many participants had concerns about confidentiality and the consequences for breaching it.

8.3 Impact on Pharmacists - Hospital 5

8.3.1 Introduction and History of Computerization in Pharmacy

The Pharmacy has a director who divides his time as a manager and pharmacist, approximately five pharmacists and four technicians. They operate a traditional prescription distribution system and process medication orders for patients who are in the hospital's acute care beds, two extended care facilities and another local hospital. They manufacture chemotherapy, TPN's and narcotic infusions, but other than that, do not have a central intravenous admixture system.

They implemented the Clinical Pharmacist® computer system in approximately 1985. It was developed by a Pharmacy department in another British Columbia hospital and they were about the fifth or sixth site to install it. They use two of its modules: the order processing module, to process medication orders for acute and long-term care and the purchase order module, to generate all of their purchase orders and maintain records of their purchases.

Access is somewhat limited as there are only five terminals in the department: three are used for the pharmacy system and two are XTECH terminals. Pharmacists use the XTECH terminals for Office Automation (word processing, electronic mail) and they are located in the director's office and in the department. One pharmacy terminal is located upstairs and used for Long Term Care medications. The other two are in the Acute Care facility, and one is used exclusively for order processing, while the other is used for reports and purchasing. These are shared by anywhere from four to eight employees, depending on the day. This means the person doing order entry is interrupted when other pharmacists need to check on orders, allergies or missing information. Alternately, the person processing orders has to watch for a break in the use of the XTECH computer to "run over and quickly glance at the e-mail messages." They use the computers a lot and can always find more things to do with them, which is frustrating because then they need more terminals. However, physical space in the department is at a premium and this is compounded by having two different types of terminals.

The system is relatively easy to use. New employees are able to process orders within two or three days, and become comfortable with it within three or four weeks. The computer is integrated into the functioning of the department, so learning to use it cannot be separated from learning other departmental procedures. They have discussed moving to the XTECH system as this participant describes:

We think it's very easy to use. We're very pleased with it. We may be going to the XTECH system and we're not at all sure from strictly a pharmacy point of view that the XTECH will be better. We have some concerns about it because we like our system... it's simple, it's geared to hospital pharmacy, while XTECH is also geared to many other things. So I would rate our system quite high. I think it works well.

8.3.2 Use and Impact of the PCIS

Pharmacists are responsible for dispensing and distribution functions, education sessions both in and outside of the hospital,[5] projects (such as medication reviews in extended care, visiting palliative care patients in the community, drug information) and clinical work for the patients when time permits.

Facsimile (fax) machines were installed on the Nursing Units at about the same time as the Clinical Pharmacist® system and Nursing began faxing medication orders to Pharmacy. The Clinical Pharmacist® system is a stand-alone system and they have no connection the XTECH ADT system. This means they have to admit all patients into the pharmacy system when medications are initially ordered. The information they need is basically available from the addressograph stamp on the doctors' order sheet. However, the initial medication order cannot be filled unless the "Cautionary Record" information with respect to allergies, sensitivities or other related problems, has been completed by the Nursing Unit. Once pharmacists have entered the demographic information, on subsequent orders they can call up the patient name on the computer and retrieve basic patient information, allergies and a complete profile of current and discontinued drugs.

Pharmacists identified a number of difficulties with faxing down medication orders. Sometimes an order is not filled because Pharmacy did not receive a fax that a Nursing Unit is certain they sent. As well, when Pharmacy receives an order sheet with a list of orders, there is often no indication which orders are to be included. Pharmacy is closed at night so even if orders are timed and dated by the Nursing Unit, the pharmacist or technician has to check every order to make sure they have all been processed. These situations are not handled consistently by all pharmacists or Nursing Units, which introduces another potential source of error.

When orders change or new orders are processed, the computer alerts pharmacists to drug interactions and incompatibilities. The pharmacist is free to ignore the flags if he or she feels the information is not significant to the patient's prescription being filled. The system generates the labels for the medication as well as to send up to the Nursing Units, where they are applied to the Medication Administration Record sheets. (This differs from some of the other hospitals that print medication orders directly on the MAR's, either in Pharmacy or on the Nursing Unit.) In long-term care the medications are re-filled every thirty-five days, so the computer produces these fill lists at the appropriate times.

Pharmacy receives a fax alerting them to discharges and those patients are purged from the pharmacy system during end of the day backup. They are discharging between thirty and forty patients a day and do not have the computer memory to support all those files. Although a paper copy of the MAR's and medication profiles are on the patient chart, none of this information is available on-line for subsequent admissions.

In this hospital either pharmacists or pharmacy technicians process the orders, a practice that varies from one hospital to another, as this participant explains:

> *According to the Pharmacy Act, the pharmacist has to review the profile and ensure appropriateness etc. etc. and so some hospitals would say that therefore the pharmacist does the order entry because at that time you're looking at the profile. Others get around it by having the tech do the entry, but they'll also print a profile off at the same time so when the pharmacist*

does the check, he or she has the profile. Other places are just ignoring it and letting them do the order entry, such as we are. The pharmacist, of course has to check it off and release the drugs. ... When the order is faxed down to us there will be no allergy information on that order. The technician enters it, but she looks into the computer and if it says, "allergic to penicillin" or "no allergies" she will write it on the hard copy. When the pharmacist does check, he is also aware of what the allergies are. There are trends towards technicians doing order entry and technicians checking technicians in some phases of, let's say pre-packaging, so they are slowly getting more responsibility. But ultimately it's the pharmacist who has to make sure that what goes out the door is OK..

Pharmacists benefit from all labels being generated from the same information, thereby reducing transcription errors. Data entry errors, such as entering twenty -five rather than two hundred and fifty, are not screened by the system and the manual checks are intended to prevent these from being dispensed. Nurses are also expected to double check the medications and labels against the original order before administering them.

Pharmacy expected a number of other benefits from their system. They would never be able to provide the same service if they were on a manual system and would need twice as many people. The system also has a positive impact on job satisfaction because if they did everything manually they would "feel like clerks." They are able to provide a fairly comprehensive, up-to-date service much more efficiently with a computerized system. The computer frees up some of their time, but this is beneficial only in the fact that they can do more work with less people. The staff is small in numbers, so they are able to do minimal clinical work because they have not got the time. They used to do more, but it has been cut back because of workload.

Until 1985 Pharmacy used a ward stock dispensing system and patient profiles were not completed for acute care patients. (Profiles were handwritten for extended care patients as their medications were pre-poured for a week at a time.) They now have drug profiles for all patients, which are beneficial in decision making. They also use the Office Automation system to produce patient teaching and lecture materials. As one pharmacist pointed out, there is also a danger that users may get caught up in the technology, and lose site of the patient:

> *It also enables me to support my other activities. If I was to prepare a lecture that required five hours on a typewriter and then decided six months later I wanted to revise it, I would be looking at another two or three hours on a typewriter, whereas now I can do that in ten minutes. So it does free my time up. One has to be careful that you don't become computer focused and decide to embellish it and do this in italics and that in underline and spend time on the computer aspect as opposed to the patient aspect. But then that that's true of any computer system, whatever you're doing, you get caught up in the computer itself.*

One disadvantage of using this pharmacy system is there is no audit trail to track who completed a refill or what was changed, which is a concern as these pharmacists explain:

> *The system we have right now doesn't track which person went in and did the refill. It allows you to change fields that really shouldn't be changed. I could go in and take a profile of an existing patient and change it all. I mean there aren't any locks on prescriptions that have already been entered, which for a computer system would tend to be ideal I think. You don't want people to go in and change history as far as the patient profile goes. So I think this system was a bargain, but it does have a few things that I don't quite like.*

> *Well as far as liability wise and audit trails, I think the system really, really lacks because so much can be fudged around. Personally I've had experience where an entry had my name on it, and I know because I picked the label up off the floor, but that was not what I entered. I really get concerned that people can change something that has my initials on it... I could actually go into this computer system, take every prescription entry that was ever entered under GB and change it to someone else's name.*

The computer system also makes inventory and purchasing much simpler than doing them manually. Except for narcotics, medication purchase orders are not sent electronically, although they do have that option with their main wholesaler. Otherwise, they generally telephone all the orders.

The Clinical Pharmacist® can be used to maintain a perpetual inventory by keeping track of all medications dispensed and returned. Pharmacy does not use this feature because it means they have to count everything they issue and credit everything that comes back, which they do not do. From an accounting and re-ordering point of view it would be beneficial to have a perpetual inventory, but the benefits would not be worth the additional work and cost of a half-time employee. However, the system does provide them with good purchase records that they can use to establish inventory levels.

Pharmacy does not have a formal drug utilization program, but every year the director does a review of their purchases for the past year and produces reports of drug use, which are reviewed. The reports may also be run at any other time it appears there is overuse of certain drugs.

8.3.3 Use and Impact of Electronic Communication

E-mail is used through-out the department and hospital. Everyone in the department is expected to read their e-mail "because they have to," but as far as sending e-mail there may be one or two that do not have the need for it. Problems or concerns with respect to a patient's drug therapy that require an immediate answer are still telephoned to the Nursing Units or physicians. E-mail is used to efficiently communicate non-urgent information with other areas in the hospital, such as when they are collaborating on a project. For example, interdisciplinary protocols can easily be sent back and forth for all parties to make their revisions and provide input (level 2).

Because e-mail is an easy way to communicate, it may be responsible for more communication going to more places. One advantage for pharmacists is that when they are on any of the Nursing Units, they can go to a terminal and send or receive messages. One pharmacist noted that terminals were available on the Nursing Units for a significant amount of time before a lot of staff would use them, perhaps because nurses, by virtue of their training, were not familiar with keyboards. Pharmacists, on the other hand, had an advantage because they had been using keyboards ever since they had typewriters. However, the downside is e-mail may be used so frequently that, as one manager described, users begin to "feel like secretaries:"

> *I find that sometimes I feel a little bit like a secretary. That was one of the things I really had a problem with at the beginning. I was spending so much time typing into the machine what the secretary would have done at one point, but I think maybe at this point we're communicating better. Sometimes the e-mail takes the place of staff meetings, but I find I use it quite a bit.*

"Junk mail" has been a problem in the past, but this has decreased as a result of several directives which discouraged inappropriate use. However, participants still noted e-mail may be used too much for messages irrelevant to their job, such as "car lights are on, I've lost my keys, or the neighbors lost their dog." The department still maintains a communication binder to keep memos from other areas, newsletters and information that comes in the mail.

8.3.4 Summary

The impact of PCIS on pharmacists at Hospital 5 is summarized in Figure 8.4. Information quality is related to not only what the system manages, but also to what is entered on a daily basis. An automated information system is not infallible. Pharmacists noted that if information is entered incorrectly or it is used without professional judgment, errors may occur. This may be more of a problem in a local departmental system than in an integrated one, particularly if more departments are sharing the information.

Maintaining confidentiality of patient information is not seen as a new responsibility for pharmacists. However, having the potential to access all the patient records for all the patients in the hospital creates some concern. There is another dimension to confidentiality that did not exist in the manual system - the ability to easily print multiple copies of, for example, records or profiles. This raises questions about how these additional copies are destroyed. As well, if an error is made in a label or medication profile and a replacement one is printed, the one in error also needs to be destroyed.

The Pharmacy Department has operated in a very independent way with their stand-alone system for ten years. While they may appreciate the overall necessity of an integrated system, they will need to adjust to operating within an integrated environment with a system that is not tailored to Pharmacy. On the other hand, they have enough experience with automated systems to be able to adapt the new XTECH pharmacy system for their use as well as adapt their practices as needed.

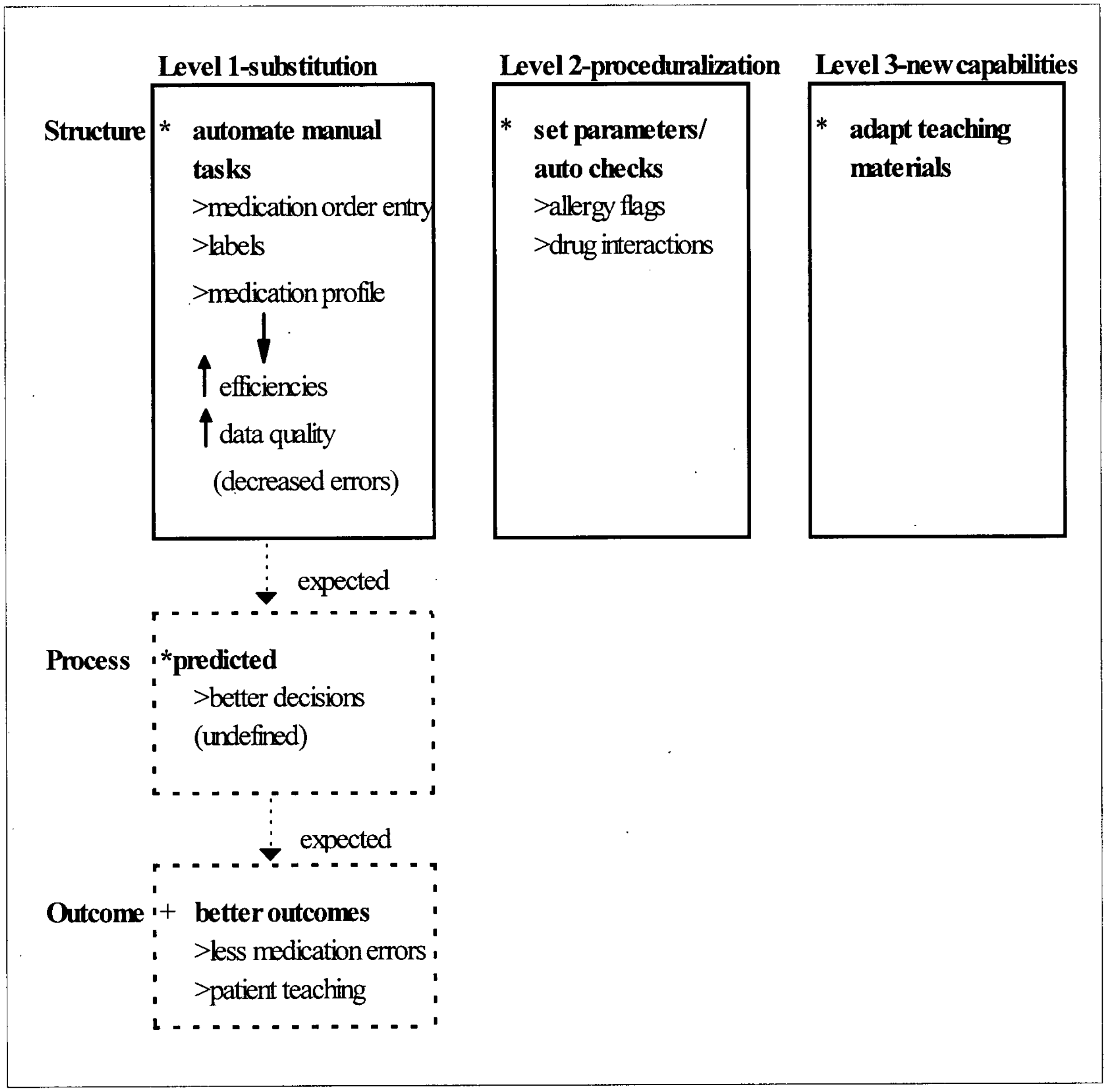

Figure 8.4 - Impact of PCIS on Pharmacists at Hospital 5

8.4 Impact on Physicians - Hospital 5

8.4.1 Introduction and History of Computerization in Medicine

In the last couple of years workshops have been offered for physicians to learn to use e-mail. Sign-up sheets were placed in the coffee room and they had a good response. Prior to that, learning took place more through "osmosis." Physicians were not involved in system selection or implementation, as this comment illustrates:

> *For the longest time the computer wasn't particularly a friend for physicians in the hospital. When it came in, there were all kinds of other functions being served. I think statistical stuff and billing and all that kind of thing was happening long before it had useful patient lists or any e-mail or transcribed reports. Those modules have all been added as the years have gone by.*

Physicians have access to on-line reports and patient lists. From their offices surgeons are able to schedule their own patients for the OR within a block of assigned time. A physician computer committee has been instrumental in getting a computer and software in the emergency room (for example, they have QMR®, which is a diagnostic problem solving program). They have upgraded the library computer to a Pentium so they can access a "stack of CD-ROM's." Physicians also have input on a community effort to develop a network node in town for future Internet access.

8.4.2 Use and Impact of the PCIS

Physicians use the computer system to keep track of their patients in the hospital. They are expected to run these patient lists themselves, which required some changes for this to happen, as this participant explains:

> *No, there are some things that you have to do or you're never going to change the system. I mean if you don't pull the requisitions when you bring up an order entry system, you're never going to get people to use the system to manage the orders. If you have somebody run patient lists for physicians they're never going to run their own.*

Physicians dictate histories, operative or radiology reports and discharge summaries, which are transcribed and available on XTECH. In the manual system these reports all required signatures to indicate they were accepted by the person doing the dictation. In almost a reverse process, the dictation is approved via electronic signature. It is assumed to be acceptable unless the person doing the dictation goes to Health Records and indicates there is an error. This places the onus on the physician to read and accept the typewritten report. In the past if reports were not signed, Health Records personnel invested a lot of time in notifying physicians to come to their department and sign them off.

Physicians have on-line access to transcribed reports, or old histories dictated by specialists (from 1991 onward). However, remote access to these reports or the OR booking system from physicians' offices may not be very practical, as this physician describes:

> *Very seldom would I [look up that kind of information] from the office. We actually do use it from the office, but in order to do that I have to push our manager aside, switch out of the system that's currently running and get onto the connection to the hospital. I'm in an office of seven doctors so we do have quite a few terminals, but there's only one that connects to the hospital. We meet each Monday to discuss all of the patients we have in the hospital and usually we take a printed list from here, but if we've forgotten to do that we can get that list from the office.*

As a security measure, these reports can only be accessed on-line with printing capabilities restricted to the Health Records Department. However, as one physician pointed out, in the manual system multiple copies of reports are placed in physicians mailboxes, and these are transported to home or office anyway. Freedom of information and privacy issues are being addressed through a hospital FIPA committee. They are leaning towards having information readily accessible, but identify issues such as passwords not being well protected and users walking away from terminals without signing off, that need to be addressed.

From the physician's perspective using the PCIS will likely not change decision-making or patient care, but may affect how they organize their day, as this physician comments:

> *It does probably affect the way you organize your day, particularly within the hospital. When we come in, a lot of us look up today's messages, and if there are ward rounds today or tomorrow, that kind of stuff. The secretary for the residents puts in today's and tomorrow's educational rounds, so that appears as a list each day. But in terms of what we do with patients, I don't think that it changes that significantly.*

Physician order entry may be considered in the future, but would require a gradual, phased-in approach, as this program director notes:

> *I think that in this organization [physician order entry] will take quite a while, but I don't know if it's any longer than any other organization. ... You gradually build a generation of docs that are used to that. There will be some diehards who are never going to do it and that's OK. The system needs to be tolerant enough that you don't need to have World War III all the time. We could do that too because we do have the general practitioner residency program that runs here. So the mechanisms are there but we also have a group of physicians who are fairly interested and would start doing that kind of thing. I'm not sure if we have a critical mass yet, but we could ease into that too. My sense of that is you probably need to have a little bit of a dual system until you get through to some of the physicians who are not comfortable with it. The other thing is there has to be some payoff or benefits there. It can't just be a 'make work project' and I don't know that our implementation mechanisms are sensitive to those kinds of issues, in my opinion... So far we have been pretty busy replicating what we do rather than where we should be headed.*

8.4.3 Use and Impact of Electronic Communication

The e-mail system is very good for communication with other physicians and people working in the hospital. However, it is not used by enough people in the hospital to be completely reliable, so if "you really want to communicate with somebody, you have to do it another way," as this physician illustrates:

There are a lot of physicians who I see using the computer and they're looking at patient lists and stuff. If I look over their shoulder, they've got 93 messages sitting on e-mail so I know they're not looking at that stuff.

E-mail does not take the place of contact with colleagues. The coffee room serves as a meeting ground for five or ten minutes between morning rounds and going on to do other things, and e-mail could never compete with that. This is a social time as well as serving as an exchange of ideas on clinical decision-making strategies and results.

8.4.4 Summary

The impact of PCIS on physicians at Hospital 5 is summarized in Figure 8.5. Physicians use the PCIS minimally. They print their own patient lists and have access to on-line reports they have dictated. At the present time they do not see any benefits with respect to their decision-making or patient outcome.

Physicians are not looking for additional features in the PCIS, but more full use of the ones they already have. As the system stands, some features are not necessarily useful. For example, accuracy and reliability is not guaranteed for patient information that frequently changes, such as consulting physician or diagnosis. If these are entered once on admission, and then not updated again during the patient's hospital stay, the users who draw on this information cannot rely on it. As indicated by physicians in other hospitals, there is also a limit on the number of physician names that can be attached to one patient so patient lists cannot be printed by groups of physicians who are taking call for one another. These elements play a large role in how useful the information is and whether the system is used.

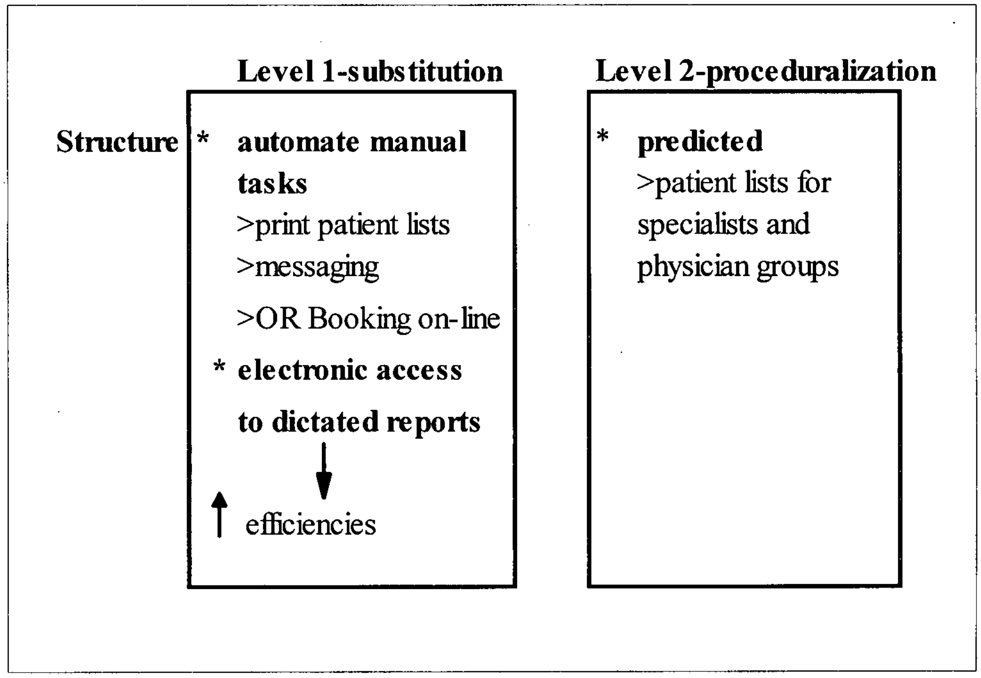

Figure 8.5 - Impact of PCIS on Physicians at Hospital 5

8.5 Summary - Hospital 5

8.5.1 Introduction and History of Computerization in Hospital 5

The hospital has a history of more than ten years with a number of information systems through out the organization. The Lab has focused on stand-alone systems for each of the sections within the Lab that tend to have IT integrated into their instruments. The dilemma they face is whether they should invest in one big lab system or try to work with the interface capabilities of their instruments. Pharmacy has also had a stand-alone system in place for ten years and have adapted it to suit their operations. They are considering XTECH's pharmacy module. Very little of XTECH's capabilities are available to Nurses, as they have limited access to ADT and some dictated reports. The hospital has some ideas about developing links with the community, particularly continuing care facilities, but have been unable to secure funding.

Two years ago the hospital began a major change to their organizational structure and philosophy. The role of IT in supporting these changes has not always been clear to the users.

8.5.2 Use and Impact of PCIS

The benefits expected for health care professionals include the availability of information that would facilitate the use of tools such as care plans or care maps. Efficiency would be increased if users had the ability to enter information as they were creating it, through hand-held devices or bedside terminals, which could reduce redundancy and time spent in charting.

8.5.3 Use of Electronic Communication

E-mail is not used consistently through out the organization, although users are beginning to see new uses for electronic communication, such as the development and refinement of interdisciplinary drug protocols.

8.5.4 Summary

The levels of impact of PCIS on all groups at Hospital 5 is summarized in Figure 8.6. Manual tasks have been automated for each group although they have not achieved benefits through integrating their systems yet. The lack of integration between automated systems creates many situations where data must be manually transcribed into automated systems, which reduces efficiency and also increases the potential for errors. This is particularly true for patient demographic information that is entered on Nursing Units, then again by each area of the Lab and Pharmacy. It is difficult for users to envision alternate ways for doing things, as Grusec (1986) suggested, because they have not reached a level of automation where they can begin to see other ways to use the technology.

One physician noted that having all this information is a double-edged sword because, while it is nice to have it available, it is also available to many people. This presents a potential disadvantage for patients in that information from previous admissions is available, but not necessarily relevant to the current admission. Unlimited access may then become an invasion of privacy.

Patients are expected to benefit because test results are more quickly available, there is less chance of tests going astray, and information is easily retrieved from earlier admissions (allergies, medications, conditions). As well, if patients are transferred to another facility, they anticipate that information could be electronically forwarded, reducing repetitive and redundant questions patients are asked. Participants also noted that for the PCIS to have an effect on patient outcomes, it will not happen automatically. Users must decide before the system is designed and implemented what information they want and how it will change outcomes. They have started developing several databases that they anticipate will provide information on the relationship between process and outcome.

	Level 1 substitution	Level 2 proceduralization	Level 3 new capabilities
Structure	* **automate manual clerical tasks** >results reporting >discharge/transfer >medication orders * **electronic access to information**	* **automate procedures** * **interdisciplinary protocols** * **predict** >automate billing codes, >lab test summaries daily to OR	* **patient admission on Nursing Unit** * **orthopedic database** >includes patient & surgeon's view * **predict** >electronic communication with community agencies
	expected	expected	expected
Process	+ **better/faster decisions**	? **better decisions**	* **coordination of care in-hospital** * **predicted** >coordination of care at community level
	expected	expected	expected
Outcome	+ **better outcomes** >less medication errors >test results sooner	? **better outcomes** (undefined)	+ **better outcomes** >less redundancy >patient satisfaction

Figure 8.6 - Impact of PCIS on All Groups at Hospital 5

Another significant factor for most participants was the lack of funding to move ahead with other systems. While XTECH has been chosen as a primary vendor, they are struggling to impose a department based system on an organization that is trying to move away from operating this way. However, it would seem that patient-focused care could be better supported with integrated systems that rely on a central patient index. Minimal use of XTECH means it is not integrated into the users' work day and therefore features such as e-mail and allergy flags are not used consistently. However, they have used one feature of XTECH very successfully to support patient-focused care; all patients are now admitted by the staff on the Nursing Units, rather than stopping in the Admitting Department.

Endnotes

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1 Only brief descriptions are provided as more detailed ones may reveal the identity of the hospital.

- Clinical - staff who are members of a discipline or profession such as Registered Nurses, Social Workers, Respiratory Therapists and Laboratory Technologists;
- Administrative - an expanded "Unit Clerk" role
- Support - staff previously employed in Housekeeping, Central Portering, Rehabilitation, etc. take on new duties for the program such as housekeeping, minor maintenance and equipment safety monitoring; delivery of meals and nourishments; portering; dirty laundry handling; inventory control; general patient care.

2 Brief descriptions of these projects include the following:

- The National Perinatal Data Base is an attempt to capture prescribed data in as many study sites as possible using a software program developed using ACCESS®.
- The orthopedic database for Total Joint Replacement (TJR) is a result of a Ministry of Health initiative to reduce waiting lists for TJR, where the hospital needs to demonstrate outcome changes, length of hospital stay, etc. The purpose of the database was to create a collection of health information specific to clients assessed for hip and knee problems which would be used to improve the efficacy of the orthopedic program delivery, educate clients and provide a mechanism of client feedback. It consists of a number of questionnaires to be completed by the patient and surgeon, both pre- and post-operatively.
- The Psychiatric Program database was created as a result of a project completed by a student from the Health Information Science Program at the University of Victoria.

3 Unit Clerks previously worked from 8 a.m. to 4 p.m., but some administrative support staff now work from 7 a.m. to 5 p.m.. Admissions are handled by the administrative support person in Emergency from 5 p.m. to midnight and the Switchboard operator takes over from midnight to 7 a.m.. The administrative support role has also been expanded to include several other duties which the Unit Clerk did not have, such as patient admissions, payroll, timesheets and calling in casual staff.

4 There are differences between units, but generally two terminals are located on every Nursing Unit: one is shared by the administrative support person and Clinician, the other in the Program Director or manager's office. Examples of other combinations include:

- Day shift on a twenty-eight bed medical/surgical unit has four RN's, an administrative support person, two LPN's, two support staff, plus a number of physicians. Three terminals are available: the manager and clinician share one, one is for the administrative support person to use and one is located in the social worker and physiotherapist's office.

- Day shift on an eight bed critical care unit has three RN's, an administrative/support person, plus a number of physicians and other staff. Two terminals are available: one is for the administrative support person's use and one is in the manager's office.

- Day shift on a surgical unit has four terminals accessed by six nurses, an administrative support person, other program staff and physicians.

[5] They provide educational sessions for a variety of patient groups such as Diabetic Daycare, The Chronic Obstructive Pulmonary Disease out-patient program or individually to post Myocardial Infarction patients in the ICU prior to discharge.

Chapter 9 - Discussion: Differences in Impact Across Groups

9.0 Introduction

From a socio-technical perspective, changes in the organization and their use of IT may evolve in ways that were not anticipated, as occurs when the organization develops Grusec's (1986) "new capabilities." The perceptions of IT impact held by each of the four professional groups within their respective settings were described in Chapters 4 through 8. The purpose of this chapter is to compare the differences across groups in the five hospitals, identifying what differences exist and why.

9.0.1 Differences Across Hospitals

The use of theoretical replication as a strategy for case selection means the hospitals were theoretically the same, but could be expected to differ in a predictable way on one variable. All cases were community hospitals that had chosen to use a single vendor, integrated PCIS strategy. The hospital size and type, as well as vendor, were expected to produce similar implementation patterns. (This is described in Chapter Two and the general pattern is financial and materiels management systems are implemented first, followed by payroll and personnel, admission system, order entry/results reporting, and decision support.) The hospitals also differed on one important variable, the extent of PCIS implementation, and differences in IT impact were expected to be related to this. As described in Chapter 3, the five hospitals were placed on a continuum based on their level of implementation and integration of PCIS modules. They ranged from Hospital 1, with most of their implementation complete, to Hospital 5, which has only a few elements of their system in place. In whatever ways the professional groups differed from each other, these differences were expected to be similar across hospitals, although the degree would relate to hospital implementation. In other words, impact on lab techs would be expected to be similar at Hospitals 1 through 5, although it may differ from any of the other groups. The level of IT in each of the hospitals is summarized in Table 9.1.

	Hospital 1	**Hospital 2**	**Hospital 3**	**Hospital 4**	**Hospital 5**
Lab Techs	XTECH lab system	XTECH lab system	XTECH lab system	XTECH lab system	independent lab systems for each area
Nurses	admissions, order entry, patient inquiry	admissions, order entry, patient inquiry	admissions, order entry, patient inquiry (selected units)	admissions, modified order entry, OR Booking, Surgical Admissions	admissions on Nursing Unit, selected database development
Pharmacists	XTECH pharmacy system	XTECH pharmacy system	XTECH pharmacy system	stand-alone pharmacy system	stand-alone pharmacy system
Physicians	registry, patient lists, on-line results (remote, on-site)	registry, patient lists, on-line results (remote, on-site)	registry, patient lists, on-line results (minimal, on-site)	registry, patient lists, modified on-line results (minimal, on-site)	registry, patient lists, on-line reports, ER software, OR Booking
system integration	high integration	moderate integration	minimal integration	minimal integration	no integration

Table 9.1 - Summary of IT Across Hospitals

According to Grusec (1986), Hospital 1 was expected to show the most evidence of level 3 impact because they have used XTECH longer, have more applications available and users are more sophisticated. This was true in Pharmacy, but not in Nursing where they have made minimal progress in automating any functions. However, Hospitals 4 and 5 are smaller facilities and farther behind in implementation, yet demonstrated achievements and linkages at levels 2 and 3 that were not seen in Hospitals 1, 2 and 3. Their narrower scope of services appeared to make it easier for them to make specific linkages between their use of IT in changing structural elements and the direct effect on process and outcome (as Figure 7.4 illustrated). Hospital 5 differed in the unique way they were attempting to change their overall hospital focus from structural elements to process and outcome, quite aside from any IT involvement.

9.0.2 Themes Illustrate Differences Among Groups

The nature of differences among jobs of the professional groups before they implemented IT was expected to contribute to differences among them in the study. Five themes that highlight those differences became evident early in the interviews. They are more or less pronounced by professional group or hospital, depending on their level of PCIS implementation and integration. The themes provide a framework for this discussion and a brief description of each precedes the more detailed discussion. Table 9.2 summarizes impact by group and theme.

Automating manual clerical tasks is one of the primary reasons for implementing a PCIS and relates to the first theme of increased efficiency and productivity. These activities or tasks (Donabedian's structural elements) are intended to support quality in patient care (process) whether they are automated or not. Hospitals expect to benefit through the effect of changes in structure on process, particularly decision-making and through that, patient outcomes.

The second theme relates to the well-defined roles and responsibilities of health care professionals that may change as distinctions between structure and process disappear with automation. Responsibilities and activities that Donabedian (1994) defines as structure or process tend to be more clearly delineated by professional groups in the manual system, but become blurred in an automated one. (For example, processing orders is a "clerical" function in the manual system, but in an automated order entry system nurses or physicans may take on this task.) The third theme, "visible" accountability, relates to one of the changes in professional roles that result when scrutiny of professional decisions and actions becomes possible through integrated information systems.

	Structure	**Process**	**Outcome**
1. efficiency/ productivity	lab techs pharmacists		patient
2. role and responsibility changes		nurses physicians	
3. "visible" accountability	lab techs pharmacists	nurses physicians	patient
4. electronic communication	lab techs pharmacists nurses physicians	nurses	
5. training vs. learning		pharmacists nurses physicians	

Table 9.2 - Summary of Impact by Group and Theme

Unexpected and extensive use of electronic communication is the fourth theme. The potential capabilities and drawbacks of e-mail were discovered in most of the hospitals to a much greater extent than they had originally expected, with some surprising results. The fifth theme concerns a socio-technical approach to change. It relates to the issues of training to use technology versus learning to use information. This becomes evident as users consciously attempt to make connections between structure and process or process and outcome more explicit.

9.1 Increased Efficiency and Productivity

Introducing automation to increase task efficiency and workers' productivity causes changes in structure to occur at levels 1 and 2, as Figure 9.1 illustrates.

9.1.1 Automating Manual Tasks

The most noticeable difference among groups is the use of PCIS to substitute manual clerical tasks with automated ones (structure at level 1). The nature of work in the Lab and Pharmacy in processing discrete requests for tests or medications, means these areas benefit more from this type of change than do Nursing or Medicine. (It is partly for this reason that the Lab and Pharmacy share a history of computerization that Medicine and Nursing do not.)

Automation of clerical tasks offers immediate benefits through reducing transcription errors and turnaround time in order processing. However, the claim for error reduction seems difficult to substantiate for two reasons. Errors in the manual system are often underestimated because they are too labor intensive to track. It is also difficult to determine the number of potential errors that may occur. Even while the potential for error decreases, there is better tracking and detection of errors. The PCIS is expected to reduce errors somewhere in-between these parameters and therefore may not be a useful predictor of impact.

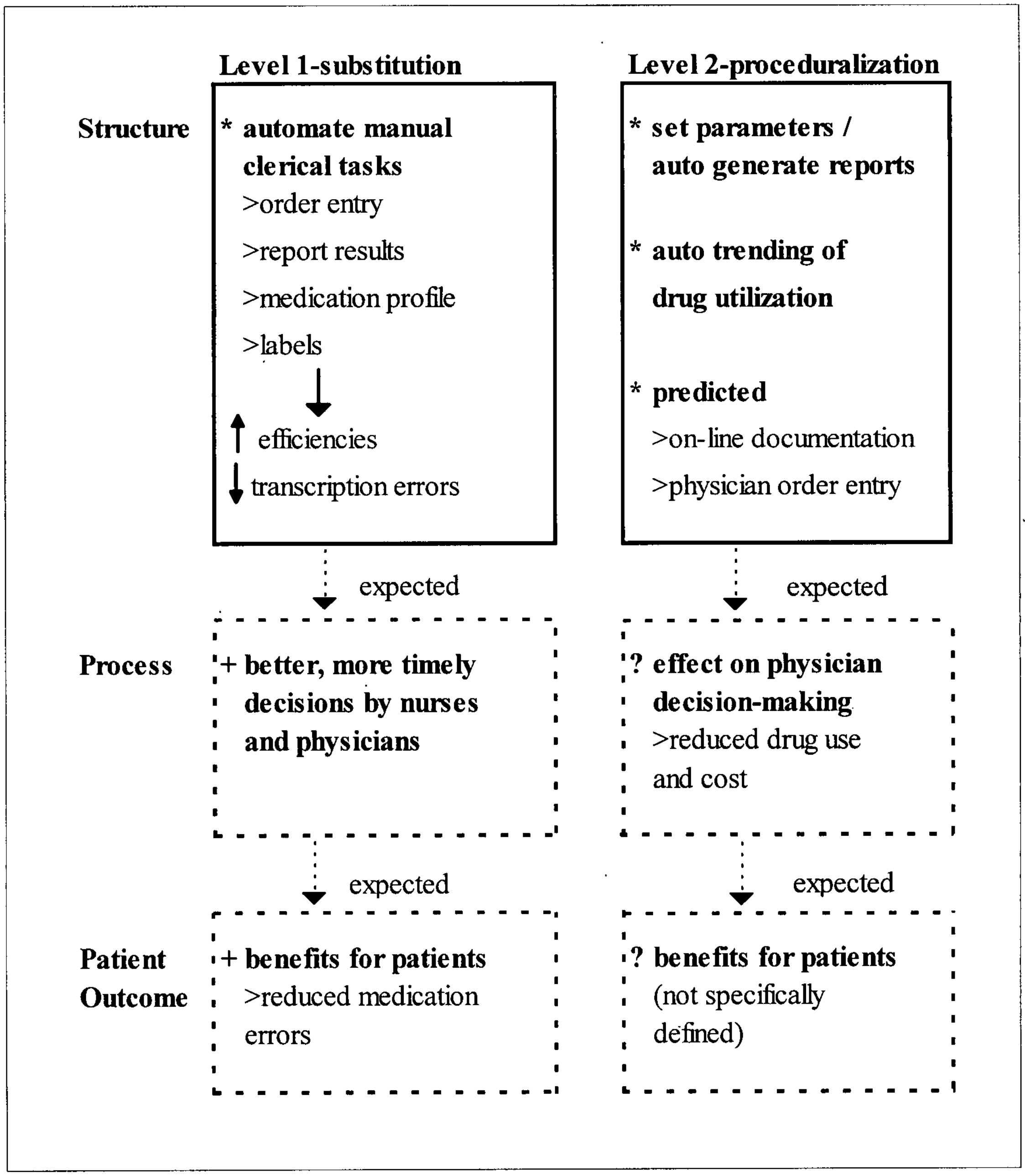

Figure 9.1 - Efficiency and Productivity Changes

9.1.1.1 Laboratory Technologists

Within different sections of the Lab, data are created through analyses of blood, tissue or fluid specimens and reported objectively through numbers (e.g., Hematology, Chemistry), subjectively through verbal description (e.g., Bacteriology, Pathology, Blood Bank) or both (e.g., urinalysis, microscopic work in Hematology). Many reporting and processing tasks in the Lab are discrete so they can be counted and the amount of time required to complete each test calculated. Characteristically, the impact of PCIS on lab technologists is the benefits in efficiency they achieve through automating manual clerical tasks (level 1). Accuracy in testing and reporting, as well as decreased turnaround time, are also benefits.

For laboratory technologists there is also an undesirable side-effect of increased efficiency in outpatient labs. The receptionist is able to quickly enter any additional information required on the requisition before the blood is drawn. The technologist then moves efficiently from one patient to the next, with little time for personal contact with the patients, answering questions or monitoring the puncture site. Patients spend less time waiting, but also less time with the lab technologist.

The Lab proceduralizes a series of tasks that they use in error checking and reporting abnormal results (level 2) as Figure 9.2 illustrates. This increases productivity and reduces human error. However, number of factors outside of PCIS continues to set productivity limits in the Lab; such as the degree of automation in their analyzers, the number and type of test orders generated by physicians.

9.1.1.2 Pharmacists

Pharmacy's primary task, drug distribution, is composed of discrete tasks as well. They benefit in similar ways to the Lab with increased accuracy and efficiency. However, Pharmacies in the study found turnaround time for processing medication orders increased with automation due to the additional information required to maintain complete medication profiles. They gain efficiencies through a division of labor where one person enters all the medication orders. This sets up lengthy data entry sessions where the computer accepts drug orders faster and longer than the pharmacist can enter them, similar to the "intellectual assembly line" described in other industries. Pharmacists feel a decreased job satisfaction due to the amount of time spent in front of a terminal versus interacting with patients and other professionals. In several hospitals Pharmacy had not implemented the XTECH system and were using stand-alone pharmacy systems. This meant lost efficiencies in re-entering patient demographic information and missing allergy information on future admissions.

In some hospitals pharmacy technicians enter the orders. This is an effort to free up the pharmacists' time for more clinical activities, but that does not necessarily happen because their time gets taken up with other duties. Direct computer entry of medication orders by physicians would virtually eliminate this task for pharmacists, but this still presents a number of technical and ownership problems for many pharmacists and physicians. Outside of PCIS, the pharmacists' productivity is highly influenced by the number and type of physician orders, as well as the medication distribution systems.

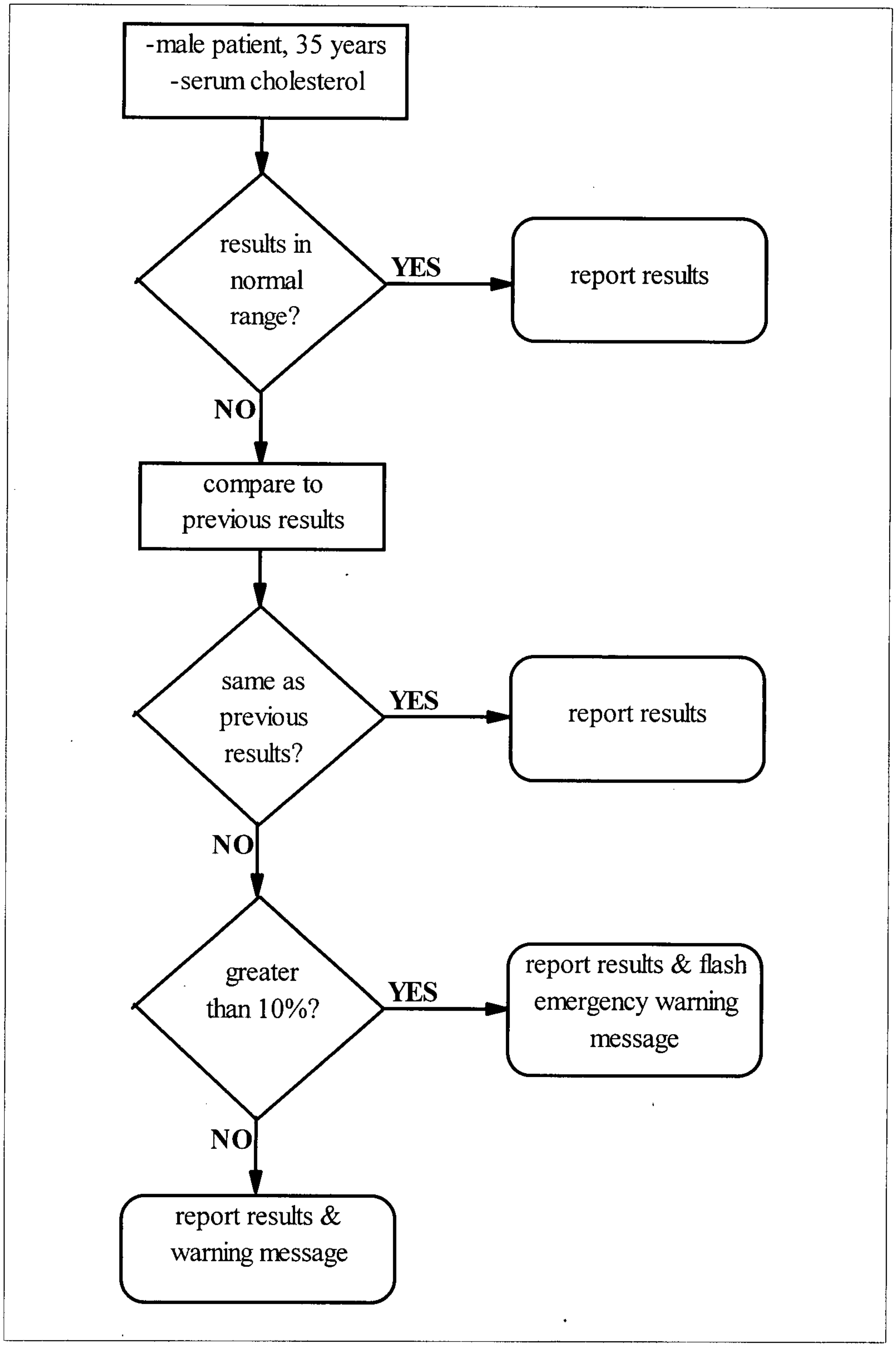

Figure 9.2 - Decision Tree for Proceduralizing Abnormal Lab Test Checks

9.1.1.3 Nurses

Nurses engage in many activities that are not as discrete as tasks in Lab and Pharmacy, although there has been some effort to identify and quantify nursing tasks in many ways. Outside of documentation and order entry, most of the nurse's tasks are not related to use of the computer. Although Nursing departments are often prime users of the PCIS to communicate physician orders and receive results, their general perception is that Nursing does not have automated information systems. They agree electronic communication of orders is efficient, but argue it is a clerical, not nursing function. However, on smaller Nursing Units and less busy shifts, nurses are often responsible for the order entry, much the same as in the manual system. Contrary to the organizational perception, nurses felt the work that had been computerized was in support of efficiencies for physicians and other departments and did not contribute to the "work" of Nursing.

Prior to order entry through PCIS, the fax machine was used extensively as a communication tool between Nursing Units and Pharmacy or Lab. There are short-term benefits in quickly transmitting information between users, but it does not reduce errors and any further use of the information requires transcription again. In this case the task is automated, but impact is limited to level 1.

9.1.1.4 Physicians

Physicians explained that they were in the business of treating patients, so any efficiencies gained in the paper work would not affect the care provided. In the hospitals where lab and radiology results were available on-line, the hospital with the highest physician use had only forty percent or less of the physicians accessing the system. (The reasons for this were discussed in the preceding hospital chapters. They were similar to DeLone and McLean's (1988) "success factors," including ease of use, leadership, training, usefulness and financial disincentives.) A small minority of physicians use XTECH in managing their records and modify their practices to take advantage of the efficiencies provided.

Physicians generally do not enter their orders at any of the five hospitals, although one or two physicians are experimenting with it. However, the hospitals, other professional groups and patients expect efficiency benefits from physicians entering their orders. From a nursing point of view this would mean less time spent calling physicians with results and waiting for new orders. Physicians could look up the results and enter new orders directly.

Many comments on physician order entry were related to the mechanics of entering the orders or training physicians how to use it. A new version of XTECH is expected to facilitate physician order entry. While it will overcome the mechanical barriers to physician order entry, other system users believe some translation, or operationalization, of the clinical request must occur, and this is best done by someone who knows the operating rules for that unit. For example, a physician who orders a chest x-ray may not know the unit routines for x-rays, or what other tests are ordered for the patient at the same time. (Use of the integrated PCIS presents opportunities to proceduralize some of these informal rules at level 2, and so these should not remain obstacles.)

9.1.2 Productivity and Workload Measurement (WLM)

Demonstrating the increase in productivity is important to hospitals, partly as justification for the money spent on IT. In an effort to develop comparative financial and clinical data across each province and the country, all hospitals are expected to develop and implement WLM systems consistent with the MIS Guidelines. Three of the four study groups are concerned about workload and productivity in their roles as hospital employees because a certain level of performance is expected. The benefits of automating manual tasks are much easier to represent in a WLM system that reports quantitative measures (the number of activities and length of time to complete them), than for more qualitative activities. These changes in WLM are best reflected in level 1 activities, as levels 2 and 3 activities are not directly comparable to their predecessors in the manual system.

In Nursing, the recording of workload sometimes takes the equivalent of several full-time employees' to conduct the data collection process. Documenting patient care on-line is expected to reduce some of this effort because workload is calculated automatically. In the Lab it is relatively easy to monitor workload because WLM data collection can be built into the specimen analyzers. In a similar way it is easy to track the numbers of medications entered and processed in Pharmacy. However, it is more difficult to determine the amount of time spent on clinical activities and Drug Utilization Review unless these activities are allocated to specific positions. Physicians control their individual workload because they are mostly self-employed. Their productivity and incentives for work are often unrelated to the PCIS.

9.1.3 Distance From Reality

One of the unanticipated effects of increased efficiencies is the movement of the user away from "reality." In other words, a shift occurs from collecting patient data directly from its source. to increased on-line access to information at the computer terminal. This is partly related to the move towards having other staff manage the initial data collection and computer entry, for example, lab assistants now collect blood specimens and label the tubes. Even as lab assistants take on more of the collection duties, the technologists still like to follow patients' progress and see where Lab contributes to their recovery.

Prior to implementation of the PCIS, it was easier to associate specimens with a name and a person. Even if technologists hadn't personally collected the specimen, they were able to note the daily results from "Mr. Smith's lab work," which indicated he was gradually improving. This lead to a sense of satisfaction that they contributed to his recovery. Using the PCIS diminishes that sense of "connecting with the patients" as it becomes more efficient for the analyzers to match bar code labels to specimens and requisitions. The patient becomes an anonymous set of numbers.

This is similar to Pharmacy where technicians may enter the medication requests into the terminal. In order to achieve the efficiencies of pharmacy techs entering orders, they end up by-passing system features intended to make the system beneficial for pharmacists. For example, they lose the immediate feedback and support in decision-making related to allergies, drug interactions and drugs in the same drug category.

This feeling of an increasing "distance from reality" was expressed by all groups, but less by nurses who have not automated many of their tasks. However, while remote access to results from the clinic or home provides efficiencies for physicians, it also creates the potential for increasing distance between physicians, nurses and patients. Few physicians in the study use remote access capabilities, but those that do have already experienced the widening gap. (Use of remote access is related to the amount of information available. At

Hospitals 1 and 2, where XTECH was more fully implemented, physicians had access to more information to make remote access worth their effort.)

9.1.4 Summary: "Doing More With Less" Means Less Time for Patients

Lab technologists and pharmacists feel increased efficiency and productivity generally contributes to their ability to complete more tasks without an increase in staff. The speed at which "work" is expected to take place is also increasing. If tasks were automated and everything else remained constant, then computers would "free up time to spend with patients" as predicted. However, increasing productivity often translates into starting new programs or adding new tests and ultimately less time to spend with patients. Other factors also contribute, such as the number of staff remains the same while the number of patients increases or patients decrease, but they are more acutely ill.[1]

This "productivity paradox" has been identified in other industries where IT has been introduced. Unlike industrial tasks that assume a predictable relationship, such as doubling the effort of "A" to produce twice as much of product "B," the same predictions cannot be made. With IT, increasing the productivity of "A" may actually result in "B1" and "B2" rather than more of "B." Grusec (1986) indicates this is what happens in levels 2 and 3 of impact where the new output is not comparable to the old.

Nurses and physicians are affected less by expected productivity increases through use of the PCIS, although orders and results are communicated more efficiently. Because the Lab and Pharmacy are more efficient and orders processed more quickly, this does not necessarily translate into nurse or physician productivity changes.

9.2 Role and Responsibility Changes

Professionals are important resources in the health care delivery system. "The health care professional is trained to perform certain functions that are unique; that is, these functions distinguish the sphere of action of health professionals from those of other professionals" (Conway, 1988, p. 111). A stratified, hierarchical system of these professionals has evolved for several reasons, among them the labor intensive nature of the health care industry and need to reduce costs. Technologic advances in the last few decades have tended to broaden the spectrum of patients who can be effectively treated, rather than cutting down the amount of labor needed to diagnose and treat patients (Bullough, 1988).

In an effort to deal with costs, hospitals have tried to rationalize the system by breaking down work roles into component parts and assigning the simpler tasks to workers with less formal training. A few of these roles grew out of the differentiation of the nursing role (producing health records technicians, dietitians and physiotherapists). Most of the Laboratory and engineering specialties had their origins in the traditional job description of the physician (Bullough, 1988).

The health care industry has become large and complex. In earlier agrarian societies, wealth and property were more crucial variables in stratification. More recently knowledge has become the basis of stratification and the learned professions in the health care industry have emerged as the most powerful occupations. A stratified system has also evolved through emergence of the professionalization process and occupational prestige seems to exist in a relatively stable hierarchy as socioeconomic indices of the major health professions illustrate (Bullough, 1988).

This differentiation and professionalization of roles has resulted in a number of undesirable consequences, as this description illustrates (Bullough, 1988, p. 301):

> *Both the differentiation of the nursing roles and the development of multiple medical technician roles have resulted in fragmented and depersonalized hospital care. It is not unusual for a hospitalized patient to have contact with as many as 30 people in one day and yet feel lonely because the encounters are brief and impersonal.*

It is not surprising that the introduction of any IT that threatens this hierarchy's stability or alters access to information affects traditional roles and responsibilities.

9.2.1 Decision-Making

Decision-making in the treatment and patient care process, as well as documenting decisions, care and response to treatment are the essence of health care professionals' roles. Ancillary departments provide the services and information needed for decision-making and patient care.

Nurses carry out many tasks that are not amenable to duplication in an automated system. However, access to on-line information may or may not influence their decisions (level 1). Nurses in the study suggested that although decisions may be made more quickly, the necessary information has always been available, so decision content or patient outcome were not likely to change. With respect to the other three groups, Nursing plays a more complex coordinating role and therefore is the most affected by introduction of an integrated system that formalizes interaction between departments. This coordination role appears to offer many opportunities for impact at levels 2 and 3. However, movement to these levels is not evident for Nursing in most of the study hospitals. Nursing is typically the last to automate, partly because of the nature of the tasks involved and partly because it is neither a revenue producing nor cost saving area, which both the Lab and Pharmacy are.

The work of physicians is similar to nurses in its process orientation, but it is much more focused with respect to diagnostic and treatment decisions for individual patients. They can benefit through efficiently collecting and retrieving objective data (level 1), and opportunities to view the information in new and different ways (levels 2 and 3). Proceduralization of data collection tasks produces more complete and consistent data. Implementing medical decisions has historically been seen as a nursing function (albeit the clerical support has been delegated to the ward clerk). A few physicians have been willing to take on the challenge of order entry, but by far the strongest feeling expressed is that physicians "are too expensive" to be doing clerical work. Physicians are users of information, as opposed to producers, and have depended on "chauffeured" use of information through written and verbal requests. This system has evolved as a result of increases in the number of patients, the amount of paper work required and distance from the patient (clinical practices may be in multiple sites such as offices, hospitals and long term care facilities). Many of the time and distance pressures are alleviated through on-line access to the PCIS, which many physicians choose not to use for a wide variety of reasons, including ones identified early in the literature, such as ease of use, access and the hierarchical structure.

Interestingly enough, all three of the other groups expected decision-making by physicians to improve or get faster (i.e. process changes) as a result of changes in information (i.e. structure). Many formal and informal procedures existed in the manual systems to ensure information was transmitted to the right people as soon as possible, such as calling abnormal results to the physician's office. With PCIS, orders are received more quickly in the ancillary departments and results are available sooner. Whether physicians act on these results more quickly or in a different manner than they had previously is a question that was not clearly answered. Study participants felt that decisions must be changing, although it was difficult for them to identify what evidence might support that feeling. As well, it seems gains from increasing reporting accuracy would necessarily be small unless the inaccuracies were very large or serious to begin with.

Physicians did not generally expect their decision-making would change, outside of perhaps being able to make decisions sooner because the information was available sooner. They were more concerned with having better access to information than having results returned "at the speed of light." For physicians, decision-making is very much a product of training, experience and abilities. However, without direct access to on-line information, they still wait for nurses to contact them with results.

Pharmacists also contribute to decision-making in the care process. In addition to their duties in drug distribution, pharmacists have the autonomy and responsibility for evaluating drug therapy and suggesting alternate therapies to physicians. Pharmacists use the PCIS to automate processes for collecting and analyzing drug utilization patterns (level 2), that they use to influence physicians' prescribing behavior. These ultimately affect patient outcome (such as moving from intravenous to oral medication therapy sooner), as well as the cost of therapy. Figure 9.3 illustrates the evidence of linkages between structure and process or process and outcome in this area of Drug Utilization Review that is particularly well supported by automation. Hospitals with active DUR programs and pharmacists dedicated to this function are better able to make a conscious effort to determine the connections among structure, process and outcome and intervene where necessary.

The related concept of decision support elicits strong feelings in nurses, physicians and pharmacists. Many feel decision support has the unintended effect of reducing individual creativity and innovativeness in problem solving, detracts from users developing the ability to think through a problem and reduces collegial sharing of knowledge. They have an additional concern that as more technology is introduced into the process of medical care, individuals become lazy. This notion of "de-skilling," or of transferring to human knowledge developed over time and through experience over to the technology, is a theme expressed by many professional groups. The concern is summed up with the question, "What happens when the equipment fails or is unavailable?" as this physician comments:

> *They will rely on the supposed decision making ability of the computer that in fact is just a decision making capability of the programmer who wrote the program and will rely less on his or her own gut instinct as to what is the right thing to do. I've seen that with anesthesia. Anesthesia has got to the point now where it's so high-tech ... that probably most physicians nowadays who have been trained in anesthesia would have a hard time giving an anesthetic without all the equipment, although it is technically feasible... So I prefer to keep the machines out of decision-making, but in the process of information dissemination so people can make decisions more easily and hopefully better.*

The access to information and decision-making is at the heart of professional roles and responsibilities. Physician order entry produces a fundamental shift in the flow of information and power associated with that. (Figure 6.8 illustrates the change in this process as orders are entered manually, by nurses and physicians.) A socio technical approach to change enables organizations to look beyond the technical feasibility of physician order entry and examine the effects of this fundamental change on roles and relationships. In a case study of the implementation of an integrated PCIS, Horak & Turner (1995) describe the changes in roles and relationships that this creates for nurses and physicians. Nurses found the system significantly reduced their roles in two ways. In coordinating care the nurse was responsible for all orders in context of the total care of the patient. With physicians entering orders, the focus for Nursing became discrete orders printed on the "due list." As well, physical control of the chart in the nursing station served as a focal point for discussing patient care with physicians. Dispersion of terminals to offices and clinics resulted in less communication between nurses and physicians in this regard. In reviewing orders the nurse was responsible for "interpreting" them and ensuring the intent of the order was carried out. Errors were informally corrected in non-threatening ways through mutual effort of nurses and physicians. When physicians began entering the orders, they alone received the warning and errors were quickly known (i.e. "visible" accountability) resulting in interdisciplinary conflicts.

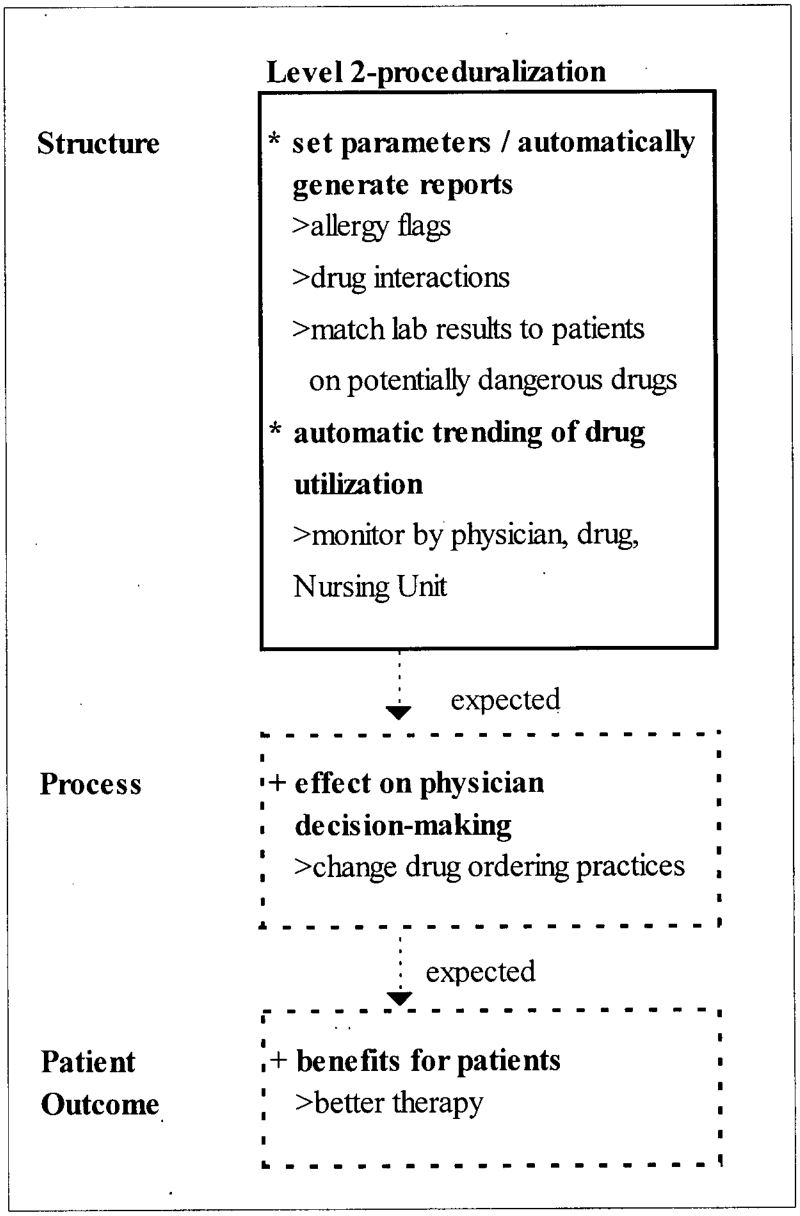

Figure 9.3 - Structure - Process - Outcome Linkages Related to Pharmacy

9.2.2 Documentation

One important role of health care professionals is the documentation of information, decisions made, care provided and outcome of care. All of these are time consuming and labor intensive. Figure 9.4 illustrates three ways participants predicted PCIS may facilitate this responsibility.

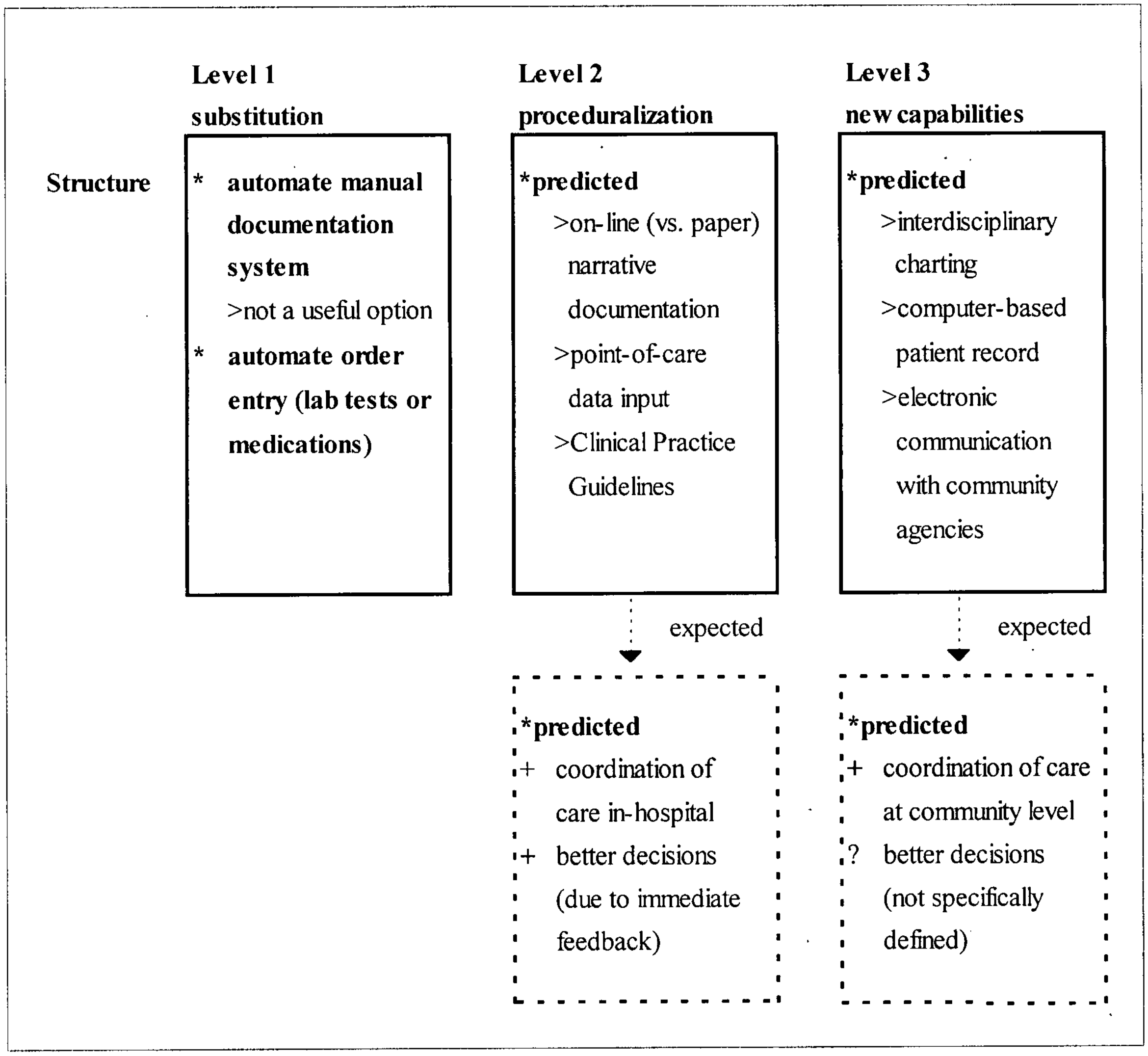

Figure 9.4 - Use of PCIS in Documentation

Automating the manual documentation system (level 1), automating some of the procedures, inputting data at the point-of-care and using Clinical Practice Guidelines (level 2) or integrating documentation between professional groups within and outside the hospital (level 3) are all possible. Each group documents its work differently. The Lab and Pharmacy depend more on the computer to create an audit trail of what they have done, whether it be tests analyzed or medications dispensed. There is room for narrative comments on the lab reports (for example, how results might be interpreted in light of particular medications), and on the patient profile for pharmacists to communicate their follow up actions.

The documentation requirement for nurses and physicians is quite different. Most of what they document is narrative, although nurses also make use of tables and graphs. Elements of documentation are often specific to each clinical area, for example, Intensive Care Nursery is different from Psychiatry.[2] These differences are important to note given the relative size of Nursing departments and effort required to change their documentation systems. Generally speaking, nurses and physicians in the study have not determined how they might make the best use of on-line documentation (or whether they should use it at all) and continue to struggle with the concept of a Computer-Based Record. Simply automating documentation in its current narrative form is not likely to be useful. Documentation is a "learned behavior" that is very much tied up with professional identity and why there are "nurses' notes" and "doctors' notes" rather than "patient care notes." Any discussion of having a single set of notes is often met with great resistance as Anderson, et al. (1995) note in their comments about the introduction of a CPR and the role of documentation as a social process.

The narrative format of "notes," as formal records of the decision-making process is difficult to review and audit. Nurses' notes are often not perceived to be valuable in the manual system, partly because they have limited access and are narrative, making it time consuming to find and retrieve important pieces of information. This also makes it difficult to justify automating these notes, as one nurse comments:

> *Doesn't anybody care about the information that nurses record on patients... the actual patient and what's going on with that patient, how that patient is reacting to the care? But, then I think a lot of times the nursing documentation has been a lot of useless junk. You know they document things like 'up and about', 'IV running left hand', and then the physicians can't wade through all that, so they don't value it. With our manual system we are trying to get that on-going stuff onto a flow sheet and only chart on a problem in the progress notes. That way they are easy to read and there's some value, not only to physicians but to other nurses and physio or whoever.*

The notes serve to communicate between caregivers during the hospital stay, but their usefulness on subsequent admissions is doubtful. Physicians approach this problem by dictating operative reports and discharge summaries that serve as a reference point for future admissions. This dictation process provides an easy transition to accessing these reports on-line at some of the hospitals where the transcription remains on-line as part of the chart. Health Records personnel also play a role in the documentation process through summarizing the care in their abstracts of the patient visit that serve both record keeping and financial purposes.

9.2.3 Summary - Role and Responsibility Changes

Changes in structure through automating tasks is expected to translate into process or outcome changes. If an organizational imperative approach to change is taken, process and outcome changes will occur because the technology has been implemented to support faster and more accurate processing of information, making it available to clinicians sooner. This perspective is evident in comments from many participants who indicate the system is easy to use so it should not be too difficult to teach physicians. Simply setting up more training classes and increasing system access will solve the problem. However, physicians' willingness to use the technology or not, is related to factors other than the technology, such as power shifts, sharing information and control.

Nurses often suggest that physicians should enter their orders without considering how the change will affect Nursing. In a manual system, nurses act as powerful conduits of information between physicians and other departments. Lorenzi and Riley (1995) discuss the changing roles that nurses in one hospital experienced when a CPR and physician order entry were introduced. Barley (1986) described a similar situation where new roles were negotiated differently when two Radiology Departments introduced computerized CT scanners. From a socio-technical perspective, the use of IT and changes in roles and power shape each other over time and may not evolve as predicted.

There are two general differences in expectations across groups:

- The tasks of laboratory technologists and pharmacists provide information to support decisions in patient care (i.e. structure);
- Nurses and physicians use this information in to make decisions in providing patient care (i.e. process).

According to Donabedian's (1988) model, the linkages between structure and process or process and outcome must be demonstrated before changes in one can be expected to affect the other. These linkages do not exist automatically, but have to be created, and this is where hospitals differ. Characteristics of the organization mediate whether this linkage is, or is not, achieved and how IT facilitates it.

9.3 "Visible" Accountability

In settings outside of health care computerization provides an opportunity to automate certain processes and also presents an opportunity to "informate" the organization by making underlying processes of the organization visible (Zuboff, 1988). When this happens in health care, accountability becomes an important issue because the previously "hidden" work of health care professionals becomes visible and therefore available for scrutiny. The PCIS can be used to generate new information by combining clinical data and costs. This presents opportunities to manage resources through identifying costs for individual patient groups and physicians. It also results in new tensions between administrative and clinical use of resources, as well as disincentives for physician use of the system. Managing this area of impact may provide an important key to increasing the value of investments in PCIS.

Use of the PCIS sharpens accountability for all four professional groups, both in structure and process areas. The most obvious example is the availability of audit trails detailing work performed. If an error was made in the paper-based requisitioning system, it was difficult to identify who made the error. Lost requisitions plagued both Nursing and ancillary departments, meaning delays in decisions related to patient care. When the "individual" responsible could not be identified, it created an organizational dynamic with whole departments or units deemed by others as "incompetent" and always losing requisitions or not completing them correctly. Use of the PCIS creates opportunities to identify individuals who incorrectly complete requests, collect specimens or enter results. These individuals can receive additional training in the areas necessary and thereby correct the problem, while maintaining their respect and encouraging good working relations between departments. There is a difference across organizations in how supportively this issue is handled.

The Lab and Pharmacy are particularly affected through automating manual tasks (level 1). The number and speed that tests or medications are entered can be monitored. Both departments proceduralize many of their checking functions (level 2). Actions taken on lab results or medications that are exceptions to the rules can be monitored. For example, allergy flags must be acknowledged by changing the order or overriding the flag. In the Lab actions taken in response to abnormal results must be documented on-line. In the manual system these decisions are left up to the individual's "professional judgment." In the automated system that judgment is open for scrutiny.

Automating the patient record is also seen as reducing individual autonomy, increasing standardization and to some extent, making the decision and care processes more "visible." As a number of nursing respondents pointed out this does not necessarily mean because it is easier to audit people's work, their behavior will automatically change. However, using clinical pathways to track trends and answer research questions about the success of interventions (level 2), as well as multidisciplinary charting (level 3) are difficult, if not impossible, to do in manual system.

For health care professionals maintaining patient confidentiality is expected as a condition of employment and on the basis of professional ethics, although inappropriate discussions of patients have been known to occur in elevators or cafeterias and patient files left open. The organization's role has been to make employees aware of the "confidentiality policy" during orientation. Adherence to the policy was informally monitored and really only became an issue if a situation arose where confidentiality had obviously been breached. Integrated systems and remote access to information presents new challenges for the organization to actively monitor whether confidentiality/security is being breached. Accountability for health care professionals becomes increasingly "visible" with audit trails detailing access to information.

Nurses who access the computer to provide information to patients or answer questions from other health care professionals felt it supported their professional image. As well, pharmacists and lab techs both felt their "professionalism" was enhanced through computer generated reports (e.g. lab reports, medication profiles, MAR's) that present a professional image compared to handwritten copies. This may be important because the reports from Pharmacy and the Lab project an image of the department to other users (such as nurses and physicians), where nursing documentation is used primarily by other nurses. Physicians historically have handwriting that borders on illegible, but is perceived as acceptable for "busy physicians."

9.4 Unexpected Consequences of Electronic Communication

Electronic communication was used more extensively than the hospitals had anticipated. Because use of this technology is relatively new in health care, many of the findings in this section are new for this industry, but they are not unique and have been reported elsewhere for other industries. Communication is an important aspect of organizations. Electronic messages take the place of notes, memos, notices, and "telephone tag". There seems to be little negative connotation attached to using this method of communication versus more personal methods, provided it is used appropriately (for example, job performance reprimands are not received well on e-mail) and there are still opportunities for face-to-face contact.

Use of e-mail unexpectedly expanded in some hospitals with the availability of "shared cabinets" on XTECH that enable them to share minutes, agendas and notices on-line. Users found collaborative work for interdisciplinary committees was facilitated when they could collectively work on documents prior to meetings. Use of e-mail extends to having manuals on-line, which are only available at two hospitals. All groups of users can benefit from manuals on-line, but Nursing needs more integrated information because they are responsible for knowing the requirements for many areas. For example, a nurse collecting blood for a particular test may need information from Pharmacy, Lab and Nursing Administration manuals.

Many respondents noted that electronic mail was expected to reduce the amount of paper being wasted. They found reality to often be the opposite because multiple copies of notices are printed. For example, where they might have posted one notice in the department, when it is e-mailed to all employees, they print many copies. In some areas there is a concerted effort to bring this use of paper to the attention of employees and develop new norms for managing paper.

On the whole, the change to electronic communication appears to lack direction and planning. Training to use the e-mail system is usually fairly good, but "ground rules" for using this new technology are missing. Formal and informal "rules" for other types of communication have developed over time, are revised as needed. For example, information contained in the hospital newsletter is different than the notices indicating doctors on call, employees on vacation, policy changes or specials in the cafeteria next week. Each of these (and many more) types of communication has specifications for its production, type and color of paper to use, who generates the information and who sends it out. Some of these "rules" are a product of time and money, and serious consideration is given to whether the information is worth both of these. Notices about specials in the cafeteria are posted outside the cafeteria and not sent to each individual employee, but a notice about upcoming salary changes may be included in every pay check.

As these "rules" develop they reflect the culture of the organization. What is missing from the addition of electronic communication to the organization is the reflection on how this communication changes relationships and communication patterns in the organization, as well as the most effective ways to communicate. In terms of organizational costs and benefits, for example, a notice to three thousand employees to look for a missing coffee mug is of high cost and no value to all the people who open this mail, read and discard it. In fact, it costs the organization time. The use of electronic communication is a prime example where the training to use the technology is excellent but application and impact of that technology was not well anticipated.

9.5 Training to Use Technology versus Learning to Use Information

An organizational approach to IT and change suggests that if users are able to use the technology "skillfully" the expected changes will occur. Therefore, large amounts of time, energy and money are invested in constructing training rooms and developing training materials. However, as technology and organizations become more complex, a socio-technical approach suggests ongoing training is necessary. This is important as hospitals move into integrated systems and users have access to wider ranges of information. Users are able to combine data in many novel ways to create new information, but also must learn to use that information in new ways. An inherent drawback in using these "derivatives" of clinical information is in their effect of removing the clinician one step further away from the original source of information - the patient (as discussed in 9.1.3). Unless an individual user is able to integrate this information into his/her decision making, decision-making is not reported to be any different than before the system was implemented. This potential to affect clinical care is not dependent on any specific clinical or decision support systems, but is not being used by the majority of physicians.

As users become more sophisticated in their use of information technology, they begin to see new ways to use and produce it, much as Grusec predicted for level 3 impact. These needs are not served by a massive initial training effort that attempts to teach people everything there is to know about the system. Instead, frequent, on-going training in short segments that addresses the application of the technology is more useful, or "just in time" training as one participant described it:

> *I've got Word for Windows and that's a big program. But I don't sit down and read the manual. If I come across something... I spend about a week trying to figure out something that I did wrong. But I keep going back into it and saying, "OK, why isn't this working? Why couldn't I get it to do this?" then getting out the manual and looking this up. So it has to be pertinent to you at the time and then you'll figure it out and then you'll remember it.*

9.6 Conclusion

Introduction of complex, integrated information systems emphasizes the need for hospitals to better understand the interaction between professional groups, with their muti-faceted contributions to cost-effective, quality patient care and why expected impact does or does not occur. Changes in the work of one group may have unexpected consequences for other groups. Laboratory technologists who use a laboratory system increase their productivity. However, in the context of using a lab system that is integrated with a PCIS, nurses send orders electronically and physicians access results on-line, the complexities and expectations for change increase.

Differences between the groups are a result of varying levels of sophistication in computing, where Nursing and Medicine are farther behind than Lab and Pharmacy. This limits user participation in system selection and focuses attention on level 1 type activities such as simply automating manual processes that do not provide as much value to nurses and physicians. However, when these users become more knowledgeable and sophisticated in their use of IT, they may move to levels 2 or 3.

The other difficulty to get around is the "stovepipe" thinking that has developed over the years where each department is responsible for their contribution. There is limited understanding of the way they contribute to the whole process and patient outcome. It is easier to automate a current procedure and not worry about the impact on other departments than it is to jointly negotiate new positions and not be certain what those changes will bring. There may be too much at risk in moving to levels 2 and 3 because success is an unknown factor. From a technological or organizational imperative, impact is "controlled" by developing and implementing the right system with a focus on substitution activities. The CPR, to which a PCIS is the foundation, is a good case in point. Much attention has been focused on technical and training issues with the assumption that if these are well managed, the electronic record will provide many potential benefits. As Rogers (1995) points out, consequences of adopting an innovation can be both unintended and unanticipated, with a gain for some recipients at the expense of others.

Participants in the study are more aware of how they use the technology than of the consequences of using it. For example, they might not be able to articulate how patients benefit from the use of computers in health care, yet when they describe their work they provide examples of how patients benefit from their use of computers. An iterative evaluation of how computers are being used and to what ends seems imperative. The focus has been on their intended use and impact, in other words, what the training says is supposed to happen. Over time, changes in the technology and the way it is used, as well as changes in the organization and individuals within it, will likely find the PCIS being used differently than expected.

The IT literature has focused narrowly on the initial selection and implementation of IT. What is much less evident is how use of the systems evolve, and how new and different ways of using the IT emerge alongside of new ways of doing business. Given the early development of strong stand-alone systems and the later difficulties in integrating them, many hospitals have moved to a single vendor solution. With this approach however, there must be some "give and take" in the system selection. While no department may find the perfect departmental system, the hospital chooses an overall integrated system that is best for the organization as a whole. One of the downsides of the choice made by these five hospitals is that in order for this type of integrated system to function well, change requests must be carefully managed. XTECH handles this by allowing only a limited number of minor changes. Major changes are made unilaterally across user sites, so depend on a majority agreeing with the change. As one participant noted, because a majority of sites request changes to the admitting module, this does not necessarily mean it will produce the best changes for your hospital's Lab or Pharmacy departments.

The single vendor approach appears to have two consequences for hospitals in this study:

1. there are strong organizational ties to the vendor (and consequently to the vendor's strategic plan for system development) with system upgrades, change request protocol and vendor sponsored user support groups with an implied organizational imperative.

2. XTECH is large and complex. The vendor has a long history that contributes to stability of the company, but also means the system is built on older technology that is harder and slower to change. There is a high degree of frustration with vendor inflexibility. The vendor is aware of the users' need to manipulate data in more sophisticated, user-defined ways outside of the mainframe environment, being able to download statistics into a database program on a local Personal Computer is a good example. HIS Departments, particularly in Hospitals 1 and 2, are trying to proactively establish the necessary hardware infrastructure to support this flexibility so they can take advantage of it when the vendor is ready.

Use of XTECH is not unfolding the same in all five sites. Hospitals 1 and 2 have strong histories of successful implementation and on-site HIS support, both technically and organizationally. Hospitals 3 and 4 have had much less consistent HIS support. In Hospital 3 their first integrated system was not successful due to many technical barriers and system inadequacies. The organization is in a state of flux with large numbers of bed closures and changes in the administrative team. On-site HIS technical support has increased and is under new leadership, but organizational support is minimal. Earlier hardware choices limit current choices. Hospital 4 attempted to implement one component of an integrated system without technical or organizational support. While technically the system is successful, there are many organizational issues that have not been resolved and may stand in the way of future system success. Hospital 5 is unique in its approach because of recent organizational structure changes (program focus) that are not totally compatible with the underlying philosophy of XTECH (departmental focus). They have successfully implemented a few modules, "modified" to suit their needs and are constantly struggling with a system that resists customization in order to remain integrated and supported by XTECH.

Each of these hospitals has used XTECH in both similar and unique ways. They have sought advice from the more experienced hospitals for their development, implementation and training issues as well as direction from the vendor to all sites. There is less evidence of sharing results of the impact of implementation (at levels 2 and 3) across sites, although there is certainly evidence of these changes.

A final note of consideration is that the very nature of PCIS promotes efficiencies in processes by making individual tasks more efficient. If too many tasks become automated, the broader, holistic perspective the health care professional brings to the care of patients may be lost. In essence a very efficient, but fragmented and task oriented health care system, will be left.

Endnotes

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[1] This phenomenon is often referred to in health care. With more alternatives to acute inpatient care such as ambulatory care clinics, community or home care services, or day surgery and shorter lengths of stay in hospital, many predictions abound that less patients will be in hospital but they will need more intense care. Other people not as acutely ill will take advantage of other services. While this seems to be an obvious explanation, one physician pointed out that there are also other factors such as changes in previous treatment patterns where patients stayed in hospital for seven days following surgery or delivery. Because they go home in three days now does not necessarily mean they are more acutely ill. Surgical techniques, anesthetics and post op mobilization all play a part.

[2] XTECH has a module for nursing documentation and markets a small, hand held computer which is suggested for use by nurses. This "point of care" device is intended for use wherever the data is generated and can then be inputted at that time rather than writing information down and then re-entering it later into a terminal at the nursing station. This device is being pilot tested at one of the hospitals not in this study. Early reports on the benefits of its use are inconclusive.

Chapter 10 - Conclusions

10.0 Introduction

In this final chapter, major interests of the research study are reviewed and findings obtained through empirical investigation and analysis are summarized. The theoretical model developed to guide this research is re-examined and a recommended amendment discussed. Implications for research and practice as well as directions for future research are then suggested. The chapter concludes with a discussion of some of the limitations and contributions of this research.

10.1 Research Questions

The underlying theme of this research is that escalating complexities and costs in health care contribute to the expectations for information technology (IT) to reduce costs, while maintaining or increasing the quality of patient care. Understanding why IT may not have the predicted impact in health care has both practical and theoretical considerations. This area of study continues to grow in importance as the technology becomes increasingly available at the same time as funds are diminishing.

One potential source of discrepancy between expectations and reality is differences among groups of health care professionals in an organization who are using an integrated Patient Care Information System (PCIS). The specific focus of this research was to identify differences among these groups and if they existed, to suggest reasons for these differences.

A multiple-case study approach was used to explore the differences among the four groups of health care professionals that participated in the study. The researcher's interpretations were informed by a theoretical framework that drew on work by DeLone and McLean (1989), Donabedian (1992) and Grusec (1986).

10.2 Implications of the Study Themes

As discussed in Chapter Nine, five themes emerged that illustrate the differences among the groups. The implications of these findings are discussed below.

10.2.1 Increased Efficiency and Productivity

In a static or shrinking health care environment, using PCIS to increase efficiency implies doing the same or less, with fewer people. Positions are identified as redundant and people lose their jobs as the new system and new ways of doing things are introduced. Of the four study groups, pharmacists and laboratory technologists are the most affected by automation of clerical tasks in their area. They are also keenly aware of the results of being more productive. However, Hospital 3 is markedly different from the other sites in this regard as their inpatient beds have recently been dramatically reduced. This is one of many changes undergone by the organization and participants attribute some of their organizational problems to misdirected expenditures on information technology (IT), rather than on maintaining jobs.

In geographic areas of high growth and expansion, as is the case for Hospitals 1 and 2, increases in productivity are less likely to be accompanied by jobs being eliminated. However, for these sites increased efficiency creates other expectations that more work can be accomplished with less people as well as implementing more sophisticated services. Examples of this occur both in more tests handled through Regionalized Laboratory Services and through Drug Utilization Programs in Pharmacy.

Health care professionals who become more efficient and productive are faced with another paradox. The desirable features of IT that enable reduction of repetitive tasks are the same ones that produce dissatisfaction or decrease the number of available jobs. A reduced need for "professional judgment" occurs when tasks are proceduralized (level 2 impact) and produces what is commonly called an "intellectual assembly line." Pharmacists in particular are affected by this as efficient deployment of staff often means one pharmacist is assigned to the "clerical tasks" of medication order entry. By defining parameters and proceduralizing the process of checking drug orders against all possible interactions and patient allergies, the computer takes over these "thinking tasks." However, the irony is that this produces a much longer list of patients with potential drug allergies, and the pharmacist must then evaluate the relative seriousness for individual patients. This places pharmacists in a stressful position of information overload.

IT users perceive that increasing the amount of information available will implicitly change decisions for the better. In reality, the time spent maintaining the system and entering increased data (even if it is more efficient) does not translate into time to use or investigate the additional information they produce. In addition, the increased information means more investigations could potentially take place, but they do not have the human resources to do so. For example, pharmacists can identify many more potential drug interactions, but are still limited in the number they can follow up. Therefore, they continue to only investigate the most serious ones as they have done in the past, and the additional information serves to increase frustration levels with "not having enough time to do everything."

A similar situation occurs through the cross purposes of funding policy and the use of IT, as the expected changes in physician behavior do not materialize. For example, physicians are currently reimbursed on a fee for service basis that includes patient visits. Increased efficiencies can be gained for the organization (and better patient outcomes predicted, if not demonstrated) when physicians enter their orders directly and access results in the same way. If the physician can retrieve results and order tests through terminals at home or in the office, a trip to the hospital may be avoided. However, a potential source of income derived from patient visits is also reduced, although the patient outcome may not change appreciably.

10.2.2 Changes in Roles and Responsibilities

Elements of control and order are expected in health care organizations because they are founded on established hierarchies of roles and responsibilities. The study identifies a number of changes in these that result from use of the IT, particularly for nurses, physicians and pharmacists. The social and cultural dimensions of professional acceptance or resistance are important factors intertwined with organizational culture. Differences within a group are expected to be small and primarily related to the degree of PCIS implementation at each site. However, across group differences may also be less than expected within an organization based on social and cultural dimensions that are handled differently in each organization. This is illustrated by the degree professional groups are included in the planning, implementation and training that varies by site, but physicians tend to be more excluded than included.

Traditional responsibilities have developed partly due to the physical limitations of data access (e.g. lab results are only available on paper copies hand delivered to the Nursing Unit), and partly due to the hierarchy of professions in the health care system (e.g. nurses are responsible for relaying lab results to physicians). A key issue under consideration is that while physician order-entry is technically possible and organizationally desirable, it introduces changes in roles that may or may not be acceptable in the organizational culture. For example, when physicians order medications in a manual system, the pharmacist is responsible for ensuring the appropriate medication and correct dosage has been ordered and dispensed. However, if physicians order directly through the PCIS, the pharmacist's role as the "gatekeeper" is diminished and may become redundant. These types of threats are easily identified and resisted, although they may surface as concerns about "patient safety and quality of care."

Another element of this issue is inherent in the resistance of physicians to using direct keyboard entry. Resistance may be related to the fact that this is seen as a "clerical" task and therefore represents a demeaning activity or alternatively may be construed as general reluctance to using the technology. The resistance may also be related to a generational difference, as evidenced by several physicians suggesting that the most likely solution to having more physicians use IT is to wait for the current generation "die out" and work with the upcoming generation who use computers from the first day of training. This issue may also be related to the degree of inclusion in plans for the PCIS from early on.

10.2.3 "Visible" Accountability

Culture plays an important role in how organizations interpret and respond to the changes resulting from "visible" accountability. For example, when errors occur Hospital 1 uses the additional PCIS information that identifies specific nurses and unit secretaries who enter requests for lab tests, or lab techs who enter results, as an opportunity to change behavior. However, this presents a dilemma when physicians are in error and it falls to Information Services Personnel to provide the feedback. In spite of the fact that this hospital is advanced in their implementation and have successfully trained all groups of employees, they still do not have an official physician liaison and have not found a satisfactory way to handle this issue.

10.2.4 Unexpected Consequences of Electronic Communication

Changes within the organization as a result of electronic communication are discussed in Chapter 9. There are many positive implications of extending electronic communication capabilities into the community that are inherent in the plans for regionalizing health care services. Of particular interest is that, while several of the study hospitals have attempted to make these connections, none have been very successful. This underscores the fact that electronic communication has much greater potential than simply using it as a replacement for the paper-based system. For this reason the study hospitals also found it requires more planning and preparation than they had been giving it at present.

10.2.5 Training to Use Technology versus Learning to Use the Information

This is one of the most interesting and unique findings of the study. All five hospitals have invested extensive time, energy and money in training to use the technology. However, there are a number of disincentives for moving beyond simply using the technology, to using the new information that becomes available.

Economic and professional motivations discussed earlier are both sources of resistance to using information in new ways. The use of IT creates situations where health care professionals need to protect their jobs and professional identity. System-wide disincentives also exist through IT funding priorities that are shared by all five hospitals in the study and defined by the Ministry of Health. These give priority to capital projects that automate aspects of finance and administration, rather than to those that "improve patient care." This is primarily because an automated financial system is expected to pay for itself in saved operating costs, including a reduction in jobs. As a number of senior managers and administrators in the study clearly pointed out, this is also one of the reasons why there is little incentive for evaluating the effect on patient care areas, and by extension, learning to use information differently. The financial portions of the information system have paid for themselves and would not be removed in either case: a classic case of the "water under the bridge phenomenon," where evaluation makes no difference in whether the innovation is accepted or rejected.

10.3 Revisiting the Theoretical Model

Research into the study of impact is a promising avenue of investigation, particularly with the potential of IT to effect patient outcomes. The study introduced an analytic framework that proved to be valuable in understanding impact of PCIS in community hospitals. The linkage expected between the structure, process and outcome aspects of

Donabedian's (1992) model provided some insight into why impact does not occur. His model was adapted to include output to reflect the financial aspects of IT impact on the organization. While economic issues are important variables in IT success, including them in the framework did not add to our understanding of the differences in impact among groups. Therefore, in future study efforts it is recommended that Donabedian's original model be used.

Donabedian's (1992) model has been previously used as a static framework to study IT impact in health care (Hebert, 1995; van der Loo, 1995). From a socio-technical perspective on IT and change, this study supports expanding Donabedian's model by using Grusec's (1986) three levels of impact to demonstrate changes in impact over time. Figure 10.1 illustrates a revised version of the analytic framework suggested for further study.

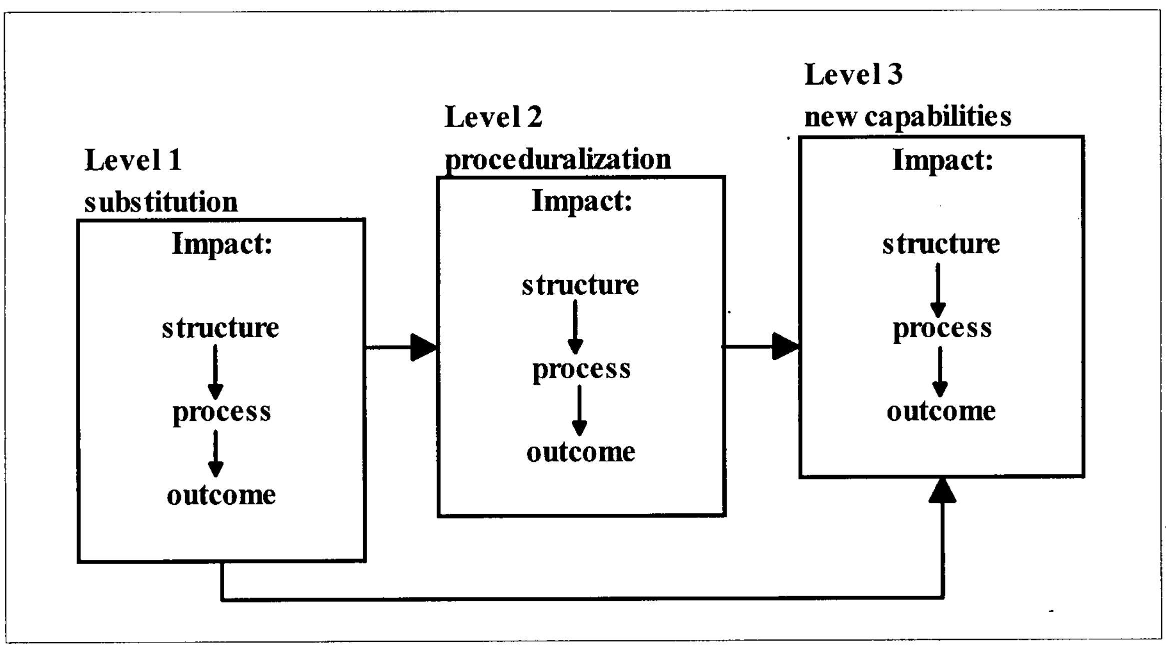

Figure 10.1 - Revised Analytic Framework

10.4 Implications for Future Research

As noted earlier, this study investigates a phenomenon that is of growing interest and importance in community hospitals - understanding why expectations for IT do not occur. This research contributes a tentative understanding of the linkages between structure and process and process and outcome that are expected to change due to IT.

Developing an analytic framework to evaluate the potential impact of IT in health care is a worthwhile endeavor for both practical and theoretical reasons. However, for this framework to be more broadly used, it must be tested under other conditions. Key variables that were held constant among the community hospitals need to be systematically varied and the framework empirically tested to determine its robustness. In particular, studying a set of community hospitals that have chosen a single vendor, but not XTECH, as well as multiple vendors will assist in determining whether the impact identified is an artifact of using XTECH or can be more broadly generalized.

10.5 Implications for Policy and Practice

A number of practical and policy implications arise from the study findings. In the policy area, one suggestion in particular is not a new one, but bears repeating because of its importance. There are few identifiable economic incentives for improving the "process" or "outcome" aspects of patient care. This is at odds with the fact that the majority of hospital employees are in the professional areas of nursing, pharmacy and laboratory and hospitals do not exist without patients. A policy initiative must include incentives for individual hospitals, such as the ability to re-allocate savings from one to another program or capital project (currently savings translate into funding losses). Of course this also extends to other areas such as reimbursement for physicians, which currently does not reward either efficiencies and effectiveness in the process of care or in better patient outcomes. As long as IT is seen as an "add-on" and not as an essential tool for doing business, funding requests will continue to receive low priority and be shuffled back and forth from the "capital" to "operational" funding sides of the Ministry of Health.

Such systems might also have more, and more positive, impact if their benefits for patient care were emphasized; a role that vendors should be asked to play. This may include identifying savings that are possible through drug utilization programs; better communication with community agencies to plan for patient discharge; better statistics and analysis of data with respect to patient care requirements; direct feedback to the physician and the potential to change ordering behavior as a result of direct physician order entry.

Insights gained from the study also have a number of practical implications for application in hospitals. The hospitals' focus on changes in Donabedian's element of structure suggests why impact on outcome has not been demonstrated in many cases. There must be a concerted and active effort to determine the expected connection between structure and process changes as well as process and outcome changes. A useful exercise for organizations is to detail the anticipated changes and how they expect these to occur, including changes in professional practice. For example, when lab test results are available in two hours as opposed to eight, the hospital must identify how use of the information by physicians and nurses will change. They also need to determine in what ways patient outcome will change. Both of these efforts provide a further basis for devising implementation and training efforts.

The study findings also suggest that access to increased electronic information through a computer terminal creates two situations that require attention from health care organizations and professionals. They need to work together to define the "liability" limits for health care professionals as they are faced with the enormous increase in, and access to, information. Limits to the knowledge required were previously defined by professional training and on the job in-service training sessions, which may no longer be adequate. What may be more effective is on-going evaluation and adjustment of the needs for information as well as developing skills in using information in new ways.

The second situation is also related to the increased availability of information from a computer terminal rather than having to retrieve it from a number of sources. This creates a perceived increase in the "distance from reality" (or the source of their data) for professional employees that may have long term implications for job satisfaction. They must consciously develop ways to develop and maintain their connections with patients. This may be done at the expense of some of the computer-related activities that generate additional information that cannot be used effectively.

10.6 Limitations and Contributions of the Research Study

The study made a number of contributions, but also had some limitations that are discussed in the following section.

10.6.1 Limitations of the Research Study

There are a number of limitations of this study that should be considered in future studies. Some are functions of the multiple case-study methodology and some are artifacts of the sites investigated. The issues related to the limitations stemming from the nature of the methodology will be addressed first.

i) Reliability and Replicability

Janesick (1994) notes that "the interpretive practice of making sense of one's findings is both artful and political... There is no single interpretive truth." Therefore, an important question to ask in a qualitative inquiry is whether a different researcher, going through the same methodological process, would necessarily reach similar conclusions. This is not simply a matter of whether or not someone else who read one, or all, of the interview transcripts would interpret the contents in the same way as the researcher. It is quite likely that he or she might very well have read the words differently.

A theoretical replication methodology used in the study is analogous to repeating similar experiments. However, this does not imply that in collecting and analyzing data, contents of the transcripts represent the same evidence as the outcome of an experiment, or some other process of "objective" measurement. The relevant evidence is more complex than its individual parts, i.e. transcripts and documents, but these "hard copies" are all that would be available for another researcher to inspect. An audit trail of data collection and analysis strategies used in the study, such as questions asked and key words used in

FolioVIEWS 3.1®, has been carefully documented, making replication by other researchers technically possible.

Two other factors also influence the unique interpretation: the researcher's own extensive background in health care and specific temporal factors. Individual organizations, as well as the overall health care environment in British Columbia, struggle to move toward a regional health care delivery system and share the stress this is causing. Regionalization involves amalgamating services, some hospitals gain while others lose. Although there has been a concerted effort to present evidence to convince the reader of the strength of the conclusions in this study, the element of interpretation belongs to the researcher in this study alone.

ii) External Validity and Generalizability

This study follows Yin's (1989) recommendation for a research design based on a replication logic, with multiple-case studies. These cases were expected to be very similar except for their differences in degree of PCIS implementation. While these choices were made to help ensure generalizability, it should also be noted that the hospitals may differ in some other respects that lead to these organizational differences. These differences became more well known as the data collection proceeded and may play a role in the generalizability of the study findings. Some of this information is included in the introduction to the hospital and summary of IT implementation documented for each hospital.

iii) Protecting Confidentiality

The most desirable option in choosing the level of anonymity of many case studies is to disclose the identity of both the case and the individual (Yin, 1989). However, in this study many participants wished to remain anonymous and the researcher's access to the hospitals was contingent on agreeing to retain confidentiality of individual participants and hospital sites. The health care community in British Columbia is relatively small and to respect these requests the position titles of participants have also been omitted. While this degree of anonymity does not affect the analysis, it does limit further comparisons with other cases. A contact person in the organization identified individual participants on the basis of their IT experience and the researcher was satisfied that they met the selection criteria. However, other factors unknown to the researcher may have played a part in these selections and introduce a bias that limits replication of the study.

Other limitations are related to artifacts inherent in the study sites and temporal factors. As mentioned previously, the health care industry is under a great deal of pressure to limit costs without reducing the quality of care. Perceptions of the contribution of IT to this process range from "essential" to a "waste of money." The hospitals and participants took part in the study voluntarily and without compensation, and therefore were free to express their opinions either way. Individual participants discussed their successes and failures with IT, however the perceptions of IT contributions (either for or against them) may have been influenced by the overall effect of IT on their departments, which the study did not investigate directly. For example, increasing automation may have resulted in a smaller Laboratory and reduced jobs for laboratory technologists.

In addition, most participants were unable to identify specific linkages among structure, process and outcome. This may have been a reflection of the person being interviewed not being aware of them, rather than the linkages not being present. As well, one of the two hospitals that declined to participate had implemented hand-held input devices and the accompanying XTECH module for Nursing. These demonstrate new sophistication in IT and inclusion of this site may have provided different results for nursing participants.

Furthermore, the interview guide was developed from the literature and based on factors shown to influence individual impact. The themes illustrating differences among groups arise partly from the types of interview questions and therefore introduce a bias in that direction.

Another potential limitation relates to the interpretation of findings. While every effort was made to objectively report findings, the data analysis process and data interpretation were also influenced by the researcher's background and experience. The computer software and keywords used to search the transcripts assisted the researcher in verifying findings in the raw data (i.e. transcripts). However, keywords were not objectively determined before data collection, but rather emerged through participants' responses to the questions and the researcher's interpretation of the data.

10.6.2 Contributions of the Study

This research attempts to lay the groundwork for a program of research to investigate the nature and implications of PCIS impact on health care professionals. It contributes to information systems research in health care by departing from existing work in a number of ways: (i) by adopting a socio-technical perspective; (ii) by including perspectives from four groups who are simultaneously engaged in using a PCIS within a hospital; (iii) by attempting to understand the meaning of experience and process versus quantitatively measuring economic endpoints.

The analytic framework used in this study identified three reasons why impact of IT in health care did not occur as expected. Knowledge of these is useful to both researchers and practitioners. They include:

- linkages between structure and process or process and outcome are often not evident in the manual system. Increasing the speed, volume and efficiency of information production does not automatically change this. In this study, where the linkages were made explicit before applying the IT, the IT had the intended effect.
- hospitals expect changes in the work of lab techs and pharmacists (structure) to change work of nurses and physicians (process). The interdisciplinary nature of health care and sophisticated IT combine to create heightened expectations such as these. They require a continuing effort before, during and after implementation to specifically identify changes in structure, process and outcome that cross professional groups and boundaries.
- roles and responsibilities of health care professionals change with the introduction of IT. IT may not have the impact intended because these changes are not recognized or carefully managed. More attention must be paid to IT's effect on social aspects of the organization including interpersonal relationships, particularly when established roles and responsibilities are susceptible to change.

These provide a basis for further study and application to the field.

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Appendix A - Hospitals in British Columbia Over 120 Beds With Patient Care Information Systems

Location	Name of Facility[1]	# Mgt[2]	Beds[3]
1. Lower Mainland			
White Rock	Peace Arch District Hospital	23	151
Langley	Langley Memorial Hospital	36	183
Richmond	The Richmond Hospital	32	207
Surrey	Surrey Memorial Hospital	30	403
Burnaby	Burnaby Hospital	30	421
N. Vancouver	Lion's Gate	23	373
Vancouver	St. Paul's Hospital	51	571
Vancouver	The Vancouver Hospital/ University Hospital		1090/ 1175
Maple Ridge	Maple Ridge Hospital	20	133
New Westminster (Fraser-Burrard)	St. Mary's Hospital/ Royal Columbian Hospital	26/ 35	178/ 493
2. Interior			
Kamloops	Royal Inland Hospital	30	343
Penticton	Penticton Regional Hospital	26	207
Kelowna	Kelowna General Hospital	36	362
Vernon	Vernon Jubilee Hospital	36	246
3. Upper Fraser			
Abbotsford	Matsqui-Sumas-Abbotsford Gen Hospital	39	230
Chilliwack	Chilliwack General Hospital	25	158
4. Northern B.C.			
Prince George	Prince George Regional Hospital	28	333
5. Vancouver Island			
Victoria	Greater Victoria Hospital Society (Royal Jubilee/Victoria General)		
Nanaimo	Nanaimo Regional General Hospital	30	225

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1 Results of a survey conducted by the B.C. Ministry of Health in 1993 have been used to identify health care facilities which have patient care-related applications.

2 This number includes all management categories, including department heads/program chairpersons, vice-presidents, chief executive officers, board chairpersons. (Canadian Hospital Directory, 1992-93).

3 The number of acute care beds (minimum 120) set up for general service use including medical and surgical, obstetrical, maternity, intensive care, coronary care, paediatric, gynaecological, ophthalmological, and otorhinolaryngology. This excludes bassinets for newborns and extended care beds. (Canadian Hospital Directory, 1992-93, p. 9)

Appendix B - Correspondence With Sites

The forms and letters used to document the research project and consent to participate were used consistently at each site and for each participant. It should be noted that initially the study outlined five stakeholder groups with four participants in each group, but this was later collapsed into four groups with five participants each by moving the managers from a separate group into alignment with their respective groups. This was necessary as their perspectives were more consistent with the professional group than with a "generic" management group.

Examples of the following forms and letters are included:

B.1 Covering Letter to CEO Inviting Participation in the Study

B.2 Organizational Consent Form

B.3 Introductory Letter to Individual Participants

B.4 Individual Consent Form

Project Description: Impact of Patient Data Management Systems on Health Care Professionals

1. Given a list of predefined criteria, you select 4 people from each of 5 groups (Nursing, Pharmacy, Laboratory, Physicians, Managers), and with their consent schedule interview times.

2. Names of the hospitals and individual participants remain confidential and if necessary will be referred to in the report by pseudonyms.

3. Participants receive a letter outlining the project, their voluntary participation, consent for the interview to be taped and confirmation of the scheduled interview time and date.

4. Interviews are conducted at your hospitals and last a maximum of 2 hours each. Each interview is tape recorded and transcribed following the interview. Participants will have the opportunity to review the written transcript and make any changes necessary to clarify their responses.

5. Use of the computer system by people in these 5 groups will be observed on several occasions with previous approval of the senior person in charge of the area.

6. Documents that assist in understanding the computer system within the context of your organization will be reviewed. These include organizational changes related to the computer system such as redefining tasks and roles, communication patterns, organizational structure and human resources policies. Minutes from Computer Steering Committee meetings, policy manuals, organizational charts, user manuals may be appropriate sources of information.

7. Draft and final reports will be circulated to respondents. Each organization will receive their own detailed report as well as summary reports from other participating organizations.

Appendix C - Description of Stakeholder Field Experts

C.1 Nurses

C.1.1 Ms. Carol Robinson, M.Sc.

- Health Care Consultant
- Chair, Canadian Nursing Informatics Special Interest Group - COACH
- extensive experience in nursing informatics, project management, administration

C.1.2 Ms Lynn McKinnon, M.A.

- Health Care Consultant
- Chair, B.C. Nursing Informatics Special Interest Group - RNABC
- extensive experience in nursing informatics, project management, administation

C.2 Pharmacists

C.2.1 Mr. Paul Koke

- Coordinator - Department of Pharmacy, B.C. Children's Hospital

C.2.2 Mr. Bruce Millin

- Acting Director - Pharmacy Department, St. Paul's Hospital

C.3 Laboratory Technologists

C.3.1 Ms. Jan Galenza, ART (Advance Registered Technologist in Immunohematology)

- Head Technologist - Blood Transfusion Service, The Vancouver Hospital and Health Sciences Centre
- extensive experience in management, operation and development of a large hospital Blood Transfusion Service
- extensive teaching experience with Medical Lab students, residents and technical staff
- experience in development and implementation of a custom designed computer system in the lab

C.3.2 Ms. Susanna Darnel, ART (Advance Registered Technologist in Immunohematology)

- Medical Laboratory Technologist, The Vancouver Hospital and Health Sciences Centre
- extensive experience as a bench technologist and manager as charge lab technologist and assistant head technologist.

- experience in development and implementation of a custom designed computer system in the lab

C.3.3 Mr. Cliff Hoban

- Project Manager, Laboratory Information Systems Project, The Vancouver Hospital and Health Sciences Centre

C.4 Physicians

C.4.1 Dr. Mel Petreman

- Family practice in Nanaimo, highly automated office using electronic records and computer terminals in each room as described in the following article:
  O'Reilly, M. Health care begins to merge with the information highway (1994). Canadian Medical Association Journal, 151, (8), 1173-1176.
- President, Wellington Medical Systems, Nanaimo, B.C. (which develops health informatics software and provides health information networking).

C.4.2 Dr. Ken Thornton

- Retired pathologist with life time interest in medical informatics
- Former Chair - SPARK Health Informatics Sector (Science Council of B.C.)
- Faculty - Health Information Science School - University of Victoria
- Consultant - Metro-McNair Laboratories
- Dr. Thornton provided many informal suggestions, but did not comment on the interview questions directly.

Appendix D - Sample Interview Guide

Impact of Patient Care Information Systems on Health Care Professionals in Hospitals

Semi-Structured Interview Questions

I Background Information About the Organization, Respondent and PCIS

A. Organization Name___________________________ Code: _____ (A - Z)

B. Respondent Code: _____ _____ _____ (org/profession/number)

- Name____
- Professional Designation _____________________________
- Dept/Unit ______________________________________

C. PCIS applications (any computer applications related to management of patient data)

==

*****Individual Background**

1. Can we start by having you talk a little bit about your position here at the hospital - your areas of responsibility, and how long you've been here?

*****Information Quality (measures of information system output and quality of output, e.g. importance and usableness of information in reports)**

2. What do you use the computer system for? (What kinds of information?)
3. How would you describe the quality of the information you receive from the system?
4. Can you compare using the computer to previous manual systems?

*****Information Use (recipient consumption of the output of an information system)**

5. Who uses the computer system regularly? (How often? Direct vs chauffered use? When, i.e. end of shift; before rounds?)
6. What is the system commonly used for by (physicians, nurses, lab techs, pharmacists)?
7. Are there other ways to get the same information?
8. Does anyone not use the system? (If yes, who? why not?)

*****System Quality (measures of the information processing system itself)**

9. How would you describe the quality of the system as a whole?
10. How easy is the computer to use?

11. Where are the terminals and printers located? Are they accessible and convenient to use?

12. Does the system make good use of resources?

13. Is the data accurate? (Are there system procedures to ensure accuracy?)

14. Can you retrieve information from the system that was difficult or not possible to retrieve in your previous manual system?

*****User Satisfaction (recipient response to the use of the output of an information system)**

15. Does the information provided by the computer system contribute to decision-making in your job? In what way?

16. How satisfied are you with the computer system?

II Potential Factors Affecting Impact

*****Implementation Generally**

17. Can you tell me about the implementation of your system.

18. What do you think has contributed to (or got in the way of) the success or impact of your computer system?

19. Who supports the computer system in your organization?

20. Can you tell me about how you learned to use the computer?

21. Is there a formal training program? Does training play a role in system success/impact? How?

22. Did people review how jobs are currently done and attempt to redesign workflows while implementing systems?

*****User Participation**

23. How were your interests represented during planning and implementation of the computer system?

*****Types of Impact: Organizational**

24. From your perspective, what benefits were expected for [physicians/nurses/lab techs/pharmacists] from the computer system?

25. Has using the computer system saved money/or incurred additional costs for your unit or department? for the organization? In what ways?

26. Have there been overall productivity gains for individual physicians/nurses/lab techs/pharmacists/managers? for the organization?

27. Has the computer system had an effect on the way your unit, department or organization operates? efficiency? effectiveness? (In what ways? Can you measure these?)

28. Did unexpected/unanticipated changes occur? Examples?

*****Types of Impact: Individual user (the effect of information on the behavior of the recipient; impact on worklife)**

*****decision-making**

29. What effects has the PCIS had on your decision making in general?

30. Specifically, what effect has the change in availability of patient information had? the timeliness of patient information?

*****control**

31. Does the computer system affect your control over your job? In what ways?

32. Does the computer system control your job?

33. Does the computer affect others' control over your job?

*****productivity**

34. What effect has the computer system had on your job performance?

35. How does using the system affect your job visibility to peers? supervisors? patients? other departments?

*****social interaction**

36. How has the frequency and quality of social interaction among co-workers changed?

37. What effect has the computer system had on your communication patterns, i.e. who you talk to, when and about what?

*****job enhancement**

38. What effect has the computer system had on the content of your job (i.e. different tasks, requires different skills)?

*****work environment**

39. How has the computer system affected your job satisfaction?

40. What changes in your unit/dept./organization have been a result of the computer system?

*****patient (client/consumer)**

41. Has the system provided any direct and/or measureable benefits for the patient? Can you think of any examples?

Appendix E - Site Interview Schedule and Participants by Category

Participant Criteria	Hospital 1 Feb 22 - 24	Hospital 2 May 8 - 12	Hospital 3 May 15 - 18	Hospital 4 June 1- 7	Hospital 5 June 26 - 28
Nursing (based on experience with hospital computer system - 24 interviews)					
1. manager	E14, E16, E17, E20[1]	C15	D8	I3	J8
2. liaison position	E10	C12	D5	I6	---[2]
3. most experience	E7	---	D16	I17	J3
4. mod. experience	E8	C13	---	I8	J4
5. least experience	E18**	C9	D3	I7	J2
Pharmacy (based on experience with hospital/pharmacy computer system - 17 interviews)					
1. manager					J11
2. liaison position	E11	C8	D7	I9	---
3. most experience	E13	C4	D4	I10	J5
4. mod. experience	E6	---	---	I14	J13
5. least experience	E5	C10	D1	I13	---
Laboratory (based on experience with hospital/laboratory computer system - 20 interviews)					
1. manager			D13	[I2]	J7
2. liaison position	E19	C11	D9	I2	---
3. most experience	E3	C16	D12	I1	J9
4. mod. experience	E12	---	D11	I16	J12
5. least experience	E9	C14	D10	I4	J14
Medical Staff (based on experience with hospital computer system - 14 interviews)					
1. Chief of Service	[E4]	[C1]		[I15]	J6
2. liaison position	E1	C6	D14	I15	---
3. most experience	E2	---	D15	I11	---
4. mod experience	---	C3	D6	---	J10
5. least experience	E4[3]	C1	---	I5	---
Info Services (5)	E15	C2	D2	I12	J1
Miscellaneous (5)		C5[4], C7, C17	D17, D18		
Total (86)	**19**	**17**	**18**	**17**	**14**

1 the combination of letters and numbers are specific transcript identifiers
2 no liaison positions at this hospital due to program management
3,4 tape did not record properly during the interview

Appendix F - Documentation Reviewed

Type of Documentation	Hospital 1	Hospital 2	Hospital 3	Hospital 4	Hospital 5
A. Proposals (include vendor description)	*Nursing Information System Proposal (1995)	*Evaluation Team		*Hospital R's Proposal (1994)	
B. Strategic IS Plan/Review -Consultants' Reports	*Feasibility Study - Computer Funding Proposal (1985) *Sierra Systems Consultant's Report (1993)	*Feasibility Study for CPI (1988) *Stevenson, Kellogg, Ernst & Whinney Consultant's Report (1988) *Day One Forward: Re-engineering of Health Record Systems (1992)	*Strategic Plan - Hospital Information System (1990) *Sierra Systems Consultant's Report: Strategic Information Systems Plan (1992)[1]	*Peat Marwick Stevenson & Kellogg Consultant's Report: Strategic Plan for IS at Hospital 4 (1992) *HIS Strategic Plan Review (1995)	*Strategic Information Systems Plan (1993) Cost/Benefits of Admitting/Health Records Systems;[2] Psychiatric System;[3] Medical Transcription System;[4] OR System[5]
C. Task Force/ Steering Committees	*Computer Users Group (1984-) *Computer Advisory Committee (1984-)	*Cost Benefit Analysis - HIS (1989) *Business Case Questionnaire to each department (1989) *HIS Steering Committee(1989-) *Project Development	*Computer Advisory Committee (1986-1990) *IS Steering Committee (1990-1991) *HPMS/Computer User Group (1992)[6] *Information Services Group	*Lab IS Task Force (1994) *HIS Steering Committee (1995) *Nursing Admin. Practice Committee (1993-95)	*Hospital IS Committee (1992-1993) *HIS Advisory Committee (1992-1993) *Ad Hoc Committee -Administrative Systems Team (1992-1993) *Meetings With

Type of Documentation	Hospital 1	Hospital 2	Hospital 3	Hospital 4	Hospital 5
		Committee (1991) *HIS Advisory Committee(1990-)	(1993) *Implementation Task Force (1993-1994) *Information Systems Advisory Group (1995-)		Physicians; Cyber Chronicles (1993-1994) *Physicians' Computer Committee (1995-)
D. Internal Correspondence (newsletters)	*Hospital Staff Newsletter[7] *internal requests to HIS	*Hospital Staff Newsletter[8] *Weekly Staff Newsletter[9] *Medical Advisory Committee Newsletter[10] *Hospital Community Report[11]	*Hospital Staff Newsletter[12] *memo's to physicians (implications of computer changes	*Hospital Staff Newsletter[13]	*Transdisciplinary Research: Evolving a New Paradigm of Collaborative Research (1991) *Transdisciplinarity: The Wave of the Future (1991) *HIS Quality Assurance Report (1992)[14] *Security and Confidentiality Policies and Procedures (1992) *Admissions/Registration System Analysis (1992) *Positioning for our Future: Change to Patient-Focused Care (1993)

Type of Documentation	Hospital 1	Hospital 2	Hospital 3	Hospital 4	Hospital 5
					*Towards a Healthier Community: Literature Sources and Resources Guide (1994) *Results of Office Link Pilot (1994) *Job Descriptions (1995)[15]
E. External Correspondence (Ministry of Health)	*Ministry of Health Policy - IS Funding (1989)[16] *Proposal to MOH *strategic plan to MOH	*MOH Policy - IS Funding (1989) *Proposal to MOH for integrated Patient Care and MIS (1991)			
F. Ongoing Projects					*Total Hip Arthroplasty *Orthopedic Database

Endnotes

1 In 1992, the consulting firm (Patient Care Systems, pg. 9-25) noted that:

- the Nursing Department is the largest in the hospital and consequently has high associated costs. This meant the potential for savings through automation was high, but to-date had not received any automation. Nursing believes significant benefits could be obtained. In addition, to their limited, or non-involvement in other systems in the past (e.g., Pharmacy), they feel they have, in some instances, been negatively affected, and are potentially not achieving the full benefits from such systems.
- Many potential benefits exist in automating reports (most information kept in manual logs) and interdepartmental manuals, workload measurement and scheduling, order communication and patient documentation.
- Operations highly paper-intensive and although information is available, large amount of effort expended on a regular basis to obtain data and change it into meaningful information.
- For physicians, they predicted benefits from remote access to patient information (including lab results, health records, and the OR slate); entering more details for booking directly from their offices electronically, and communication systems like e-mail.
- In the Laboratory, they process 100 inpatient, 100 outpatient and 150 referral patients from regional hospitals, diagnostic and treatment centers, clinics and collection facility. They participated in a study reviewing turnaround time of lab tests. For inpatients the average time for routine tests was 220 minutes (elapsed time from time order placed to time result returned to the ward). This was below average compared to other hospitals. (The fastest time was 98 minutes in a hospital with an integrated order entry and lab system). Urgent tests can be turned around in 15 minutes. For referrals test requests received in evening, tests performed next day and referring facility receives test results that night.

2 Benefits expected included:

- reduced redundant tasks and demographic information entered only once,
- increased information accuracy (system does the checking),
- system automatically captures statistics,
- standardization,
- integrated systems result in departments working together more closely,
- information available from any terminal within the hospital,
- access to information can be restricted to authorized users.

[3] Benefits expected included to:

- keep patients out of hospital,
- create longitudinal record,
- empower patients.

[4] Benefits expected included:

- ease of data entry, such as use of "canned text"
- physician access to reports

[5] Benefits expected included:

- availability of management data,
- automatically conduct conflict checking,
- surgeon's book surgeries directly,
- reduced forms.

[6] May 1990 - Computer User Group identified that a project manager or implementation coordinator was essential for most implementations (small projects could be managed by existing staff). The position would be a new position to initiate implementation project and remain on staff to maintain the system, implement new versions, train staff, communicate with other departments with respect to impact of computer systems on each other. This person should be qualified person of that department (like a pharmacist).

[7] References to the computer system and implementation were found in the following issues:

- November 1990 - e-mail (inaugural issue of the newsletter)
- December 1990 - lab information system
- January 1991 - Nurse Scheduling
- August 1991 - Radiology
- November 1991 - Electronic Data Interchange
- April 1992 - Nurse Scheduling
- July 1992 - Order Entry conversion
- September 1992 - Order Entry - new module
- September 1992 - HIS Department
- October 1992 - Pharmacy

- February 1993 - Health Records
- October 1993 - Pharmacy
- January 1994 - hospital forms
- January 1994 - Continuing Care IS
- March 1994 - Employee Computer Purchase Program
- September 1994 - Payroll
- February 1995 - new Office Automation

[8] From December 1984 - Spring 1995, the Communications Department published 32 issues, 6 were related to HIS.

- Winter 1985 - planning to move from IS in Business Office to automate all departments; formed HIS department with staff of six.
- Winter 1986 - new VAX 8500
- April 1987 - computers introduced to Hospital 2 - 3 business office applications and ADT
- March 1988 - new ADT/Dietary interface
- April 1992 - Pharmacy Department goes "live"
- June 1992 - first phase of XTECH integrated HIS began in fall 1991
- May 1993 - Lab goes "live"

[9] Weekly newsletter for and about employees - 53 issues published from August 1993-May 1995, 12 issues contained articles with respect to HIS.

- August 1993 - access to lab results via XTECH terminals on some nursing units
- November 1993 - system improvements; library on-line; all directors create databases of active projects
- January 1994 - upcoming new version of software. Expected benefits include simplified and expanded electronic mail, less paperwork with OPD billing, increased security of patient information, graphing of lab results, scheduling patient appointments. "Over time these new systems will decrease our costs while increasing our ability to provide quality, timely patient care."
- February 1994 - computer viruses, procedure to follow
- March 1994 - upcoming changes to XTECH and newest version of software
- June 1994 - information about system use including 1073 users, patient lists being used by physicians, Office Automation, patient inquiry module
- July 1994 - installing Office Automation (electronic messaging, simple word processing, spreadsheets, database functions)

- August 1994 - use of "spooling" to queue print jobs
- September 1994 - payroll implementation
- December 1994 - computerized medication distribution system and MAR's
- March 1995 - Order/Entry system "live"
- May 1995 - use of XTECH passwords

[10] First of a series of newsletters to medical staff; building strategic IS is evolutionary process requiring commitment and time

[11] From April 1990-January 1995, 13 issues were published and only 1 issue was related to HIS.

- July 1993 - new optical disk imaging used in Health Records.

[12] References to the computer system and implementation were found in the following issues:

- May 1991 - CD-ROM pilot test in the Health Sciences library
- December 1991 - Strategic Planning Education
- February 1993 - MedLine on CD-ROM
- June 1993 - Patient Information Management (Health Records)
- September/October 1993 - Computer Talk (first column in regular series in IS at the hospital)
- November/December 1993 - systems integration; strategic IS plan
- January/February 1994 - Computer Talk - disaster recovery
- May/June 1994 - MIS Guidelines
- September/October 1994 - Moving to new Hospital Information System
- November/December 1994 - regional computer systems
- January/February 1995 - distributed network explained
- March/April 1995 - regionalization initiative

[13] The newsletter was initiated in 1992, but only 14 copies from 1993-1995 were available. One article was related to HIS.

- May/June 1994 - computer streamlining lab tests, installation of lab IS.

[14] Questionnaire used to evaluate the effects that implementation of computerization (or changes in software) had on the Admissions, Health Records, Payroll and Personnel staff.

[15] New job descriptions included:

- Administrative Associate,
- Resident Care Associate,
- Patient Care Associate.

16 Highlights from this policy include the following:

- strategic plan and each phase should involve cost-benefit analysis
- expenditures for IS treated as an investment in collection, analysis or dissemination of better information or collection of information in a more efficient way
- recommend that all hospitals move to MIS compatibility
- in considering requests for the approval of computer applications the following priorities apply:
    1. financial management - greatest direct return on investment such as replacement of manual data collection and analysis;
    2. improve financial operation and management reporting of the hospital;
    3. clinical and patient support systems which improve productivity of personnel, quality of patient care and decisions related to allocation of resources;
    4. integration of management reporting with clinical IS is desirable and depending on hospital's strategic systems plan, the order of priority list may be modified.
- Priority of systems is therefore:
    - general ledger, accounts payable, accounts receivable, materiels management, financial and statistical reporting
    - laboratory, radiology, pharmacy, abstracting, ADT, dietary, fixed assets.

Appendix G - Description of Information Systems Implementation at Each Site

All five sites have selected a single vendor (called XTECH) which supports an integrated system strategy. This system has a proprietary operating system and limits choices with respect to network typology and peripherals. There is a recognition of the need to move to an open systems architecture in order to broaden the range of software available to users. While the vendor is addressing this concern, some facilities have been making hardware and software selections with this move in mind.

===

Implementation at Hospital 1

The Director of Hospital Information Services and Biomedical Engineering has an information services staff of approximately twelve FTE's which includes analysts, operations staff and part-time secretarial help. The original implementation plan for installing an integrated HIS had three phases expected to span three years. Financiallimitations made it impossible to realize those original objectives on time. Theplan was modified slightly along the way to exploit certain financial and clinical opportunities. Some modules, implemented but not in the origianl plan, were not available in 1985.

1985

- Financial systems (GL, AP, AR); Admitting/Discharge/Transfer; Medical Record Index; Admission information to ancillaries; Outpatient registration

1986

- Doctors' In/Out/E-mail

1987

- NPR Report Writer; Payroll/Personnel

1988

- Clinical Laboratory; Pharmacy

1989

- Blood Bank (partial); Order Entry/Communication; HMRI Abstracting; Global Data Search

1990

- Office Automation

1991

- Nurse Scheduling

1992

- Appointment Scheduling; Executive Support

1993

- Medical Dictation; Departmental Option
- Consultants hired to develop strategic direction for IS, recommended continued support of the IS infrastructure within hospital; support a community focus for automation, supporting regionalization; support an ambulatory focus for information systems; support for the concept of the continuous health chart. - continue with prime vendor strategy

Future/Planned

- Microbiology & Anatomical Pathology (originally planned for inclusion with other lab modules in 1986; some functions being accommodated by lab module but does not provide functionality that these departments require)
- Nurse Workload/Acuity & Patient Care Inquiry - not originally available, promised greatly enhanced productivity, efficiencies and better quality pt care
- MIS Guidelines to department level

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Implementation at Hospital 2

The Health Information Services Department has a full time Director and several technical support staff. A new director was hired in 1990, in preparation for implementation of the XTECH system.

1977

- financial system

1983

- internal study identified priorities consistent with Ministry of Health Guidelines; replace the financial systems; install an ADT system; implement ancillary department systems.
- recommended creation of a data processing department
- planning document recommended that the hospital proceed with systems in conjunction with HCS (BC Hospitals Shared Systems Society) and BC Hospital Association as they became available. This group had a few major installations in BC.

1984

- pilot site for HCS financial and materials management systems; ADT, CPI added.

1985

- limit of computer system capability reached

1986

system upgraded to include Health Records Abstracting, Doctors' Registry, OR Booking and a Dietary System. Benefits of integration through out the organization were questioned by some users because it slowed down the progress in individual departments.

1987

- five year document developed which included the sequencing of activities and costs.

1988

- consulting firm prepared a hospital information systems strategy for the hospital including input from potential users:
    - doctors - aware of potential automation of medical charts; more interested in decreased turnaround time of orders/results; decreased errors in patient information (eg. getting lost or patient transferred); highlighting abnormals.
    - nursing - frustrated because had not received any direct benefits from computerization; priorities were terminals on the units, ADT, e-mail; no assessment of costs or benefits had been done.
    - laboratory - had limited computerization; research done by lab into lab systems concluded they were too expensive and involved a number of trade-offs between different areas in the lab; might be OK for high volume areas such as chemistry and hematology but other areas best addressed by using specialized and individual clinical systems; interaction with other areas of the hospital (eg. nursing) not explored.
    - pharmacy - considering computerization for a number of years; computerization project initiated with representatives from pharmacy, nursing and HIS; RFI & RFP issued; comprehensive from pharmacy view but less from perspective of integration with other hospital systems (felt it was more a departmental, rather than hospital, solution)

1989/90

- developed a strategic plan, site visits, XTECH selection
- mandate of HIS to implement strategic plan through a five year implementation process; main goal was electronic patient record; new IS director
- HIS to provide technical support (hardware, software), network implementation, strategic planning; little training done internally, most either done through the vendor that implements the system or external sources
- recommended that application coordinators be designated in each area
- began new health records program for scanning health records and storing via laser optical disk

1992/93

- Phase II of implementation included Admitting, OR Booking, Health Records and Doctors' Registry

1995

- order entry 6 weeks ago; all diagnostic information, radiology, pharmacy, laboratory results, anatomic pathology; small number of physicians accessing from home or office
- projected on-line end of the summer: health records transcription (doctors' summaries, discharge summaries); small diagnostic areas (ECG, cardiology area, nuclear medicine,

respiratory); missing therapy services, social work, outpatient areas (diabetes clinic, dietetic clinics, oncology)

- projected end of June: doctor's notes
- projected end of 1995: 85-90% of electronic health record complete; missing nurses' notes
- even though the vendor's system runs on their network, they have a true client-server based information system. Any time the vendor is ready, they can "turn the switch" which will allow the user to extract information from the vendor's system and put it onto user friendly tools in the client server (an open systems environment).

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Implementation at Hospital 3

Hospital 3 began implementing IT more than ten years ago. They ran into some problems with one of their first systems and converted to the XTECH system in 1994. The Hospital Information Services Department has a full time director who was hired in 1992. He has a staff of four, including two technical support analysts, one operator and a manager for special projects.

1982

- Lab system (LABMAN) running on a DEC-VAX

1985

- Information Services Department created; two people with experience managing the lab system hired as director and analyst; two additional staff hired
- added IBM System 36 (IBAX - IBM/Baxter joint venture); Admitting; ADT; Dietary; Health Records, Pharmacy, Finance (GL, AP, AR partial)
- Accession, Chemistry, Hematology on the Lab system, which operated as a stand-alone with no interface with ADT; patient demographics re-entered by the Lab
- Material Management System OR-MED on PC
- bought, but did not install: nursing orders, radiology and others

1987-1991

- IS Department philosophy: to provide comprehensive services hospital wide; IS staff responsible for everything - purchasing, training, manuals, troubleshooting; limited success because only 3-4 people couldn't "do it all"
- moved to AS400 (lab and system 36)

1992

- new director plus 2 additional staff hired (2 technical support analysts, 1 operator, 1 manager special projects); new philosophy of user department responsiblity for projects
- problems with unreliable equipment, costly to maintain, not integrated, lots of customization
- consultant recommended changes in staffing (to support end-users), committee restructuring and prime vendor approach

- Office Automation: word processing, spreadsheets, graphics, e-mail, calendaring

1994
- replaced systems in laboratory, ADT, pharmacy, medical records and abstracting with XTECH integrated system
- installed new systems in materials management, payroll/personnel, Accounts Payable, BAR (billing, accounts payable)
- consolidated e-mail from three systems onto one system on XTECH

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Implementation at Hospital 4

The Department of Information Services has a part-time Manager who is shared 50% of the time with another facility of similar size, business analyst, half-time electrician (responsible for repairs of the hardware). They will add one business analyst and increase the manager's position to full time within four months. The philosophy of the department is that users take control of project and they do it, while the IS manager acts as project manager (ie. making sure dates and the things happen). It is up to each department to assign a department leader who will coordinate the development of the systems including building dictionaries, procedures and processes, and the training around that.

199?
- financial system; admissions

1992
- consultant's report recommends integrated approach

1994
- lab system; implemented somewhat independently, without real involvement or ownership of the hospital. Lab decided orders should be entered by nursing through the order entry system and took on the training of nursing staff. Two key members of the project team were injured shortly after live date and were just returning after 6 months off.

1995 - future/planned
- next phase is projected 4 year plan that re-affirms the clinical approach to include: pharmacy, radiology, patient scheduling (any patient occurrence such as OR booking, ambulatory care, lab visits, physiotherapy, physician scheduling from their offices)
- electronic patient chart systems to include: patient care inquiry, order entry systems, cost accounting, executive support, physician access

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Implementation at Hospital 5

The Health Information Systems Department has a Director and three analysts responsible for financial and administrative systems; clinical systems; systems and technical support. The philosophy of the department is to technically support end-users endeavors in the planning and implementation phases, but those users are responsible for training and needs assessment. The Director is also responsible to develop an overall IS plan for the organization.

1984
- Clinical Pharmacist system installed in pharmacy

1990
- single vendor chosen for an integrated hospital system
- five systems that offered the greatest financial payback implemented first: Human Resources/Payroll, Accounts Payable, General Ledger, Health Records and Admissions (Master Patient Index)
- terminals were installed though out the hospital when the admissions systems was implemented and hospital wide e-mail added; all employees included but little structure provided with respect to how it could be used
- OR module (scheduling) and terminals in the OR provided access from the OR to consultation, ultrasound, OR and x-ray reports

1993
- move to a radically different view of patient care from a traditional, departmental focus to a program based patient focus
- program management organizes care around a groupings of common patient needs, focuses attention on patient outcomes rather than departments and creates distinct units for planning, budgeting and service delivery
- created a continuum view of the client's health data base
- philosophy to implement systems in a manner that decentralizes input and control rather than centralizes. Systems remain somewhat centralized in nature but use of them cuts across functional boundaries, eg. admitting process traditionally housed in the Admitting Department; department and function eliminated in the hospital and replaced with care stations and program teams responsible for information requirements of their program

1993
- OR Preference Card Module-facilitates picking of supplies for cases and manages inventory levels through a link to the materials management system

1994
- Surgeon Office Booking, electronic link to physicians' offices provides access to all patient information stored in electronic format
- additions to Payroll/Personnel (time and attendance tracking, direct deposit) and Materials Management (electronic purchase requisitioning, inventory requisitions)

- Physician Registry allows physicians to sign in to the hospital, collect messages, do patient/inquiry reports
- Clinical System implementation originally scheduled for Feb 94 - June 95 to include order entry, laboratory, pharmacy, radiology, nursing care planning

1995

- decreased emphasis on placing orders electronically in favor of increased emphasis on clinical tools used to assess whether patients should be there in the first place
- standard scales used to identify the client's requirements (including whether Acute Care is appropriate) and automated tools used to help diagnose and develop care plans
- self assessment programs developed in psychiatry and underway in orthopedics
- pharmacy - receives orders by fax from the Nursing Units, orders entered into their computer (patient information re-entered, no connection to ADT system), orders checked for allergies and drug interactions, labels printed for Medication Administration Records and sent up to Nursing Unit with medications; use word processing and e-mail
- nursing - completes discharges and transfers (admissions done by unit secretary), some areas have access to e-mail
- laboratory - many automated instruments have report generators, no integrated lab system but components implemented with computerized print-outs in microbiology, chemistry, hematology; access to e-mail
- physicians - access to histories, consults; access to e-mail
- access in library to health information on-line, MedLine and various other data bases on CD-ROM available throughout the hospital
- modem linkages in pilot programs in mental health and continuing care share information on hospital data bases, hospital has access to some of their information

Appendix H - Glossary

Acronyms seem to abound in every discipline so this glossary is intended to facilitate reading across disciplines. In some cases there are nearly as many definitions for a term as there are acronyms, eg. electronic health record. While the definitions given here reflect how the terms are used generally within the field of health informatics. If there are any discrepancies, the definition most appropriate for use within this body of work is noted.

Automated Hospital Data Management Systems (AHDMS)
Systems comprising an identifiable class of computerized interdepartmental hospital information systems which have evolved between the class of narrower scope, department specific systems (e.g. laboratory, business office, medical records, etc.) and the broadest scope, hospital-wide Automated Hospital Information Systems (Young, et al., 1984).

Automated Patient Data Management Systems (APDMS)
Automated systems for the management of patient data which include both information systems and physiological monitoring or clinical data systems. In the past this term has also been synonymous with PCIS, but most recently its use in the literature has reflected this broader definition.

Computer-Based Information Systems (CBIS)
CBIS is used as a generic term, and in a health care setting indicates a range of patient-care related applications. It is also used to distinguish automated systems from manual, or paper, information systems. Many other terms related to CBIS are found in the literature including Medical or Management Information Systems (both MIS), Hospital or Health Information Systems (both HIS) and Clinical Information Systems (CIS). However, the terms are not used consistently and may include information used for clinical and/or management decision-making. To reduce the number of acronyms used in this paper, all references to information systems (IS) are assumed to be automated.

COACH
Canadian Organization for the Advancement of Computers in Healthcare

Computer-Based Patient Record (CPR) - also known as Electronic Health Record (EHR)
In their study of the development and diffusion of the CPR, the Institute of Medicine (1991) suggested that no current system was capable of supporting the complete CPR. However, they identified several traits that clinical information systems most closely approximating the CPR have in common (IOM, 1991, p. 4):

- they maintain a large data dictionary to define the contents of their internal CPR's;
- all patient data is tagged with the time and date of transaction, therefore making the CPR a continuous chronological history of the patient's medical care;
- the systems retrieve and report data in the CPR in a flexible manner; and
- the systems offer a research tool for using CPR data.

Most current clinical information systems use a centralized design that rely on data transmitted to the CPR system through interfaces with departmental systems. These systems are changing to include distributed database designs and local area networks (IOM, 1991).

Decision Support Systems (DSS)
Systems that assist in the decision-making process. For clinicians this includes decision analysis, reminders, risk assessment and graphical data displays. Automated patient records can support decision making and quality assurance activities through providing clinical reminders to assist in patient care (IOM, 1991).

Electronic Mail (e-mail)
Electronic form of communication where messages and information is sent and received via information technology.

Hospital Information System, Health Information System (HIS)
A broader definition of a selection of systems in a health care organization which may include patient related information as well as financial and support systems.

Information Systems (IS)
Within an organization, includes hardware, software, the information generated and people using the system

Information Technology (IT)
Includes the hardware and software of a computer system

Management Information System (MIS) Guidelines (Hospital 1 Consultants' report, p. 16; Hospital 3 Consultants' report, p. 40-1):
In 1981, the Federal/Provincial Advisory Committee on Institutional and Medical Services approved and funded the Management Information Systems Project to develop guidelines:

- to improve the timeliness and comparability of information/data collected within Canadian health care facilities for management, planning, evaluation, reimbursement and research purposes.
- to better measure input (resources) an output (activities) by integrating financial, statistical and clinical operational data bases.

The MIS Guidelines represent the outcome of this major research and development effort. The guidelines are designed to meet the above mentioned objectives and to provide the structure and flexibility necessary to ensure improved comparability of data while being useful to all Canadian health care facilities regardless of type, size, or complexity.

MIS Guidelines are a set of standards which specify
1) what and how data is to collected;
2) how data is to be aggregated and used; and
3) who should use the data.

These standards include the following:

- Standard Definitions or a Glossary of Terms
- Accounting Guidelines
- Chart of Accounts
- Chart of Statistics

Patient Care Information Systems (PCIS)

A generic term to indicate a selection of information systems which together provide comprehensive information on patients and their care. The use in this project is not to be confused with an earlier proprietary name of one of IBM's products.

Appendix I - Literature Summary Based on DeLone & McLean's (1992) Success Variables
(*Note: some studies and articles report on variables contributing to an "unsuccessful" system)

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
Drazen (1980) -methods for evaluating costs						-cost benefit
Coffey (1980) -Technicon MIS					-↑productivity	-↓ LOS
Kennedy (1980) -implementation	-response time -data retention		-user involvement -type & use of output identified			
Hughes (1980) -successful implemen-tation implies use			-user involvement			
Rogers, et al. (1982) -computerized medical record summary -controlled, randomized study of 479 patients						-patient outcome
Drazen (1984) -summarizes several studies re: cost impacts		-information flow -timeliness -reliability -accuracy			-staff productivity	-personnel costs -cost implica-tions of benefits unknown (eg. ↑ accuracy)
Bradley & Campbell						-economic

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
(1984) -methods for translat-ing service benefits into unit measures						savings -improvements in hospital op-erations unrela-ted to cost
Counte, et al. (1984) -case study of clerical users				-attitude	-job satisfaction -role tensions -work activities	
Blum (1984) -historical overview	-↑ timeliness of reporting -↓ errors			-user satisfaction	-enhance communication	
Jelovsek, Deason & Richard (1984) -IS in medical office	-data quality				-↑ productivity -modify behavior of physicians & clerical	-↓ missed charges -↑ cash flow
Kerlin (1984) -COSTAR V - patient chart				-user satisfaction		
Ward (1984) -implementation			-training			
Krampf & Robinson (1984) -nursing use of computers			-use	-attitude		
Cook (1985) -Patient Care Information System						-integration into existing communication

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
						network
Peterson (1985) -descriptive -hosp changed use of computers to make more effective						-patient outcome
Zielstorff (1985)						-cost-benefit analysis
Hebert (1986) -implementation -questionnaire			-training	-attitudes		
Siegel, et al. (1987) -impact of drug prescription monitoring on prescribing behavior		-feedback to user		-attitudes	-↑knowledge -behavior change (prescribing practice)	
Anderson, et al. (1987) -physician use -survey	-threats to privacy			-attitude	-legal & ethical problems -threat to trad'l role & autonomy	-↑govt & hosp control -medical manpower -cost/quality of care
Desborough (1987) -effect of computers on nurses -interviews and survey	-ergonomics		-training		-delivery of nursing care -↑ workload due to ↑ patient information generated	
Brady (1987)	-access	-timeliness			-better patient	-↓/avoid

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
					care	operating costs -↑productivity -↓LOS
Anderson & Jay (1987) -network analysis			-physician communication networks (referrals, consults)-> influence use			
Mandell (1987) -cognitive style			-resistance			
Young (1987) -doctors underuse of computers			-compliance	-attitude	-unlikely status↑ -relative status may ↓ -↑perceived workload -support doctor's role, not replace it	
Zoltan-Ford & Chapanis (1987) -4 professional groups			-experience	-attitude	-computers depersonalize	
Fox (1987)			-user involvement			
Fischer, et al. (1987) -PROMIS system			-training		-accountability -perceived impact differed	

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
					for physicians, nurses, pharmacists and lab techs	
Kennedy (1987) -implementation of HIS at St. Clare's Mercy Hospital						-cost avoidance --labor savings --↑productivity --↑revenues
Huesing (1987) -implementation of HIS at Sunnybrook Hospital	-flexibility (to accomodate change from trad'l to clinical units)		-training			-ID & manage cost of treating ind. patients -↑speed of processing admissions - ↑ patient attitude
Hebert (1987) -implementation of HIS on nursing units at Red Deer Hospital			-training	-attitudes		
Davies (1987) -implementation of HIS at Grey Bruce Regional Health Centre		-timely -accurate -improved turnaround time on orders			-↓order processing time to free up staff time for more "hands on" care	-↓LOS -ability to collect more data to meet MoH requirements
Huesing (1988) -HIS implementation at Regina General	-service-ability -ease of use	-quality -timeliness	-training			-ROI --direct dollar savings --avoid future

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
						expenditures -↑quality of patient care
Ischar & Aydin (1988) -computerized medication order entry -survey	-↑ accuracy	- ↑ timeliness of order entry		-attitudes		
Grams (1988) -direct use by health care professionals					-limited success in helping with clinical decision-making	
Willems (1988) -implementation strategy	-flexibility			-user acceptance		
Kjerulff & Counte (1988)				-attitude	-job satisfaction	
Staggers (1988) -evaluated 5 empirical studies of nursing computer use		-current information -accuracy, completeness			-↑efficiency -↓time looking for document -↑speed of communication -↓phoning time -↓duplication	
Summers, et al. (1989) -nursing use of computers to document nursing care	-system slow -downtime disruptive -poor quality	-poor quality printed output	-user involvement		-interdepart-mental "bugs" -non-nursing data to be	

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
	monitors -access				entered	
Barnett (1989) -implementation of medical records system in ambulatory care -175 sites			-training			-limited formal evaluation or objective evidence on either costs or benefits
McDonald, Tierney & Blevins (1989) -benefits of automated medical record system for ambulatory care		-improved data display -prospective QA -retrieval				-information re: severity of illness & resource use -↑ management of outpatient practices
Moidu & Wigertz (1989)	-easy to update -accessibility	-accuracy -timeliness -availability			-multiple users and uses for information	
Lundsgaarde (1989) -attitude re: implementation plan for HELP system	-accessible -maintain confidentiality of records -must ensure continuous operation -easy to use		-training -user involvement			
IBM study (1990) -use of workstations	-access	-timeliness			communication -↓time/easier to review	

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
					patient information -↓errors	
Blaschke (1990) -Clinical/Hospital Information System						-↓ adverse reactions to drugs -↓suboptimal/ inappropriate use of drugs
Michael, et al. (1990) -computerized clinical history	-rapid access				-↓time spent locating clinical history -↑time for patient care -↑access to guidelines for care -↓time to chart location & perusal	-guidelines for treatment -preventing allergic reactions -improving infectious disease control -improved patient care -cost benefits
Protti (1990) -impact of computer-based decision support on clinical decision-making (survey)						
Hendrickson & Kovner (1990) -nursing system					- ↓ nursing resource use --time savings --↑productivity	

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
Kraemer & Danziger (1990)					-worklife --control, decision-making, productivity	
Bailey (1990) -instrument development	-flexibility	-timeliness -accuracy -completeness	-training -ease of use	-attitudes	-effects on job -saves time	-HIS staff -organizational factors
Graham (1990) -HIS implementation at Hamilton Civic	-accessibility	-usefulness			-↑productivity	
Peterson (1990) -physician use	-direct access to information	-↑accuracy -↓errors			-protection through documentation of patient care activities	
Nauert (1991) -bedside documentation	-accessibility of patient information	-quality of documentation -improved legibility			-time savings	-↑reimbursement of fees - ↓ charting overtime
Malec (1991) -cost justifying systems						-return on investment
Robinson (1991) -evaluation of bedside system				-satisfaction	-↑productivity -improved documentation	-patient acceptance & satisfaction with care
Patterson (1992) -automating patient care plans	-access	-timeliness				-assume manual system makes a difference so

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
						automating will result in benefit to patient of ↑timeliness and accessibility
Woodend & Cluett (1992) -HIS implementation at Markham Stouffville	-ease of use	-data quality	-training			
Tierney, et al. (1993) Hagland (1993) -RCT of physician order entry					-↑physician time than paper charts	-↓health resource use --↓patient/bed charges --↓hosp costs (include LOS)
Bergman (1993) -physician use	-ease of use -confidentiality and security	-timely patient information			communication	
Lumsdon (1993) -physician use of IS in clinical practice	-easy to use	-quality of documentation	-involvement		-↑quality of care, time with patients -time saving -efficiency	-improved utilization -↑efficiency ↓costs
Hard (1993) -medical staff use of IS	-access		-use	-cooperation		
Abbott (1993) -student nurses' perceptions				-attitude	-workload -image/ professionalis	-patient care

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
-interviews					m	
Dakin (1993)	-accuracy	-↓turnaround time				-cost and time savings through better data and ↓staff time -↓LOS
Massaro (1993) -physician order entry	-user friendliness		-training	-strict literal interpretation of rules by computer (restrictive)	-changes in responsibilities, patterns and priorities of work -too much time on computer	-personnel reductions not realized
Aydin (1994) -survey methods to assess social impacts			-level of system use -adaptation	-user satisfaction -attitudes	-social impacts --decision-making,control, productivity etc.	-efficiency -cost effectiveness
Kattan, Adams (1994) -scale to measure perceived usefulness of IT					-perceived usefulness --↑productivity --effectiveness --↑job performance	
Bolley (1994) -physician use	-access to medical information				-clinical effectiveness --practice patterns	-operational efficiencies

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
					--clinical outcomes --resource use	
Chapman, et al. (1994) -implement a LAN for nursing -surveys	-access to information	-↑accuracy -timeliness -efficiency of data	-training -use	-improved computer literacy	-work related benefits --time saved --improved communication	
Sheps, Rumanek & Noronha (1994) -computers in medical office (predictive)					-time mgt -improved communication -↑efficiency /quality -time/effort investment to learn new method of working	-faster service for patients -maximize receivables
Burns (1994) -potential consequences of computerized patient records/DSS for clinical family practice	-↑accessibility to medical information	-↓errors -useful alerts & reminders			-no affect on doctor/patient relationship -professional role affected -↓need for specialist consultation	-↑patient responsibility for accessing on-line medical information services
Nauright & Simpson (1994) -3yr descriptive	-accessibility	-information more complete -timeliness			-benefits related to quality of care	-important to people chosing the system

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
correlation study		-uniformity of information			more important -no difference between nurses and other hospital staff	--cost savings --↑productivity --↑profession-alism, recruit-ment, retention
Kaplan (1995) -evaluating complex systems			-factors related to use: user characteristics; interrelation-ships among system-organization and individual; work practices; politics			
Drazen (1995) -survey	-availability of information	-accuracy of test results, med admin records -↓turnaround time -completeness of information -timeliness		-satisfaction as measured by 30-50 items	-↓time locating information	
Milholland (1995) -PDMS Effectiveness Measure	-↑access to data	-↑data quality -computerized chart			-↑data management & analysis	-provide savings -↑quality of patient care
Chae, et al. (1995)				-user	-↑productivity	-↑satisfaction of

	Categories of System Success					
Reference / Study	**System Quality**	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
-measuring success of Health Management IS				satisfaction critical for use	-no effect on decision-making	patients
Lee, et al. (1996) -survey -nurse, physician use of physician order entry system	-ease of use -accessibility		-frequency of use -perceived usefulness	-training & previous computer experience not assoc with satisfaction	-characteristics related to efficiency more important than quality of care	