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Towards Information Polycentricity Theory: Investigation of a Hospital Revenue Cycle

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TOWARDS INFORMATION POLYCENTRICITY THEORY
– INVESTIGATION OF A HOSPITAL REVENUE CYCLE

By

RAJENDRA SINGH

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree

Of

Doctor of Philosophy

In the Robinson College of Business

Of

Georgia State University

GEORGIA STATE UNIVERSITY

J. MACK ROBINSON COLLEGE OF BUSINESS

2011

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ACCEPTANCE

This dissertation was prepared under the direction of Rajendra Singh's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business Administration in the J. Mack Robinson College of Business of Georgia State University.

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ABSTRACT

TOWARDS INFORMATION POLYCENTRICITY THEORY – INVESTIGATION OF A HOSPITAL REVENUE CYCLE

By

RAJENDRA SINGH

December 14th, 2011

Committee Chair: *Dr. Lars Mathiassen*

Major Academic Unit: *Center for Process Innovation*

This research takes steps towards developing a new theory of organizational information management based on the ideas that, first, information creates ordering effects in transactions and, second, that there are multiple centers of authority in organizations. The rationale for developing this theory is the empirical observation that hospitals have great difficulty in managing information relating to transactions with patients. The research illustrates the detailed workings of an initial conceptual framework based on an action research project into the revenue cycle of a hospital. The framework facilitates a deeper understanding of how information technology can help to transform information management practices in complex organizations, such as hospitals. At the same time, this research adds to the literature on Polycentricity Theory by linking its two core concepts—multiple nested centers of decision making and context-dependent governance—with Transaction Cost Theory and information management theories to establish a new foundation for understanding the role of information technology in organizational contexts.

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ABBREVIATIONS

List of Abbreviations (in Alphabetical Order)

CEPRIN – Center for Process Innovation (at Georgia State University)

CMS – Centers for Medicare and Medicaid Services (www.cms.gov)

CPOE – Computerized Physician Order Entry

CPSI – Computer Programs and Systems Incorporated

DRG – Diagnosis Related Grouping

EMC – Pseudonym for the research site (“the hospital” or “the provider”)

EMR – Electronic Medical Record

ER – Emergency Room

ICD – International Classification of Diseases

ICU – Intensive Care Unit

IPF – Information Polycentricity Framework

IS – Information Systems

IT – Information Technology

JCAHO – Joint Commission on Accreditation of Healthcare Organizations (www.jcaho.org)

MRI – Medical Resonance Imaging

PACS – Picture Archiving and Communication Systems

ABSTRACT

This research takes steps towards developing a new theory of organizational information management based on the ideas that, first, information creates ordering effects in transactions and, second, that there are multiple centers of authority in organizations. The rationale for developing this theory is the empirical observation that hospitals have great difficulty in managing information relating to transactions with patients. The research illustrates the detailed workings of an initial conceptual framework based on an action research project into the revenue cycle of a hospital. The framework facilitates a deeper understanding of how information technology can help to transform information management practices in complex organizations, such as hospitals. At the same time, this research adds to the literature on Polycentricity Theory by linking its two core concepts—multiple nested centers of decision making and context-dependent governance—with Transaction Cost Theory and information management theories to establish a new foundation for understanding the role of information technology in organizational contexts.

► PART A: SETTING THE STAGE

This section sets the stage by introducing the study and describing the business context of interest. It covers the following chapters:

- **Introduction (Chapter 1):** This chapter introduces the research setting, the research approach, and the key contributions of this research.
- **The Hospital Revenue Cycle (Chapter 2):** This chapter discusses the revenue cycle in hospitals and describes the activities involved in each stage. It also discusses the inherent complexity of the revenue cycle, the challenges of managing information within and across organizational boundaries, and the role of information technology (IT). This lays the foundation for the first research question.

1 INTRODUCTION

1.1 Research Domain

In recent years, most hospitals in the United States have struggled to deliver healthcare services to patients in the face of rising costs, low or declining rates of reimbursement, and an increasing number of uninsured and Medicaid-eligible patients (Bazzoli et al. 2005; Friedman 2005; Woolhandler et al. 2003). As a result, many hospitals across the nation have already closed or are on the verge of closing down, while others have substantially reduced the healthcare services they provide (Friedman 2005). The closure of hospitals seriously affects the provision of healthcare to underserved local communities (Fleming et al. 1995). These closures affect the community's economic health as well, because hospitals are typically large employers (Holmes et al. 2006). Favorable policy changes, such as enhanced insurance coverage, included in the recent Healthcare Reform (US Government 2010), and availability of grants to improve IT infrastructure as part of the Economic Stimulus (US Government 2009), might relieve some cost pressures for hospitals. However, it is imperative that they continue to make efforts to sustain their healthcare delivery in response to downward pressure on public and private reimbursement rates and labor shortages that exacerbate the financial pressures on hospitals.

In response to these challenges, hospitals have focused on cost-cutting measures through improved operations (Devaraj and Kohli 2000). They have used various medical and information technologies, such as electronic medical records (EMR), computerized physician order entry (CPOE), nursing and pharmacy automation, picture archiving and communication (PACS), telehealth, and remote monitoring to improve effectiveness and efficiency of healthcare delivery (Cho et al. 2008; Davidson and Heslinga 2007; Furukawa et al. 2008; Menachemi et al. 2007; Paré et al. 2007). These IT-enabled innovations have yielded dividends in the form of better management of patient care and improved clinical outcomes (Bhattacharjee et al. 2007; McCullough et al. 2010; Schoen et al. 2006), particularly in underserved communities (Custodio and Graham 2009). However, most of the resulting transformations have occurred in the areas of clinical decision-making or focused transactional processing (such as billing and registration) rather than in the form of improving the overall revenue cycle. The revenue cycle includes all activities related to the delivery of health services to patients and receiving reimbursements for those services (Porn and Minugh 2004; Rauscher and Wheeler 2008). The lack of focus on IT-

enabled revenue cycle transformation has resulted in heterogeneous IT systems and fragmented information management. Multiple actors collect and distribute large amounts of information within and across organizational boundaries using an assortment of IT and non-IT systems. This results in multiple hand-offs and media breaks while information becomes error-prone, unreliable, and disjointed (Gronau and Weber 2004; Leape et al. 2000). In addition, the revenue cycle involves multiple independent centers of decision making, and related governance arrangements. Consequently, information management of the revenue cycle is a major challenge in hospitals.

This research originated from an earlier engagement in 2007 with a group of rural hospitals and community health centers in Georgia, in which the goal was to learn how these institutions could strengthen their position through IT-enabled collaboration. Through this engagement, it became clear that all these healthcare organizations found it challenging to manage their revenue cycles in ways that ensured a sustainable basis for their operation. In March 2008, this led to a more focused involvement with one of the hospitals. Over the next two years, my dissertation supervisor and I worked closely with key stakeholders to improve the hospital's financial performance using IT-enabled transformation of its revenue cycle. We made a final follow-up visit in June 2011.

In its nature and function, this hospital is like any other non-profit hospital in US: providing emergency room (ER) care and other health services to insured and uninsured patients alike with flat or decreasing revenues and increasing costs of care. A key aspect of this financial duress, as we learned during our first few visits to the hospital, was a loss of revenue¹ due to avoidable factors, such as rejection of some claims by third-party payers because of errors, non-collection of co-payments from some patients during registration, and missed charges on some medical services provided to patients. Further, we learned that the hospital's billing department was spending about 80% of its time handling exceptions created upstream in the revenue cycle. A

¹ As in any public, non-profit hospital, some revenue loss had always occurred at this hospital because it could not collect payments for some services provided to patients. However, the revenue loss became a major concern in 2007–2008 when the local economy began to falter, substantial job losses occurred in manufacturing and service industry in the area, and more people lost their health insurance. As a result, the Medicaid-eligible population in the county increased, more patients turned to the ER for non-emergency health needs, and more people defaulted on balance payments owed to the hospital. Therefore, in order to sustain its operations, it became imperative for the hospital to focus on improving its revenue cycle, reducing avoidable losses, and not “leaving money on the table.”

majority of these exceptions occurred in the registration department. As the billing manager told us, they saw the same exceptions created all the time. For example, incorrect insurance payer information and missing pre-authorizations were among the top exceptions each month. Apparently, these problems suggested broken information management throughout the revenue cycle. Therefore, the research team embarked on an action research project (involving several cycles of interventions) in collaboration with key stakeholders at the hospital with the goal of improving information management in specific areas of the revenue cycle.

During the two-year collaboration, it became evident that the hospital had great difficulty in managing information relating to transactions with patients. It also became clear that it was considerably more difficult and challenging to understand, diagnose, and innovate the hospital's revenue cycle than we had expected. In fact, the more we became engaged in problem solving, the more complex the issues appeared. This motivated our approach to study information management in the revenue cycle by viewing the hospital as a complex system (Plsek 2001; Rouse 2008; Tan et al. 2005). This "complex system" view was essential to uncovering the hospital's information management requirements and to understanding the basis of any effort to improve its revenue cycle. Further, our initial data analysis suggested that there were multiple levels of governance involved in the hospital's revenue cycle. This added to the complexity of decision making and information management. It also led us to consider alternative ways of looking at the delivery of health services to a patient: an exchange-oriented perspective rather than a task-oriented perspective. These observations, which resulted from ongoing discussions between the two researchers, shaped the theoretical analysis of the study.

1.2 Research Perspective

The recent World Health Report, published by the World Health Organization, refers to the healthcare sector as "extraordinarily complex" (Wim Van Lerberghe et al. 2008). Existing literature has also viewed hospitals as complex systems (Plsek 2001; Rouse 2008; Tan et al. 2005). This view draws on Complexity Theory, which defines a complex system as having large number of interdependent parts that together work as a whole and are interdependent with larger organizational structures or external environments (Simon 1981; Thompson 1967). By this

definition, hospitals are complex systems (Tan et al. 2005). As a result, decision making and information management in hospitals involve considerable challenges.

Hospitals exhibit complexity at internal and external levels. At the internal level, a hospital consists of various functional departments—some that are directly associated with clinical decision-making and patient care, and others (such as registration, billing, and business office) that support delivery of care to the patient. To provide care for a typical patient, these departments interact with each other and with non-clinical departments within the hospital (such as administration and finance) and exchange information that relates directly or indirectly to patient care. At the external level, some of these departments interact with a variety of payers, clinical providers, laboratories, billing service providers, and collection agencies. Thus, for each patient encounter (which involves a patient arriving at the hospital to receive healthcare services, including emergency services), the process not only includes delivering clinical care at the hospital, but also communicating care-related financial and clinical information to several internal and external partners. Consequently, the information management relating to even a simple patient encounter becomes very complex. In addition, a variety of factors—such as the super-specialized and fragmented nature of healthcare, diversity of payers, large volume of transactions, ever-changing coding and diagnostic standards, and the need to integrate new scientific evidence into the daily practice—make the task of managing care-related information, and any attempts to improve its management, extremely challenging (Chaudhry et al. 2006).

Information technology can support the hospital revenue cycle by facilitating the management of clinical, administrative, and financial information within the hospital and with external partners. For example, an EMR system can facilitate sharing of patient-related information in various stages of the revenue cycle, including registration, patient encounter, documentation, coding, and billing. IT-enabled information management can also support the organization of the revenue cycle by identifying opportunities for improvement of the overall revenue cycle. For example, the billing clerks can use an IT application to share information related to patient accounts (such as missing or incorrect payer information) with the clerks in the registration department. This sharing of information across the revenue cycle can improve healthcare delivery and overall hospital performance. However, the current health-IS literature has not focused on the role of IT in improving the revenue cycle performance in hospitals. Therefore, the first objective of this

study was to examine how IT-enabled information management can support the revenue cycle in a hospital.

Many recent studies have used the transaction cost approach to explain how and why IT can help organizations to reduce coordination costs and improve overall productivity (Ang and Straub 1998; Kauffman and Mohtadi 2004; Kumar and van Dissel 1996; Lacity and Willcocks 1995; Sankaranarayanan and Sundararajan 2010). However, except for a few studies, such as Ciborra (1981; 1993), the potential of the transaction cost approach to build IS theory has been underutilized. Further, no researchers have drawn on the transaction cost approach for theory building in relation to IT-enabled information management, especially in the context of complex organizations. Therefore, drawing on the Transaction Cost Theory developed by Coase (1937), Williamson (1975; 1981), Ouchi (1980) and others, and building on the conceptualization of IS from a transaction cost perspective developed by Ciborra (1981; 1993), this research investigates information management in a complex organization—a hospital. This choice focuses attention on the basic transactions involved in the delivery of healthcare services in a hospital.

However, our observations led us to appreciate additional limitations in extant theories on organizational information management. First, these theories typically assume a central authority in the organization with decision-making responsibility. Organizations, however, exist not only as large pyramidal structures that are managed as a bureaucracy, but also as a network of small firms, functional departments, work groups, teams, and informal peer groups (Piore and Sabel 1984). Second, decision making (and by implication, information management) also occurs at multiple levels within an organization and across organizational boundaries. Further, these multiple levels of decision making have heterogeneous and (often) diverging interests, and require context-dependent governance. Extant theories on information management fail to account for this fragmented authority with diverging interests.

To understand the multiple levels of decision making and governance requirements relating to information management in complex organizations, such as hospitals, this research draws on Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961). Over the last 50 years, researchers have applied Polycentricity Theory to various contexts, ranging from the political governance of urban areas (Ostrom et al. 1961) to the management of multinational subsidiaries (Perlmutter 1969). Essentially, a polycentric organization has multiple centers of decision making that

function independently or constitute an inter-dependent system of relations, and it requires context-dependent governance (Ostrom et al. 1961). A hospital is polycentric since it exchanges clinical, financial, and administrative information with internal and external partners, it has multiple centers of decision making (such as physicians, nurses, payers, billing specialists, and business office managers), and it requires different governance structures and contractual arrangements to facilitate coordination among the different decision-making units. As a result, Polycentricity Theory offers a promising theoretical base for investigating the dynamics of information management in a hospital. However, to our knowledge, no studies have explored the potential of this theory to investigate information management in such complex organizational contexts. Therefore, the second objective of this study was to examine how Polycentricity Theory can develop our understanding of information management in complex organizations.

1.3 Research Approach

Given the complexity and changing nature of problems (for example, insurance payers' frequently changing payment rules) relating to revenue cycle management in hospitals, no optimal solutions can make significant improvements in a hospital's financial performance. However, if hospitals are to improve their financial performance, they need to have a comprehensive approach to managing their revenue in addition to cost control initiatives. The advantage of a polycentric approach is that it encourages experimental efforts at multiple levels as well as the development of methods for assessing the benefits and costs of particular strategies adopted in one organizational process (or unit) and comparing these with results obtained in others. A strong commitment to finding ways of reducing inefficiencies in key activities related to the revenue cycle is an important element for improving a hospital's financial performance. Building such a commitment, and the trust that all involved actors are also taking responsibility, can be undertaken in an action research project involving several cycles of interventions enacted throughout the revenue cycle and linked through information networks, monitoring, and feedback at all levels.

Against this backdrop, we conducted action research (Baskerville and Wood-Harper 1996; Checkland and Holwell 1998; Davison et al. 2004; Rapoport 1970; Susman and Evered 1978) into the revenue cycle of a small, non-profit, rural hospital—EMC (a pseudonym)—in Georgia.

Similar to any other rural, non-profit hospital in the United States, EMC operates in a resource-constrained environment. It is especially vulnerable to reducing reimbursements as it serves a large indigent and Medicaid population and has few resources (Gamm et al. 2002; Moscovice and Stensland 2002; Ricketts 2000). EMC's small size facilitated our research objectives because we could easily focus on all parts of its revenue cycle. It helped too that EMC's chief financial officer gave us full access to investigate revenue cycle problems at the hospital.

Over a period of two years, we worked closely with key stakeholders at EMC and assisted them in designing and implementing IT-enabled interventions to improve information management across the entire revenue cycle—from patient registration to receiving reimbursements for medical services provided to patients. Action research has previously proven useful for studying complex issues related to health IT (Braa et al. 2007; Braa et al. 2004; Kohli and Kettinger 2004). We relied on collaborative practice research (Mathiassen 2002), which involves iterative and collaborative problem solving and research. To ensure rigor, we adopted principles of canonical action research (Davison et al. 2004) to provide practical solutions to EMC while at the same time investigating the specific challenges related to effective design of IT-support for information management in the revenue cycle. Following McKay and Marshall (2001), we engaged in multiple cycles, each focusing on problem-solving and research interests. Overall, the research was designed as a longitudinal, qualitative field study (Miles and Huberman 1994; Pettigrew 1990) aimed at investigating phenomena in the context of social practice in an organization, namely, the provision of health service delivery in a hospital. The research also reports on the institutional changes that resulted from the researchers' interventions.

Accordingly, besides contributing to EMC's practical concerns (that is, the problem situation related to its revenue cycle), this research has a dual theoretical focus: on the one hand, it contributes to the IS literature, and on the other hand, it contributes to the health-IS literature. Table 1.3.1 summarizes the contributions of this research. Contributing to IS, this research explains how IT can support information management in complex organizations. We draw on Transaction Cost Theory to develop Polycentricity Theory as a conceptual lens to inform our understanding of the dynamics of information management in complex organizational settings, such as hospitals. On a broader level, we seek to explain two phenomena that are of great importance to IS researchers, healthcare administrators, and policy makers: 1) Why it is so

difficult to manage information in complex organizations, and 2) Why it is so challenging to implement IT-enabled innovations in the healthcare context.

Contributing to the health-IS literature, this research investigates the challenges of information management in a hospital and explains how IT-enabled information management can improve revenue cycle performance. In doing so, we investigate how the polycentric nature of information (and the organization) affects information management practices in the revenue cycle. In addition, on a practical level, the objective of this study is to design interventions to improve the revenue cycle at EMC.

Table 1.3-1 Contributions of this Research

Contribution Area	Literature	Contribution
Problem situation (P) ²	<ul style="list-style-type: none"> Hospital revenue cycle management 	Improve revenue cycle performance at EMC
Area of Concern (A)	<ul style="list-style-type: none"> Health-IS 	Develop our understanding of how IT-enabled information management can support a hospital revenue cycle
Theoretical Framing (F)	<ul style="list-style-type: none"> Information management theory Transaction Cost Theory 	Develop Polycentricity Theory to inform our understanding of information management in complex organizations

1.4 Summary of Dissertation

The following structure of the dissertation summarizes the argument:

- **Part A: Setting the Stage**

- Chapter 1 introduces the research setting, the research approach, and the key contributions of this research.
- Chapter 2 discusses the revenue cycle in a hospital and describes the activities involved in each stage. It also discusses the inherent complexity of the revenue cycle,

² The notations P (problem situation), A (area of concern), and F (theoretical framing) are drawn from Checkland, P.B., and Holwell, S. 1998. "Action Research: Its Nature and Validity," *Systemic Practice and Action Research* (11:1), pp 9-21.

the challenges of managing information within and across organizational boundaries, and the role of IT. This lays the foundation for the first research question.

- **Part B: Theoretical Foundations**

- Chapter 3 discusses the nature of information in organizations and reviews extant theories on information management. Next, it presents a critique of traditional approaches to information management. This allows us to identify gaps in current understandings and state the foundation for developing our theoretical contribution.
- Chapter 4 provides the conceptual foundations of the transaction cost approach to organizational analysis and then presents related literature. Next, it presents the role of information systems and information management in transaction cost analysis. Subsequently, it considers the limitations of the transaction cost approach to information systems, which leads us to explore a complementary lens to understand information management in complex organizations.
- Chapter 5 provides the additional, new theoretical framing by reviewing the conceptual foundations and current applications of Polycentricity Theory. The chapter highlights the key theoretical elements of Polycentricity Theory and identifies a research opportunity to use the theory to understand information management in complex organizations.

- **Part C: Empirical Foundations**

- Chapter 6 describes the research setting and the overall research design. This chapter also describes our application of action research methodology, collaborative practice research, and our employment of the principles of canonical action research.
- Chapter 7 details the problem context, the problem-solving cycles we engaged in, and the areas and sequence of the involved interventions.
- Chapter 8 presents the approach to data collection and data analysis in the research cycle.

- **Part D: Theory Development**

- Chapter 9 draws on Polycentricity Theory, Transaction Cost Theory, and existing theories of information management to develop an initial conceptualization—Information Polycentricity Framework (IPF)—that can help explain the challenges of

information management in complex organizations and lay the foundation for further theoretical development. The chapter discusses the premises and components of IPF.

- Chapter 10 illustrates the detailed workings of IPF by applying its four components to information management in the revenue cycle of a hospital, EMC. Next, it provides a detailed contextual account of ten interventions (grouped into four cases) to improve EMC's revenue cycle as part of the action research study. For each case, I interpret the findings based on IPF.
- **Part E: Theory Evaluation**
 - Chapter 11 evaluates IPF based on the empirical results from the action research interventions at a hospital and based on conceptual notions of theory.
 - Chapter 12 discusses the study's contributions to theory and practice, and its limitations.

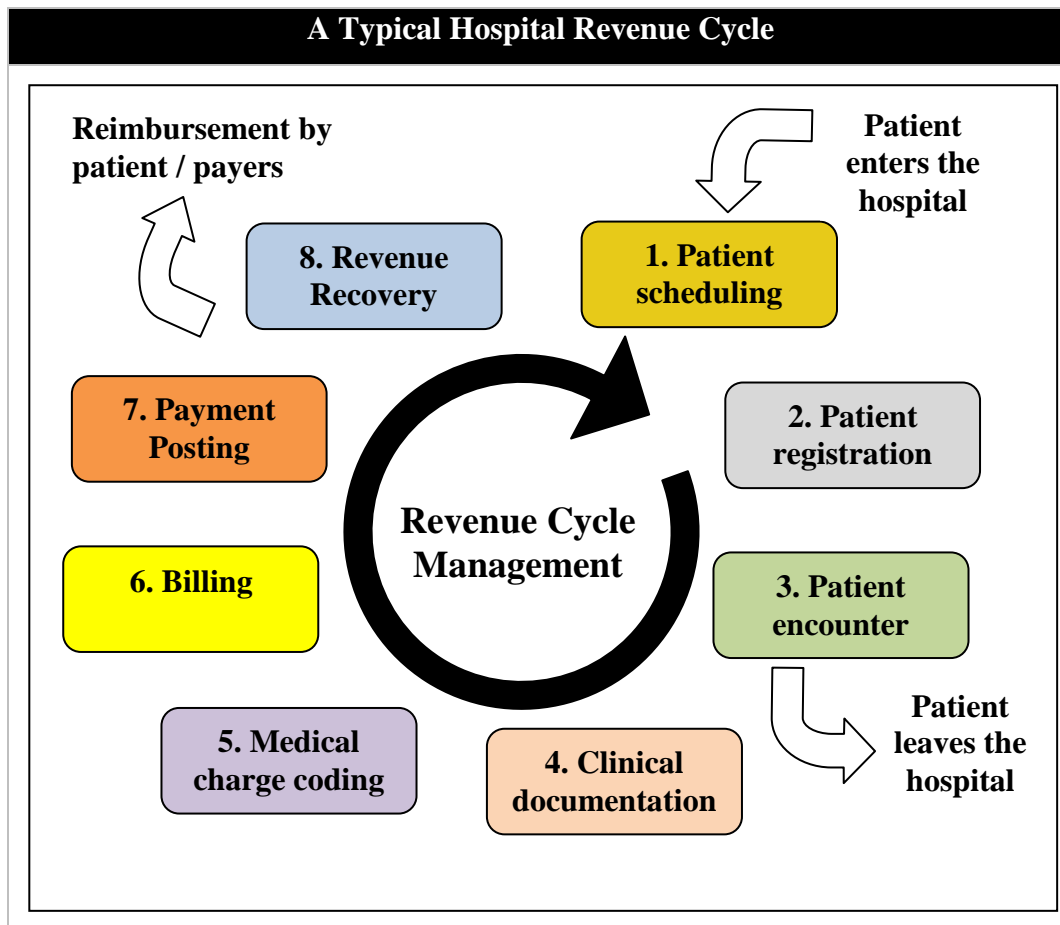
2 THE HOSPITAL REVENUE CYCLE

In this chapter, I describe the context of our research: the revenue cycle in hospitals. First, I describe a typical revenue cycle and highlight key stages and activities that are involved in delivering health services to patients. Next, I discuss the complex nature of the revenue cycle and identify some challenges related to managing information. Subsequently, I discuss the role of IT in healthcare delivery in general and in the hospital revenue cycle in particular. Finally, drawing on a discussion of how IT-enabled information management can support the revenue cycle in a hospital, I present the first research question.

2.1 The Revenue Cycle in Hospitals

With hospitals facing stricter regulations and billing requirements from public (that is, governmental) and commercial (including for-profit and not-for-profit) third-party payers, revenue cycle management has become critical to hospital performance (Rauscher and Wheeler 2008). As a result, most hospitals in the United States are trying to find ways to implement effective revenue cycle management practices, although many of them struggle in their efforts to do so. The revenue cycle involves all activities related to delivering healthcare services to patients and receiving payment for those services (Berger 2008; Porn and Minugh 2004; Rauscher and Wheeler 2008). Thus, the revenue cycle begins when a patient or a physician determines the need for a medical service and ends when the charges associated with the service have been resolved through the application of insurance payments, contractual allowances, write-offs, or payments by the patient (Porn and Minugh 2004, p34). While the hospital staff manages and executes the revenue cycle, the cycle itself is an intrinsic part of a larger transaction involving patients; a variety of payers including Medicare, Medicaid, and commercial insurers; state and federal regulators; and other stakeholders such as consulting clinical specialists, laboratories, blood banks, collection agencies, and other service providers. Figure 2.1-1 provides an overview of the various stages in a typical revenue cycle at a hospital.

Figure 2.1-1 Revenue Cycle in a Hospital



Typically, the first stage of the revenue cycle is patient scheduling, during which a scheduling coordinator receives physician's referral information for a patient and schedules an outpatient procedure, test, or admission into the hospital. It may also involve verifying eligibility from the patient's insurance company.³ The next stage is patient registration, during which a registration clerk verifies the patient's contact and insurance information, collects appropriate co-payment, and registers the patient using the hospital's EMR system. Subsequently, the patient encounter occurs, during which a physician on medical staff examines the patient, conducts any scheduled procedure, or admits the patient for surgical intervention or continued observation. Clinical documentation occurs next, during which a nurse documents all the examinations, procedures, and medical services provided to the patient. In the subsequent stage, medical charge coding, a coding specialist receives the documented procedures from the nurse and creates standards-based

³ In some hospitals, a scheduling coordinator conducts the insurance eligibility verification; in other hospitals, the registration staff conducts the verification.

codes according to appropriate diagnosis-related grouping (referred to as DRGs). During the billing stage, a billing clerk receives the coded charges, generates claims, and sends the claims to the patient or to third-party payers such as Medicare, Medicaid, and commercial insurance companies (including for-profit and not-for-profit), as appropriate. During payment posting, the business office receives all payments from the individual and the third-party payers and posts relevant information to the patient's account. During the revenue recovery stage, a clerk in the business office follows up with patients (or their insurance providers) for late or denied reimbursements.

Each of these stages⁴ involves several activities performed by one or more individuals in different functional departments within the hospital. However, the same department may handle more than one activity (for example, a hospital's business office may handle payment posting and account recovery). Table 2.1-1 shows the major stages in the revenue cycle, and examples of specific activities involved. A brief description of these activities follows.

Table 2.1-1 Stages and Activities in a Typical Revenue Cycle

#	Revenue Cycle Stages	Brief Description of Activities
1	Patient scheduling	<ul style="list-style-type: none"> • Receive referral information from physician • Schedule patient for a procedure, test, or admission
2	Patient registration	<ul style="list-style-type: none"> • Enter/update patient information • Verify insurance benefits coverage • Collect co-payment, as appropriate • Verify procedure pre-authorization from insurance provider
3	Patient encounter	<ul style="list-style-type: none"> • Patient's meeting with a physician (or clinical staff) for medical examination, diagnosis, and performing a scheduled procedure
4	Clinical documentation	<ul style="list-style-type: none"> • Document all procedures and medical services provided to patient
5	Medical charge coding	<ul style="list-style-type: none"> • Code charges based on standards
6	Billing	<ul style="list-style-type: none"> • Generate and review claim-related information

⁴ The exchanges, and flow of the associated information, occur not only within the revenue cycle, but also with external entities such as insurance payers, clinical specialists, blood banks, laboratories, and other service providers. However, for the sake of simplicity, Figure 2.1-1 does not depict these linkages and interactions with external entities.

		<ul style="list-style-type: none"> • Submit claims to appropriate payers • Resubmit denied claims after modifications
7	Payment posting	<ul style="list-style-type: none"> • Manually or automatically post claims to patient account
8	Revenue recovery	<ul style="list-style-type: none"> • Follow-up with payers • Negotiate discounts • Arrange for debt collection • Write-offs

2.1.1 Patient Scheduling

The first stage in the revenue cycle is patient scheduling.⁵ Typically, a scheduling clerk receives referral information from a physician, contacts the patient, and schedules an outpatient procedure or admission into the hospital. Some hospitals have centralized scheduling in which a dedicated department handles the scheduling responsibilities for all patients, while other hospitals have distributed scheduling in which individual clinical departments handle scheduling for their patients (for example, an X-Ray laboratory that schedules patients independently). Scheduling may also include verifying insurance eligibility (that is, checking if a pre-authorization approval or medical necessity certification from payers is available). Some insurance payers require the eligibility verification before conducting particular procedures, and in its absence, the payer may refuse payment.

2.1.2 Patient Registration

Patient registration forms the basis of interaction with patients, irrespective of whether the patient comes for admission (for example, to deliver a baby) or for an outpatient procedure (such as a blood test or a CT-Scan). Upon arrival at the hospital, the patient meets a registration clerk who collects key demographic information, including name, social security number, and insurance benefits coverage. If a patient's record already exists in the hospital's EMR system (because of a prior visit), the clerk verifies and updates the information. This information serves as foundation for payment of services. During this interaction with the patient, the registration clerk also collects any co-payment as determined by the patient's insurance coverage, and enters

⁵ Patient scheduling is only relevant for inpatients, outpatients, and nursing home patients. In case of ER and walk-in patients, no scheduling is involved.

this point-of-service collection information into the EMR system. The clerk also verifies that any pre-authorizations⁶ (if required by an insurance payer) are available before accepting the patient. Upon completion of registration activities, the clerk allocates a patient account number and a patient tag that are unique to that visit. The hospital staff uses the patient account number⁷ in subsequent stages of the revenue cycle, including patient encounter, documentation, coding, and billing.

2.1.3 Patient Encounter

Once a patient has obtained the necessary pre-authorization approvals, the registration staff completes registration-related formalities and releases the patient to the clinical staff. The clinical staff then begins preparations to provide medical services to the patient. An outpatient receives the scheduled procedure (for example, an X-Ray, a CT-Scan, or a blood test) and can typically go home after a brief observation period. In case of an inpatient, a nurse transfers the patient to a private room or a general ward for treatment and observation. If needed, the inpatient may receive appropriate clinical interventions (for example, a knee surgery). Following physicians' orders, the nursing staff transfers critical patients to an intensive care unit (ICU) and relatively stable patients to an observation ward. Once the patient recovers sufficiently, the hospital discharges the patient to home or community setting.

2.1.4 Clinical Documentation

Clinical documentation includes a physician's orders on primary diagnosis, a physician's notes about any associated diagnosis, nurses' notes on procedures and treatment, and any other material relevant to billing for the medical services provided to the patient. Accurate and timely clinical documentation is critical for revenue cycle management. It ensures that all medical services (and materials) provided to the patient produce payable claims. Often there are procedures-to-charges gaps. For example, while the nurse responsible for clinical documentation

⁶ If a pre-authorization approval or medical necessity certification is required by the payer but not yet received by the hospital, the registration clerk may ask the patient to wait until it becomes available or sign an agreement to pay personally in case the insurance denies payment for the medical services.

⁷ A patient may have multiple account numbers, but each visit refers to only one patient account number. However, a patient returning within a specified period (typically 24 hours) for a follow-up visit or to report unmitigated or adverse symptoms is usually allocated the same patient account number as for the previous visit.

includes an X-Ray (such as, for a broken bone), the application of a plaster cast may not be included in the list of services provided. This would ultimately result in a missed charge and loss of revenue to the hospital. If a nurse identifies such cases quickly, she may amend the clinical documentation. In addition, the physician may fail to provide accurate diagnosis-related information (for example, ordering tests for diabetes without mentioning the reason) or to document such information in a timely manner.

2.1.5 Medical Charge Coding

The coding specialist (coder) typically receives the physicians' orders related to diagnosis and the nurses' notes on procedures and treatment within 24 to 48 hours after patient discharge. These clinical documents could be hand-written, transcribed and printed, or available digitally in real-time in hospitals that have implemented CPOE. The coder reviews the documentation to identify the elements required for accurate medical coding⁸ by using classification standards⁹ approved by the Health Insurance Portability and Accountability Act of 1996 (HIPAA). In case of missed charges (for example, a patient gets an X-Ray for a broken bone, but the charge for application of plaster cast or wound dressing may be missing), the coder coordinates with the physician or nursing staff to clarify. Typically, there is a lag of three to five days (after the patient discharge) before the coders begin processing charges for a particular patient account. Late or incomplete reporting of clinical documentation and errors in coding (for example, applying the wrong code for a procedure) are the most common issues. If these errors remain uncorrected, the hospital cannot claim reimbursement from the insurance payers.

2.1.6 Billing

After all charges for any service or procedure provided to a patient are coded, a billing specialist collects all patient accounts that are ready for billing, generates claims, and reviews them. In case

⁸ According to American Health Information Management Association (AHIMA), medical coding is the “transformation of narrative descriptions of diseases, injuries, and healthcare procedures into numeric or alphanumeric designations (i.e., code numbers). The code numbers are detailed in order to accurately describe the diagnoses (i.e., what is wrong with the patient) and the procedures performed to test or correct these diagnoses.” <http://www.ahima.org/coding/>

⁹ For more information on coding classification standards, see <http://www.ahima.org/coding/standards.aspx>

of any edits¹⁰ (for example, missing payer information for a particular patient account), the billing specialist contacts the relevant department (in this example, registration) to seek additional information. The claims are typically bundled together and submitted to the patient's payer. For self-pay patients, the billing occurs separately—in-house in the billing department or outsourced to an external provider. The billing department also processes denied claims, often requesting reconsideration from the payer with additional information from the physicians, coders, or registration staff.

2.1.7 Payment Posting

Payment posting involves receiving payment for all claims from various payers. It can occur through an electronic process (as in case of Medicare) or manually. A business office clerk updates patient accounts to reflect all received payments and contractual allowances (that is, pre-agreed discounts negotiated between the hospital and a payer). Payers may deny some claims for reasons such as late submission, insufficient documentation, and coding or diagnosis errors. The billing department typically reviews such cases, follows up with other departments to provide missing or additional documentation, and resubmits claims, if allowed by a particular payer.

2.1.8 Revenue Recovery

Different payers have different rules for reimbursement. For example, Medicare reimburses any “clean” claim (that is, with no errors) usually within two weeks, while other insurers may take between two weeks and two months to send reimbursement checks (or electronic payments) to the hospital. Inaccuracies in claims lead to delayed payments. Follow-up for self-pay accounts typically occur on a monthly cycle. A business office clerk may negotiate discounts or easier payment terms with some patients to encourage them to pay the balance amount. Any account becomes delinquent if it remains unpaid for a specified period (typically over 120 days), and may then be referred to an external collection agency for balance recovery. Finally, after exhausting all attempts of revenue recovery, the business office may write off some account balances.

¹⁰ An edit is the outcome of an automated check that informs a billing specialist of an error in the claim. Vendors such as 3M provide software that scrubs the claims to check for inaccuracies (shown as billing edits) before transmitting the claim to the insurance companies. The list of edits is configurable, i.e., the billing specialists can define which inaccuracies will be “caught” by the software. For example: a patient name has to match patient subscriber name, and if it does not, the system will show it as a billing edit and this error must be corrected before sending the claim to Medicare or other third-party payers.

2.2 The Complexity of the Revenue Cycle

A recent World Health Report, published by the World Health Organization, refers to the healthcare sector as “extraordinarily complex” (Wim Van Lerberghe et al. 2008). Drucker (2002) described hospitals as “altogether the most complex organization ever devised.” Existing literature has also viewed hospitals as complex systems (Plsek 2001; Rouse 2008; Tan et al. 2005). This view draws on Complexity Theory, which defines a complex system as having a large number of interdependent parts that together work as a whole and are interdependent with larger organizational structures or external environments (Simon 1981; Thompson 1967). Following these definitions, hospitals are complex systems as they have many interdependent and interacting parts that are also interdependent with the external environment (Tan et al. 2005). The discussion of challenges in various stages of the revenue cycle in the previous section attests to this complexity.

However, hospitals are unique in their complexity. Explaining this uniqueness, Malvey (1981, p17) reflected,

A hospital has few characteristics which find exact parallels in business firms. The structure itself, the multiplicity of professional viewpoints, the effects of status [for example, physicians vs. other hospital staff] are not easily accommodated within profit-seeking firms. Even the number of actors capable of influencing policy would create chaos in business firms.

Hospitals face a constant struggle to manage restrictions and demands placed on them (Malvey 1981, p22). The restrictions arise from federal and state agencies, professional organizations, and public groups that limit activities of hospitals through reimbursement policies, regulations, licensures, accreditations, and reporting requirements. The demands arise from the increasing need for medical services by the local community, which stresses the scarce resources of hospitals (Malvey 1981, p23). Moreover, the physicians and nurses concern themselves with treating patients, not primarily with the cost¹¹ of treatment, leaving the problem of managing efficiency, cost containment, and service volume to the financial administrators (Malvey 1981,

¹¹ This dichotomy of authority protects ethical considerations in care delivery, as pragmatics or economics do not determine the quality and quantity of care to a patient. Malvey, M. 1981. *Simple Systems, Complex Environments: Hospital Financial Information Systems*. Beverly Hills, CA: Sage Publications.

p23). In addition, the super-specialized and fragmented nature of healthcare, large volume of transactions, and the need to integrate new scientific evidence into practice further complicate information management (Chaudhry et al. 2006). These unique characteristics of the healthcare sector place a heavy load on financial and clinical management—thus, in effect, the entire revenue cycle—in hospitals.

Further, a typical revenue cycle exhibits multiple levels of complexity—both internal and external. At the internal level, the revenue cycle involves coordination between various functional departments, some that are directly associated with clinical decision making and patient care, and others (such as registration, billing, documentation, coding, and business office) that support delivery of care to the patient. To provide care for a typical patient, these internal departments interact with each other and with other organizational departments such as administration and finance. These departments exchange complex information that relates, directly or indirectly, to patient care. For example, an ER receives trauma or accident patients, stabilizes them and, depending on the patient's condition, discharges them, admits them to an inpatients facility, or transfers them to a larger hospital with improved critical-care facilities. However, a typical ER encounter involves not only the ER physicians and nurses, but also a large team of clinical, technical, and administrative personnel who support delivery of care to each patient. As a result, the related decision-making becomes highly complex.

At the external level, some functional departments interact with a variety of payers, clinical providers, laboratories, billing service providers, and collection agencies. For example, the billing department in the hospital that we studied interacts with a variety of payers, among them about a dozen different insurance payers, including Medicare, Medicaid, the Georgia state government, the Georgia prisons department, and the department of Veterans Affairs. For each payer, a separate contract prescribes payments for each documented charge item for a patient. Some services, such as billing and initial follow-up for self-paying patients and laboratory have been outsourced. Thus, for each patient encounter, the process not only involves delivering clinical care at the hospital, but also communicating care-related information to several internal and external partners. This inherent complexity of healthcare delivery may explain why many hospitals increasingly use IT to improve their operations.

2.3 Managing Information in the Revenue Cycle

A hospital revenue cycle is highly information intensive (Anderson 1997) and involves managing large amounts of clinical and administrative information. As discussed earlier, the revenue cycle involves collaboration across administrative and clinical boundaries (Kohli and Kettinger 2004), which leads to increasing levels of information requirements. Healthcare delivery for any patient requires information exchanges between clinical departments (such as radiology, physicians, and nursing), administrative departments (such as registration, billing, and business office), and with a variety of payers, clinical providers, laboratories, billing service providers, and collection agencies. Thus, managing exchanges of such a large amount of clinical and financial information relating to even a simple patient encounter becomes demanding, and any attempt to improve related practices is extremely challenging.

The challenge of managing information in hospitals becomes even greater because hospitals typically utilize IT to a varying degree to fulfill the clinical, administrative, and financial activities associated with care delivery. This heterogeneous IT enablement—including an assortment of IT and non-IT systems across the revenue cycle—results in fragmented information as various actors collect and distribute information using different systems. These assorted IT systems often have different architectures, including user interfaces, application servers, and back-end databases. These IT systems may also connect to multiple legacy operating systems, applications, and databases. Over time, the heterogeneity and complexity of these systems increases as the IT departments try to extend functionality by customizing or by integrating with other systems.

In our investigation of the revenue cycle at EMC, we identified two types of information management: one that supported individual revenue cycle activities and another that supported the organization of the revenue cycle. The first type focused on the content of the revenue cycle activities, matched information availability with requirement for a particular activity, and thus directly supported the revenue cycle. For example, billing involved collecting medical charges for a patient after those charges have been coded using standards-based procedure and diagnosis-related grouping as prescribed by Medicare, matching charge information to that patient's account information, generating billing claims, reviewing any exceptions (such as incomplete

payer information), and submitting the claims to appropriate payers. In contrast, the second type of information management helped coordinate and organize the overall revenue cycle. This type of information management can facilitate workflow across the revenue cycle and, if needed, enable changes to make the workflows more effective and efficient. For example, a billing clerk may provide feedback to a registration clerk about errors generated during patient registration; this can reduce similar exceptions in the future and improve efficiency of claims' processing.

2.4 Role of IT in the Revenue Cycle

Information technology can support the hospital revenue cycle by facilitating management of clinical, administrative, and financial information within the hospital, and with external partners. In recent years, IT has played an important role in managing and coordinating health services (Chiasson and Davidson 2004). Although the use of IT in healthcare has lagged behind other industries (Menon et al. 2000; US Congress 1995), application of IT in healthcare has grown in recent years (Thompson and Dean 2009). This trend has the potential to improve cost-effectiveness, quality, and accessibility of healthcare services (Chiasson and Davidson 2004; Devaraj and Kohli 2000; McCullough et al. 2010; Schoen et al. 2006), and there are increasing calls to further exploit emerging IT to improve healthcare delivery (Tuttle 1999). IT has also opened up new possibilities of "e-health" through telemedicine and remote patient monitoring, thus allowing delivery of health services beyond the traditional physician's office or hospital settings (Chiasson and Davidson 2004).

To discuss IT's role in healthcare delivery in general and in the hospital revenue cycle in particular, we use Davenport's (1993) framework that discusses the various ways in which IT can improve an organization's performance. He suggested nine categories representing areas of opportunity for IT-enabled process innovation (Davenport 1993, p50). Using this framework, Table 2.4.1 provides examples of the role of IT in the hospital revenue cycle.

Table 2.4-1: The Role of IT in the Revenue Cycle

#	Role of IT	Description	Examples (<i>Related Revenue Cycle Stage/s</i>)
1	Automational	Eliminating human labor from a process	<ul style="list-style-type: none"> • Electronic prescribing by physicians for outpatients, and delivered directly to pharmacy (<i>patient encounter</i>) • Computerized checking for possible harmful drug interactions (<i>patient encounter</i>)
2	Informational	Capturing process information for purposes of understanding	<ul style="list-style-type: none"> • Digitized X-Ray, CT-Scans etc. through picture archiving and communication systems (<i>patient encounter</i>)
3	Sequential	Changing process sequence, or enabling parallelism	<ul style="list-style-type: none"> • Transformation from paper-based case record to EMR, allowing simultaneous viewing and real-time processing (<i>entire revenue cycle</i>)
4	Tracking	Closely monitoring process status and objects	<ul style="list-style-type: none"> • Remote monitoring of post-acute and chronic patients in home or community settings (<i>patient encounter</i>) • Around-the-clock care for critically ill and injured patients in ICU, monitored and managed by remotely located intensivists (<i>patient encounter</i>)
5	Analytical	Improving analysis of information and decision making	Clinical decision-making systems, integrating a medical knowledge base, patient data and an inference engine to generate case-specific advice (<i>patient encounter</i>)
6	Geographical	Coordinating processes across distances	<ul style="list-style-type: none"> • Telehealth systems, delivering medical services over distance, facilitating knowledge sharing, and distributing complex diagnostic processes and medical decision making across healthcare organizations (<i>patient encounter</i>)
7	Integrative	Coordination between tasks and processes	<ul style="list-style-type: none"> • EMR systems, allowing clinical and non-clinical hospital staff to view and exchange patient care related information (<i>entire revenue cycle</i>)
8	Intellectual	Capturing and distributing intellectual assets	<ul style="list-style-type: none"> • Centralized health portals, allowing healthcare professionals and patients to share and analyze information, complete transactions and workflow, and collaborate using email and other internet applications (<i>entire revenue cycle</i>)
9	Disintermediating	Eliminating intermediaries	<ul style="list-style-type: none"> • Personal health records, allowing individuals to maintain and control access to health and medical history

		from a process	<p>(<i>registration, patient encounter</i>)</p> <ul style="list-style-type: none"> • Self check-in and registration by patients in dedicated kiosks in hospitals (<i>registration</i>) • Self-service appointment scheduling by patients (<i>registration</i>)
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Gurbaxani and Whang (1991) suggested a similar framework outlining five roles of IT in any organization: 1) operational, 2) transaction processing, 3) decision support, 4) monitoring and performance evaluation, and 5) documentation and communication. One can also draw upon their framework to describe the role of IT in the hospital revenue cycle. As frameworks like these suggest, IT can play an important role in information management in the hospital revenue cycle. For example, most EMR systems have built-in or add-on modules that facilitate information management. Some of these EMR systems may have linkage to a diagnosis-related grouping application to facilitate the documentation and coding activities. A coding clerk can use this application to identify appropriate codes to charge for a particular procedure (for example, a knee arthroscopic surgery). IT-enabled information management can also support the organization of the revenue cycle by sharing activity-level information across different stages of the revenue cycle and identifying opportunities for improvement of the overall revenue cycle. For example, the billing clerks can use an IT application (which could be a module in the EMR system, or a dedicated application) to share exceptions identified in specific claims (such as missing or incorrect payer information) with the registration clerks. This sharing of information across the revenue cycle can reduce delays in processing of claims, improve cash flow (by reducing rejected claims), and thus improve overall hospital performance.

The increasing role of IT in health delivery is also represented in the growing literature on health-IS (Chiasson and Davidson 2004; Cho 2007; LeRouge et al. 2007). A recent special issue in the *Journal of the Association of Information Systems* (February 2011), a forthcoming special issue in *Information Systems Research*, and focused journals on health informatics such as the *Journal of American Medical Informatics Association* represent this increasing focus on health-IS. However, the main emphasis of existing literature has been on improving clinical IS, including EMR (Davidson and Chiasson 2005; Hanseth et al. 2006; Lapointe and Rivard 2005), CPOE (Davidson and Chismar 2007), PACS (Paré et al. 2005), clinical decision support (Devaraj and Kohli 2000), and telemedicine (Cho and Mathiassen 2007; Paré et al. 2007; Paul

and McDaniel Jr. 2004). The preponderance of clinical IS (mostly related to the patient-physician encounter) in the examples shown in Table 2.4-1 also support this observation. A recent study of hospitals in Florida may point to the reason for this emphasis of IT on clinical decision-making systems. In this case, Bhattacharjee et al. (2007) found that adoption of IT in healthcare had differential performance effects and only clinical IT had a significant positive impact on the hospitals' operational performance.

The literature on non-clinical IT-enabled information management is sparse. Despite the fact that automation of billing activities was among the first IT application in hospitals (Fisher 1984; Lindberg 1979), and billing remains among the most commonly used IT applications by physician offices and hospitals (Audet et al. 2004), it is unfortunate that little attention has been paid to IT-enabled information management in the revenue cycle in the health-IS literature. While most EMR systems have functionality relating to the revenue cycle (such as billing, registration, and automated payment posting) that is built in or available as add-on modules, few applications integrate the entire revenue cycle or enable re-organization through identification of improvement opportunities in revenue cycle workflows. In addition, although Davenport's categories about the role of IT in organizations apply to clinical as well as non-clinical information management in the hospital revenue cycle, we did not find any studies that focus on such applications. Because of the under-emphasis of current health-IS literature on information management in the hospital revenue cycle, there is no comprehensive view of using IT to support or reorganize the revenue cycle.

2.5 Research Opportunity #1

Information management is fundamental to healthcare delivery (Chaudhry et al. 2006). It plays a critical role in preventing and minimizing errors, coordinating care among settings, and ensuring that relevant and accurate healthcare information is available when needed (Chassin and Galvin 1998). However, as discussed in the previous section, information management in healthcare organizations is highly complex. Although the literature on information management in organizations has provided significant insights into the nature and process of information management in general (Daft and Lengel 1986; Galbraith 1974; 1977; Mathiassen and Sørensen

2008; Mintzberg 1979; 1980; Ramaprasad and Rai 1996), our knowledge of how complex organizations such as hospitals manage information is still limited.

Information technology can play an important role in the revenue cycle by facilitating the management of clinical, administrative, and financial information within the hospital, and with external partners. IT can support individual activities in the revenue cycle and facilitate organization of the overall revenue cycle to improve the efficiency of the underlying workflows. Unfortunately, the current research focuses more on clinical IS and to a lesser extent on individual parts of the revenue cycle. Therefore, contributing to the health-IS literature, this study's first research question is:

RQ1: How can IT-enabled information management support the revenue cycle in a hospital?

► PART B: THEORETICAL FOUNDATIONS

This section describes the theoretical foundations for this study, which include the following:

- **Information Management Theory (Chapter 3):** This chapter discusses the nature of information in organizations, and reviews extant theories on information management. Next, it presents a critique of traditional approaches to information management. This allows us to identify gaps in current understandings and state the foundation for developing our theoretical contribution.
- **Transaction Cost Theory (Chapter 4):** This chapter provides the conceptual foundations of the transaction cost approach to organizational analysis. Next, I consider the role of information systems and information management in transaction cost analysis. Subsequently, I consider the limitations of the transaction cost approach to information systems, which leads us to explore a complementary lens to understand information management in complex organizations.
- **Polycentricity Theory (Chapter 5):** This chapter provides a new theoretical framing by reviewing the conceptual foundations and current applications of Polycentricity Theory. The chapter highlights the key theoretical elements of Polycentricity Theory and identifies a research opportunity to use the theory to understand information management in complex organizations.

3 INFORMATION MANAGEMENT THEORY

In this chapter, I first review two broad schools of thought regarding the nature of information in organizations: one focusing on the transmission of messages (objective view) and the other on the content of messages (subjective view). Next, I review select theories on information management in organizations. For each of these theories, I discuss how they can lead to different organizational configurations. Finally, I present a critique of traditional approaches to information management. This allows me to identify gaps in current understandings and state the foundation for developing theoretical contribution.

3.1 Nature of Information in Organizations

Organizations produce and consume information for operational and strategic purposes (Feldman and March 1981; Ramaprasad and Rai 1996). Although information is integral to the functioning of any organization, there is still substantial debate about its nature (Lee 2010; McKinney Jr. and Yoos 2010; Mingers 1996). A wide variety of literature, ranging from economics to neurosciences to business management, has reflected on the nature of information (Dayan and Abbott 2001; Galbraith 1974; Radner 1992). Organizations are fundamentally information-processing systems, structured to achieve specific goals and comprised of individuals and teams that process information using available communication tools (Levitt et al. 1994). This information processing view of organizations draws on General Systems Theory (Von Bertalanffy 1950) and Cybernetics Theory (Weiner 1948) to describe how organizations function. According to this view, organizations are conceptualized as streams of information and information processing activities, linked dynamically to the internal and external environment by information flows (Kmetz 1998, p3). Following Mingers (1996), I review two broad perspectives on the nature of information in organizations.

3.1.1 Objective View of Information

From an objective viewpoint, information is an independent entity with its own structure (Mingers 1996). This viewpoint draws heavily on the theory of information transmission from the engineering perspective of the early telephone and telegraph industry (Shannon 1948; Shannon and Weaver 1949). Their thinking formed the basis of a significant portion of the later

work on information processing and management theories. Their representation of information only concerned the transmission of messages, and not the content of communication (Alluisi 1970). The proponents of this view—referred to as the telemetry school by Kmetz (1998, p4)—focused almost entirely on the bandwidth capacity and signal clarity of the transmission medium. Accordingly, information equaled processed data, and “signal loss” was the principal criterion to gauge the efficiency of the transmission medium (Shannon and Weaver 1949). Further, the early telemetry theorists considered “information gain” to be identical to “uncertainty reduction” relative to an unspecified previous level of knowledge (Kmetz 1998; Sayre 1976). Hintikka also defined information in terms of reduction in the receiver’s uncertainty and focused on measuring the amount of information rather than its content (1968, p312). Thus the telemetry school’s perspective assumed that information is devoid of context or meaning and derives from data that is processed for a specific purpose—namely for delivering a message and thus closing a connection (Kmetz 1998, p4; Mingers 1996). McKinney Jr. and Yoos (2010) refer to this view as the “token view,” in which information is indistinguishable from data.

3.1.2 Subjective View of Information

From a subjective viewpoint, information is contextual and concerns content and meaning. The proponents of this view—referred to as the content school by Kmetz (1998, p4)—distinguished between data and information and considered information as representation of data structured into meaningful symbols. This school also involves extracting meaning from streams of received data as well as acquiring and processing information for decision making (Kmetz 1998). Applying this thinking, Farace et al. (1977) defined information as “pattern recognition in matter and energy flows.” Thus, a stream of symbols lacking any discernible pattern lacks information; therefore, uncertainty is a lack of pattern or randomness in the stream of matter and energy flows (Kmetz 1998, p5). Farace et al. (1977, p23) also pointed out that information depends upon the perceiver and that no “objective” patterns exist that universally constitute information. Nauta (1972, p222) considered the pragmatic nature of information by making it clear that the uncertainty to be reduced is relative to particular goals and purposes. This view considered the actual content of messages by recognizing that what they convey to someone will depend upon that person’s prior knowledge and expectations, rather than being concerned only with the amount of information (Mingers 1996).

Applying a behavioral and social science perspective, MacKay (1956; 1969) defined information as some change in the cognition of the receiver, thereby explicitly incorporating meaning into information theory. Following this line of thinking, Checkland and Scholes (1990) defined information as the outcome of data and meaning. Accordingly, meanings that we perceive from information are socially or behaviorally mediated (Kmetz 1998, p5). Further, different observers may generate different information from the same data given their differing values, beliefs, and expectations (Lewis 1993). In developing the theory of meaning-constituting systems, Luhmann (1990) extended the notion that meaning generates information and that meaning is not primarily content but a function of selection. Similarly, some proponents of the content school, focusing on the social processes involved in communication, argue that information is not only the communicated content but the interpretation mediated by the context and focus on attributions made to nonverbal cues as well as the message itself (Kmetz 1998, p5).

Taking a different philosophical perspective within the content school, Dretske (1981) viewed information as a causal component of knowledge. Accordingly, signals carry information about their causes and origins (Mingers 1996). Dretske defined information as the propositional content of a signal, thus focusing on “what” the signal transmits. This view differed from MacKay (1956; 1969) and Luhmann’s (1990) view in that it considered information as a generator of meaning instead of meaning generating information (Mingers 1996). Ciborra (1993, p112) argued for a similar perspective on information:

Information is not simply interpreted data; rather, it is an argument to convince other decision makers. To be effective, it must have attributes other than exactness, clarity, etc.: rather than being purely objective, it must be convincing and adequate to the situation at hand.

Semiotic theories (Morris 1938; Stamper 1973; Stamper 1997), focusing on the production and interpretation of meaning, also relate to the subjective view of information. Semiotics refers to the study of signs and includes their representation, signification, and communication in a social context. The semiotic perspective suggests four types of information: a) empirical, relating to signal properties and transmission; b) syntactical, relating to systems of signs or symbols, including their relationships; c) semantic, relating to meaning of signs or symbols; and, d) pragmatic, relating to negotiated usage of signs or symbols (Mingers 1996).

One can also consider information (and consequently, information management) from a transactional perspective. As this perspective turns out to be particularly important for the development of our theory, I will discuss the transactional view of information (and information management) in detail in Chapter 4.

3.2 Information Management in Organizations

Information management refers to the application of management principles to the acquisition, organization, control, dissemination, and use of information relevant to the effective operation of organizations (Wilson 1997). Information management is critical to organizational performance. Therefore, organizations continuously strive to improve information management, both within organizational boundaries and with external partners. As a result, organizations select different configurations to align information requirements to information availability. In this section, I discuss key theories on information management that relate to this alignment.

3.2.1 Information Processing Model (March and Simon 1958; Galbraith 1974, 1977)

Drawing on March and Simon (1958), Galbraith analyzed the complexity of information processing in organizations (1977, p36). Galbraith considered the relationship between task uncertainty and variation in organizing modes and proposed a model linking organizational performance to information processing. The model suggested that, the greater the task uncertainty, the greater the amount of information that must be processed among decision makers during task execution in order to achieve a given level of performance. Galbraith argued that the basic effect of uncertainty was to limit the ability of the organization to preplan or to make decisions about activities in advance of their execution (1977, p36). While Galbraith's concept of uncertainty referred to a lack of information, he defined uncertainty differently from the telemetry school and considered it a general problem of meaning within the context of organizations (Kmetz 1998, p6). Galbraith argued that uncertainty is not inherent in the task, and therefore task analysis alone cannot determine the degree of uncertainty. He considered uncertainty to be the difference between the amount of information required to perform the task and the amount of information already possessed by the organization (1977, p37). Accordingly, two factors determine the information required for a task: 1) the nature of a task, in terms of diversity of goals and the internal diversity of the organization and 2) the level of performance

required. Thus, greater task uncertainty requires greater need for information, and higher level of organizational performance necessitates considering more alternatives, more variables, and more variables simultaneously (1977, p37).

Based on this argument, Galbraith (1974; 1977) proposed two general design strategies by which organizations can fill the information processing needs created by uncertainty. First, the organization can reduce the need for information processing by creating slack resources and by creating self-contained tasks. Second, the organization can increase the capacity to process information by building vertical information systems and by developing lateral relations. Galbraith's model was the first to explicitly consider an organization's performance in relation to its information processing needs (Kmetz 1998, p6).

3.2.2 Information Contingency Models (Daft and Lengel 1986; Daft and Macintosh 1981; Tushman and Nadler 1978)

Tushman and Nadler (1978) built on the view of organizations as information processing systems and extended this concept to develop a model of organizational design and structure. They adopted the contingency-theory concept of "fit" between organizational components and processes and argued that an organization is more effective when its information processing requirements match its information processing capacity. They suggested that uncertainty facing organizational units was a product of three groups of variables—sub-unit task characteristics, sub-unit task environment, and inter-unit task interdependence—which determined the organization's information processing requirements. Based on the information processing capacity of organizational sub-units, complexity of information processing requirements, and cost considerations, they suggested structures (such as rules and procedures, planning and control systems, and product teams) to coordinate activities of interdependent sub-units.

Drawing on organization theory, Daft and Lengel (1986) discussed two basic requirements to organizational information processing: task uncertainty and task equivocality. In distinguishing between uncertainty and equivocality, they argued that the principal underlying reason for organizational information processing was the need to cope with these two informational problems. Hence, Daft and Lengel differentiated Galbraith's (1974; 1977) concept of uncertainty from Weick's (1979) concept of equivocality. Galbraith referred to uncertainty as absence of

information. Thus, as additional information becomes available, uncertainty decreases. Weick defined equivocality as essentially synonymous with ambiguity—the existence of multiple and conflicting interpretations about an organizational situation (Daft and Macintosh 1981; Weick 1979). High ambiguity suggests confusion and lack of understanding but not lack of information. Thus, additional information is unlikely to reduce equivocality. From an information management perspective, Daft and Lengel's (1986) framework suggests a strategy in which an organization uses existing workflows to maximize information availability (and thus deal with uncertainty). Further, the framework suggests another strategy wherein the organization develops new workflows by incorporating information systems and developing relationships with internal and external partners to improve analytical capability (and thus deal with equivocality).

3.2.3 Organizational Structuring Model (Mintzberg 1979; 1980)

Similar to Galbraith (1974; 1977), Mintzberg argued that information processing requirements determine organizational structures. He suggested a typology of four ideal-type configurations of organizational structures based on coordination mechanisms required for different types of information processing: 1) simple structure, 2) machine bureaucracy, 3) professional bureaucracy, and 4) adhocracy. In addition, he suggested a fifth form—the divisionalized structure—in which any of these four forms can exist as sub-units of a superstructure. Drawing on Mintzberg (1979; 1980), we discuss these briefly here:

- A *simple structure* emerges in an environment characterized by low complexity and high uncertainty. It requires a high degree of centralization and direct supervision as the main coordinating mechanisms.
- A *machine bureaucracy* emerges in an environment characterized by low complexity and low uncertainty, as is the case in large organizations. It requires limited decentralization with standardized work processes.
- A *professional bureaucracy* emerges in an environment characterized by high complexity and low uncertainty. It involves work among autonomous specialists who achieve coordination through standardization of skills.
- An *adhocracy* emerges in an environment characterized by high complexity and high uncertainty. It emerges when “the organization is structured into work constellations to

which power is decentralized selectively and which are free to coordinate within and between them through mutual adjustment” (Mintzberg 1980). Here, the need for collaboration in decision-making is high, owing to the expertise of the support staff.

- Finally, a *divisionalized form* emerges as autonomous, market-based units within an organization that can control their own decisions. It exists as an aggregate superstructure that can split into sub-units according to custom, geography, product category, or as a solution to a specific problem. Coordination among such units occurs through standardization of outputs (Mintzberg 1980).

From an information management perspective, Mintzberg’s (1979; 1980) framework can inform organizational design strategies, as shown in Figure 3.2-1. Accordingly, a machine bureaucracy is suitable for tasks with low uncertainty and complexity; an adhocracy can provide decentralized decision making for tasks with high complexity and uncertainty; a professional bureaucracy is suitable for tasks with high complexity and low uncertainty; and a simple structure is suitable for tasks with low complexity and high uncertainty.

Figure 3.2-1 Mintzberg’s Organizational Structuring Model

		Uncertainty	
		Low	High
Complexity	High	Professional bureaucracy	Adhocracy
	Low	Machine bureaucracy	Simple structure

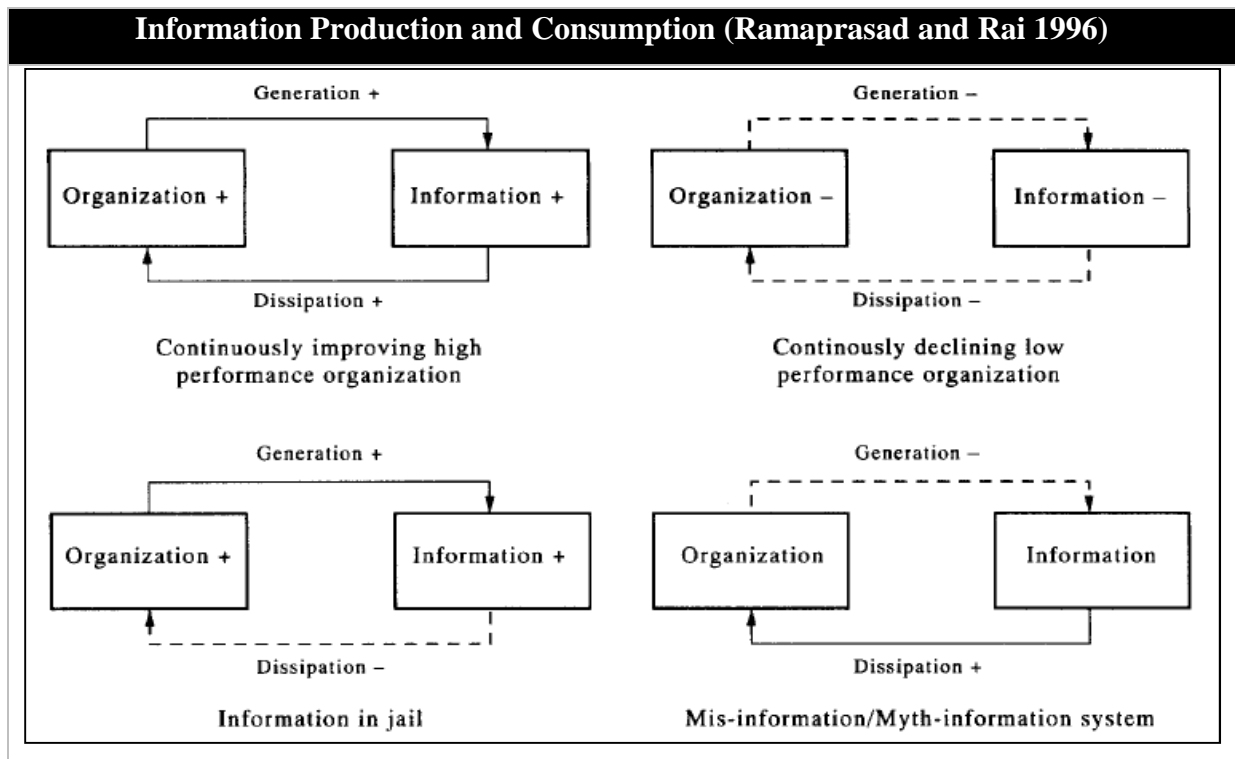
3.2.4 Information Production and Consumption Model (Ramaprasad and Rai 1996)

Ramaprasad and Rai (1996) suggested an information management model based on two continuous, complementary processes that are critical to organizational performance: 1) production (they used the term “generation”), which refers to creating information about an organization (for example, about entities or processes), and 2) consumption (“dissipation”), which refers to creating organization from information (for example, decision making, plan

formulation, and implementation). They proposed that, in effective organizations, there is a symbiotic relationship between information production and consumption. Thus, actors produce information about business phenomena by deriving meaning from stimuli in the organization and its environment. At the same time, actors consume information when they transform it into stimuli that support and guide organizational action.

Further, Ramaprasad and Rai (1996) suggested that any mismatch between production and consumption reduces organizational performance. Therefore, an organization must ensure that the information production-consumption cycle is positively reinforcing and that production and consumption are balanced. They argued that “a positively reinforcing cycle will result in a continuously learning, effective organization; a negatively reinforcing cycle will result in a decadent, ineffective organization.” Therefore, a cycle in which production and consumption are balanced is functional; lack of balance manifests itself as dysfunctions such as information overload, information in jail, and misinformation. Figure 3.2-2 depicts these four scenarios showing complementarity of information production and consumption in an organization.

Figure 3.2-2 Information Production and Consumption Scenarios



3.2.5 Organizational Information Services Model (Mathiassen and Sørensen 2008)

Mathiassen and Sørensen (2008) built upon existing theories of information management (Daft and Lengel 1986; Galbraith 1974; 1977; Mintzberg 1979; 1980; Ramaprasad and Rai 1996) and adopted information processing as an integrating concept in organizational design. Combining the notions of information processing options and information processing requirements, Mathiassen and Sørensen (2008) outlined a contingency theory that explains how organizations design, consume, and provide information services. They suggested that information exists as services in organizations, which enact in response to specific information processing requirements to support work, communication, and decision making within and across organizational boundaries. Further, they suggested that information services occur as heterogeneous portfolios of information processing capabilities enabled by people and IT. Organizational actors evoke these information services to execute tasks.

Drawing on the concepts of uncertainty and equivocality (Daft and Lengel 1986; Daft and Macintosh 1981; Tushman and Nadler 1978) and on Mintzberg's organizational structuring model (1979; 1980), Mathiassen and Sørensen (2008) distinguished between different types of information processing. Considering uncertainty, they suggested that some types of information processing focus on using readily available information (which involves low uncertainty), while other types of information processing focus on producing new information (which involves high uncertainty). Considering equivocality, in some cases, an organization can process available information in a straightforward and standardized manner (which involves low equivocality), thereby allowing the organization to develop standardized approaches across many tasks. In other cases, the involved actors can have diverging or even conflicting interpretations of a given situation (thereby involving high equivocality) which requires close interaction and dedicated analytical effort to resolve the problem. Following this line of thinking, and drawing on Galbraith's (1974; 1977) Information Processing Model, Mathiassen and Sørensen (2008) proposed that a fit is necessary between information requirements (which includes uncertainty and equivocality) and the portfolio of available information services that enable delivery of business services to the customer. Figure 3.2-3 shows the various types of information services.

Figure 3.2-3 Organizational Information Services Model

		Uncertainty	
		Low	High
Equivocality	High	Adaptive services	Collaborative services
	Low	Computational services	Networking services

The computational information services in Mathiassen and Sørensen's (2008) framework represent day-to-day processing of work that is low in equivocality and uncertainty; adaptive information services represent high equivocality and low uncertainty; networking services represent low equivocality and high uncertainty; and collaborative information services represent high equivocality and uncertainty.

Most of these theories of information systems rely on contingency models and have common underlying assumptions of information requirements, information processing, and organizational design options. Next, we discuss limitations of these theories in explaining information management in complex organizational settings.

3.3 Critique of Information Management Theory

Ciborra (1993) explored existing approaches to information systems (and by implication, to information management and information) and distinguished between two broad approaches: the data¹² approach and the decision approach. In the data approach, Ciborra argued, the role of information systems is limited to analyzing and designing the data flows in an organization. Further, the set of data obtained by examining all reports, files, and other sources constituted the information needed by the management. This is consistent with earlier findings by Munro and Davis (1977). However, this approach ignores the economic and social nature of information

¹² The data approach corresponds to the objective view of information (see Section 3.1). The decision approach corresponds roughly to the subjective view of information.

production and consumption in organizations (Ciborra 1993, p111). The decision approach goes beyond these limitations and focuses on the role of information systems in reducing uncertainty associated with the decision-making process. This approach—drawing on Simon (1977), Galbraith (1977), and Keen and Morton (1978)—is the dominant approach used to analyze information production and consumption in organizations. However, this approach “emphasizes control and feedback rather than communication processes” (Ciborra 1993, p111) and, therefore, suffers from other limitations. Specifically, the decision-making approach to information management tends have the following attributes:

- *Individualistic*: It focuses on decisions made by individual managers¹³ rather than in a collective manner. Most decision-oriented design strategies focus on the information needs and cognitive style of the individual decision maker (Ciborra 1993, p112) even though collective, coordinative problem-solving is the main task of organizations (Sproull and Kiesler 1991; Turoff and Hiltz 1982).
- *Common goals*: The decision-making approach assumes that all participants in an organization share common goals; information problems related to task execution and coordination are considered to be caused by environmental or technological uncertainty only (Ciborra 1993, p112). Therefore, this approach ignores the presence of cooperation and conflict between participants during a decision-making process, and it fails to account for phenomena such as misrepresentation, resistance, selective disclosure, lack of transparency, and exercise of authority based on information (p113). It does not account for opportunistic behavior by certain participants, which can result in additional information processing to ensure information reliability. Thus, the decision-making approach only considers uncertainty that characterizes the task, the technology, or the environment, and fails to consider uncertainty of a behavioral or strategic nature (p113).
- *Hierarchical*: Drawing on Arrow (1974), Simon (1981), and Wiseman (1988), the decision-making approach assumes that organizations are hierarchical in nature. In practice, however, one finds that “the boundary and structure of an organization are not indefinitely fixed: they change every time a manager implements a make or buy decision, or he/she decides to integrate or disintegrate a stage of the production process, an office

¹³ The increasing literature on Group Decision Support Systems addresses this issue to some extent, but most organizational contexts still reflect individual-centric decision-making processes.

or a department” (Ciborra 1993, p114). This assumption also suggests a central authority in any organization that is responsible for making decisions. However, organizations exist not only as large pyramidal structures that are managed as a bureaucracy, but also as a network of small firms, functional departments, work groups, teams, and informal peer groups (Piore and Sabel 1984). Moreover, decision making and information management also occur at multiple levels within organizations and across organizational boundaries. However, the current literature on information management fails to account for such distributed and multiple-level decision-making.

In addition, Ciborra implicitly criticizes the focus on tasks in traditional approaches to information management, including the decision-making approach. Many of these approaches reflect the traditional view of the firm (that is, they consider task, instead of exchange, as the basis of organization and organizational analysis). Consequently, with organizational structures designed around execution of tasks, the decision making and information systems become task focused. However, limitations of this task-focused view become apparent when considering IT-enabled information flows within and across organizational boundaries. For example, technologies such as remote patient monitors, remote ICUs, and telemedicine extend the traditional boundaries of healthcare organizations and, in effect, bring to focus the exchange-based nature of decision making and information management. Patients can send their vital data over telecommunication networks from their homes, through ICU specialists managing critical patients from remotely located control rooms, and through clinical specialists examining patients in remote locations by means of specialized equipment. The related decision making in this case is not focused on tasks but on exchanges—primarily, the exchange of information between the patients and care providers, between various functional units in the provider organization, and with external partners such as payers, laboratories, and pharmacies. The resulting information systems, and information management, have to take into account these exchanges.

Other researchers have also followed the transaction cost approach to IS (Ang and Straub 1998; Cordella 2006; Krickx 1995; Kumar and van Dissel 1996; Lacity and Willcocks 1995). However, as we will discuss in Chapter 4, none of these researchers has drawn on the transaction cost approach for theory building in relation to IT-enabled information management. Except for

Ciborra (1981; 1993), no studies have used the transaction cost approach to analyze information management in complex organizations, let alone in the context of healthcare organizations.

The role of IT artifacts (such as hardware and software applications) in information management, and their relationship to business processes, has also been under-emphasized in current IS literature (Benbasat and Zmud 2003; Orlikowski and Iacono 2006). Emphasizing IT artifacts, Mathiassen and Sørensen (2008) suggested a three-level architecture of IT-enabled information services: 1) the service level, in which business processes are executed; 2) the information level, in which information relating to business processes is produced and consumed; and 3) the artifact level, in which IT artifacts combine to support the service and information levels. One can also relate these levels to information management, in which the service level corresponds to transactions. Further articulation of these three levels and, in particular, examination of the relationship between them can help understand the challenges of IT-enabled information management in complex organizations.

To address these gaps, I seek to develop a new theory of information management in complex organizations drawing on empirical insights from the revenue cycle at EMC. These efforts rely on the subjective view of information, focusing on the context, meaning, and decision-enabling nature of information (Ciborra 1993, p112; Dretske 1981; Mingers 1996). Further, they build on existing theories of information management (Daft and Lengel 1986; Galbraith 1974; 1977; Mintzberg 1979; 1980) by adopting information processing as an integrating concept in organizational design. Specifically, we will consider information production and consumption (Mathiassen and Sørensen 2008; Ramaprasad and Rai 1996) as the foundation of information management in different revenue cycle activities at the hospital.

In addition, we explore and relate two aspects of information management in complex organizations currently ignored in IS literature: a focus on exchange (rather than task) and a focus on multiple decision-making centers. Taking the transaction cost approach to information systems (Ciborra 1993) can help to investigate the exchange focus in information management in complex organizations. I discuss this in Chapter 4.

However, the transaction cost approach alone does not provide a theoretical basis for explaining the non-hierarchical nature—and consequences—of decision making in organizations. To

achieve this objective, I draw on political science literature that discusses distributed decision-making centers and related governance in organizations. I present that discussion and relevant literature review in Chapter 5.

4 TRANSACTION COST THEORY

In this chapter, I first provide the conceptual foundations of the transaction cost approach to organizational analysis. Next, I consider the role of information systems and information management in transaction cost analysis. Subsequently, I consider the limitations of the transaction cost approach, which leads us to explore a complementary lens to understand information management in complex organizations.

4.1 Conceptual Foundations of Transaction Cost Theory

The transaction cost approach considers a transaction¹⁴ as the unit of analysis of organizational activity. This approach, first propounded by Commons (1934) and later elaborated upon by Coase (1937) in his essay, “The Nature of the Firm,” was a major departure from the existing micro-economic theory, which focused on a task as the unit of analysis of organizational activity. The traditional theory only included costs (such as production and transport costs) directly related to organizational tasks and neglected the costs of entering into and executing contracts as well as costs of managing the transaction. In his attempt to “discover why a firm emerges at all in a specialized exchange economy,” Coase (1937, p390) concluded that “why it is profitable to establish a firm would seem to be that there is a cost to the price mechanism.” These costs of “organizing” production through the market price mechanism include search and information costs (such as those involved in discovering what the relevant prices are), negotiating costs, and costs involved in creating and monitoring the execution of contracts for each exchange that takes place within a market. Such costs, referred to as transaction costs, can account for a considerable share of the total use of resources in an organization (and in the overall economy) but were not the focus of organizational economic analysis until Coase’s path-breaking work (for which he was awarded the Nobel Prize in Economics in 1991). Coase provided the *raison d’être* for a firm by suggesting that, under certain conditions, this form of contractual arrangement minimizes, although it does not eliminate, transaction costs. Further, Coase argued that a firm continues to grow until the costs of organizing additional transactions within the firm outweigh savings in

¹⁴ According to Williamson, “a transaction occurs when a good or service is transferred across a technologically separable interface” [Williamson, O.E. 1981. “The Economics of Organization: The Transaction Cost Approach,” *American Journal of Sociology* (87:3), pp 548-577.]

transaction costs. Thus, by explaining resource allocation within the firm and by means of market transaction, Coase paved way for the systematic analysis of firms.

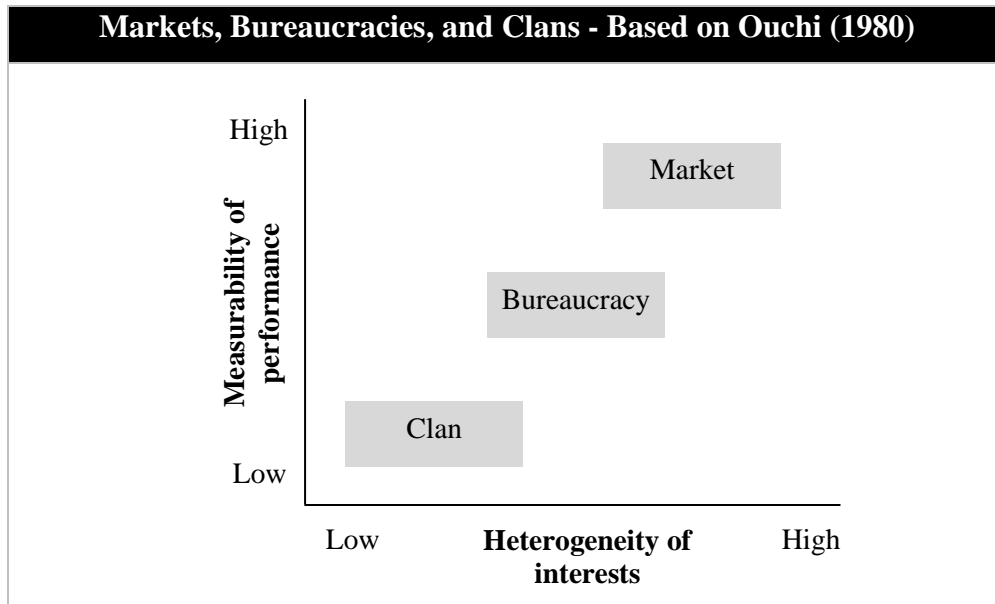
Subsequent researchers extended this line of thinking to explain the nature and complexity of transactions in different contexts and to examine the structuring and governance of transactions. In particular, Williamson (1975; 1981) explored alternative forms of economic organizations, such as markets, hierarchies, and teams, and how these were feasible mechanisms for governing transactions under different conditions. He suggested that the relative efficiency of these organizational forms determines which method of organization is optimal. For example, when compared to firms, markets generally have lower production cost, but the coordination cost associated with a market exchange is usually higher than the coordination cost inside a firm. Williamson (1975; 1981) suggested three features that can favor internal organization (that is, production within a firm) over market-based transactions:

- *Bounded Rationality*: This feature emphasizes that decision makers can act rationally only to a limited extent due to the constraints of future uncertainty and the complexity of problem solving. Further, decision making in the absence of relevant information can lead to sub-optimal outcomes, hence imposing additional transactional costs.
- *Opportunism*: This refers to the pursuit of (or incentives for) individual self-interest, possibly at the expense of wider system benefits (such as those occurring through increased organization slack and inefficient resource use).
- *Asset Specificity*: This arises when transactions require specific investments in physical and human assets. A direct consequence of this feature is the preference for long-term contractual arrangements since purchasers and providers would have invested human and other capital in drawing up service specifications and contracts.

Drawing on Coase's (1937) transaction cost approach, several researchers in economics and organizational theory have presented typologies of organizational forms (Alchian and Demsetz 1972; Arrow 1974; Ouchi 1979; Ouchi 1980; Williamson 1975; 1981). For the sake of simplicity, we discuss a representative typology of organizational forms suggested by Ouchi (1979; 1980). He identified three ideal-type mechanisms—markets, bureaucracies, and clans—based on contractual arrangements to govern transactions between interdependent individuals or

organizations. These mechanisms may be present in different degrees in any organization. Ouchi (1980) considered two contingencies to mediate transactions efficiently: 1) measurability of performance and 2) heterogeneity of interests between parties. Based on whether these contingencies were high or low in a given context, Ouchi suggested the three mechanisms discussed below (and shown in Figure 4.1-1):

- *Markets:* The market form of organization has a large number of agents that exchange products and services; there is competition among buyers and sellers (thus assuring equitability of the trade); there are no barriers to the transaction; and all parties have access to relevant information (for example, related to price and quality) to carry out the exchange (Ciborra 1993, p117). A market works as a decentralized control system in which an “invisible hand” guides the actions of participants based on rewards according to performance. Market structures are efficient when there is little ambiguity over performance; so parties can tolerate relatively high levels of opportunism or goal incongruence (Ouchi 1980). In other words, a market organization would be preferable when both the measurability of performance and the heterogeneity of interests are high.
- *Bureaucracies:* The bureaucratic form of organization is a hierarchical arrangement of transactions based on legitimate authority. In such organizations, a hierarchy of decision-makers set the goals and rules prescribing behaviors of selected participants and apportion rewards based on performance (Ciborra 1993, p117). Bureaucratic structures are efficient when both performance ambiguity and goal incongruence are moderately high (Ouchi 1980). In other words, a bureaucratic organization would be preferable when the measurability of performance and the heterogeneity of interests are moderately high.
- *Clans:* The clan form of organization relies on high identification among members, mutual sharing of goals, and internalization of norms, values, and traditions (Ciborra 1993, p117). Therefore, a clan structure has low goal incongruence while tolerating high levels of ambiguity (Ouchi 1980). In other words, a clan organization would be preferable when both the measurability of performance and the heterogeneity of interests are low. Thus, a clan is the obverse of the market organization; it achieves efficiency under opposite conditions (Ciborra 1993, p117).

Figure 4.1-1 Transaction Costs and Organizational Design

Based on contractual arrangements among participants, these organizational forms can also co-exist within an organization. For example, a large healthcare organization may have a formal bureaucratic structure that links its various units (such as hospitals, clinics, affiliated physician offices, and ERs) with the central office. These units may have an internal market that regulates the exchange of human, technical, and financial resources. Further, within each unit (such as a hospital) and in the central office, clan forms exist among physicians, managers, and other staff.

Interests between parties can be homogenous or heterogeneous (Ciborra 1993; Ouchi 1980). Further, heterogeneous interests can be converging or diverging. Taking the example of hospitals, the heterogeneity of interests between the patient and the provider is very high and diverging. The primary interest of the patient is to get quality care at the cheapest possible cost, while for the provider (the hospital, not the involved physicians) the interest is to maximize the reimbursement for the services provided to the patient. Even within the hospital, the interests may be heterogeneous and diverging: the business office may focus on maximizing the revenue reimbursement, while the physicians and nurses focus on providing quality care to the patient. Similarly, the interests of the patient and insurance company as well as the interests of the provider and insurance company are also heterogeneous and diverging.

In addition, the measurability of transactions can be low or high (Ciborra 1993; Ouchi 1980). In the case of hospitals, the measurability of a transaction between a patient and provider is low. The treatment of (or relief to) a patient might be elusive, or occur very slowly. The overall quality of care (at least from a patient's perspective) is therefore difficult to determine precisely. This ambiguity also makes the transactions between patients and providers more complex. Within a hospital, however, the measurability of a transaction is relatively higher (as compared to the measurability of quality of care). The exchanges between clinicians (that is, physicians, nurses, and allied staff) and administrative staff (such as billing, coding, and business office staff) are more straightforward and measurable (as they occur through the exchange of patient data within the hospital's EMR system).

Next, drawing on Williamson (1975; 1981; 1985) and others, I summarize the salient features of the transaction cost approach:

- Broadly, there are two types of transaction costs: 1) *ex ante*, which includes search and negotiating costs that are associated with reaching an exchange agreement, and 2) *ex post*, which includes costs relating to monitoring of outcomes, contract compliance, and, possibly, arbitration.
- Both parties involved in an exchange incur transaction costs; they must bear the costs relating to setting up, managing, and controlling the contractual arrangements that support a transaction.
- If transaction costs were zero, no firms would arise: all allocation would take place through simple contracts between individuals (Coase 1937).
- Transaction costs occur even if the transaction does not eventually occur. However, if no expectation of a transaction ever happened, the related transaction costs (for example, in making payment arrangements) would be low.
- Transactions differ in complexity. The complexity and cost to carry out a transaction are due to possible losses in defining and implementing the contract governing the transaction (Ciborra 1993, p115).
- Transactions can occur in an ad-hoc manner or they can be ongoing. For example, bureaucracies have permanent transaction costs associated, while markets can have ad-hoc transaction costs (for example, in a one-time market exchange) or permanent

transaction costs (for example, in repeated market exchanges, in which both parties must account for all relevant contingencies).

In recent years, several researchers have used the transaction cost perspective to explain a variety of organizational phenomena, including vertical integration (Jacobides 2005; Krickx 1995; Rangan et al. 1993; Ray et al. 2009), outsourcing (McIvor 2009; Williamson 2008), joint ventures (Hennart 1988), and international acquisitions (Hennart and Park 1993). In fact, Ciborra used the transaction cost perspective to define an organization as “a stable network of contractual arrangements to govern a set of transactions among individuals” (1993, p116). He argued that these contractual arrangements define how individuals join and coordinate their efforts to cope with the complexity of the task environment and exchange uncertainties (such as those arising from opportunism). As discussed in the next section, this argument has particular relevance in understanding the implications of information systems on organizations’ transactions.

4.2 Transaction Cost Approach to Information Systems

Information systems can lower market-related coordination costs and substantially improve transactional efficiencies through increased information sharing and communication capabilities, resulting in improved organizational performance (Gurbaxani and Whang 1991; Zhu and Kraemer 2005). In recent years, IS scholars have used the transaction cost approach as a common framework for understanding the choice of governance mode in economic activities in organizations. Several studies have applied this approach to explain the role of inter-organizational information systems (such as electronic markets) to improve collaboration and coordination with external partners (Kauffman and Mohtadi 2004; Kumar and van Dissel 1996; Sankaranarayanan and Sundararajan 2010). Other researchers have used the transaction cost approach to explain contemporary IS phenomena, including outsourcing (Ang and Straub 1998; Chen and Bharadwaj 2009; Lacity and Willcocks 1995; Nam et al. 1996) and e-commerce (Bakos 1998; Bakos et al. 2005). Most of these studies have focused on explaining how and why different technologies (such as electronic exchanges) and IS phenomena (such as outsourcing) help organizations to reduce coordination costs and improve overall productivity.

Although the transaction cost approach has been very valuable in explaining complex IS phenomena, few studies have used this approach to develop theory on organizational information

management. A notable exception is the work of Ciborra (1981; 1993), who considered a transaction as the basic unit of analysis and suggested that “management information systems can be appraised in terms of the reason that transactions use and produce information.” In this conceptualization, Ciborra (1993, p110) emphasized:

Organizations are not viewed as cybernetic clockworks but as institutional, contractual arrangements to govern set of transactions. The availability of better information through various data-processing devices may affect the efficiency differentials of alternative contractual arrangements and thus provide a powerful tool of organizational design.

Drawing on Williamson (1981), Ciborra (1993) suggested that the information processing costs related to transacting through negotiation of a contract can be grouped into four main classes, each governing a segment of the transaction life cycle:

- *Search costs*: These include costs necessary to set up the minimum social unit for the transaction.
- *Contracting costs*: These include costs related to the negotiation of the terms of the exchange and drawing up of the contract that regulates the transaction.
- *Control and regulation costs*: These include costs associated with the implementation of the contract under conditions of uncertainty, the policing of deviations from the contract terms, and the enforcement of sanctions to restore conditions suitable to the agreed upon terms.
- *Maintenance costs*: These include costs of resources employed to let the exchange develop from one phase to the next.

Other researchers have followed the transaction cost approach to information systems (Cordella 2006; Malone et al. 1987). However, no researchers have drawn on the transaction cost approach for theory building in relation to IT-enabled information management. Further, few studies have used the transaction cost approach to analyze IT-enabled information management in complex organizations, such as hospitals. One exception is a study by Ferguson and Keen (1996), which used this approach to analyze the impact of information and communication technologies in lowering transaction costs in UK’s National Health System by reducing “information imperfections” in hospitals. Moreover, in terms of methodological approach, most studies have

used quantitative methods to validate their hypotheses about the implications of transactions costs; few studies have used qualitative methods to explain the dynamics of information management in organizations.

Therefore, drawing on the transaction cost approach developed by Coase (1937) and Williamson (1975; 1981) and building on the ideas about information management from a transaction cost perspective developed by Ciborra (1993), this research investigates information management in an organization. This theoretical framing allows us to consider human transactions in a hospital as the basic context for theorizing information management. Further, it focuses its attention on how the basic conditions for delivery of healthcare services to patients affect information processing requirements and options.

While the transaction cost approach to IS facilitates an exchange-oriented analysis of decision making in organizations, it provides limited insight into how the decision making (and by implication, information management) occurs in multiple independent centers within and across organizational boundaries. The transaction cost approach assumes at least two centers of decision-making (one at each end of a transaction) and therefore accounts for distributed decision making to some extent. Nevertheless, as we noticed during our initial data analysis at EMC, organizations exist not only as large pyramidal structures that are managed as a bureaucracy but also as a network of small firms, functional departments, work groups, teams, and informal peer groups (Piore and Sabel 1984). These units (for example, physicians, nurses, payers, and billing specialists) exist as multiple nested centers of decision making that function independently or constitute an inter-dependent system of relations. Further, these independent decision-making centers have heterogeneous and (often) diverging interests. However, the transaction cost approach to IS does not pay explicit attention to organizational contexts involving fragmented authority with diverging interests.

Our initial data analysis at EMC also suggested that hospitals require context-dependent governance; they require different governance structures and contractual arrangements to facilitate coordination among the distributed decision-making units. The transaction cost approach to IS fails to account for context-dependent governance in complex organizations. Therefore, our challenge was to develop a theory of organizational information management that takes into account 1) a transaction between two parties, and 2) the high levels of fragmented

authority with diverging interests and context-dependent governance required to coordinate the transaction. The next chapter explores the latter aspect and presents a complementary theoretical lens to examine information management in complex organizations, such as hospitals.

5 POLYCENTRICITY THEORY

In this chapter, I introduce Polycentricity Theory as an intellectual tool to investigate information management in complex organizations. First, I discuss the conceptual foundations of Polycentricity Theory. Next, I conduct a literature review to identify some applications of the theory. Finally, I discuss a research opportunity: how we can develop Polycentricity Theory concepts to help understand information management in complex organizations, such as hospitals.

5.1 Conceptual Foundations of Polycentricity

In her Prize Lecture in Stockholm, Sweden, in December 2009, Dr. Elinor Ostrom, the Nobel Prize winner in Economic Sciences, discussed the governance of complex economic systems. By analyzing the use of common-pool resources¹⁵ among various communities around the world, Elinor Ostrom emphasized the value of polycentricity in understanding and managing complex human action situations. Polycentricity, she argued, may enable a better fit than a top-down hierarchical system of governance. Almost 50 years earlier, Elinor's husband, Vincent Ostrom, and his colleagues discussed polycentricity in the context of the organization of urban governments. Ostrom et al. (1961) described a polycentric system as "having many centers of decision making which were formally independent of each other." Vincent Ostrom was inspired by political thinkers such as Thomas Hobbes, James Madison, Alexander Hamilton, Woodrow Wilson, and Alexis de Tocqueville and discerned two enduring patterns of governance: a hierarchical order and a polycentric order (Sproule-Jones et al. 2008). The hierarchical order is based on a theory of sovereignty that exercised ultimate authority and exemplified in practice as an all-powerful *Leviathan* (Hobbes 1651). In contrast, the polycentric order represented in the self-governing communities of New England described by Tocqueville (1863) and in the constitutional democracy espoused by James Madison and Alexander Hamilton in *The Federalist Papers* (Madison et al. 1787).

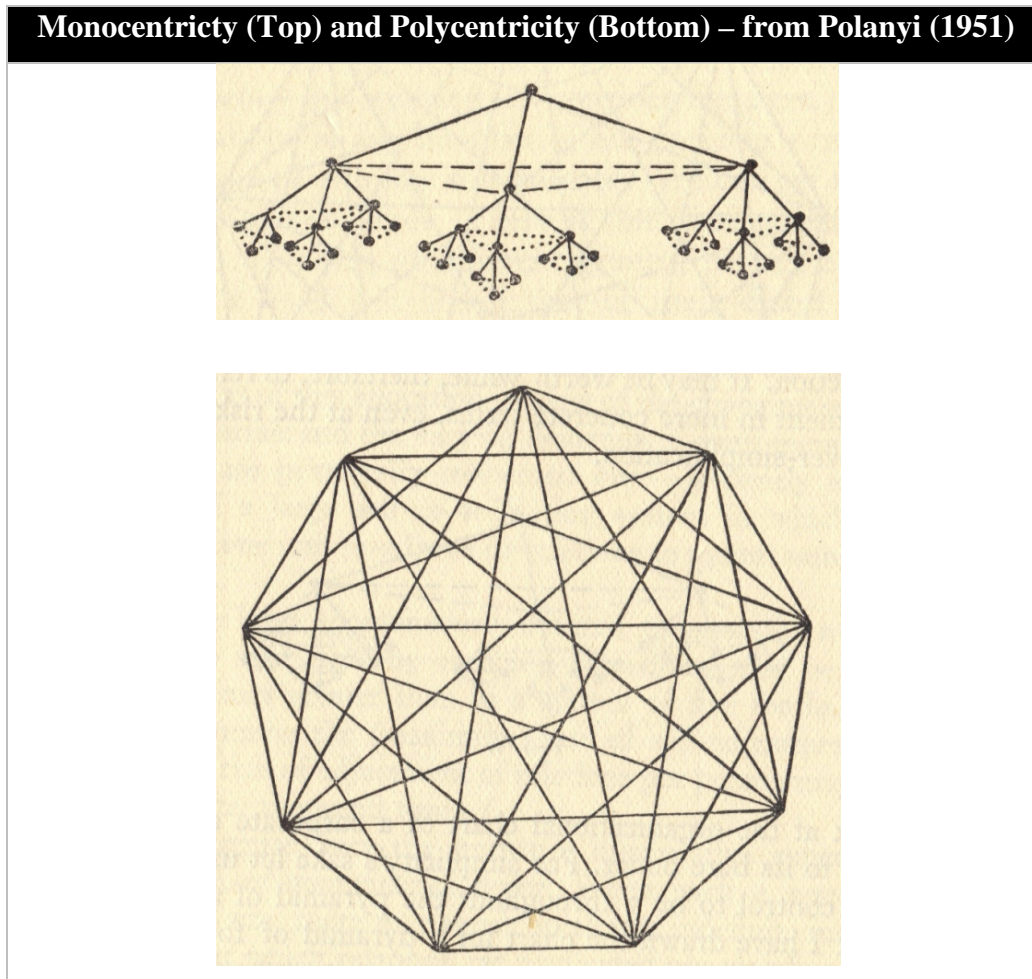
¹⁵ Common-pool resources (e.g., water, forests, and fisheries) have the following two characteristics: 1) they are subtractable (i.e., one person's use reduces the amount available for others) and 2) it is difficult to exclude or limit potential beneficiaries (users) once they are provided by nature or through activities of other individuals [Ostrom, E., Gardner, R., and Walker, J. 1994. *Rules, Games, and Common-Pool Resources*. Ann Arbor: University of Michigan Press.]

The term “polycentricity” was first introduced by Michael Polanyi (1891–1976) in *The Logic of Liberty*, a collection of essays published in 1951 (Ostrom 1972). Polanyi distinguished between two different methods of organization of social tasks: 1) a deliberate, monocentric order and 2) a spontaneous, polycentric order. In a monocentric order, an ultimate authority (like Hobbes’ Leviathan) coordinates by exercising control through a unified command structure (which Polanyi called a corporate structure). This centrally-directed structure can be conceptualized as a superior-subordinate relationship where a superior A may direct subordinates B1, B2, B3,...Bn to perform specific tasks or to accomplish particular missions (Ostrom 1972). In contrast, in a polycentric order,

Many elements are capable of making mutual adjustments for ordering their relationships with one another within a general system of rules where each element acts with independence of other elements. Within a set of rules, individual decision-makers will be free to pursue their own interest subject to the constraints inherent in the enforcement of those rules. (Ostrom 1972)

The existence of polycentricity does not preclude the possible existence of monocentricity (Ostrom 1972). In fact, monocentricity and polycentricity can co-exist and be equally effective, depending on context. Whether the governance of metropolitan areas, or any organizational unit, can be organized as a viable political system will depend upon various aspects of rule-making and rule-enforcing being performed in polycentric structures (Ostrom 1972). If individuals or units operating in a polycentric order have incentives to take actions to enforce general rules of conduct, then polycentricity will become an increasingly viable form of organization (Ostrom 1972). Polanyi emphasized such a general system of rules as providing a framework for ordering relationships in a polycentric system (Ostrom 1972). The notion of polycentricity maintains that there are independent sources of authority and judgment that act informally but collectively in determining community standards of behavior and the focus of collective (but voluntary) action (Ostrom 1972). Figure 5.1-1 shows typical monocentric and polycentric arrangements:

Figure 5.1-1 Monocentric and Polycentric Arrangements



The centers of decision making in a polycentric system may function independently or instead constitute an inter-dependent system of relations (Ostrom et al. 1961). Further,

To the extent that they take each other into account in competitive relationships, enter into various contractual and cooperative undertakings or have recourse to central mechanisms to resolve conflicts, the various political jurisdictions in a metropolitan area may function in a coherent manner with consistent and predictable patterns of interacting behavior. To the extent that this is so, they may be said to function as a “system.” (Ostrom et al. 1961)

Thus, a metropolitan area could be conceptualized as a polycentric political system in which ordered relationships underlie the “fragmentation of authority and overlapping jurisdictions” (Ostrom et al. 1961). These overlapping jurisdictions need not be inefficient or “pathological” because they created a duplication of services or functions. In this seminal article, Ostrom and

his colleagues (Ostrom et al. 1961) argued that such polycentric arrangements were, in fact, no less efficient than fully integrated systems with one governmental unit having exclusive jurisdiction over any particular metropolitan area. Vincent Ostrom argued later that the only condition for polycentric arrangements to be successful was that the agencies should offer “differentiated services that impinge upon diverse communities of interest” (1972). As a result, the overall performance of a polycentric system will depend upon the patterns of cooperation, competition, and conflict that may exist among its various units (Ostrom et al. 1961). A polycentric view should, therefore, explain the patterns of behavior observed in the organization of government in urban areas and predict the behavioral tendencies of such units.

Ostrom argued that both individuals and organizations could become the unit of analysis in a polycentric order. He stated:

Individuals are the basic unit of analysis. Individuals are assumed to be interested decision-makers who can calculate potential benefits and costs subject to elements of risks and uncertainty. Individuals will select those strategies which are anticipated to enhance their net welfare potential. Individuals may occupy positions where decisions are taken on behalf of the interests of others. All such cases will involve a choice from among strategic opportunities in light of potential payoffs derived in part from the calculation of power and liability contingencies where each choice is a move in a series of simultaneous games. *Business firms, legislatures, political parties, public agencies, or nation states may also be used as units of analysis where structural conditions expose the sets of individual decision-makers involved to similar strategic calculations.* (Ostrom 1972)
[Emphasis added]

5.2 Applications of Polycentricity Theory

I conducted a literature review to understand how researchers have applied the concept of polycentricity in different domains. I searched the ISI Web of Knowledge database using the following terms:

- “Polycentric” OR
- “Polycentrism” OR
- “Polycentricism” OR
- “Polycentricity”

The search, conducted in May 2011 produced 535 citations¹⁶. Table 5.2-1 shows a summary of this literature analysis. As the summary suggests, the fields of management, or information systems, have not utilized the potential of Polycentricity Theory. The healthcare literature also barely applied the concept of polycentricity.

Table 5.2-1: Polycentricity – Literature Analysis

Select Subject Areas	Number of Citations (Total = 535*)
Environmental Studies	131
Urban Studies	117
Geography	113
Economics	57
Planning and Development	47
Political Science	25
Microbiology	23
Biotechnology	19
Public Administration	16
Management (including Information Systems)	9
Health Policy and Health Services	4

**Some citations appear in counts for more than one subject area.*

Drawing on his earlier work (Ostrom et al. 1961), Vincent Ostrom examined polycentricity as a means of governing a wide variety of complex human transactions in different contexts: market structures, judicial decision making, constitutional rule, selection of political leadership and formation of political coalitions, and in the operation of public service economy (Ostrom 1972). Later studies by Vincent Ostrom, his colleagues and students further elaborated the concept of polycentricity. They used it to explain and provide alternative approaches to a wide variety of complex issues such as management of underground water resources (Ostrom 1962), sharing and maintaining forest resources (Poteete and Ostrom 2004a), determining strategies for coping with climate change caused by greenhouse emissions (Ostrom 2009), and governance of common pool resources (Ostrom et al. 1994).

¹⁶ These citations include articles, proceedings papers, book review, review, and editorial material.

The concept of polycentricity has also informed the debate about the structure and behavior of modern society. The German philosopher, Niklas Luhmann (1927–1998), examined ways in which the modern society, through social evolution, has developed into a social system with significant capacity for complexity management (Luhmann 1995). He maintained that the current society is developing towards a polycentric social system that applies different codes of self-observation related to different positions of observation in order to manage an increasingly complex environment (Luhmann 1995). In his book, *The Hypercomplex Society*, Qvortrup (2003) argued that the ability to manage this complexity will shape the differentiation of the current and emerging information society. Further, drawing on Luhmann’s notion of polycentricity, Qvortrup suggested the label “hypercomplexity” to understand the multiple levels of complexity in the post-industrial information society (2003, p4). According to the Theory of Hypercomplex Society,

We are developing towards a society with a large number of functionally differentiated centers, i.e., a polycentric society, in which the stabilizing factor is not a central guiding body, or social ideology, but the communication-based processes of coordination. Stability is then not the outcome of order and centralization, but of a high degree of complexity and decentralization. Here, information and communication technologies are not understood as determining factors, but as socially shaped technologies formed by the need for decentered processes of mutual observation and coordination among the social sub-centers. (Qvortrup 2003) [Emphasis added]

Polycentricity is similar to the concept of polycontextuality in logic. Polycontextuality represents a many-system logic, in which the classical logic systems (called contextures) interplay with each other, resulting in a complexity that is structurally different from the sum of its components (Kaehr and Mahler 1996). Gotthard Günter (1900–1984) first described polycontextuality (Günther 1973), and subsequent researchers have applied this multi-placed conceptualization to several phenomena, including polycentricity (Luhmann 1995; Qvortrup 1998; 2003).

In urban and regional planning literature, polycentrism refers to the organization of a region around several political, social, or financial centres (Davoudi 2003; Kloosterman and Musterd 2001; Shaw and Sykes 2004). Thus, a region is polycentric if its population (or industrial activity, transportation networks, etc.) distributes almost evenly among several centers (Taylor et

al. 2006). Examples of polycentric regions include the Ruhr area in Germany (van Houtum and Legendijk 2001), Los Angeles metropolitan area (Gordon and Richardson 1996), and San Francisco Bay Area (Cervero and Wu 1997). These city-regions have no single center, but several. As a result, several economic geographers and urban planning researchers have applied Polycentricity Theory to complex problems such as designing transportation networks to cope with growing urban conglomerations and overall regional planning (Davoudi 2003; Richardson and Jensen 2000).

In international business literature, Perlmutter (1969) used the concept of polycentricity to explain the evolution of management in multinational corporations. Perlmutter presented three stages of development of an organization as a multinational: 1) ethnocentric, in which decision making and control reside in the headquarters in the home country; 2) polycentric, in which decision making and control are determined locally; and 3) geocentric, which entails a collaborative, standards-based approach to decision making and control. In the polycentric approach, Perlmutter suggested, the multinational corporation staffs its workforce in foreign subsidiaries with as many local people as possible. The belief behind this strategy is that local management—with superior knowledge of the host country’s culture, language, and work ethic—is better suited to take decisions such as local product pricing and distribution. However, the parent organization reserves the right to review decisions of the local management and overrule if necessary. The parent organization in a polycentric structure may also intervene in case of any dispute between two local subsidiaries.

The concept of polycentricity also finds reference in the legal literature. Polycentric law is a legal structure in which providers of legal systems compete or overlap in a given jurisdiction, as opposed to monopolistic statutory law according to which there is a sole provider of law for each jurisdiction. Bell (1991) suggests that polycentric law might be helpful in alternative dispute resolution, private communities, and issues relating to the Internet. Cane (1996, p35) describes a polycentric issue as one which “involves a large number of interlocking and interacting interests and considerations.” Following Cane’s interpretation, the Supreme Court of Canada in *Pushpanathan v. Canada* (1998, p36) drew distinction between bipolar and multipolar contexts and explained that,

While judicial procedure is premised on a bipolar opposition of parties, interests, and factual discovery, *some problems require the consideration of numerous interests simultaneously, and the promulgation of solutions which concurrently balance benefits and costs for many different parties.* Where an administrative structure more closely resembles this model, courts will exercise restraint. [Emphasis added]

As Table 5.2-1 suggests, almost all the current work on polycentricity comes from Environmental Studies, Urban Studies, Geography, Economics, and Political Science. For many years, the Workshop in Political Theory and Policy Analysis at Indiana University has attracted researchers from different fields, with polycentricity as the unifying theme of their research. However, the concept of polycentricity (Ostrom et al. 1961) has potential to provide theoretical framing in organizational and healthcare contexts as well. In fact, the IS field has started to take note of polycentricity. In a recent article in the *MIS Quarterly*, Taylor et al. (2010) considered IS a polycentric field. Based on a longitudinal analysis of co-citation patterns of over 30,000 citations between 1986 and 2005, they found that the IS discipline has “shifted from fragmented adhocracy to a polycentric state” and reflects “a set of core concerns for the IS field,” rather than a single focus. These core concerns include some persistent themes (for example, IS strategy, group work and decision support, and IS development and use) and some shifting themes (for example, foundations and reference disciplines, internet applications, qualitative methods, and qualitative methods) that reflected in the academic IS literature over the 20-year period of study.

5.3 Polycentricity and Complexity

The current literature suggests two distinct views regarding the relationship between complexity and polycentricity: 1) polycentricity as a response to complexity, and 2) polycentricity as a cause of complexity. According to the first view, polycentricity enables multiple nested decision-making arrangements resulting in improved performance in some complex human action situations, such as governance in metropolitan areas, judicial decision making, and management of common pool resources (Ostrom et al. 1994; Ostrom 1972; Ostrom et al. 1961). Thus, polycentricity represents complexity of governance institutions, with flexible ties linking various independent units. The organization and management of these individual units are, to an appropriate degree, locally adapted and lead to diversity of meaning even within the same

organizational context. This leads to local patterns of “variety and redundancies” (Sproule-Jones et al. 2008), thereby making polycentric systems capable of responding to complex situations.

The second view, proposed by Luhmann (1995) in his book, *Theory of Social Systems*, suggests that polycentric structures and behaviors in modern society result in complexity. This view is particularly concerned with the reduction of complexity (Bruun 2008). Qvortrup argued that a new phase has emerged in the twentieth century in which complexity has been replaced by hypercomplexity, anthropocentrism by polycentrism, and unlimited rationality by bounded rationality (Qvortrup 2003, p6). As a result, coordination and information management across the various involved units lead to overall complexity of the system.

In this research, I consider polycentricity as an ontological statement about a human action situation; that is, polycentricity actually exists, or can exist, in human systems. Consequently, we consider both options feasible. Thus, polycentricity can occur as a response to complexity, suggesting that the fragmented decision-making can help to cope with the complexity of the organizational context. In addition, the fragmented nature of a polycentric system can also add to the existing level of complexity of an organizational context (by requiring appropriate governance mechanisms to coordinate exchanges between different functional units). I follow a descriptive view of polycentricity by focusing on how one organization dealt with polycentricity. In addition, although several studies have explored polycentricity as a system of multi-organizational arrangements, this research considers an organizational transaction as the level of analysis and assumes that other units and levels of analysis can build upon that foundation.

5.4 Key Theoretical Elements of Polycentricity

Based on a review of the literature, I sought to identify the key theoretical elements of Polycentricity Theory that relate to information management in complex organizational settings. The goal was to use these theoretical elements to anchor theory development and as possible starting points of data analysis. After several iterations, two elements emerged: 1) multiple nested centers of decision-making and 2) context-dependent governance. Table 5.4-1 shows recurring themes in polycentricity literature relating to these theoretical elements.

Table 5.4-1: Key Theoretical Elements in Polycentricity

Theoretical Element	Related Themes in Literature	Key References
Multiple nested centers of decision making	Multiple independent centers of decision making	Ostrom et al. (1961); Ostrom (1972)
	Fragmentation of authority	Ostrom (1972)
	Overlapping jurisdictions	Ostrom et al. (1961); Ostrom (1972)
	Diversity of meaning	Sproule-Jones et al. (2008)
	Intra-organizational and inter-organizational relationships	Ostrom (1972)
	Diverse communities of interest	Ostrom (1972)
Context-dependent governance	Context-dependent governance	Ostrom (1972)
	Patterns of cooperation, competition and conflict	Ostrom et al. (1961)
	Directed vs. spontaneous governance	Polanyi (1951)
	Self-governing communities	Tocqueville (1863)
	Coordination mechanisms	Poteete et al. (2004b)
	Local governance	Andersson and Ostrom (2008)
	Rules	Ostrom et al. (1961), Ostrom (2009)

Polanyi (1951), Ostrom et al. (1961), Ostrom (1972), and subsequent researchers have challenged the assumption of monocentric decision-making in organizational settings. They have argued that polycentric systems—multiple nested centers of decision making—can exist as viable entities. The notion of polycentricity maintains that there are multiple independent sources of authority and judgment that act informally but collectively in determining community standards of behavior and the focus of collective (but voluntary) action in a societal or organizational context (Ostrom 1972). This fragmented authority with overlapping jurisdictions is particularly applicable in case of complex organizations, where the workflows and information exchanges extend beyond functional and organizational boundaries (Tan et al. 2005) and therefore require multiple centers of decision making to respond to internal and external challenges.

To manage the fragmented authority in polycentric systems, organizations need to develop coordination mechanisms that can accommodate patterns of cooperation, competition, and conflict among the involved actors within and outside of the organizational boundaries (Ostrom et al. 1961; Poteete and Ostrom 2004b). In particular, complex organizations require different governance structures and contractual arrangements to facilitate coordination among the distributed decision-making units. These coordination mechanisms are often spontaneous, arising from informal adjustment among the involved actors to develop rules of engagement for the informational and other exchanges in the transaction.

5.5 Research Opportunity #2

While recent literature has explored complexity as a useful lens to understand the post-industrial society (Luhmann 1995; Qvortrup 2003) and organizations (Galbraith 1977; March and Simon 1958), information management in complex organizations is largely unexplored. Complex organizations exchange information with internal and external partners, they have multiple nested decision-making centers, and they constitute an inter-related system of relations that require context-dependent governance systems. As a result, complex organizations exemplify a polycentric system where “many elements are capable of making mutual adjustments for ordering their relationships with one another within a general system of rules where each element acts with independence of other elements” (Ostrom 1972).

Thus, Polycentricity Theory can offer a promising theoretical lens to understanding the multiple levels, and dynamics, of information management in complex organizations, such as hospitals. Therefore, this research seeks to develop Polycentricity Theory to explore the dynamics of information management in hospitals. Accordingly, our second research question forms as follows:

RQ2: How can Polycentricity Theory inform our understanding of information management in complex organizations?

► PART C: EMPIRICAL FOUNDATIONS

This part describes the empirical foundations for this study and includes the following:

- **Research Method (Chapter 6):** This chapter describes the research setting and the overall research design. It also describes the application of action research methodology, collaborative practice research, and employment of the principles of canonical action research.
- **Problem Solving Cycle (Chapter 7):** This chapter details the problem context, the problem-solving cycles we engaged in, and the areas and sequence of the involved interventions.
- **Data Collection and Analysis (Chapter 8):** This chapter presents the approach to data collection and data analysis in the research cycle.

6 RESEARCH METHODOLOGY

In this chapter, I discuss the overall research methodology to investigate IT-enabled transformation of information management in the revenue cycle at EMC. First, I describe the research setting and organization. Next, I discuss the specific research methodology—action research—that the research team used to facilitate problem solving and understand information management in the hospital. As part of this discussion, I state the philosophical perspective adopted for this research. Subsequently, I discuss the dual focus on problem solving and research as well as the collaborative and iterative process of this research. Finally, I evaluate the research process in terms of established canonical principles.

6.1 Research Setting

EMC is a small, acute care hospital located in the state of Georgia. It has a capacity of 72 beds, and provides many medical services, including ER, intensive care, medical surgery, radiology, women's health, laboratory, nursing home, operating room, and pharmacy. An after-hours urgent care facility has recently started to handle patients with non-life-threatening ailments, with the goal of reducing the ER workload.

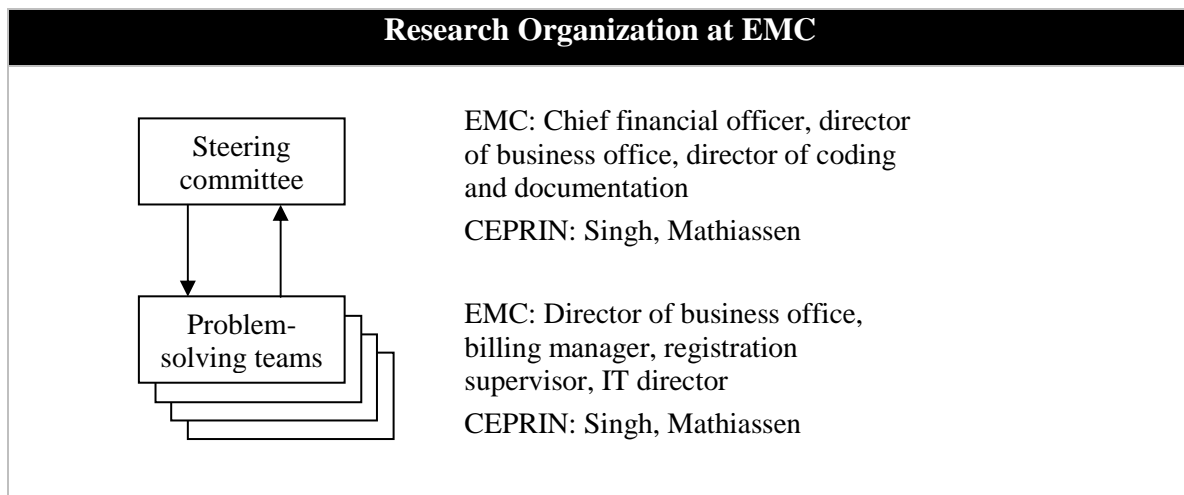
The hospital, founded in 1952, serves the medical needs of a largely rural county, where the poverty level is more than double of the national average (according to 2000 Census). The hospital operates as a public, non-profit organization. A publicly elected body, the County Hospital Authority, governs the overall functioning of the hospital. A Chief Operating Officer and his team are responsible for the day-to-day functioning of the hospital. About 280 full-time employees, including 12 physicians on medical staff, 80 nurses, 40 nursing assistants, and 35 technicians, provide healthcare services to patients. EMC has an IT staff of four people, including an IT director, who provide support for clinical and non-clinical applications. The number of patients receiving medical care at EMC varies seasonally; on average, about 1000 outpatients, 150 inpatients, and 1100 ER patients receive medical care each month. A majority of them are Medicaid-eligible or Medicare patients.

6.1.1 Research Organization

The research engagement was a close collaboration between the research team (which comprised of Professor Lars Mathiassen at CEPRIN and me) and key revenue cycle stakeholders at EMC. Initiated in March 2008, the engagement involved an action research project (involving several cycles of interventions) over a two-year period. Each intervention focused on improving the performance of EMC's revenue cycle. We first conducted a workshop at EMC during which we discussed the need for collaboration. EMC's chief financial officer became the primary sponsor and agreed to a broad agreement summarizing the objectives of the research collaboration. This researcher-client agreement established guidelines for functioning relations between research and practice. A grant from Georgia Research Alliance supported the research efforts.

Figure 6.1.1 illustrates the overall organization of the collaboration at EMC. Two interconnected stakeholder groups participated: 1) a steering committee, consisting of the two researchers, EMC's chief financial officer, the director of the business office, and the director of coding and documentation; and 2) problem-solving teams, consisting of both researchers and different managers at EMC. The composition of each team depended upon individual intervention needs.

Figure 6.1-1 Organization of the Collaboration at EMC



The initial workshop and hospital visits provided us with insight into the problem situation as perceived by revenue cycle stakeholders. We discussed, planned, and evaluated various options for interventions during monthly workshops and meetings with the chief financial officer and

other members of the steering committee. The EMC representatives on the problem-solving teams provided context and direction for implementing specific actions.¹⁷ We also conducted field observations of various stages of the revenue cycle (for example, registration and billing) and participated in staff meetings and training sessions. Our interactions with registration clerks, nurse managers, coding specialists, billing specialists, and IT representatives occurred through formal interviews, informal chats in hallways or in EMC's cafeteria, and occasional workshop discussions. All workshops and meetings were voice-recorded. We took detailed notes of discussions about any issues or questions needing further explanation and of any decisions made by the collaboration teams.

6.2 Research Design

We selected action research (Baskerville and Wood-Harper 1996; Checkland and Holwell 1998; Davison et al. 2004; Rapoport 1970; Susman and Evered 1978) as our research method to investigate and improve the problem situation at EMC. Rapoport (1970, p499) emphasized the dual goals of action research: “To contribute to both the practical concerns of people in an immediate problematic situation, and to the goals of social science by joint collaboration within a mutually acceptable ethical framework.” Following Rapoport, our interventions to improve information management in the revenue cycle at EMC had dual objectives.

The practical objective of the study was to identify opportunities for improvement of the revenue cycle at EMC in ways that reduce exceptions, increase revenue, and enhance overall hospital performance. To achieve that, we began by first identifying immediate problems relating to information management in the revenue cycle and subsequently designing interventions to address those problems. While we identified some of these problems during our initial visits to EMC (through a diagnostic mapping exercise—refer Appendix A.1), most other problems surfaced as we gained a better understanding of various stages of the revenue cycle over the next two years.

The research objective of the study was to understand the challenges of information management in complex organizations. Considering hospitals as complex systems, we wanted to investigate

¹⁷ Chapter 7 discusses the proposed actions, and Chapter 10 presents further context and evaluation of those actions.

information management challenges in a hospital and examine how IT can support information management to improve revenue cycle performance. Accordingly, we examined the information processing during various stages of the revenue cycle and considered information exchanges between departments within EMC and with external entities. Importantly, we considered how and when these information exchanges broke down. This examination allowed us to design IT-enabled interventions to improve specific information exchanges and overall information management in the revenue cycle at EMC.

The study explores the information processing and supporting technologies related to delivery of health services to patients. It also discusses ten interventions (grouped into four cases) to improve information management in EMC's revenue cycle. By a longitudinal, qualitative analysis (Miles and Huberman 1994) of data related to information exchanges associated with health service delivery and the interventions, the study takes initial steps to build a new theory (Eisenhardt 1989) for understanding information management in complex organizations rooted in the dynamics of polycentricity.

6.2.1 Philosophical Perspective

The research adopts a critical realism perspective (Archer et al. 1998; Bhaskar 1978). Various researchers have promoted the use of critical realism in IS research (Mingers 2004; Smith et al. 2005). However, this perspective has seen limited use in IS, where the dominant philosophical perspectives are positivist and interpretivist (Dobson 2001; Khoo and Robey 2007). Mingers (2004) proposed critical realism as an underpinning philosophy that can overcome some of the problems presented to IS researchers when trying to adopt purely positivist or interpretivist philosophies. In particular, critical realism overcomes these problems by advancing research through a combination of realism and social construction. Mingers stated, "Critical realism asserts that the conditions for knowledge do not arise in our minds but in the structure of reality, and that such knowledge will not be universal and ahistorical" (2004). He argued that critical realism re-establishes "a realist view of being in the ontological domain whilst accepting the relativism of knowledge as socially and historically conditioned in the epistemological domain."

Because action research uses intervention into real world settings as one of its tenets, critical realism is a well-aligned philosophical position to investigate IT-enabled interventions to

improve information management in the revenue cycle at EMC. Accordingly, we adopt a philosophical perspective that explicitly acknowledges the existence of an objective reality that can be studied and is worthy of attention from researchers while at the same time maintaining the value of a socially constructed reality. Mingers (2004) suggests that critical realism supports the use of multiple research methods, both quantitative and qualitative in nature. This is consistent with our choice of action research as a qualitative research method for our investigations.

6.3 Action Research Methodology

The engagement at EMC calls for research that is iterative, collaborative, and has organizational development and theory development as its primary goals. Accordingly, we followed McKay and Marshall (2001) and organized our research into two parallel and interacting cycles: the problem-solving cycle and the research cycle. We used collaborative practice research (Mathiassen 2002) as a specific type of action research, and worked closely with the revenue cycle professionals and related stakeholders to improve revenue cycle practices. Finally, in an effort to enhance both rigor and relevance of action research, we followed the five canonical principles and associated criteria suggested by Davison et al. (2004).

Action research as a mode of social research was developed by Kurt Lewin at the Research Centre for Group Dynamics of the University of Michigan to study the resolution of critical social problems within the framework of field theory (Lewin 1946). Lewin's pioneering approach combined "generation of theory with changing the social system through the researcher acting on or in the social system" (Susman and Evered 1978). Working independently, researchers at the Tavistock Clinic (later the Tavistock Institute of Human Relations) in Britain developed a similar method through their study of repatriated prisoners (Wilson et al. 1952). Thus, action research was intended to overcome some of the shortcomings of positivism and developed as a means of changing the system and generating critical knowledge about it (Baburoglu and Ravn 1992; Susman and Evered 1978).

Susman and Evered (1978) offer six beneficial characteristics of action research. First, action research is future oriented: the researcher purposefully acts to solve practical concerns of people. Second, action research is collaborative: the researcher is not a detached observer who merely comments, analyzes, or criticizes; instead, the researcher actively participates in both the

research and problem-solving aspects of a problem situation. Third, action research implies system development: the researcher “encourages the development of the capacity of a system to facilitate, maintain and regulate the cyclic process of diagnosing, action planning, action taking, evaluating and specifying learning” (Susman and Evered 1978). Fourth, action research generates theory grounded in action: while theory provides a guide for diagnosis of a problem situation and appropriate action taking, the actions themselves can inform theory through evaluation of action. Fifth, action research is agnostic: the researcher cannot fully know the theory and prescriptions for actions ahead of time; these are subject to reexamination and reformulation (based on consequences of the actions taken) throughout the research process. Finally, action research is situational: each research situation is unique, and the researcher takes action based on current understanding of the problem situation through interactions with involved stakeholders and upon achieving consensus on planned actions. Similarly, Baskerville and Wood-Harper (1998) suggested that action research is characterized by 1) its multivariate social setting, 2) its highly interpretive assumptions about observations, 3) intervention by the researcher, 4) participatory observation, and 5) the study of change in the social setting.

In recent years, researchers have suggested using action research to bridge the gap between rigor and relevance in IS research (Baskerville and Wood-Harper 1996; Keen 1991; Wood-Harper 1985). Following this call, many studies have successfully adopted and applied action research to implement IT-enabled organizational change, and to study the varied outcomes of such change (Baskerville and Pries-Heje 1999; de Vreede 1997; Iversen et al. 2004; Lindgren et al. 2004; Mårtensson and Lee 2004; Mathiassen 2002; Olesen and Myers 1999; Street and Meister 2004). Action research has also proven useful in investigations of the complex issues related to healthcare, and specifically the implementation and consequences of health-IT (Braa et al. 2007; Braa et al. 2004; Chiasson and Dexter 2001; Cornwall and Jewkes 1995; Davidson and Heslinga 2007; Kohli and Kettinger 2004; Lau and Hayward 2000; Ziegenfuss et al. 1998).

Several researchers have called for using action research for theory development (Baskerville and Pries-Heje 1999; Susman and Evered 1978). In a recent paper in MISQ, Mathiassen et al. (forthcoming) examined 83 action research articles published in 10 leading IS journals between 1982 and 2009, and identified five compositional styles based on the main contribution of these articles. Among them, problem-solving method is the dominant contribution style (34% of

articles), followed by field study (30%), research method (20%) and, to a lesser extent, experience report (11%). Theoretical development style was the least reported: only 5% (4 out of 83) of all articles contributed by presenting critique of existing theory or by developing new theoretical frameworks. Thus, the potential of using action research to develop new theory has been under-utilized in IS literature.

Despite its utility, action research presents some challenges for researchers. One major challenge is that the context of study is often evolving and unpredictable, and the researcher must adapt the research design and specific interventions to accommodate the changing context. As Checkland (1981, p153) noted,

The problem with action research arises from the fact that it cannot be wholly planned and directed down particular paths ... [The researcher] may express his research aims as hopes, but cannot with certainty design them into his “experiments.” He has to be prepared to act [based] on whatever happens in the research situation; he has to follow wherever the situation leads him or stop the research.

Another challenge that IS researchers face relates to reporting the complex and diverse insights that emerge in action research studies consistent with the requirements of leading academic journals (Mathiassen et al. forthcoming). Fully cognizant of these practical challenges, this research has adopted action research because it facilitates our two broad goals: organizational development and theory development. Further, as one particular form of engaged scholarship, action research allows us to obtain “different perspectives of key stakeholders (researchers, users, clients, sponsors, and practitioners) in studying complex problems” (Van de Ven 2007).

6.3.1 Dual Cycle Model of Action Research

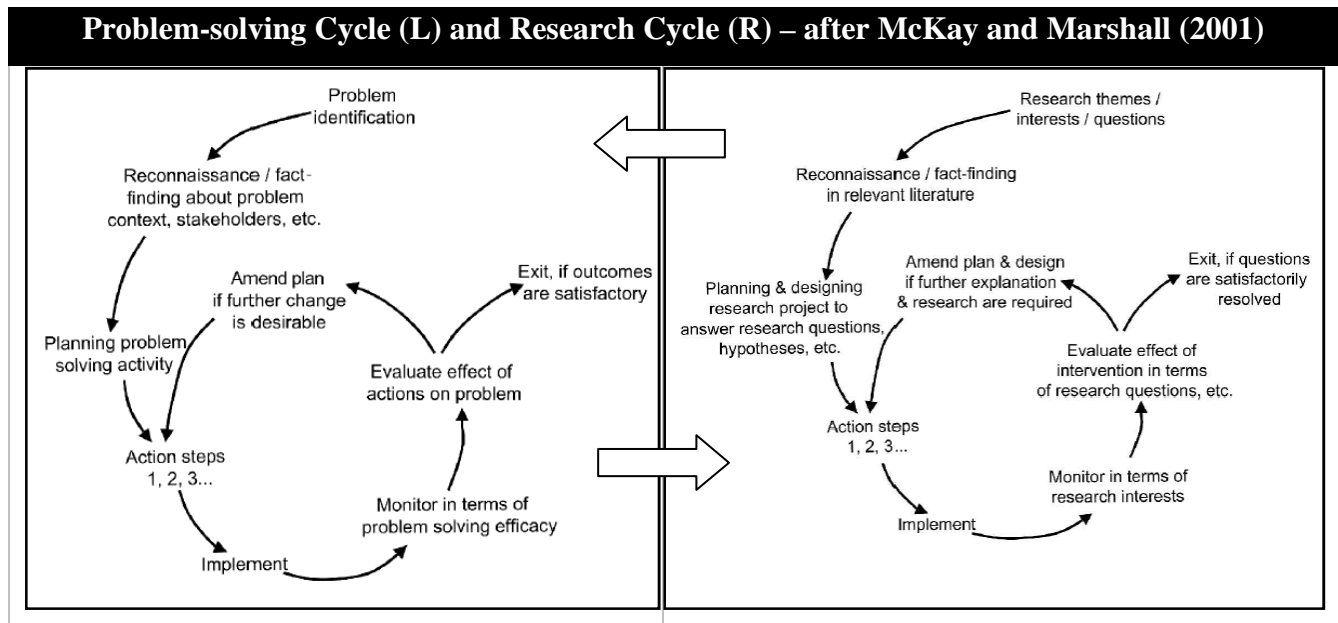
From the beginning, we focused on providing practical recommendations to EMC, and publishing meaningful research that emerged from the interventions. Drawing on McKay and Marshall (2001), the focus of the problem-solving cycle lies on diagnosing and finding a solution to a real-world problem situation, with the researcher working closely with key stakeholders in the problem-solving process. By emphasizing the analytic separation between the research and the problem-solving cycles, McKay and Marshall’s framework allows investigation into how knowledge is applied and discovered interactively between research and problem-solving

activities (Chiasson et al. 2008). Based on outcomes of planned interventions, the researcher may amend the action plan or exit the situation if the interventions result in satisfactory outcomes.

In contrast, the research cycle focuses on developing and evaluating theory, with the researcher beginning with an initial idea or area of research interest and subsequently adopting a theoretical framework of relevance. Following this, the researcher plans, designs, and monitors the outcomes of the interventions with the express purpose of finding answers to research questions, themes, or objectives (McKay and Marshall 2001). If the planned actions result in satisfactory answers to the research questions, the researcher exits the organizational setting; otherwise, the researcher amends the plans to seek further explanations. Evaluation of the outcomes may lead to reinforcement, withdrawal, or modification of the theoretical framework to reflect the realities of action-taking (Baskerville and Pries-Heje 1999).

This dual aim (that is, organizational development through the problem-solving cycle and theory development through the research cycle) provides a win-win scenario for both researcher and participants in an action research study by enhancing their skills and competencies (Chisholm and Elden 1993; Hult and Lennung 1980). Figure 5.3-1 depicts these two parallel cycles (the thick arrows show the ongoing exchanges of information and learning between them).

Figure 6.3-1 Dual Cycle Model of Action Research at EMC



6.3.2 Collaborative Practice Research

Drawing on McKay and Marshall's (2001) dual cycle framework, and responding to Minger's (2001) call for pluralist methods in IS research, Mathiassen (2002) suggested a new approach to action research, called collaborative practice research. By combining action research, experiments, and conventional practice studies, this approach strikes a useful balance between rigor and relevance. Collaborative practice research has successfully been applied in IS-related studies (Börjesson and Mathiassen 2005; Frederiksen and Mathiassen 2005; Holmqvist and Pessi 2006; Iversen et al. 2004). A similar approach has been applied to address issues for families of psychiatric patients (Galinsky 1993) and to facilitate improvements in community health (Lasker and Weiss 2003).

Iversen et al. (2004) suggested the following characteristics of collaborative practice research:

- Focus on understanding, developing support for, and improving specific professional practice in the participating organizations;
- Researchers and involved practitioners work in close collaboration to implement agreed upon activities;
- A pluralist methodology (Mingers 2001) guides the overall research process, with action research as the dominant approach and other conventional methods (such as case studies, literature reviews, or field experiments) as supplementary approaches; and
- Each collaborative practice research effort can lead to a portfolio of focused research initiatives based on ongoing and emerging problem-solving efforts in participating organizations (Chiasson et al. 2008; Mathiassen 2002).

6.3.3 Principles of Canonical Action Research

The importance of achieving rigor and relevance in IS research has been increasingly emphasized over the last 15 years (Applegate 1999; Benbasat and Zmud 1999; Lee 1999). Specifically, action research has faced criticism for lack of scientific rigor and close resemblance to consulting (Baskerville and Wood-Harper 1996). In response, Davison et al. (2004) have suggested five canonical action research principles to address these concerns. Each principle

offers specific criteria and questions that we used to ensure rigor and relevance in the context of our research at EMC.

6.3.3.1 Principle 1: The Researcher-Client Agreement

The Principle of the Researcher-Client Agreement (Davison et al. 2004) guided the action research project by describing the research team's roles and overall objectives. While there was no explicit agreement with EMC to follow principles of canonical action research, we used them to guide the research effort. Our initial agreement clearly specified the focus of the action research project at EMC: IT-enabled transformation of the revenue cycle to improve overall financial performance. On its part, EMC committed to the project and dedicated resources, time, and innovation efforts from senior managers. The chief financial officer became the sponsor of the initiative and identified EMC's representatives to the steering committee and the problem-solving teams (see Figure 6.1-1). The initial agreement clarified the roles and responsibilities of the involved actors: the two researchers, the steering committee, and the problem-solving teams. The agreement also described the evaluation criteria and key deliverables for individual collaboration interventions. Our research design explicitly acknowledges the interpretive nature of data collection methods. Accordingly, the agreement included data collection methods such as interviews, field study observations, reports from EMR system, internal communications, and workshops. Table 6.3-1 summarizes the evaluation of the criteria for the Principle of Researcher-Client Agreement.

Table 6.3-1 Criteria for the Researcher-Client Agreement

Principle 1 – Criteria for the Researcher-Client Agreement	Applied at EMC?
1a – Did both the researcher and the client agree that canonical action research was the appropriate approach for the organizational situation?	No
1b – Was the focus of the research project specified clearly and explicitly?	Yes
1c – Did the client make an explicit commitment to the project?	Yes
1d – Were the roles and responsibilities of the researcher and client organization members specified explicitly?	Yes
1e – Were project objectives and evaluation measures specified explicitly?	Yes
1f – Were the data collection and analysis methods specified explicitly?	Yes

6.3.3.2 Principle 2: The Cyclical Process Model

Davison et al.'s (2004) Principle of Cyclical Process Model focuses on the relationship between diagnosing and acting, and on the importance of dynamically adjusting the process based on ongoing evaluations. Instead of using Susman and Evered's (1978) single cycle model involving the five phases of diagnosing, action planning, action taking, evaluating, and specifying learning, we adopted McKay and Marshall's (2001) dual imperative model. By consciously selecting a model of interactive mixing of problem-solving and research activities (rather than allowing either of them to become dominant), we followed collaborative practice research (Chiasson et al. 2008; Mathiassen 2002). Hence, the knowledge from problem-solving cycle fed the research cycle, whereas knowledge from the research cycle applied to the problem-solving cycle. We often had to change our plans based on new knowledge about the challenges faced in the revenue cycle. We often discussed the intervention strategy and evaluation of results. The bi-monthly steering committee meetings provided a forum for ongoing evaluation and adjustment of the interventions. We took decisions to continue or drop interventions at these meetings. Table 6.3-2 summarizes the evaluation of the criteria for the Principle of Cyclical Process Model.

Table 6.3-2 Criteria for the Cyclical Process Model

Principle 2 – Criteria for the Cyclical Process Model	Applied at EMC?
2a – Did the project follow the cyclical process model or justify any deviation from it?	Yes
2b – Did the researcher conduct an independent diagnosis of the organizational situation?	Yes
2c – Were the planned actions based explicitly on the results of the diagnosis?	Yes
2d – Were the planned actions implemented and evaluated?	Yes
2e – Did the researcher reflect on the outcomes of the intervention?	Yes
2f – Was this reflection followed by an explicit decision on whether or not to proceed through an additional process cycle?	Yes
2g – Were the exit of the researcher and the conclusion of the project due to either the project objectives being met or some other clearly articulated justification?	Yes

6.3.3.3 Principle 3: Theory

Davison et al. (2004) suggested the Principle of Theory to guide the project and help to focus the research cycle. This principle ensures that the research activities remain grounded in theoretical reflections. During our collaboration with EMC, we understood that IT support for information

management would need to build on existing information management theories. However, as we evaluated the impact of our initial interventions and, in the process, gained a better understanding of the complexity of EMC's revenue cycle, we modified our theoretical framing to reflect the realities of our action-taking (Baskerville and Pries-Heje 1999). Specifically, to capture the observed complexity and the multiplicity of stakeholders with divergent interests in the revenue cycle, we took a transactional view of information processing, and considered the dynamics of information management in contexts involving multiple decision-making centers and related governance mechanisms. As a result, we combined theories of information management (Daft and Lengel 1986; Galbraith 1974; 1977; Mathiassen and Sørensen 2008; Ramaprasad and Rai 1996), Transaction Cost Theory (Ciborra 1981; 1993; Coase 1937; Williamson 1975; 1981), and Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961; Polanyi 1951). This selection of theoretical frameworks helped us to focus the research and evaluate the outcomes. Table 6.3-3 summarizes the evaluation of the criteria for the Principle of Theory.

Table 6.3-3 Criteria for the Principle of Theory

Principle 3 – Criteria for the Principle of Theory	Applied at EMC?
3a – Were the project activities guided by a theory or set of theories?	Yes
3b – Were the domain of investigation and the specific problem setting, relevant and significant to the interests of the researcher's community of peers and the client?	Yes
3c – Was a theory-based model used to derive the causes of the observed problem?	Yes
3d – Did the planned intervention follow from this theory-based model?	Yes
3e – Was the guiding theory, or any other theory, used to evaluate the outcomes of the intervention?	Yes

6.3.3.4 Principle 4: Change through Action

Davison et al.'s (2004) Principle of Change through Action ensures that researchers and clients identify and mutually agree upon a problem situation and work together to address it. According to this principle, the researchers must base their action planning upon stipulated causes. In discussions prior to agreeing on collaboration, both the researchers and EMC's steering committee expressed a desire to improve the problem situation (see Chapter 7 for a detailed discussion). While we were interested in understanding and improving information management

in the revenue cycle, EMC was motivated to reduce the delays and denials of billed claims and thereby improving the overall performance of EMC. Through interviews, observations, and initial workshop, the researchers and EMC specified several possible causes of the problem. The suggested interventions, agreed to after our discussions with EMC stakeholders, sought to address these causes. A comprehensive assessment occurred before and after each intervention. The research team worked closely with EMC based on collaborative practice research (Mathiassen 2002) and documented the process, including decisions, plans, assessments, and solutions. As a result, EMC remained committed to our research throughout the project and was appreciative of our efforts to support the design and implementation of IT-enabled interventions to improve the information management in their revenue cycle. Table 6.3-4 summarizes the evaluation of the criteria for the Principle of Change through Action.

Table 6.3-4 Criteria for the Principle of Change through Action

Principle 4 – Criteria for the Principle of Change through Action	Applied at EMC?
4a – Were both the researcher and client motivated to improve the situation?	Yes
4b – Were the problem and its hypothesized cause(s) specified because of the diagnosis?	Yes
4c – Were the planned actions designed to address the hypothesized cause(s)?	Yes
4d – Did the client approve the planned actions before implementation?	Yes
4e – Was the organization situation assessed comprehensively both before and after the intervention?	Yes
4f – Were the timing and nature of actions clearly and completely documented?	Yes

6.3.3.5 Principle 5: Learning through Reflection

Davison et al.'s (2004) fifth principle focuses on learning through reflection from both research and practical perspectives and helps researchers and clients to address the problem situation in a methodical way. In the workshop in March 2008, we discussed the problem situation with key EMC stakeholders and subsequently made initial recommendations for change. In each bi-monthly steering committee meeting thereafter, we gave an update on the status of each intervention, and identified and discussed items needing more attention. We also had several off-site meetings in which we assessed progress of ongoing interventions, explored possible research

contributions, and discussed ways to ensure rigorous data collection and organize preliminary analyses. Table 6.3-5 summarizes our evaluation of the Principle of Learning through Reflection.

Table 6.3-5 Criteria for the Principle of Learning through Reflection

Principle 5 – Criteria for the Principle of Learning through Reflection	Applied at EMC?
5a – Did the researcher provide progress reports to the client and organizational members?	Yes
5b – Did both the researcher and the client reflect upon the outcomes of the project?	Yes
5c – Were the research activities and outcomes reported clearly and completely?	Yes
5d – Were the results considered in terms of implications for further action in this situation?	Yes
5e – Were the results considered in terms of implications for action to be taken in related research domains?	Yes
5f – Were the results considered in terms of implications for the research community (general knowledge, informing / re-informing theory)?	Yes
5g – Were the results considered in terms of the general applicability of canonical action research?	Yes

In summary, by applying existing information management theories, Transaction Cost Theory and Polycentricity Theory as theoretical framing and action research as the method of investigation, we engaged in iterative problem solving at EMC through multiple cycles of planned interventions and observation of outcomes. These interventions provided rich data and deep insights into IT-enabled transformation of information management practices in EMC's revenue cycle.

7 PROBLEM-SOLVING CYCLE

In this chapter, I first discuss the problem situation at EMC. Next, I discuss how the research team used a diagnostic mapping technique to identify the problem situation, including the challenges relating to EMC's revenue cycle. Subsequently, I discuss the initial portfolio of interventions proposed by the research team to resolve the problem situation.

7.1 Problem Situation at EMC

In 2008, when we began our research engagement at EMC, the hospital was beginning to experience the effects of the severe slowdown in the local and regional economy. The unemployment rate in the county started to increase, and fewer patients (especially as inpatients—see Appendix C.1) came to the hospital to receive medical services. The economic slowdown forced EMC to reduce its service offerings (for example, closing of a rural health clinic), lay off some nursing and other staff, reduce benefits for all employees, and reduce working hours (32 hours per week instead of 40) for many employees. EMC's deteriorating revenue cycle performance resulted in fewer resources to invest in the maintenance of critical infrastructure, such as the EMR system. This situation made it imperative for EMC's management to look for ways to improve its financial performance and sustain its health service delivery.

After our initial meetings with EMC's key stakeholders, it became clear that the hospital was losing a substantial (but unknown) amount of revenue, which affected its ability to sustain its operations. The research team understood that EMC's focus was on providing healthcare, and therefore, the clinical staff (that is, physicians, nurses, and allied staff) paid little attention to reimbursement issues associated with delivery of the healthcare services. In March 2008, the research team conducted a full-day workshop at EMC to identify specific challenges related to its revenue cycle, and to discuss possible solutions to improve reimbursement for medical services provided to patients. We believed that if we could identify ways to increase the focus on reimbursement issues, then many of the problems faced by the hospital—chiefly, sustaining the healthcare operations amidst the economic slowdown—would be resolved.

EMC's chief financial officer represented the hospital at the workshop. In addition, we also invited representatives from similar hospitals in the region. The purpose was to get different perspectives on challenges related to the revenue cycle and possible solutions. We also hoped that discussions among these representatives would provide them, and us, with a richer understanding of problems and potential solutions. In all, nine representatives from five regional healthcare institutions participated in the workshop.

In the first half of the workshop, we asked each participant to list key challenges relating to the revenue cycle, and group the challenges according to key stages of the cycle (such as patient scheduling, patient registration, patient encounter, clinical documentation, medical charge coding, and billing). In the second half of the workshop, we opened the floor to discussing broader perspectives on each problem and its potential solutions. These discussions were very informative and further clarified the picture, allowing us to later compile and further explore challenges and potential solutions. It became apparent that EMC and the other hospitals shared similar problems (such as losing revenue) and struggled with inefficiencies in key revenue cycle stages that affected their financial performance. Thus, the workshop gave us an initial sense of the complexity and scope of challenges faced by EMC and similar healthcare institutions.

After the workshop, we conducted a full-day site-visit to EMC in April 2008. During the visit, we observed first-hand various stages of the revenue cycle, such as patient registration, patient encounter, coding, billing, and business office operations. We interviewed managers, and clinical and non-clinical staff, eliciting information about their day-to-day challenges. These discussions helped us to understand further the various challenges relating to EMC's revenue cycle. Subsequently, the research team conducted a detailed diagnosis of the problem situation by adopting a diagnostic mapping technique.

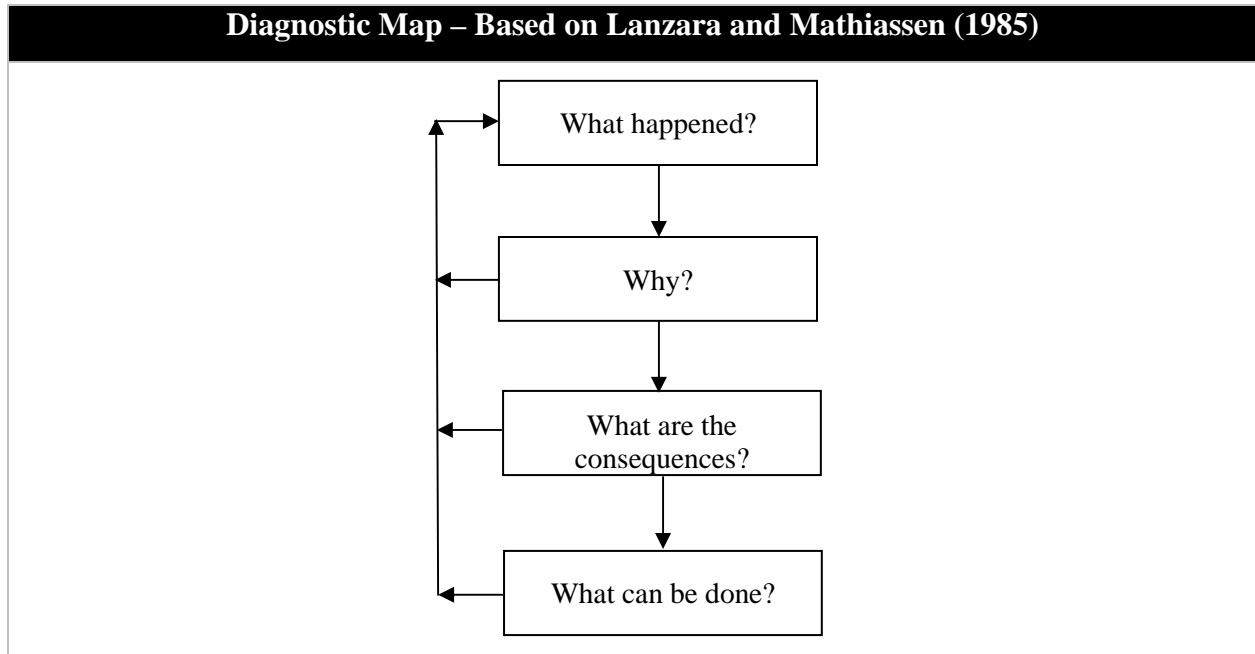
7.2 Diagnostic Mapping of Problem Situation at EMC

The purpose of diagnostic maps¹⁸ is to relate situations specifically perceived as problems (anomalies, failures) to sources and to more general organizational or behavioral features

¹⁸ A map is an interpretive description of a situation, which provides insight into possible ways of acting on that situation or on similar situations. Maps are, like all descriptions, incomplete, but they contain some knowledge about the situation, which might be useful for understanding and undertaking action. By drawing a map we can select and

(Lanzara and Mathiassen 1985). Diagnostic maps locate and describe existing problems and dysfunctional responses in the organization (as perceived and accounted for by the actors). Figure 7.2-1 shows the basic pattern of a diagnostic map.

Figure 7.2-1 Basic Pattern of a Diagnostic Map



According to Lanzara and Mathiassen (1985), the basis of diagnostic maps is the idea of causation: a problem situation (what happened?) has a cause (why?) and effects (what are the consequences?). By answering these questions in a structured manner, the diagnostic mapping technique forces a researcher to examine a given situation as a specific problem, viewing it as the cause or consequence of other problems within the framework of other maps. Thus, diagnostic mapping provides a practical approach to structuring information about a problem situation that point towards possible interventions (what can be done?). Following Lanzara and Mathiassen (1985), we discuss the questions that a researcher must ask before an intervention:

- *What happened?* Actors identify problems, failures, or anomalies. They see the situation as problematic and attempt to explain the problem. A key feature of the diagnostic map is

attach meaning to some elements or events instead of others [Lanzara, G.F., and Mathiassen, L. 1985. "Mapping Situations within a System Development Project," *Information & Management* (8:1), pp 3-20.]

that it requires actors to see the situation as a specific problem. Based on the information from other questions, the researcher may iteratively reformulate the problem. However, the interpretation of the situation expressed through the problem is the focus of the analysis, to which possible causes, consequences, and alternatives are then related.

- *Why?* Actors formulate general or specific theories about what happened in the situation by inquiring about possible causes, and then provide possible explanations. Actors may
 - List acknowledged or perceived causes, or actions that might be causing the problem,
 - Assess to what extent a perceived cause or action is relevant to the problem,
 - Check for incoherence or inconsistency between different sources,
 - Provide evidence for what they account for as a source of the problem, or
 - Produce alternative explanations that might expose other maps, and this in turn might reveal conflicts and dilemmas embedded in contradictory explanations.
- *What are the consequences?* Actors assess the consequences of the problem, which may be observable in the situation at hand or may occur in the future. This facilitates evaluation of the interpretation of the situation: is it a serious problem? For whom is it a problem? One possible outcome of this process is to drop the chosen problem and return to a new interpretation of the situation. Evaluating the importance of the problem is a valuable step before undertaking any correcting and restructuring action.
- *What can be done?* Actors attempt to restructure the situation by designing options for action. They project the existing situation into a desired one; going from evaluation of consequences of existing problems to positive statements about a possible future. The actors begin by considering the conditions and possibilities within their domain of action, and iteratively address the desired goals and future states that are achievable through intervention in the situation.

Following these principles, the research team created the diagnostic map (refer A.1 in Appendix A) based on discussions with key stakeholders and field observations during the initial visits to EMC. The map allowed us to develop both a collectively shared awareness of the problem and a joint commitment to action. However, this map goes beyond providing just descriptions of the problem situation; it helped relate to the actions and choices of the research team and to the existing conditions at EMC. To improve validity of the diagnostic analysis, the research team

sought feedback from key stakeholders and, as a result, further refined it. By performing this joint diagnostic activity, the research team and EMC stakeholders came to share a common understanding of the problem situation and of possible interventions.

Based on the diagnostic mapping at EMC, I summarize the main points of the research team's understanding of the problem situation relating to the revenue cycle:

- The insurance payers rejected a large number of claims submitted by EMC because of errors (that is, exceptions) originating in different areas of the revenue cycle, such as registration, patient encounter, documentation, coding, and billing. We identified over 30 types of exceptions relating to the registration task alone, including incorrect payer information, incorrect primary insurance subscriber information, and missing pre-authorizations. EMC had no estimate of these rejected claims over any given period.
- The billing department at EMC was spending about 80% of its time handling exceptions created upstream in the revenue cycle. A majority of these exceptions occurred in the registration department. As the billing manager told us, they saw the same exceptions occurring all the time. For example, incorrect insurance payer information was among the top exceptions each month.
- EMC did not collect appropriate co-payments (typically 10 or 20 dollars, depending upon insurance benefit) during patient registration, primarily because the registration clerk had no system to confirm how much a particular patient owed. Some patients did not have any cash (or other form of payment, such as a check or credit card) at hand, and many patients claimed they had no money at all. This lack of timely verification of patient benefit resulted in revenue loss to EMC.
- EMC was not charging for some of the medical services it was providing to patients. For example, when the clinical documentation staff applied charge for a diagnostic test (such as an X-Ray to identify a broken bone), the related medical service (in this case, application of plaster cast) was not always included. A nurse manager told us that there were “probably many such cases, but we have no way to know.”
- EMC did not properly verify insurance eligibility for patients arriving for inpatient admissions or for outpatient procedures. As a result, the insurance payers rejected claims in which the medical service provided exceeded the patient's eligibility. Thus, lack of

timely verification of patient eligibility (before EMC provided medical service to the patient) resulted in revenue loss to the hospital.

Broadly, these problems fit into two categories: some result in delays in payment (suggesting, for example, a need to provide accurate and complete information during registration) and others result in denials of payment and lost revenue (suggesting, for example, a need to provide adequate clinical documentation to support the highest possible code). We address both categories of problems in our interventions.

7.3 Proposed Interventions at EMC

Against this backdrop, the research team first considered developing a system to record the major exceptions in each stage of the reimbursement cycle; this would allow tracking them over a period and know where to focus our efforts. Further, EMC lacked a system to track the amount of claims submitted to payers (for medical services provided to patients), what it could have claimed for those services (by not missing any procedures and treatments that were given to the patient), and what was finally reimbursed by the various payers. If we could compile and publish the claim-related financial information, it would help to focus on “the money left on the table” by identifying ways in which the claimed amounts matched the charges for the services provided by the hospital and the amount reimbursed by the payers. However, as discussed in Chapter 2, EMC was a resource-constrained organization: they had few IT personnel to create the required information systems, and little or no budget to buy such systems. Therefore, the question before the research team was, how can we obtain the information in a cost-effective manner?

Prior research experience and technical expertise of the research team helped in this process. The research team considered ways of using IT to develop appropriate interventions in EMC’s revenue cycle. One option was to focus on the front-end; that is, beginning with the admissions process, which included scheduling, pre-registration insurance verification, and registration. The registration department had high turnover, so the staff was typically new and inexperienced. As a result, the registration staff did not always understand the implications of their actions. For them, a missed field, such as payer information on the EMR system’s registration screen, was not a significant cause of delays in reimbursement or denials of claims (although it led to a revenue loss for EMC). Therefore, there was a need for some education for the registration staff, and

across the revenue cycle, including better understanding of what the process was, what the problems were, and how each person could help to improve the process.

Based on this initial understanding of the problems in the revenue cycle, the research team's goal was to create an efficient and effective reimbursement system. However, since EMC was financially constrained, any potential solution had to be a low cost one. Thinking thus, the research team communicated an initial diagnosis of the problem situation at EMC and proposed some possible ways forward (see Table 7.3-1). This communication became the basis of our interventions.

Table 7.3-1 Initial Diagnosis and Proposed Interventions at EMC

Excerpt from communication to EMC's chief financial officer in April 2008

We thank you for inviting us to visit your hospital and meet with your colleagues. We had very interesting and fruitful discussions at the workshop and during the hospital visit. We look forward to continuing and strengthening this collaborative relationship with your hospital.

During the hospital visit, we met with key people involved in the various activities of the reimbursement process. We had opportunity to observe the details of the process, we discussed the different exceptions and breakdowns that typically occur, and we discussed what management information was currently collected about, or related to, reimbursement for medical services to patients. The workshop and the subsequent hospital visit gave many important insights:

1. *Patient information validation:* There is a need to identify ways to improve the validity of patient information to ensure follow-up and access.
2. *Insurance eligibility and co-payment verification:* It is essential to verify eligible insurance benefits and related co-payment systematically for all patients during admission process and before any patient encounter. This can be achieved either through manual procedures or through adoption of verification software. Both options should be analyzed from a cost-benefit standpoint and one of them should be implemented.
3. *Patient charge capture:* At present, there is no standardized way to capture and monitor charges for all services provided to the patient. Unless such a system is in place, many charges will continue to be missed.
4. *Exception improvement tracking:* Currently, exceptions are tracked through the reports generated by the EMR system. Additionally, there is a need to aggregate exception

information for admission, coding, billing and other tasks each month and then start comparing it across months. Such monitoring would help to identify, track, and support improvements in the reimbursement process.

5. *Reallocate exception handling*: Currently, most exceptions are identified and fixed during the billing process. A reallocation should be based on the principle that the place where exceptions were caused should be accountable for fixing them. Therefore, while exceptions may be identified during billing, they should be aggregated and fed back to the responsible department for reprocessing. Such practices are likely to support learning and lead to fewer future exceptions.
6. *Information-based accountability*: There is a need to develop accountability at individual and department level so people use and act on information available about exceptions and improvement initiatives. This should be facilitated by joint management interventions and support.

Thus, following collaborative practice research methodology (Chiasson et al. 2008; Mathiassen 2002), the diagnosis of the problem situation led to a portfolio of focused interventions. As we dug deeper into EMC's revenue cycle and related activities over the next two years, other problems surfaced that required additional interventions. Moreover, as we gained more knowledge about the revenue cycle, we modified each intervention cycle for better alignment with the objectives of the action research project. Thus, during the entire period of action research engagement, we continued to evaluate and refine current interventions and add new interventions. For each intervention, we worked closely with the steering committee and individual problem-solving teams. The sequence of specific interventions was not always pre-determined; at times, it emerged as the problem-solving cycle progressed.

Chapter 10 describes the context of these interventions in detail. The design, implementation, and review of outcomes of these interventions provided rich data that allowed us to gain better understanding of the revenue cycle related challenges faced by EMC. We also gained better understanding of the informational challenges as well as the specific information consumed and produced at each stage of the revenue cycle.

8 DATA COLLECTION AND ANALYSIS

In this chapter, I discuss the data collection and analysis procedures used in this research. First, I discuss the data collection, including identification of primary and secondary data sources at the research site, EMC. Next, I discuss the analysis of the data collected between March 2008 and April 2010, with a follow up visit to EMC in June 2011.

8.1 Data Collection

In our interventions at EMC, we sought to 1) examine how IT-enabled information can support a hospital's revenue cycle and 2) explore how Polycentricity Theory can inform our understanding of information management in complex organizations. To achieve these objectives, we investigated information exchanges related to the revenue cycle within EMC and with its external partners. Importantly, we considered the challenges in these information exchanges. This data became the basis of designing IT-enabled interventions to improve specific information exchanges and overall information management at EMC. With a set of ten interventions (grouped into four cases) that focused on improving EMC's revenue cycle, we sought to develop and illustrate our theory (that is, Information Polycentricity Framework, IPF) with empirical observations (Eisenhardt 1989; Orlikowski 1992). Overall, our goal was to develop IPF to offer faithful explanations of the challenges of IT-enabled information management at EMC.

Data collection for the study started in March 2008, when we held the initial workshop with revenue cycle stakeholders at EMC. In April 2008, EMC's chief financial officer invited us to visit the hospital. During the visit, we conducted interviews with the chief financial officer, the director of the business office, the director of coding and documentation, the billing supervisor, a nurse manager, and the IT manager. These early interactions with EMC resulted in a deeper engagement with the hospital. After initial communication of our diagnosis of EMC's problem situation (see Table 7.3-1), we began a formal engagement that lasted over the next two years. Both researchers visited EMC about once every month for full day sessions, in which we reviewed progress of various interventions with the steering committee, interviewed other stakeholders, and planned for subsequent interventions. In addition, I visited EMC almost every

other week and at times stayed overnight in the city¹⁹ to continue data collection the next day. Besides collecting data, the purpose of these visits was to design and implement interventions, provide training to revenue cycle staff about specific interventions, and coordinate any technical issues with EMC's IT team. After each meeting, the research team held a de-briefing session to discuss our observations. In June 2011, we made a final follow-up visit.

In all, we conducted over 125 semi-structured in-person interviews at EMC. We transcribed most interviews and all workshops. Following Yin (2003) and Miles and Huberman (1994), we collected evidence from multiple sources to enhance data quality and facilitate research. We conducted direct observations of how different revenue cycle stakeholders conducted their day-to-day work, what technologies they used, how they consumed and produced information, what challenges they faced, and which opportunities for improvement they saw. Fortunately, with support from the chief financial officer, we could interview any member of the revenue cycle any number of times, and we made full use of this opportunity. For example, if we had any follow-up questions about billing-related activities, we could interview the billing supervisor or a billing clerk as needed. Apart from face-to-face interviews and direct observations, we also interacted through e-mail and phone to clarify issues raised in interviews and to collect additional documents. In particular, I requested and received weekly data updates for key interventions. I also had remote access to the Exception Management System that we implemented at EMC. This allowed me to re-configure the system remotely based on feedback (such as, requests for new categories of registration-related exceptions). We reviewed usage statistics regularly and ascertained need for training to various users.

The research team prepared a protocol to structure the interview process and to collect appropriate information. We tailored the protocol for specific interviewees. For example, the protocol for the IT specialist included information about EMC's IT infrastructure, an overview of IT applications supporting the revenue cycle, current and planned projects, security risks, and other technical challenges. Typically, each interview lasted between 30 minutes and two hours, and both researchers took separate notes. We recorded all interviews, except those that discussed specific patient cases, or when requested by an interviewee. Whenever we discussed a particularly "sensitive" issue (such as the resistance of nurses to adopt EMR-facilitated clinical

¹⁹ The research site was about 180 miles away from Georgia State University, Atlanta.

documentation), we asked multiple interviewees to reflect on the same issue. These multiple perspectives improved our understanding of the involved complexities.

The research team also reviewed secondary data sources such as technical specifications of the EMR system (which allowed us to create many custom reports), consultant reports, internal presentations, minutes of staff meetings, e-mails, and other written materials. A summary of information about these data sources is included in Table 8.1-1.

Table 8.1-1 Primary and Secondary Data Sources at EMC

Primary data sources	Secondary data sources
<ul style="list-style-type: none"> ❖ Workshops (6) ❖ Steering committee meetings (20) ❖ Clinical and non-clinical staff meetings (8) ❖ Semi-structured interviews (125) with EMC's <ul style="list-style-type: none"> • Chief financial officer • Business office manager and staff • Billing supervisor and staff • Quality manager • Utilization review manager • Documentation and coding manager • IT manager and staff • Nursing managers • Registration supervisor and staff • EMR system consultant ❖ Field observations (50), including <ul style="list-style-type: none"> • Patient registration • Clinical documentation • Coding • Billing • Follow up of delinquent accounts • Interaction with insurance payers 	<ul style="list-style-type: none"> ❖ Internal documents (150), including <ul style="list-style-type: none"> • EMR system reports • Presentations • Meeting notes • E-mails • Clinical documentation • Consultant's audit reports • Personal communications • IT resources questionnaire ❖ External documents (5) <ul style="list-style-type: none"> • Public data (www.cms.gov; www.jcaho.org)

CMS—Centers for Medicare and Medicaid Services; JCAHO—Joint Commission on Accreditation of Healthcare Organizations

The research team also collected as many facts as possible from secondary sources and triangulated between the different empirical materials, perspectives, and observers (Denzin and Lincoln 2005; Miles and Huberman 1994; Yin 2003). This triangulation allowed us an in-depth understanding of the phenomenon in question, provided validation, and added rigor, breadth, complexity, richness, and depth (Flick 2002, p229). In summary, the action research engagement at EMC involved multiple workshops, interviews, and presentations. We used these sources to generate and collect data, and to diagnose the problem, plan and take actions, evaluate interventions, and specify learning.

8.2 Data Analysis

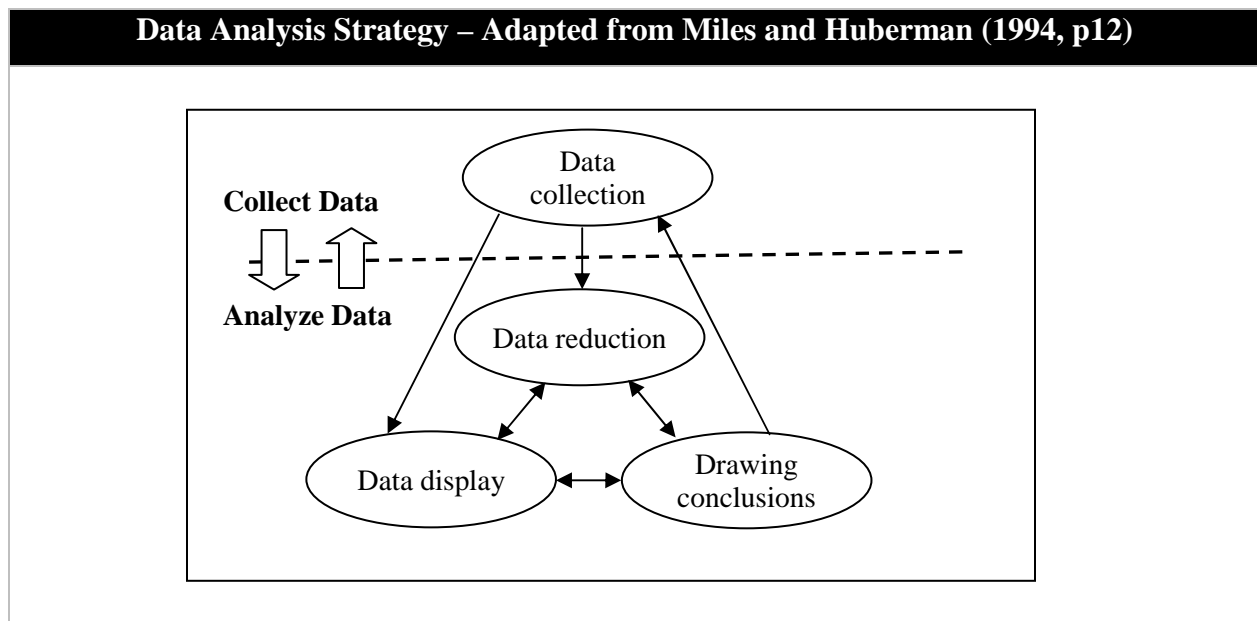
During the problem-solving phase, we followed the cyclic process of diagnosing, action planning, action taking, evaluating and specifying learning (Susman and Evered 1978). Accordingly, we used a diagnostic mapping technique suggested by Lanzara and Mathiassen (1985) to analyze the qualitative data from workshops, meetings, and field-observations, and quantitative data from EMR reports, questionnaires, and other sources with the goal of diagnosing EMC's problems relating to the revenue cycle (see description of the technique in Chapter 7, and outcome of the analysis in Appendix A). This analysis enabled planning and execution of appropriate interventions (Chapter 10), evaluation and interpretation of the interventions (Chapter 11), and specifying the contributions (Chapter 12). The analysis also helped to illustrate the theoretical framework that emerged from the study.

As discussed in Chapter 6, the goal of data analysis during the research phase of our engagement at EMC was to develop new theory. Towards that goal, we followed data analysis procedures suggested by Miles and Huberman (1994) for qualitative case data. They suggest three concurrent flows of activity: data reduction, data display, and conclusion drawing and verification. Furthermore, all three activities take place not only after data collection is finished but continuously throughout the data collection process. In fact, we continued to collect data even as we developed our theoretical framework. For example, the most recent visit in June 2011 provided further data about the heterogeneity of technology configurations at EMC (see Chapter 9 for details and Chapter 10 for illustrative examples). This additional data provided support for a key component of our framework, and facilitated empirical analysis of the case. This

concurrent and interactive pattern of data collection and analysis helped determine subsequent data collection choices for theory development and facilitated iterative development of the proposed theoretical framework in this research.

Figure 8.2-1 represents the data analysis strategy during the research cycle. We leveraged the outcomes of the problem-solving phase to develop and evaluate our theoretical framework (McKay and Marshall 2001). Evaluation of the outcomes of the problem-solving phase also led to reinforcement and modifications of the theoretical framework (Baskerville and Pries-Heje 1999).

Figure 8.2-1 Data Analysis Strategy for Theory Building



8.2.1 Data Reduction

Miles and Huberman describe data reduction as “the process of selecting, focusing, simplifying, abstracting, and transforming the data that appear in written-up field notes or transcriptions” (1994, p10). They assert that data reduction occurs continuously throughout the life of any qualitatively oriented research project. It can start even before fieldwork commences—through initial research questions and conceptual framework from which the researcher operates, and by the site selection and initial data collection choices made by the researcher. As data collection

proceeds, further episodes of data reduction occur through writing summaries, coding, teasing out themes, and writing memos.

Following this strategy, the process of data reduction and transforming began when we were working with a group of rural hospitals and community health centers in Georgia in 2007 and selected EMC for a deeper collaboration. During our two-year engagement at EMC, data reduction occurred through presentations for bi-monthly steering committee meetings, summaries of monthly problem-solving team meetings, and communications (such as in Table 7.3-1). Further reduction occurred through identifying problems relating to EMC's revenue cycle, teasing out practical themes (for example, complexity of revenue cycle), as well as through the evolving application of theoretical frameworks—the transactional approach to information management, multiple centers of decision making, and context-dependent governance—to make sense of the observations and experiences at EMC.

8.2.2 Data Display

Data display refers to “an organized, compressed assembly of information that permits conclusion drawing and action” (Miles and Huberman 1994, p11). Data displays may include matrices, graphs, charts, and networks—all designed to assemble organized information into immediately accessible form. Like data reduction, the development of data displays is an iterative process that occurs during the data collection process as well as after its completion.

Accordingly, we created appropriate displays, including tables, graphs, and flowcharts (such as Figure 2.1-1 and Table 2.1-1), that helped us to understand the complexity of a hospital revenue cycle and framed our understanding of the overall workflow and individual activities related to revenue cycle. Table 2.4-1 helped to understand the role of IT in a hospital revenue cycle and to appreciate the heterogeneous technologies prevalent in any hospital. Another example of data display is the diagnostic map (refer A.1 in Appendix A), which helped in identifying opportunities for solving problems related to information management in EMC's revenue cycle. These data displays developed iteratively, based on the improved understanding of the research team during the two-year engagement and feedback from key stakeholders.

8.2.3 Drawing Conclusions and Verification

Drawing conclusions includes identifying regularities, patterns, explanations, possible configurations, causal flows, and propositions from available data (Miles and Huberman 1994, p11). As data collection progresses, these conclusions gradually become more explicit and grounded (Glaser and Strauss 1967), and “final” conclusions may not appear until data collection is over (Miles and Huberman 1994, p11). Miles and Huberman (1994) point out that it is important to iterate between drawing conclusions and verifying those conclusions in an ongoing process to maximize the validity of the study’s findings.

The conclusion drawing and verification phase of data analysis occurred during both the problem-solving cycle and the research cycle. During the problem-solving cycle, a thorough diagnostic mapping exercise (refer A.1 in Appendix A) provided a framework to identify key problems relating to each stage of EMC’s revenue cycle by asking (and answering) the four questions: “what happened,” “why,” “what are the consequences,” and “what can be done.” By adopting this structured problem identification exercise, the research team made sense of the problem situation at EMC and was able to provide an initial diagnosis and propose interventions to improve EMC’s revenue problems (see Table 7.3-1). These recommendations reflected the conclusions drawn from the interactions during the initial workshop in March 2008 and subsequent meetings with key stakeholders during visits to EMC. During the planning and execution of each intervention (A through J, see Figure 10.2-1), the research team collected additional data, conducted data analyses using content analysis of transcribed interviews and workshops; analysis of field notes, e-mail communications, archived electronic and paper-based documents; and by using statistics, tables, graphs, and numbers (Denzin and Lincoln 2005, p7). These data analyses confirmed and contextualized the problem situation and helped to fine-tune each intervention based on feedback and review of initial outcomes.

Based on ongoing reflective discussions and the de-briefing sessions between the two researchers about the observations at EMC (“what does it mean?”), we began to make more sense of the context in which EMC’s revenue cycle operated. In addition, following the recommendations of Eisenhardt (1989), Boyatzis (1998), and Yin (2003), we repeatedly read the transcripts, interview notes, and other material to identify key themes relating to the challenges of information management in EMC’s revenue cycle. I also did write-ups for each intervention (A through J),

provided detailed contextual information about the problem situation, explained how the research team approached possible solutions, and described the outcomes of the intervention. Based on this iterative, within-case analysis (Eisenhardt 1989), we developed a preliminary list of themes (“premises,” see section 9.1) that represented underlying patterns across the interventions. These four premises helped us to tie the case data directly to the study’s research questions and provided a foundation for developing theoretical concepts (Miles and Huberman 1994, p70). Based on these premises, we iteratively identified related components of the new theory (see section 9.2 and Table 9.2-1), while ensuring that the case data provided sufficient evidence for each component. Thus, conclusion drawing in the research cycle led to theory generation, which I discuss in Chapter 9.

In Chapter 10, I verify the applicability of the components of the theoretical framework in the context of a health delivery transaction at EMC. I also verify the applicability of the framework to our interventions to improve information management in EMC’s revenue cycle (see Section 10.2).

► PART D: THEORY DEVELOPMENT

This section describes the development and application of the theory and draws on the research team's efforts to improve information management at EMC.

- **Information Polycentricity Framework (Chapter 9):** This chapter draws on Polycentricity Theory, Transaction Cost Theory, and existing theories of information management to develop an initial conceptualization—Information Polycentricity Framework (IPF)—that can help to explain the challenges of information management in complex organizations and lay the foundation for further theoretical development. The chapter discusses the premises and components of IPF.
- **Application of IPF (Chapter 10):** This chapter illustrates the detailed workings of IPF by applying its four components to information management in the revenue cycle at EMC. Next, it provides a detailed contextual account of ten interventions (grouped into four cases) to improve EMC's revenue cycle as part of the action research study. For each case, I interpret the findings based on IPF.

9 INFORMATION POLYCENTRICITY FRAMEWORK

In this chapter, I develop a new conceptual framework—the Information Polycentricity Framework (IPF)—to explain the challenges of information management in complex organizations and to lay the foundation for further theoretical development. First, I draw on Polycentricity Theory, Transaction Cost Theory, and existing theories of information management to present the premises of IPF. Subsequently, I discuss the key components of IPF.

9.1 Premises of IPF

In the philosophy of science, a premise²⁰ is a statement that is assumed to be true and upon which further theory is built (Vargo and Lusch 2009, p223). A premise can be a known fact or data or an expression that has a certain degree of certainty or intuitive obviousness and forms the basis of our knowledge. Thus, a premise is the starting point of theory development and has been used in developing several organizational theories, including the structuration model of technology (Orlikowski 1992).

The first premise of IPF—polycentric conditions—draws on Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961; Polanyi 1951) and is essential to our conceptualization of information management in complex organizations. To conceptualize IPF's other premises, we draw on Mathiassen and Sørensen's (2008) three-layered structure of IT-enabled information management:

- 1) *Transactional layer*, in which business processes are executed (for example, through delivery of healthcare services by a provider to a patient);
- 2) *Informational layer*, in which the information relating to the transaction, and its governance, is produced and consumed, thus creating shared meanings among the involved actors (for example, between the provider and a patient); and

²⁰ On the other hand, a *proposition*, at least from a logical positivistic perspective, is a statement that is testable for its truth content. However, premises, if they are rich, provide the foundation upon which to derive propositions that can then undergo scientific investigation and empirical testing [Vargo, S.L., and Lusch, R.F. 2009. "A Service-Dominant Logic for Marketing," in: *The Sage Handbook of Marketing Theory*, P. Maclaran, M. Saren, B. Stern and M. Tadajewski (eds.). London, UK: SAGE Publication Ltd., pp. 219-234.]

- 3) *Technological layer*, in which technology hardware and software applications (such as telecommunication network, computers, and EMR system) combine to support the transactional and informational layers through capturing, processing, storing, and sharing information within and across the organizational boundaries.

The three-layered structure focuses the discussion of IPF's premises around transactions, information, and technology. Thus, the second premise—a transactional view of information—relates to the transactional layer. The third premise—the ordering effects of information—relates to the informational layer. Finally, the fourth premise—heterogeneous configurations of technology—relates to the technological layer. Next, I elaborate on these premises.

9.1.1 Premise 1: Polycentric Conditions

Recent studies have challenged the assumption of monocentric decision making in complex organizational settings and have, instead, identified polycentric decision making as an alternative perspective (Andersson and Ostrom 2008; Ostrom 2009; Ostrom 1972; Ostrom et al. 1961; Polanyi 1951). Polycentric decision making arises from polycentric conditions in complex organizations, which manifest in the multiple independent sources of authority and judgment that act informally but collectively in determining community standards of behavior and the focus of collective action (Ostrom 1972). IPF posits that polycentric conditions are the norm in complex organizations, where the workflows and information exchanges extend beyond functional and organizational boundaries in response to internal and external challenges (Tan et al. 2005). Further, the multiple independent sources of authority in a complex organization are often “nested”—with centers of decision making existing side-by-side (such as a hospital and its external partners) and centers of decision making existing *within* centers of decision making (such as the various functional units in a hospital, represented by clinicians, nurses, registration clerks, and billing staff). This multiple nested decision-making approach is different from that of Arrow (1974), Simon (1981), and Wiseman (1988), who assume a central decision-making authority in organizations. This approach stresses that organizations exist not only as large pyramidal structures that are managed as a bureaucracy (which may justify a monocentric decision-making structure), but also as networks of firms, functional departments, work groups, teams, and informal peer groups (Piore and Sabel 1984) with multiple centers of decision making supported by polycentric structures.

Polycentric conditions are also implicit in Ciborra's (1981; 1993) criticism of information management studies in the IS literature. He noted that most of the decision-oriented design strategies focus on the information needs and cognitive style of the individual decision maker (Ciborra 1993, p112) even though collective, coordinative problem-solving is the main challenge in organizational settings (Sproull and Kiesler 1991; Turoff and Hiltz 1982). A solution, Ciborra might have argued, would be to move away from the assumption of monocentric decision making (for example, by an individual manager) and adopt a polycentric philosophy in which collective and coordinative decision-making is the norm. A second criticism forwarded by Ciborra involved ignoring the mixed-interest (that is, heterogeneous) context in organizational decision making by assuming that all participants share common goals (Ciborra 1993, p112). This approach ignores the presence of cooperation and conflict between participants during a decision-making process, and it fails to account for phenomena such as misrepresentation, resistance, selective disclosure, lack of transparency, and exercise of authority based on information (Ciborra 1993, p113). Additionally, the traditional view does not take into account certain participants' opportunistic behavior, which can result in additional information processing to ensure reliability of information. This line of reasoning suggests multiple centers of decision making with heterogeneous interests in what constitutes effective design strategies, information management, and related governance mechanisms.

Therefore, drawing on Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961; Polanyi 1951) and Ciborra's suggestion of a collective decision-making approach that is mindful of mixed-interest contexts (1993, p113), IPF posits polycentric conditions in complex organizations. By taking this view, IPF focuses attention on 1) multiple levels of information exchange leading to collective (rather than individualistic) decision making among multiple actors with heterogeneous interests and 2) fragmented information management and decision-making authority requiring the various institutions, functional departments, teams, and informal peer groups to coordinate at multiple levels across organizational boundaries.

Further, IPF's embrace of polycentric conditions in complex organizations has two implications relating to information management. First, polycentricity can manifest on the transactional layer, informational layer, and the technological layer. As a result, the transaction can be polycentric, the information management for that transaction can also be polycentric, and the technological

configurations that support the transaction and the related information processing can be polycentric too. Second, if the interests of different actors in multiple nested arrangements are aligned (that is, homogeneous), authority will be less likely to fragment (Ostrom 1972; Ouchi 1980). Alternatively, if the interests of different actors are heterogeneous, fragmentation of authority will occur and the information management strategy will have to consider those. This is particularly the case in complex organizational settings where a large number of interdependent parts work together as a whole and interact with larger organizational structures or external environments (Simon 1981; Thompson 1967), thereby resulting in heterogeneity of interests among the involved actors.

9.1.2 Premise 2: A Transactional View of Information

Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961) adopts a transactional approach to analyzing complex human action situations (see Chapter 5). The theory assumes patterns of cooperation, competition, and conflict that may exist among various actors in such settings. In fact, two of the core features of Transaction Cost Theory (Williamson 1975; 1981)—bounded rationality and opportunistic behavior in individual decision making—are consistent with Polycentricity Theory. Further, the tenet of multiple nested decision-making centers—a defining aspect of Polycentricity Theory—also assumes a transactional perspective of ongoing exchange among actors on different levels of analysis.

The traditional industrial organization approach considered a task as the unit of analysis (Coase 1937). Based on classical economic theory, this task-focused approach only included costs (such as production and transport costs) that directly related to organizational tasks. The reason for questioning this approach was that in any transaction (for example, between a buyer and a supplier of goods or services), there are additional costs of entering into and executing contracts, as well as costs of managing the transaction. The alternative approach—which considers a transaction as the basis of analysis—has been adopted in recent studies in institutional economic theory (Coase 1937; Williamson 1975; 1981; 1985; 2000) and information systems (Ang and Straub 1998; Chen and Bharadwaj 2009; Ciborra 1981; 1993; Kauffman and Mohtadi 2004; Kumar and van Dissel 1996; Lacity and Willcocks 1995; Sankaranarayanan and Sundararajan 2010). For these researchers, transactions determine decision making in organizations (and

related governance structures) and provide a richer understanding of complex organizational functioning.

Ciborra (1981) was the first researcher to adopt a transaction as the unit of analysis for information management when he analyzed transaction costs in information systems. He defined an organization as “a stable network of contractual arrangements to govern a set of transactions among individuals” (1993, p116) and argued that these contractual arrangements define how individuals join and coordinate their efforts to cope with the complexity of the environment and exchange uncertainties (such as those arising from opportunism). A consequence of taking the transaction cost approach is that setting up and managing transactions will require governance mechanisms (that is, contractual arrangements). Following Ouchi (1980), Ciborra suggested that these mechanisms can be combinations of teams, markets, or systems.

Therefore, drawing on the rich literature associated with Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961; Polanyi 1951), Transaction Cost Theory (Coase 1937; Williamson 1975; 1981), and building on Ciborra’s (1981; 1993) transactional approach to IS, the proposed theory—IPF—posits transactions as the basis of information processing and decision making. IPF takes a transactional view of information, and considers organizations as contractual arrangements that process information to govern sets of transactions. This view allows IPF to consider information management as the basis of governance of transactions and focuses attention to the transactions involved in the delivery of services.

As discussed in Chapter 3, complex organizations involve interdependent parts that work as a whole and are interdependent with larger organizational structures or external environments (Simon 1981; Thompson 1967). By taking a transactional view of information, IPF overcomes the limitations of task-focus because multi-level human transactions (and related information exchanges) in complex settings extend beyond functional and organizational boundaries.

9.1.3 Premise 3: The Ordering Effects of Information

Information management involves structuring data into meaningful symbols and acquiring and processing information for specific purposes such as decision making (Ciborra 1993; Kmetz 1998; Nauta 1972). This understanding of information management as a basis of decision

making is implicit in the subjective view of information, which focuses on the context and meaning of received data and its interpretation by the receiver based upon prior knowledge and expectations (Dretske 1981; Farace et al. 1977; Mingers 1996). On the other hand, taking an objective view of information—which concerns itself with the transmission of messages and not the content of communication (Alluisi 1970)—provides only limited understanding of decisions and their impact based on the messages received.

Several theories of information management consider information processing as the basis of organizational design. For example, Galbraith's (1974; 1977) model links information processing and organizational performance by considering the relationship between task uncertainty and variation in organizing modes (for example, greater task uncertainty requires greater information processing at a given organizational performance level). Tushman and Nadler's (1978) model adopts the contingency-theory concept of fit between organizational components and processes, suggesting that an organization will be more effective when its information processing requirements match its information processing capacity. Mintzberg (1979; 1980) proposed that information processing requirements determine organizational structures and suggested organizational design strategies based on different combinations of complexity and uncertainty of information processing. Similarly, Daft and Lengel's (1986) information contingency model describes how organizations can be structured based on how they deal with task uncertainty and task equivocality.

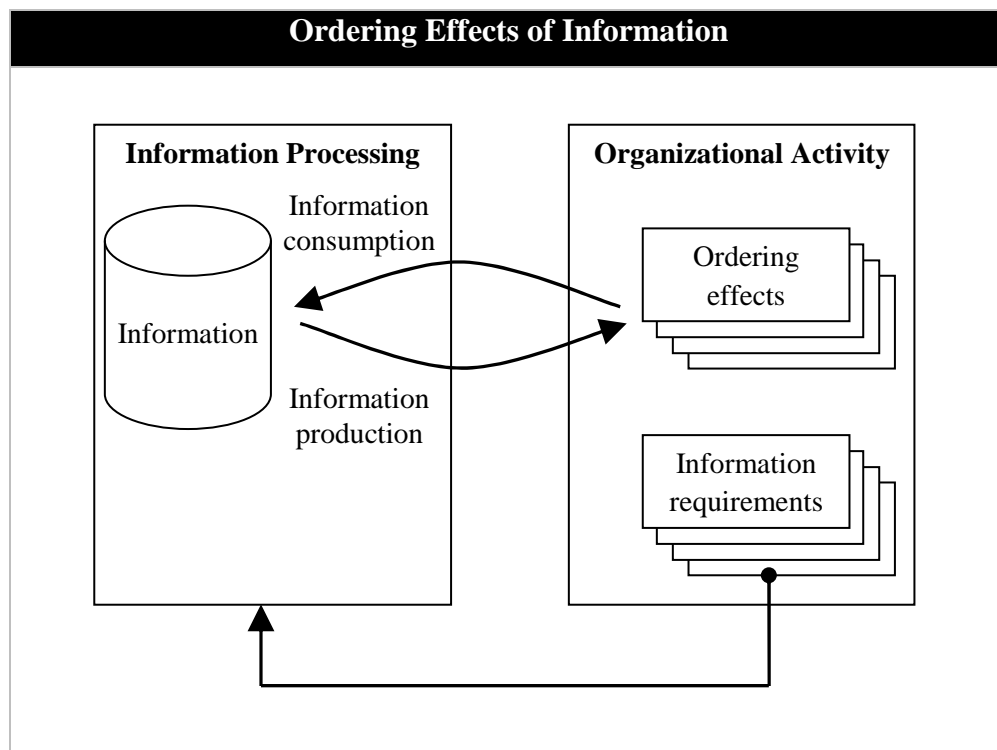
Information processing occurs through two complementary mechanisms: information production and information consumption (Ramaprasad and Rai 1996). Actors produce information about business phenomena by deriving meaning from stimuli in organizational activity and the environment. At the same time, actors consume information when they transform it into stimuli that support and guide organizational action. In effective organizations, there is a symbiotic relationship between information production and consumption, and this relationship is positively reinforcing. Moreover, organizations must strive to maintain a balance between information production and consumption; else, organizational performance diminishes due to dysfunctionalities²¹ such as information overload, information in jail, and misinformation (Ramaprasad and Rai 1996). Following this line of thinking, Mathiassen and Sørensen (2008)

²¹ See Figure 3.2-2 for conditions that lead to these dysfunctionalities.

suggested that organizational information is provided as services, and these information services are enacted in response to specific information processing requirements to support decision making within and across organizational boundaries.

Drawing on these information management theories, and on Ciborra's (1981; 1993) transactional approach to IS, our conceptualization proposes that information processing occurs as part of a transaction. It results in organizational activity or structuring of organizational activity through information consumption or it results in new information about organizational activity through information production. The impact on organizational activity and its structuring represents the *ordering effects* of information. At the same time, information processing occurs in response to the information requirements of transactions and their governance (Daft and Lengel 1986; Galbraith 1974; 1977; Mintzberg 1979; 1980). Thus, information processing also results from organizational activity as responses to the embedded information requirements. Figure 9.1-1 represents the relationship between information processing (production and consumption) and organizational activity in transactions (ordering effects and information requirements).

Figure 9.1-1 Ordering Effects of Information



The ordering effects of information do not suggest the “ordering” of information in the sense the term has been applied in survey research²² and economic theory.²³ They also do not suggest the “stabilizing” effects on any organizational activity or transaction. Rather, the ordering effects of information have a neutral connotation; they could represent stability or instability, convergence or divergence, equilibrium or disequilibrium, harmony or conflict. Further, ordering effects of information can challenge previous ordering effects.

The ordering effects of information are also implicit in Polycentricity Theory. Vincent Ostrom (1972) defined a polycentric order as one where “many elements are capable of making mutual adjustments for ordering their relationships with one another within a general system of rules where each element acts with independence of other elements.” This “ordering” of relationships among different elements represents organizational structuring (or change in behavior) and it results from information exchanges across multiple decision-making centers and from a related system of rules (that is, governance mechanisms). Polanyi (1951) also emphasized that such governance mechanisms provide a framework for ordering relationships in a polycentric system. Again, this “ordering” of relationships does not suggest a stable structure or behavior; it only reflects a change in structure or behavior.

Therefore, building on existing information management theories (Daft and Lengel 1986; Galbraith 1974; 1977; Mintzberg 1979; 1980) and on the ongoing structuring of organizational activity through information production and consumption (Mathiassen and Sørensen 2008; Ramaprasad and Rai 1996), IPF posits information processing as the core of organizational decision making. Further, consistent with the notion of ordering of relationships through information exchanges in Polycentricity Theory (Ostrom 1972; Polanyi 1951), IPF focuses attention on information requirements, information processing, and the ordering effects of information on transactions and their governance.

²² The effect of placement (i.e., ordering) of items in a survey instrument on the responses

²³ An ordering effect in economic theory is the “value of a particular good as perceived by the respondents depending on where in a sequence it is valued; when a given set of goods are valued in a sequence” [Kahneman, D., and Knetsch, J.L. 1992. "Valuing Public Goods: The Purchase of Moral Satisfaction," *Journal of environmental economics and management* (22:1), pp 57-70.

9.1.4 Premise 4: Heterogeneous Configurations of Technology

As discussed in previous sections in this chapter, polycentric conditions in complex organizations result in multiple nested centers of information processing, and decision making. A consequence of this is that polycentric systems will likely require heterogeneous configurations of technology. Taking such a view allows us to understand the spectrum of technology configurations that can effectively support multiple levels of internal and external coordination to deliver services to customers. Similarly, in proposing a fit between information requirements and a portfolio of available IT-enabled information services, Mathiassen and Sørensen (2008) suggested that information services were supported by “heterogeneous portfolios” of information processing capabilities enacted by people and IT; organizational actors then evoke these information services differently to meet the specific requirements they face.

By definition, a complex system has many interdependent and interacting parts that are also interdependent with the external environment (Simon 1981; Tan et al. 2005; Thompson 1967). As a result, information exchanges in a complex organization involve a large number of individuals and groups who collect, process, and distribute information in many different ways within and across organizational boundaries. Therefore, the inherent nature of information processing in such settings typically involves a considerable heterogeneity of technological solutions; only under special circumstances should we expect to find well-functioning homogeneous information systems that serve all needs of the involved actors.

Heterogeneous configurations of technology include different hardware (such as computers, communication, and networking equipment) and software applications (such as enterprise resource planning and business analytic systems), as well as interfaces to non-IT systems. From empirical observation, a typical organizational setting involves an assortment of standalone and integrated systems, with a wide variety of IT architectures. Further, these heterogeneous systems may connect to multiple legacy operating systems, user interfaces, application servers, and back-end databases. These diverse and disparate systems give rise to high technical complexity as the data must be extracted, transformed, loaded, maintained, and analyzed (Wixom and Watson 2001). Over time, the heterogeneity and complexity of these configurations increase as IT departments try to extend functionality by customizing existing systems or by integrating with new systems to cope with changing business requirements.

The shift towards greater heterogeneity in technology configurations can result from 1) planned managerial interventions, and 2) improvisational adoption of technology. Ciborra and associates (2000) outlined a vicious circle of how organizations strive for management control of technology adoption, but instead experience drifting due to forces of turbulent environments, implementation tactics, power of the installed base, complexity of the technology, side effects, surprises, and users' resistance and creativity. Accordingly, technology adoption manifests itself primarily through two forms of change management: controlling and drifting. Controlling represents the traditional, top-down approach to change management and involves planning and designing the adoption process. In contrast, drifting manifests itself on the local-level as "plasticity in response to the re-inventions carried out by users and specialists, who gradually learn to discover and exploit features, affordances, and potentials of systems" (Ciborra 2002, p-87). This process requires key stakeholders to remain flexible and constantly negotiate technology adoption practices between control and drift, creating momentum and direction according to organizational goals through attempts to control, while at the same time exploring options and innovations from drifting forces inside and outside the firm (Tjørnehøj and Mathiassen 2008).

Therefore, drawing on Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961), complexity theory (Simon 1981; Tan et al. 2005; Thompson 1967), IT-enabled information services theory (Mathiassen and Sørensen 2008), and based on empirical observation, IPF embraces the notion of heterogeneous configurations of technology for information processing and decision making.

9.2 Components of IPF

A common approach to developing a theory is to outline the assumptions and then to establish the key constructs of the theory (Orlikowski 1992). Following this approach, I discussed the assumptions—the premises—of IPF in the previous section. In this section, I discuss the core constructs—the components—of the proposed theory.

Corresponding to the four premises discussed in Section 9.1, IPF proposes four components: 1) governance, 2) transaction, 3) information processing, and 4) technology configuration. As in the premises, the first component—governance—overarches the other three components and, accordingly, I discuss the implications of the first component in relation to the other three

components. In developing the three components, I consider previous ones, thereby incrementally accounting for the relationships and interactions between them. Next, I elaborate the four components of IPF. Figure 9.2-6 summarizes the resulting relationships among them.

9.2.1 Component 1: Governance

We define governance as the contractual arrangements between the parties involved in an exchange. Thus, drawing on Transaction Cost Theory (Williamson 1981), IPF posits governance to include mechanisms for searching (finding partners to exchange goods, services, information, or money), contracting (agreeing to terms of exchange by defining delivery expectations), controlling (determining measures of performance monitoring and verification thereof), and maintenance of the relationship between the involved parties.

A consequence of polycentric conditions in complex organizations is that the multiple nested decision-making centers will require governance mechanisms appropriate for each center and their exchanges. Therefore, drawing on Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961), IPF suggests a need for context-dependent governance mechanisms to accommodate the diverse standards of behavior and the heterogeneous focus of collective action by the involved actors (Ostrom 1972). In our conceptualization, context-dependent governance mechanisms can occur at the transactional, informational, and technological layers (Mathiassen and Sørensen 2008).

Considering the transactional layer, IPF considers the governance mechanisms for a transaction as representation of *first-order governance*. A consequence of this first-order governance mechanism is that the need for coordination becomes increasingly important to develop and maintain the relationships between the involved actors across organizational levels and boundaries. This is particularly relevant in case of an ongoing transaction (as opposed to a one-time transaction).

IPF also suggests that the governance mechanisms necessary to process information represent *second-order governance*, with information requirements for the transaction (and its governance) determining the related governance structures. The focus on these second-order contractual

arrangements suggests that the need for coordination is as important for information processing as it is for the transaction itself.

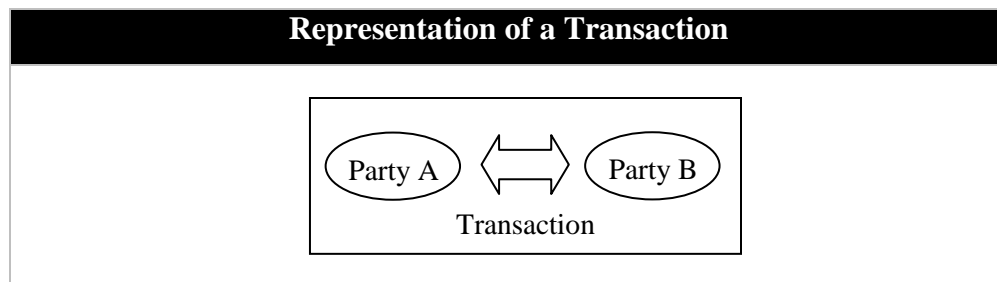
Finally, IPF suggests that governance mechanisms are also required at the technological layer, representing *third-order governance*. Again, the focus on these third-order contractual arrangements suggests that the need for coordination is as important for technology as it is for the transaction or the related information processing.

To facilitate the operationalization of this component in an organizational context, we will consider some key analytical questions relating to governance mechanisms. Specifically, we will explore the nature of governance mechanisms for 1) the transaction, 2) information processing for the transaction, and 3) the technological configurations that support the transaction and related information processing. We will explore how existing governance mechanisms contribute to the problem situation, and how modifications in the governance mechanisms can address the problem situation.

9.2.2 Component 2: Transaction

Drawing on Transaction Cost Theory (Coase 1937; Williamson 1975; 1981), IPF considers a transaction as the basis of organizational analysis and thus sets the stage for further elaboration of the theory. A transaction occurs when a good or a service is transferred across a technologically separable interface (Williamson 1981). Figure 9.2-1 shows a basic transaction, in which the two involved entities are Party A (for example, a hospital that provides medical services) and Party B (for example, a patient who receives medical services and directly or indirectly reimburses the hospital).

Figure 9.2-1 Representation of a Transaction



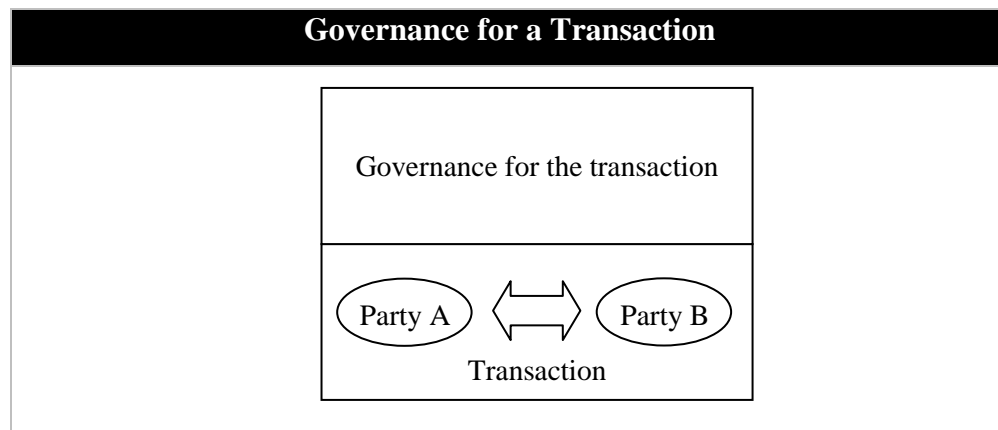
Using a Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961) perspective, IPF considers transactions as multiple nested arrangements of human activity. This formulation emphasizes that 1) a transaction is the basis of organizational activity enacted through the decision making of the involved actors, such as Party A and Party B, and 2) the transaction occurs as an embedded exchange involving multiple levels of relationships between the actors. Typically, any transaction would involve several actors, each playing some role in the overall exchange.

Drawing on the Transaction Cost Theory (Coase 1937; Williamson 1975; 1981) and on Ciborra's (1981; 1993) transaction cost approach to IS, the IPF posits that the nature of a transaction determines the governance mechanisms (that is, contractual arrangements) for the transaction. Further, these mechanisms are integral to executing the transaction, as they are required to set up and manage the transaction. These mechanisms relate to the following:

1. *Searching*, by means of which Party A and Party B find each other to conduct the transaction
2. *Contracting*, by means of which Party A and Party B agree on the terms of the exchange
3. *Controlling*, by means of which Party A and Party B set up measures of performance monitoring, and
4. *Maintenance*, by means of which Party A and Party B develop the exchange relationship over time.

Figure 9.2-2 represents the governance for a transaction between Party A and Party B.

Figure 9.2-2 Governance for a Transaction

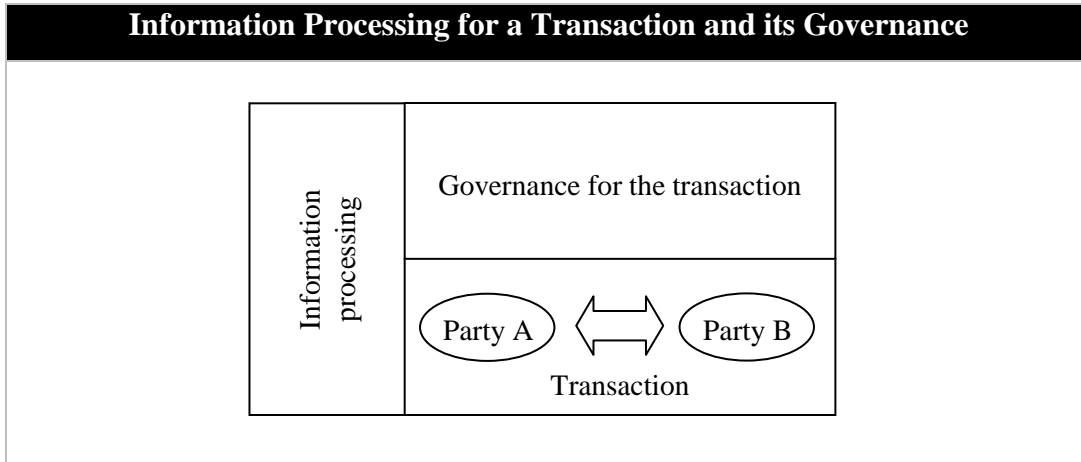


The three stereotypical organizational structures—clans, markets and hierarchies—suggested by Ouchi (1980) and Ciborra (1993) can inform our understanding of how different types of contractual arrangements can govern transactions. The transaction costs (and therefore contractual arrangements) in a clan are implicit because of the high levels of trust and shared values and goals among the involved actors. In case of a bureaucratic structure, the contractual arrangements are more explicit because to execute the transactions efficiently in an environment of lower trust (in comparison to a clan), a clearer determination of roles, responsibilities, and deliverables becomes necessary. In a market structure, the contractual arrangements have to be explicit to enable the two parties to overcome the challenge of goal incongruence.

To facilitate the operationalization of this component in an organizational context, we will consider some key analytical questions relating to the nature of transaction, the actors involved, and the transaction costs incurred in facilitating the exchange. Specifically, we will explore how the problem situation relates to the transaction and to the multiple nested centers of decision making involved in the transaction. We will examine how interventions to improve the problem situation affect the transaction (and the related transaction costs).

9.2.3 Component 3: Information Processing

Information processing occurs in response to information requirements. This is a core principle of information processing theory (Daft and Lengel 1986; Galbraith 1974; 1977; Mintzberg 1979; 1980). Combining this principle with Ciborra's transactional view of information (1981; 1993), IPF suggests that information processing occurs in response to information requirements of a transaction and its related contractual arrangements. Figure 9.2-3 shows this fundamental relationship between information processing and the requirements for a basic transaction between two parties, A and B, and for the related governance mechanism.

Figure 9.2-3 Information Processing During a Transaction

Information processing occurs through two complementary mechanisms: information production and information consumption (Ramaprasad and Rai 1996). Actors produce information about transactional phenomena by deriving meaning from stimuli in the transaction and its contractual arrangements. At the same time, the actors consume information when they transform it into stimuli that lead to changes in the organizational activity and structure related to the transaction. These changes represent the ordering effects of information. In turn, the ordering effects can lead to new information processing.

Drawing on Polycentricity Theory (Ostrom 1972; Polanyi 1951) and on Ciborra's (1981; 1993) transactional view of information, IPF posits that information enables mutual adjustments (through information exchanges) among the involved actors in multiple centers of decision making. Accordingly, the ordering effects of information also manifest in multiple centers of decision making in an organization. These ordering effects enable organizational structuring based on information processing to support the transaction. In summary then, IPF draws on Polycentricity Theory to emphasize that the major role of information in organizational contexts is to create ordering effects that enable mutual adjustments among the multiplicity of actors involved in a transaction. Thus, in IPF, we define information as follows:

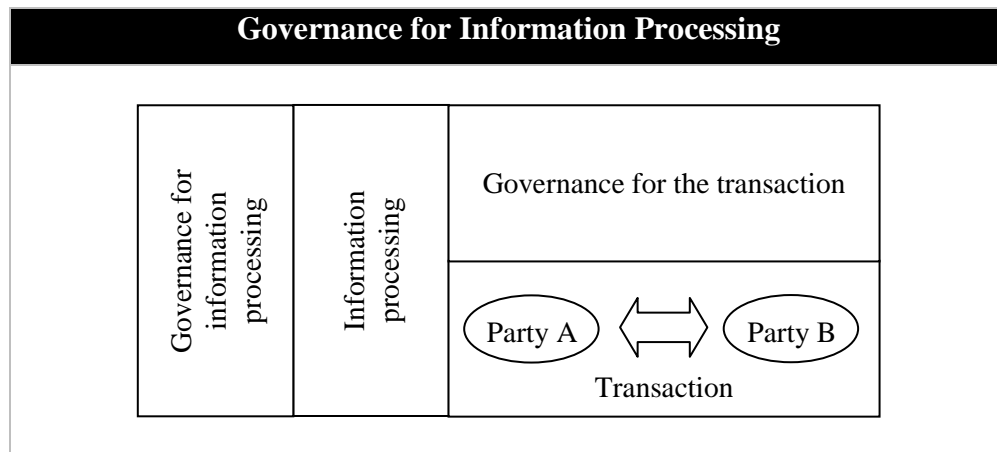
Information is a resource for creating ordering effects in transactions.

Focusing further on information processing, IPF contends that, just as governance mechanisms are required for a transaction, a different but related set of governance mechanisms are required for information processing for the transaction. These mechanisms relate to the following aspects:

- 1) *Searching*, by means of which Party A identifies Party B to conduct the required information processing,
- 2) *Contracting*, by means of which Party A and Party B agree on who should do what, when, and how information should be structured and shared,
- 3) *Control and regulation*, by means of which Party A and Party B determine the measures of performance to monitor the required information processing, and
- 4) *Maintenance*, by means of which Party A and Party B sustain and develop the information processing relationship over time (assuming that the transaction, and the resultant information processing, are ongoing).

Figure 9.2-4 represents these governance mechanisms for information processing resulting from a transaction between two parties, A and B. The mechanisms refer to the ways in which the parties organize to produce and consume the information required for the transaction and its governance.

Figure 9.2-4 Governance for Information Processing



To understand the governance mechanisms for information processing, consider a hypothetical situation where a single person does all the information processing for a transaction. In such a situation, there would be little need for governance mechanisms because the same person would

be responsible for producing and consuming all the required information. The need for governance mechanisms arises because transactions involve multiple actors. A single transaction typically involves multiple handshakes, with each handshake requiring some information production and consumption. To facilitate this information processing (such as describing who does what, when, and where), one would require a second level of handshakes between senders and receivers of information so that overall information processing can support the transaction.

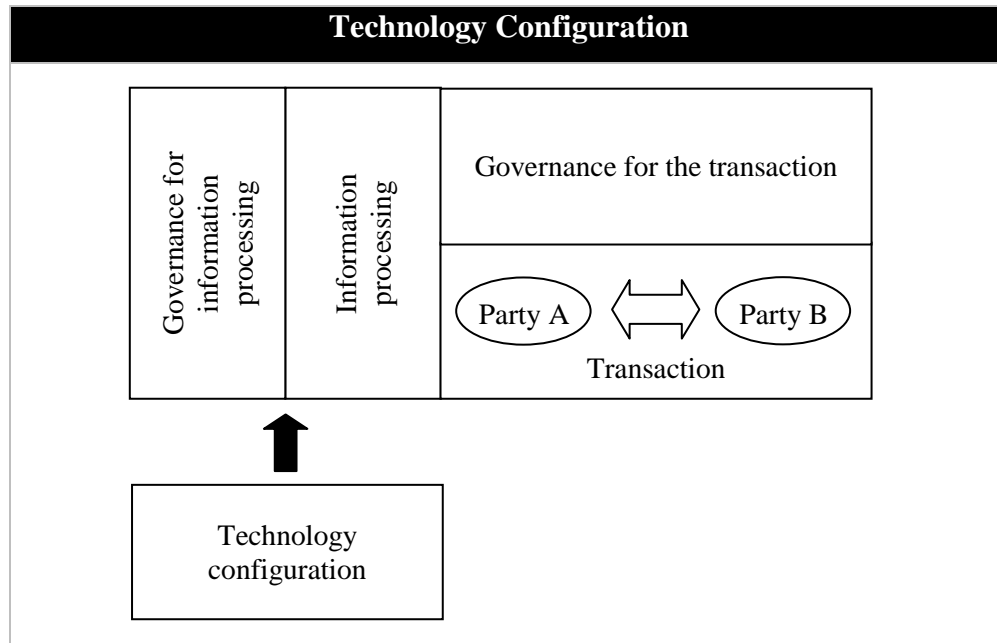
The clan, market, and hierarchy conceptualization of organizational structure (Ciborra 1993; Ouchi 1980) can also help understand the notion of governance mechanisms for information processing. The mechanisms in a clan structure are typically informal and even implicit (because of the high levels of trust, and shared values and goals among the involved actors). In bureaucratic structures, the governance mechanisms for information processing are more explicit and formalized (due to lower trust and higher degrees of goal incongruence). In market structures, the governance mechanisms for information processing are very explicit (because of high levels of goal incongruence).

To facilitate the operationalization of this component in an organizational context, we will consider some key analytical questions relating to information processing. Specifically, we will consider information production and consumption, as well as the ordering effects of information, at various levels. We will examine how the problem situation relates to information requirements for the transaction, and how the multiple nested centers of decision-making affect information processing. We will also consider how interventions may lead to better addressing the information requirements.

9.2.4 Component 4: Technology Configuration

The final component of IPF considers the role of technology and artifacts in organizational transactions. Drawing on information processing theory (Daft and Lengel 1986; Galbraith 1974; 1977; Mintzberg 1979; 1980) and information services theory (Mathiassen and Sørensen 2008), IPF suggests that actors utilize technology configurations to support information processing in response to the requirements they face. Figure 9.2-5 represents how technology configuration relates to information processing for a transaction between two parties, A and B.

Figure 9.2-5 Technology Configuration



Taking a Polycentricity Theory perspective (Ostrom 1972; Ostrom et al. 1961), the technology configurations arise from the multiple levels of decision making involved in a transaction, and from the needs for context-dependent governance of the many actors and their unfolding relationships. The configurations manifest through two complementary processes: 1) planned managerial interventions and 2) improvisational adoption of technology (Ciborra et al. 2000).

Adopting Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961) to understand technology configurations allows us to consider the implications of imposing a monocentric technological solution on polycentric organizational arrangements. Consider, for example, the introduction of an EMR system in a hospital to improve information exchange and coordination across all departments. One may, of course, consider the introduction of the EMR system purely from a technology adoption perspective and, accordingly, examine the various factors that inhibit (or encourage) its integration and usage in day-to-day operations related to healthcare delivery. A limitation of this approach is that the design and implementation of such technological systems typically follow a monocentric perspective (as reflected in their centralizing and standardizing objectives). However, complex organizations exist as networks of firms, functional departments, work groups, teams, and informal peer groups (Piore and Sabel 1984) with multiple centers of decision making (Ostrom 1972; Polanyi 1951). Therefore, a system designed (or implemented)

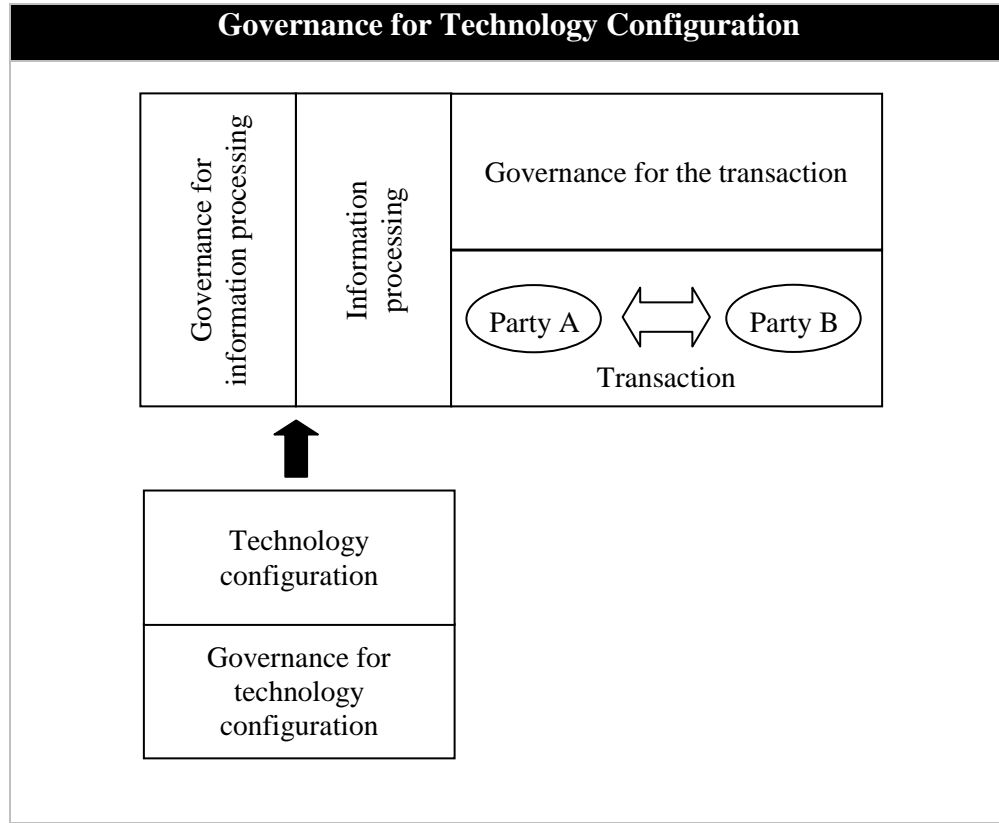
with monocentric assumptions may not be suitable for the polycentric reality of complex organizational arrangements, making it necessary to consider technological solutions that support fragmented decision making and context-dependent governance. Failure to do so can have adverse outcomes, both in economic terms as well as in terms of overall performance.

Further, IPF contends that just as governance mechanisms are required for a transaction and its associated information processing, a different but related set of governance mechanisms are required to manage the technology configurations. These mechanisms relate to the following aspects:

- 1) *Searching*, by means of which Party A and Party B select appropriate technology configurations required for executing the transaction and related information processing,
- 2) *Contracting*, by means of which Party A and Party B agree on what, when, and how the technology configurations should be selected, implemented, and governed,
- 3) *Control and regulation*, by means of which Party A and B determine the measures of performance to monitor the implementation and use of the technology configurations, and
- 4) *Maintenance*, by means of which Party A and Party B sustain and develop the technology configurations over time to meet the changing needs of the organization.

Figure 9.2-6 represents these governance mechanisms for technology configurations resulting from information processing for a transaction between two parties, A and B.

Figure 9.2-6 Governance for Technology Configuration



To facilitate the operationalization of this component, we will consider key analytical questions relating to the technology configurations for a transaction. We will examine whether the existing configurations cause or contribute to the problem situation, and how the interventions affect the configurations (or vice versa). We will also consider how multiple centers of decision making affect the technology configurations.

Table 9.2-1 summarizes the four components of IPF.

Table 9.2-1 Components of IPF

#	Component	Description	Foundation
1	Governance	Contractual arrangements between at least two parties to facilitate an exchange between them Multiple nested centers of decision making require context-dependent governance mechanisms	(Ostrom 1972; Ostrom et al. 1961; Williamson 1975; Williamson 1981)
2	Transaction	Business process involving exchange between at least two parties	(Ciborra 1981; 1993; Coase 1937; Williamson 1975; 1981)
3	Information processing	Production and consumption of information in response to information requirements of a transaction and its governance Information processing has ordering effects on a transaction	(Daft and Lengel 1986; Galbraith 1977; Mathiassen and Sørensen 2008; Mintzberg 1979; 1980; Ostrom 1972; Ramaprasad and Rai 1996)
4	Technology configuration	Technology portfolio to enable information processing for a transaction	(Mathiassen and Sørensen 2008; Wixom and Watson 2001)

10 APPLICATION OF IPF

This chapter illustrates the detailed workings of the proposed theoretical framework, IPF. First, I apply its four components to information management in the revenue cycle at EMC. Next, I provide a detailed contextual account of ten interventions (grouped into four cases) to improve EMC's revenue cycle as part of the action research study. For each case, I interpret the findings based on IPF.

10.1 Information Management in EMC's Revenue Cycle

Based on the data collected and analyzed during our engagement at EMC, I illustrate IPF by considering health delivery transactions between the hospital and a patient. I apply the four components of IPF to examine information management in EMC's revenue cycle.

10.1.1 Governance at EMC

Multiple independent decision-making centers were evident in EMC's revenue cycle. In fact, these centers were "nested"—centers of decision making existed side-by-side (for example, EMC and its external partners and patients) and centers of decision making existed *within* centers of decision making (for example, the various functional units within EMC). Thus, the health delivery transaction-related decision making occurred at multiple levels: with EMC's external partners and within EMC. To manage this multi-level transaction, EMC and its partners relied on governance arrangements that helped to determine community standards of behavior and focus on collective action. These governance arrangements were context-dependent; that is, different mechanisms were required for each decision-making center. Further, these governance mechanisms were enacted at the transactional, informational, and technological layers (Mathiassen and Sørensen 2008), representing first-order, second-order, and third-order governance respectively. Below, I present related case evidence.

First-order Governance for Transaction at EMC

Setting up and managing the health delivery transaction required governance mechanisms. These mechanisms (shown in Table 10.1-1) represent *first-order governance*, and facilitate coordination between EMC and a patient, between its various internal units (such as registration and billing), and with its external partners (such as insurance companies, laboratories, and clinical specialists). The governance mechanisms between EMC and a patient relate to setting up the health delivery transaction and involve mechanisms for searching (for example, finding a pediatric pulmonologist) and contracting (for example, the patient admitting to EMC as an inpatient for a surgical procedure and agreeing to pay for the services provided). The governance mechanisms within EMC relate to delivering medical care and involve controlling (for example, by establishing standard of care during and after a surgical procedure). Finally, the governance mechanisms between EMC and external partners relate to organizing and controlling the health delivery transaction, and maintaining relationships (for example, commission-based service agreements with collection agencies, per-visit contracts with mobile MRI unit, long-term service contracts with clinical specialists, and long-term care contracts with local home health agencies).

Table 10.1-1 Examples of Governance Mechanisms for Transaction at EMC

Patient - EMC	EMC (Internal)	EMC - External Partners
<ul style="list-style-type: none"> • Patient contracts with EMC to provide medical services. • Patient makes payment arrangements to reimburse EMC for medical services (for any amount not covered by insurance payer). • Patient arranges for transfer of medical records and any laboratory results to EMC. • Patient negotiates payment plan with EMC's business office (in case of self-pay, patients with outstanding balance). 	<ul style="list-style-type: none"> • Patient access coordinator coordinates with clinical departments to check availability of clinical specialist (e.g., cardiac surgeon) before scheduling patient's visit. • The registration clerk coordinates with nursing staff to initiate patient-physician encounter. • The physician follows protocol to examine patient (e.g., collecting patient's medical history, chief complaint, and current symptoms). 	<ul style="list-style-type: none"> • EMC contracts with external agency to verify credit-worthiness of self-paying patients. • EMC sets up arrangements with external specialists (e.g., a radiologist) to provide consultations. • EMC contracts with external laboratories to collect samples (e.g., blood) and provide results. • EMC negotiates with insurance payers to determine reimbursements for specific procedures.

Further, these governance mechanisms were combinations of market-related, bureaucratic, and clan-driven forms. For example, the contractual arrangements with external partners (such as laboratories) were mainly market-driven; the contractual arrangements with insurance payers and between various functional departments within EMC were mainly bureaucratic; and the contractual arrangements within groups of internal specialists, nurses, and allied staff were mainly clan-driven.

These mechanisms mitigated the diverging interests between the parties involved in the health delivery transaction. At each stage of the revenue cycle, heterogeneity of interests between the patient, EMC's medical and administrative staff, and external partners was noticeable. For example, whenever a patient visited EMC, some staff had to engage to provide appropriate medical services. At the same time, however, the transaction typically involved some financial payout by the patient (in case of self-paying patients) or a third-party payer (such as, commercial insurance payers, Medicare, and Medicaid). However, these third-party payers strive to ensure that they pay only for necessary services provided in a manner consistent with medical standards and paid at the contractual level. The various governance mechanisms determine the conditions under which payouts occur (or do not occur, for example, in case of hospital acquired infections) and seek to avoid opportunistic behavior by some parties that may undermine smooth flow of health delivery operations.

Second-order Governance for Information Processing at EMC

Information processing for the health delivery transaction at EMC also required governance mechanisms. These mechanisms represent *second-order governance*, with information requirements for the transaction (and its governance) determining the related governance structures. The mechanisms facilitated the processing, exchange, and sharing of information to support the transaction between the patient and EMC. For example, when a physician has finalized an encounter, he uses a standard operating procedure (such as electronic forms on CPOE, or paper-based forms) to enter information related to medical services provided to the patient and sends it to a nurse for further processing. The nurse then uses that information to apply relevant charges for the services provided to the patient. This information exchange between the physician and the nurse requires a governance mechanism by which the physician agrees to provide information related to the patient encounter in a particular format to the nurse.

The nurse, in turn, exchanges information in a particular format with a coder. The coder uses information related to the patient charge and processes it to create standards-based codes. This exchange between the coders and nurses also requires a separate governance mechanism.

Third-order Governance for Technology Configurations at EMC

The technology configurations that supported the transaction and related information processing at EMC also required governance mechanisms. These mechanisms represent the *third-order governance* at EMC.

When a patient arrives at EMC for a routine physical check-up and gets some blood tests done, information processing occurs at multiple levels. Information exchanges occur between various functional units within the hospital, such as scheduling (to set up appointment for the tests) and registration (to register the patient and collect appropriate co-pay amount). Information exchanges also occur with external partners, such as laboratories (to collect the blood samples and report on the blood test), payers (to reimburse), and external specialists (to interpret any abnormalities in the test results). Each of these parties requires appropriate technology configurations to facilitate the health delivery transaction. The third-order governance becomes instrumental when there is a need to ensure a fit between the information processing requirements at each decision-making center and the portfolio of available technologies.

As EMC attempted to improve its health delivery operations, the heterogeneity and complexity of technology configurations increased over time. For example, the business office director worked with the EMR vendor to extend functionality by developing custom reports and by creating new alerts in the registration module. EMC also implemented a new module to provide PACS functionality in the EMR system (to aid radiology consultations). The increasing heterogeneity amplified the need for appropriate technology-related governance mechanisms. To cope with the increasing governance demands, EMC hired an experienced IT director in 2009. Prior to this, a network engineer had played that role. Over the next two years, the IT director streamlined the IT governance processes. He further supplemented the IT team in 2011 by bringing in a senior nurse manager—who had worked at EMC for nearly 20 years—as the clinical IT supervisor. The responsibility of the supervisor was to interface with physicians and nurses during implementation of new technological solutions, and to provide first level of

support for the growing portfolio of clinical IT applications (for example, updates to EMR, CPOE, and PACS).

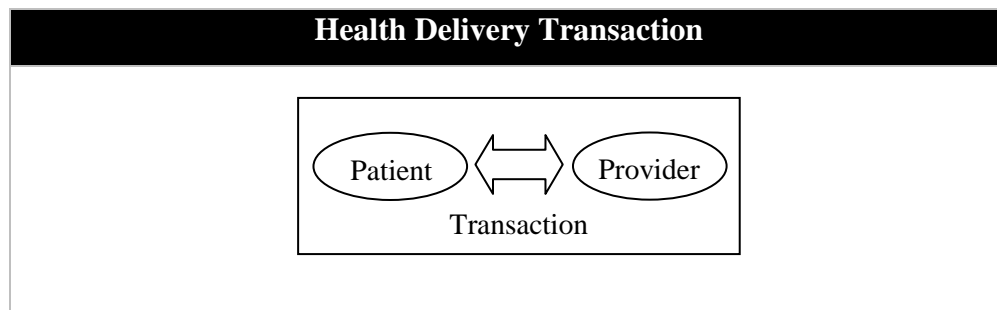
These three mechanisms—first-order, second-order, and third-order governance—can be formal (as discussed above) or informal. For example, when a billing clerk noticed a discrepancy in a claim, she would immediately call the registration clerk who had admitted that patient and seek clarification or walk over and leave a hand-written note at the registration clerk's desk describing the error for a particular patient account (for example, missing pre-authorization, incorrect subscriber information, or missing payer information). This informal mechanism served the purpose of communicating a specific problem (although, the billing clerks often complained of the time and effort that it required). Moreover, the registration clerks hardly gained any learning from this informal governance mechanism; they continued to make the same errors.

The need for these formal and informal governance mechanisms arose because multiple actors were involved in information processing for a single health delivery transaction between a patient and EMC. These included people in different stages of the revenue cycle (such as physicians, nurses, registration clerks, billing clerks, coding specialists, and business office staff), and people in laboratories, blood banks, insurance companies, collection agencies, and other service providers who were all, directly or indirectly, involved in fulfilling the transaction. As a result, there were multiple, and at times partly overlapping, contractual arrangements in play, all designed or cultivated to enable smooth flow of information (and information processing) between the involved actors. For example, after examining a patient, a physician wrote an order describing the diagnosis and a course of treatment; a nurse then compiled a list of all medical services provided to the patient and sent the information to a coder. This information exchange required overlapping governance between all three levels: transactional, informational, and technological. The first-order governance (relating to the transaction) controlled what the physicians, nurses, and coders did and when. The second-order governance (relating to information processing) determined who sent what information, in what format, and to whom. The third-order governance (relating to technology configuration) determined what technologies supported the transaction and information processing and how and when different actors accessed the technologies and interacted with EMC's overall technological infrastructure.

10.1.2 Transaction at EMC

The health delivery transaction at EMC involved a sick patient arriving at the hospital, receiving medical services (such as an X-Ray, or a knee surgery), and paying for the services through a combination of cash, insurance reimbursements, and government support. Figure 10.1-1 represents this transaction, the desired outcome of which is that the patient is treated and the provider (EMC) is paid. The double-headed arrow depicts health service provisioning by EMC and the payment by (or on behalf of) the patient for the services. The transaction ends when the patient recovers and does not need to revisit the hospital for follow-ups.

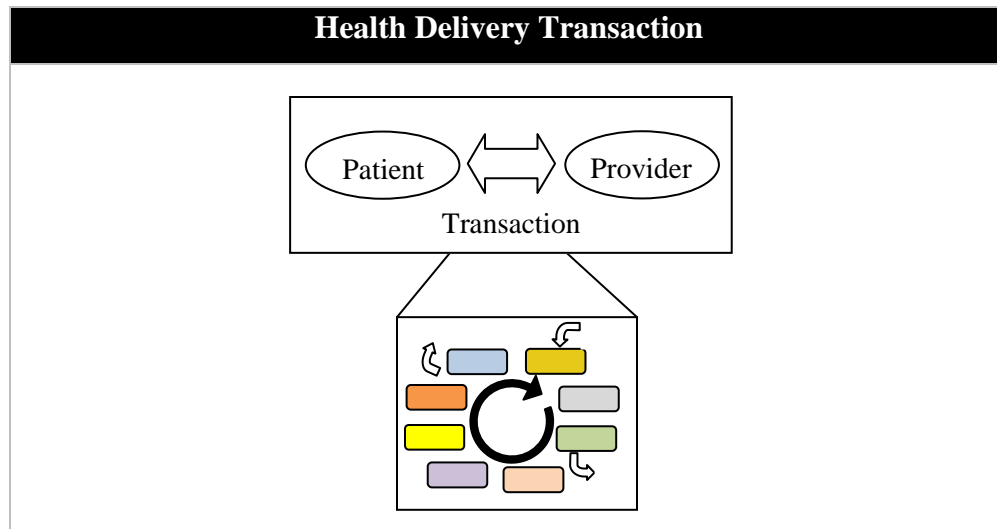
Figure 10.1-1 Health Delivery Transaction at EMC



This seemingly simple transaction was, in fact, very complex and involved several stages of the revenue cycle (see Figure 2.1-1 in Chapter 2). For example, an outpatient must first schedule a visit to EMC (walk-ins were generally discouraged, unless it was an emergency). A patient access coordinator conducted pre-registration verification with the patient's insurance company to obtain certification of approval for any procedure. The patient then arrived at the hospital, signed in, and registered. During registration, the registration clerk verified identity, collected appropriate co-payment, and updated the patient's record in EMR if there were any changes in contact or subscriber information. Then the patient transferred to an examination room for the actual patient-physician encounter. During or immediately after the encounter, a nurse recorded the various examinations done by the physician (to determine patient charges). In case of inpatients, the process was slightly different: the patient was admitted for a scheduled procedure (such as a knee surgery), and after the procedure completed, the patient was transferred to an observation ward. Once the patient's condition stabilized, the nurses discharged the patient to home or community setting. A nurse recorded all procedures and medicines for the patient

during their stay at EMC. In both cases, the coding department created standards-based codes based on the patient's charges, and then the billing department reviewed and submitted individual claims to the patient or appropriate insurance payers. As a result, one could consider the entire revenue cycle (discussed in Chapter 2) as part of this transaction between EMC—the provider—and the patient (see Figure 10.1-2).

Figure 10.1-2 Expanded View of Health Delivery Transaction



Every stage of the revenue cycle involved an independent center for making decisions and processing information. For example, the patient access coordinator made all decisions about patient's insurance eligibility—before the patient arrived or at the time of registration—based on the insurance payer and coverage information provided by the patient. The multiple centers of decision-making were “nested”—they contained other centers of decision-making. For example, the clinical team took all care-related decisions during a patient's stay at EMC; the team included clinical specialists, nurses, nursing assistants, technicians, and other allied staff who independently handled different aspects of the patient's care based on their expertise and patient's care requirements. These multiple independent sources of authority acted collectively to coordinate care for patients, and determined appropriate standards of behavior in their interactions within EMC and with external partners.

The transaction between a patient and EMC becomes even more complex if we consider all the external partners involved in the exchange. The external partners include laboratories, payers,

clinical specialists, mobile CT-Scan service provider, drug manufacturers and suppliers, medical device manufacturers and suppliers, state and federal regulatory agencies, collection agencies, credit rating agencies, and other service providers. Each of these parties introduces a center of authority, related information processing, and specific technological boundaries. For example, a neurologist must assess a patient arriving at the ER with stroke symptoms immediately (typically within three hours, after which the patient may suffer irreversible brain damage or even death). However, since EMC had no neurologist on medical staff, it relied on a relationship with the Medical College of Georgia which provided the services of Augusta-based neurologists who used a telemedicine system (called REACH—remote evaluation of acute ischemic stroke) to conduct real-time stroke assessment for the patient. The structuring of the transaction in this example involved actors at other institutions (in this example, the neurologists at Medical College of Georgia) and relied on technology configurations (telemedicine) at both ends to enable remote assessment for a potentially life-threatening patient condition.

However, for the sake of simplicity, we focus the analysis more narrowly on the inner workings of EMC's revenue cycle, while acknowledging the complex external context in which it operates. Accordingly, we only consider the basic representation of the health delivery transaction (shown in Figure 10.1-1) in our discussions.

10.1.3 Information Processing at EMC

Next, I consider the various revenue cycle stages at EMC from an information processing perspective. As discussed in Chapter 3, information processing occurs through information production and consumption.²⁴ At EMC, clinical and non-clinical staff produced information that supported patient care (and related financial activity) by deriving meaning from stimuli that resulted from activities within the hospital and with external partners. At the same time, the clinical and non-clinical staff consumed information when they transformed it into stimuli that supported and guided activities at the hospital to deliver patient care. Further, information led to ordering effects, which reflected in changes in EMC's structure and behavior. Table 10.1-2

²⁴ Information production refers to creating information (e.g., about entities or processes) from organizational activity, and information consumption refers to creating organizational activity (e.g., decision-making, plan formulation, and implementation) from available information [Ramaprasad, A., and Rai, A. 1996. "Envisioning Management of Information," *Omega* (24:2), pp 179-193.]

shows the information requirements, the information production and consumption, and the ordering effects of information at EMC.

Table 10.1-2 Information Processing in EMC's Revenue Cycle

Revenue Cycle Stage	Information Requirement	Information Production and Consumption	Ordering Effect of Information
Patient scheduling	<ul style="list-style-type: none"> • Referral information (or order) from physician's office • Patient's contact information • Availability of procedure (e.g., MRI) 	<ul style="list-style-type: none"> • A clerk verifies any pre-authorization or medical necessity requirement from payers for specific procedures. • If the pre-authorization is available, or not required, the clerk develops schedule for individual patients. • The clerk maintains consolidated schedule for all admissions (including inpatients and nursing home patients), as well as for outpatient procedures. • The clerk confirms schedule to the patient, and communicates it to concerned departments to coordinate the patient encounter. 	<ul style="list-style-type: none"> • The patient requests services from EMC. • The patient arrives at the scheduled time and location. • Appropriate personnel are available to provide medical services to the patient.
Patient registration	<ul style="list-style-type: none"> • Patient's demographic information (including social security number) • Patient's (or subscriber's) contact information • Patient's (or subscriber's) insurance information, including payer information, 	<ul style="list-style-type: none"> • A registration clerk verifies or updates patient demographic and contact information in the EMR system. • The clerk determines credit-worthiness of self-pay patients. • The clerk determines co-payment amount based on patient's insurance information, and collects appropriate amount. • The clerk generates patient account number used to administer medical services to 	<ul style="list-style-type: none"> • The patient is accepted and ready for encounter (e.g., with a specialist).

	coverage, and co-payment amounts	the patient and to support billing. <ul style="list-style-type: none"> • The clerk creates “patient tag” that identifies patient within hospital. 	
Patient encounter	<ul style="list-style-type: none"> • Pre-authorization (or medical necessity, in case of Medicare) information from patient’s insurance company • Patient’s physical condition, clinical history, chief ailment, and current symptoms • Patient’s current medications • Patient’s diagnostic results (such as X-Ray and blood tests) 	<ul style="list-style-type: none"> • Clinical staff uses pre-authorization information to determine the course of treatment. • A physician uses patient’s history and clinical information to examine and diagnose the patient’s condition or perform a scheduled procedure. • The physician writes an order (using CPOE, manually, or by dictation), containing diagnosis, treatment plan, and follow-up schedule • A nurse uses patient’s clinical information to monitor the patient’s condition during stay in EMC (in ICU, as inpatient, or under observation). 	<ul style="list-style-type: none"> • Patient receives appropriate medical services from the clinical staff.
Clinical documentation	<ul style="list-style-type: none"> • Patient’s length of stay information (i.e., duration in observation, or as inpatient) • Medical services provided to a patient (including procedures, and medications) • Comorbidities²⁵ that may also need to be coded 	<ul style="list-style-type: none"> • A nurse uses patient’s length of stay information to determine charges. • The nurse uses list of medical services provided to a patient to determine charges. • The nurse creates charge list that becomes the basis of coding and billing. 	<ul style="list-style-type: none"> • Charges for patient’s stay and medical services are finalized and ready for coding.
Medical charge coding	<ul style="list-style-type: none"> • Clinical documentation for 	<ul style="list-style-type: none"> • The coder reviews clinical documents to identify any 	<ul style="list-style-type: none"> • The coder coordinates with the involved

²⁵ For example, the nurses’ documentation (and subsequent coding) may include diabetes, but not the patient’s diabetic foot ulcers.

	a particular patient (including physician's orders and patient charts)	missed charges or inconsistencies. <ul style="list-style-type: none"> • The coder applies standards-based codes for all charges to a patient account, which then becomes the basis of billing. 	nurse to resolve issues, <ul style="list-style-type: none"> • Charges for medical services provided to the patient are coded and ready for billing.
Billing	<ul style="list-style-type: none"> • Patient account information • Patient discharge information • Payer information • Coded medical charges for each patient account 	<ul style="list-style-type: none"> • A billing clerk collects all claims (prepared by coding since the last collection). • A billing specialist reviews claims to identify deficiencies ("edits"). 	<ul style="list-style-type: none"> • The billing specialist coordinates with registration clerk, nurse, or coding team to resolve edits in the claims. • The billing specialist submits medical claims to patient's payer.
Payment posting	<ul style="list-style-type: none"> • Payment posting information from payers 	<ul style="list-style-type: none"> • A business office clerk uses payment-posting-related information from payers and updates the associated patient accounts. • The clerk generates a report of denials from payers and request payers for reconsideration. 	<ul style="list-style-type: none"> • EMC receives payment for services provided to patient. • The billing clerks receive denials of claims (because the patient authorization or medical necessity determination is missing, or the claim has other errors). • The clerk re-examines the denied claims, and resubmits if reasons for denial are fixed.
Revenue recovery	<ul style="list-style-type: none"> • EMR reports of delinquent accounts (i.e., accounts that have balance due beyond a certain threshold—typically 90 to 120 days) • Patient's account balance • Patient's credit- 	<ul style="list-style-type: none"> • A business office clerk uses information about patient's account balance and credit-worthiness to negotiate easier payment terms or to offer discounts. • The clerk reviews information about delinquent accounts and provides information to a collection agency to recover the balance amount. • Business office manager 	<ul style="list-style-type: none"> • The business office engages collection agency to recover balance amount from patients. • The business office takes decision to write-off outstanding balances.

	worthiness • Account reconciliation information ²⁶	reviews reports from collections agencies. • The manager generates financial reports relating to unpaid accounts, discounts, bad debts, and write-offs. EMC's financial balance sheet reflected this information.	
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The information exchanges and decision-making authority at EMC were fragmented, as was evident in the fact that patient care involved actors across functional units within EMC and a variety of external partners (such as, insurance companies, consulting specialists, blood banks, and laboratories). As Table 10.1-2 shows, from patient scheduling to revenue recovery, the health delivery transaction at EMC involved actors in multiple centers of decision making who processed information at each center, thereby resulting in ordering effects. For example, the ordering effects on the transaction resulted from new information about patient symptoms or about the profile of involved medical professionals. In addition, the ordering effects enabled structuring based on information processing to support the transaction's governance. Such ordering effects resulted from new information about the patient's medical history and insurance situation, or about the provider's available resources and service offerings.

10.1.4 Technology Configurations at EMC

The technology configurations supported information processing (and resulting decision-making) for the transaction between patients and EMC. The technologies focused on both clinical and non-clinical support. However, as Table 10.1-3 shows, the technologies related to clinical support clearly outnumbered technologies associated with non-clinical support (such as for billing). The table relates each technology to the overall context—whether a technology largely supports patient's exchanges with EMC, exchanges within EMC, or exchanges between EMC and its external partners.

²⁶ This represents the difference between the amount received for each patient billed and the anticipated collectable amount based on the contractual relationship with the payer. Often, the payers and hospitals interpret the contract differently; so there is a difference in the payment that the two parties need to clarify.

As shown in Table 10.1-3, there was significant heterogeneity of the technology configurations at EMC. This led to a situation where EMC's IT department had to support an ever-increasing number of clinical and non-clinical applications. The hiring of a clinical IT supervisor—a new position—clearly indicates EMC's concern, and effort, to cope with the challenge of increasing complexity due to technological heterogeneity. Further, the technological heterogeneity (and associated complexity) had increased over time. Even during the period of our engagement with EMC—from early 2008 to our most recent follow-up visit in June 2011—we found an increased variety and sophistication of technological configurations. Earlier, EMC had only one production server for their EMR system. Now, the IT director was negotiating to buy a new test server to stage new software updates for the EMR system. Within the last two years, EMC had implemented the PACS system, credit-verification system, voice-over-internet-protocol based phone system, web-based portal for physicians, enterprise-wide scheduling system, bar-code scanners, digital signature pads, and many other technologies. These technologies not only provided new functionality, but also extended the functionality of the existing systems.

The heterogeneity of technology created both opportunities and challenges for EMC. On the one hand, it provided more functionality to the actors (both internal and external) involved in the health delivery transaction. On the other hand, it increased the complexity of organizational information management as different actors used different technologies to produce and consume information to facilitate the transaction. While EMC's goal was to enable seamless flow of information, often there were problems as some actors used a variety of IT and non-IT systems. For example, when the nurses sent paper-based patient charts to the coding team, the coder had to review the charts line by line, enter the information about the diagnosis and any procedures manually. This created media breaks. Another example illustrates the problems faced in using multiple technologies for the same activity. While most physician offices have started sending orders electronically (via eFax, which can be e-mailed and stored digitally as PDF documents), some still send paper orders to EMC. This remnant of the old process requires a registration clerk at EMC to scan the paper-based order sheets, attach the scanned file to the patient's account in the EMR system, and then store the papers securely. This not only creates more work but also makes the process error-prone (for example, a patient who brings a paper-based order may lose or misplace some sheets).

This heterogeneity of technology configurations at EMC was both a reflection of the polycentric conditions at the hospital and the result of technological evolution. EMC made earnest attempts to address the latter by simplifying some technological systems (for example, it discontinued a stand-alone PACS system and licensed a module of the existing EMR system that provided the same functionality). Interestingly, the polycentric conditions at the hospital dictated a non-standardizing approach: they warranted heterogeneous technology configurations to meet the unique needs and the governance requirements of each center of decision-making. EMC tried to address both concerns: a move towards homogeneity (as suggested by discontinuing the stand-alone PACS system) and a move towards heterogeneity (as suggested by the addition of new technology systems to meet the needs of internal and external customers).

Table 10.1-3 Illustrative Technology Configurations of Revenue Cycle at EMC

Technology	Description	Context	Revenue Cycle Stage
EMR System (supplied and maintained by CPSI —Computer Programs and Systems, Inc.)	Software that allows sharing of patient information within the hospital	Patient-EMC	Entire revenue cycle
ChartLink (supplied and maintained by CPSI)	A web-based portal that provides physicians access to the EMR system	EMC (internal)	Patient encounter
Enterprise-wide Scheduling System (supplied and maintained by CPSI)	A software application to facilitate centralized patient scheduling	EMC (internal)	Patient scheduling
Credit Verification System	An online service that shows credit-worthiness of self-pay patients	EMC (external)	Patient registration; revenue recovery
CPOE system (supplied and maintained by CPSI)	Software to allow electronic entry of physicians' orders for the treatment of patients and to provide access to the medical staff and departments responsible for fulfilling the order (e.g., pharmacy, laboratory, and radiology)	EMC (internal)	Patient encounter; clinical documentation
ImageLink PACS system (supplied and maintained by CPSI)	Software to digitally store and communicate patients' images (e.g., X-rays and MRI scans) to be retrieved and reviewed by a radiologist on site or	EMC (internal)	Patient encounter

	remotely		
ICD ²⁷ Code Finder	Software to manage the complex rules and terminology of ICD-9-CM coding practice	EMC (internal)	Coding
DRG ²⁸ Finder	Software to provide accurate diagnosis-related grouping capabilities for Medicare	EMC (internal)	Coding
Contract Verification System	Software that verifies that the payer has actually paid as per the agreed amount for a particular procedure	EMC (internal)	Billing
Exception Management System (built by the research team)	A customized software application to improve communication (relating to revenue cycle exceptions) between various departments	EMC (internal)	Entire revenue cycle
Pharmacy automation system (supplied and maintained by PIXUS)	Bedside computers and ward-based systems to automate pharmacy and clinical supplies	EMC (internal)	Patient encounter
Digital signature pads	Used by registration clerks to capture patient signatures on various forms	EMC (internal)	Patient registration
Bar code scanners	Hardware and software system used by nurses and pharmacy to match medicines and clinical supplies for patients	EMC (internal)	Patient encounter
Database servers (Oracle)	To provide database services for clinical and administrative applications	EMC (internal)	Entire revenue cycle
Application servers (multiple)	To support applications relating to EMR, PACS, E-mail, intranet, etc.	EMC (internal)	Entire revenue cycle
Network routers and switches (multiple)	To facilitate internet, intranet, and phone connectivity throughout EMC and its associated clinics	EMC (internal)	Entire revenue cycle
Telemedicine cart	Video-conferencing and related equipment to facilitate telehealth consultations with remote specialists	EMC (external)	Patient encounter

²⁷ The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) is based on the World Health Organization's Ninth Revision, International Classification of Diseases (ICD-9). ICD-9-CM is the official system of assigning codes to diagnoses and procedures associated with hospital utilization in the United States. ICD codes are alphanumeric designations given to every diagnosis, description of symptoms and cause of death attributed to human beings.

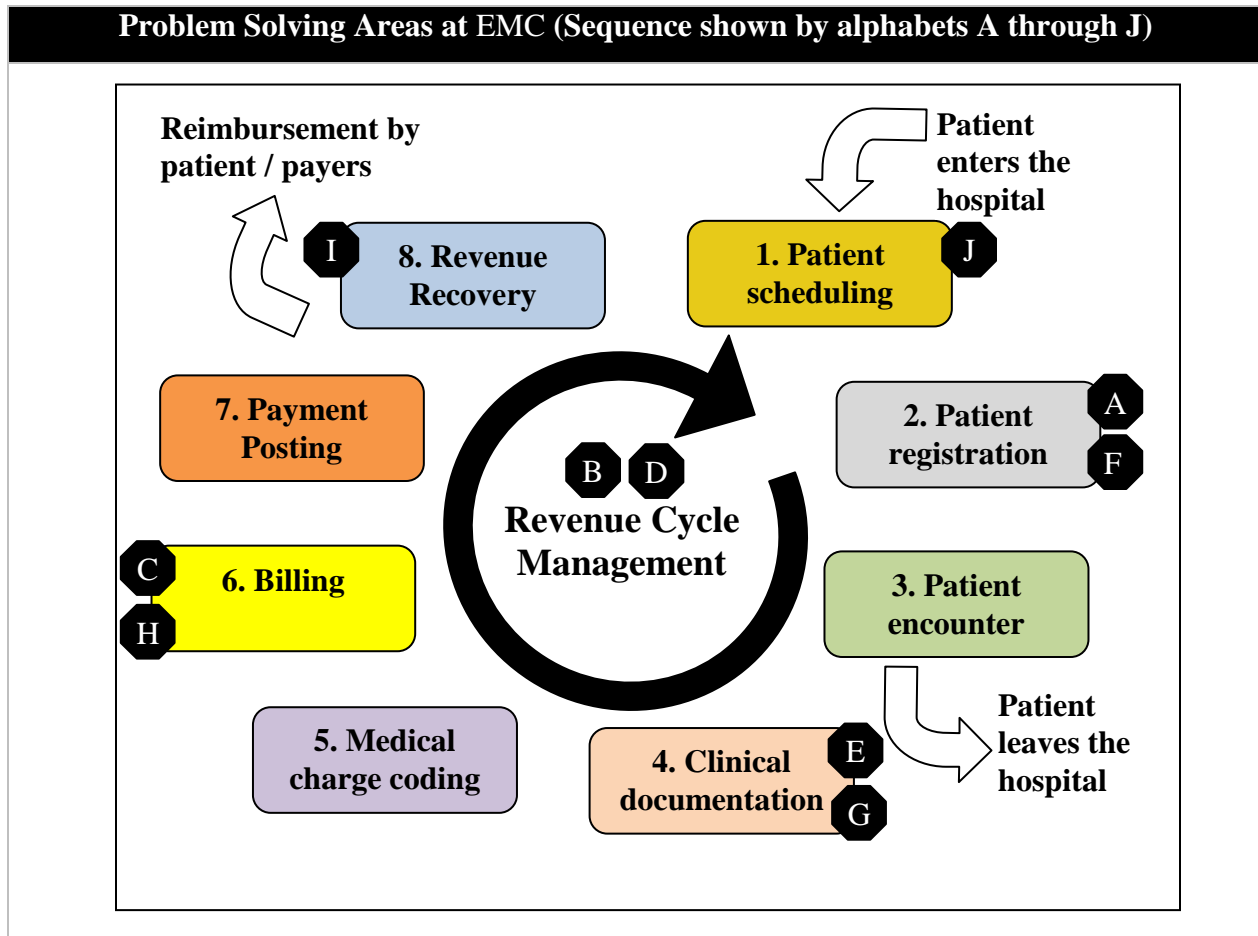
²⁸ Diagnosis-related groups or DRGs are the basis for per-episode payments made to the medical office on inpatient hospital visits

REACH cart	Dedicated video-conferencing and related equipment to facilitate stroke consultations with remote neurologists (located at Medical College of Georgia)	EMC (external)	Patient encounter
Intranet	This included several applications for training, general communication, and requests for IT support.	EMC (internal)	Entire revenue cycle
Telephone system (and associated telephone exchange)	The phone system was used for internal and external communication	EMC (internal); EMC (external)	Entire revenue cycle
Dictaphone	Telephone-based dictation system used by physicians to record orders (for transcription by an external agency)	EMC (internal)	Clinical documentation

10.2 Interventions into Information Management at EMC

Following a collaborative practice research methodology (Chiasson et al. 2008; Mathiassen 2002), the diagnosis of EMC's problem situation led to a portfolio of focused interventions. As we delved deeper into the identified problems and related activities over the two-year period, other problems surfaced which required additional interventions. Moreover, as we gained more knowledge about the revenue cycle and specifically the health delivery transaction, we modified the intervention cycles for better alignment with the objectives of the action research project. Thus, during the entire period of engagement at EMC, we continued to evaluate and refine current interventions and add new interventions. For each intervention, we worked closely with the steering committee and individual problem-solving teams. Figure 10.2-1 shows the interventions to improve EMC's revenue cycle. The sequence of specific interventions was not always pre-determined; it sometimes emerged as the problem-solving cycles progressed.

Figure 10.2-1 Intervention Areas at EMC



We group these interventions into four cases, each of which consists of one or more related interventions. The grouping provides parsimony and coherence by avoiding repetition of case interpretation. Case 1 relates to improving exception management at EMC; it has an internal focus on the provider's administrative involvement in the health delivery transaction. Case 2 relates to improving clinical documentation at EMC; it has an internal focus on the relationships between the provider's clinical and administrative activities. Case 3 relates to improving interactions with patients and payers; it has a focus on the provider's key external relationships as part of the health delivery transaction. Case 4 relates to the entire revenue cycle. Below, I describe each case by providing detailed context of the problem situation and the researchers' interventions. For each case, I draw on IPF to provide interpretations of the problem situation, the interventions, and the outcomes of each intervention. The letters A through J represent the

sequence in which the individual interventions occurred at EMC. The case numbering 1) through 4) is arbitrary; it does not suggest sequence of the included interventions.

10.2.1 Case 1: Improving Exception Management

CASE DESCRIPTION

Intervention A

The immediate focus area of our intervention was the patient registration stage of the revenue cycle, because incorrect information entering into EMC's electronic medical record (EMR) system during registration was a major cause of exceptions observed during billing. In October 2009, our analysis of exception data suggested that more than half (67 out of 120) of all exceptions reported in the entire revenue cycle operation during that month originated at the registration stage. The situation in December 2009 was no different, when the total number of exceptions had reduced, but registration related exceptions still accounted for a major share (42 out of 80). We identified over 30 types of exceptions relating to patient registration, including incorrect payer information, incorrect primary insurance subscriber information, and missing pre-authorizations (from commercial insurance companies) and medical necessity certifications (from Medicare). Often these errors escaped notice during billing review and ultimately resulted in delays and denials of claims by the insurance payers. Although EMC maintained account information of all unpaid claims, it had no estimate of the number (or amount) of claims rejected for a specific reason (for example, missing pre-authorizations). This made it difficult to understand the scope of the problem, and to identify appropriate interventions.

Working with the registration supervisor, we identified an available report (Registration Census Quality Report) in the EMR system that showed registration-related exceptions based on nine pre-configured parameters (for example, incomplete or missing address information of the insurance subscriber). In November 2008, we set up a process by which each registration clerk would run this report on their computers at the end of their shift and clear any exceptions that showed up (by correcting relevant data for a particular patient account). We tracked the total number of outstanding exceptions that showed up on the report at the end of the month. Once this process was set up, we identified and added additional parameters to the standard report. We

reviewed the trends with the registration supervisor and the steering committee during monthly meetings and discussed opportunities for training and feedback to registration clerks. This intervention helped to reduce the number of exceptions during registration. As Appendix B.1 shows, the number of open exceptions at the end of each month dropped significantly after the intervention in November 2008 (from an average of nearly 70 per month to less than 10 per month). The outcomes suggested a continuous process of learning among the registration staff. The minor upward blip in May 2009 resulted from a training issue, which highlighted the importance of ongoing training.

During a follow-up visit in June 2011, we met a new registration supervisor—she had been a billing clerk²⁹ at EMC for several years and had worked with us during some of the interventions. She noted that her team still ran the Registration Census Quality Report at the end of each shift, and the exceptions generated during registration stage had been consistently few. In a related discussion, the business office director (to whom both the registration and billing departments reported) informed us that EMC had engaged the EMR vendor to add new functionality to the registration module. For example, if a registration clerk did not enter information in key fields on the registration screen, the system would alert the registration clerk with a pop-up message. They had now created such alerts for all common registration errors. During our discussions in early 2010, we had often discussed such functionality.

Intervention B

To address the pressing issue of exceptions during various stages of EMC's revenue cycle, we built an application (the Exception Management System) to manage exceptions created during the health delivery transaction. We considered different options, including off-the-shelf software and open-source alternatives. Finally, we decided to build on the resources that EMC already possessed. Accordingly, we asked the IT director about applications that they used for some tracking purpose. He mentioned an open-source application that the IT department used for managing requests for IT support. After reviewing the functionality of that application, we concluded that it was a promising candidate to fulfill the exception management function. Over

²⁹ In our discussions with the business office director, we had often discussed a need for cross training between the registration and billing departments.

the next few months, we got full administrative access to a fresh instance of that application on a dedicated server. We configured the application, keeping in mind a few simple design rules:

- The final application should be easy to learn and use;
- Using the application should not increase workload of EMC's staff;
- The application should allow easy configuration; and
- EMC should own, and be able to maintain, the application on an ongoing basis.

We demonstrated a pilot application (see snapshot in Appendix B.2) at a steering committee meeting in February 2009. Based on feedback from the committee and potential users, we made changes to the application. Once it was ready and approved by the committee, we prepared a user-training plan. We met the revenue cycle staff in small groups, and explained the purpose of the Exception Management System. In April 2009, we gradually rolled out the application, starting with the registration and billing staff. Initially, I maintained and configured the application in response to requests from users (for example, to add new categories of exceptions). A few months later, the director of the business office took responsibility for the ongoing configuration, and EMC's IT department took responsibility for the application's back-end maintenance. I obtained remote access to the application, which allowed us to track data on a regular basis (see trend in Appendix B.2). During our monthly visits to EMC, we discussed training needs for the staff based on trends and individual usage statistics from the Exception Management System. We conducted additional training sessions as needed.

During a follow-up visit in June 2011, we found that the revenue cycle staff was still using the Exception Management System (although, the usage was mostly by the registration, billing, and utilization review departments). The director of the business office had added several new categories of exceptions. The turn-around time for fixing any exception was typically less than a day. In response to our comment that it was remarkable that the process was still being followed, the registration supervisor joked, "I threatened to break their fingers if they don't do it."

Intervention C

In 2008, a major problem relating to exception management was that EMC's billing department was spending about 80% of its time handling exceptions created elsewhere in the revenue cycle,

which left little time to follow-up with payers for denied claims. As the billing manager told us, they saw the same exceptions occurring all the time. For example, incorrect insurance payer information was among the top exceptions each month. Therefore, once the Exception Management System was functioning, we initiated a process of re-allocation of exceptions found in any department to the department where the exception originated. In the new process, upon finding incorrect payer information during review, a billing specialist would create an exception ticket in the Exception Management System, enter brief information about the exception, and assign it to the relevant person (in this example, the registration clerk who created that patient account). This activity of creating a ticket took less than a minute. Upon submitting the ticket, the Exception Management System sent an automated e-mail to the assignee.³⁰ Once the assignee “cleared” the ticket (by providing requested information), another automated e-mail informed the sender. Initially, many users hesitated to use the system to re-allocate exceptions to other departments, fearing that the new process would delay submission of claims. Moreover, as one billing specialist told us, they were concerned that other departments may not like the pushback from billing department, which may lead to inter-personal (and inter-departmental) issues. As part of the user training, we explained the importance of the principle of accountability to all such hesitant users of the Exception Management System: “Whoever makes a mess cleans it up.” We emphasized that this principle was critical to improving the revenue cycle process as it facilitated learning from one’s mistakes and would help to reduce errors that occurred month after month.

The chief financial officer and steering committee members supported this initiative and sent out frequent communications to all users, encouraging them to use the new system. Adoption of the new process improved over time, resulting in fewer exceptions found during billing reviews (see Appendix B.3), and reduced the time the billing staff spent on reviews. During a follow-up visit in June 2011, the business office director noted that the billing staff processed about 1800 claims per month, and of these, more than 80% were now clean (that is, without any errors). This was a marked improvement over his estimate of 50–60% clean claims in 2008.

³⁰ We configured the Exception Management System to allow manager-level privileges to all users. This made the task of ongoing administrative maintenance of the application easier and, importantly, allowed all users to view all exception items. We believed that this would help to improve user learning and provide better perspective over the entire revenue cycle operations.

Table 10.2-1 Summary of Interventions in Case 1

Stage	Intervention	Rationale	Implemented In ▼	Participants	Outcomes
Patient registration	A. Identify and address exceptions created during registration by using reports in the hospital's EMR system	Majority of exceptions identified during billing review were generated during registration	Nov-08	Registration clerks	<p><i>Successful</i></p> <ul style="list-style-type: none"> • Each registration clerk reviews a custom report daily to identify and address registration-related exceptions. • The number of exceptions created during registration has reduced over time (see Appendix B.1).
Entire revenue cycle	B. Facilitate users to track exceptions during different stages of the revenue cycle by building an exception management application	EMC had no system to track and manage exceptions, and to improve coordination and organizational learning	Mar-09	Entire revenue cycle staff	<p><i>Successful</i></p> <ul style="list-style-type: none"> • The revenue cycle-related staff now tracks most exceptions through the new intranet-based application (see Appendix B.2). • The number of exceptions initially increased (suggesting increased usage of the system) and then reduced over time (suggesting improvement in overall process).
Billing	C. Re-allocate exceptions found during billing to the department from where the exception originated by creating an IT-enabled process	Billing clerks spent 80% of their time in handling exceptions, leaving little time to follow-up with payers for denied claims	Apr-09	Billing clerks	<p><i>Successful</i></p> <ul style="list-style-type: none"> • The billing clerks now use the Exception Management System to assign exceptions to persons responsible for creating them. • The new process has reduced the number of exceptions found during billing reviews (see Appendix B.3). • The new process increased the proportion of clean claims from 50–60% in 2008 to more than 80% in 2011.

CASE INTERPRETATION

Interpretation of problem situation

The main reasons for the high number of exceptions created during the registration stage were the high level of production and consumption of information and the overall complexity of the hospital revenue cycle. For any patient admitted to EMC, a registration clerk collected a considerable amount of information. This information related to the patient's demographics (including age, sex, and race), contact information, insurance information, and relationship to the insurance subscriber. Some of the information was specific to certain patient types (for example, for an uninsured patient, the clerk had to collect additional information, such as the social security number, to verify credit-worthiness). Often, a patient had no identification, insurance card, or a fixed address. In such cases, the registration clerk had to decide whether to register the patient. Overwhelmed with the information requirements, the clerks often missed collecting critical information, resulting in delays or denials when the billing specialists submitted the claim to the payers. Understandably, the number of exceptions increased whenever a new registration clerk joined the team. Moreover, the registration staff had high turnover, which further exacerbated the problem. Table 10.2-2 gives an indication of the types of exceptions that occurred routinely during registration, reflecting the high level of information requirements.

Table 10.2-2 Examples of Common Registration-related Exceptions at EMC

Common Registration-related Exceptions	
<ul style="list-style-type: none"> • No pre-authorization—outpatient • Incorrect insurance payer • Subscriber–patient name mismatch • Address error • Incorrect insurance contract number • Incorrect insurance group number • No insurance card scan • No driving license scan • Poor scan quality • Medical necessity not checked 	<ul style="list-style-type: none"> • Incorrect stay type • Incorrect service code • Missing eligibility • Missing face sheet • No occurrence code • No order • Missing additional payer source • No admit/discharge date • Incorrect admission date • Incorrect admit/discharge code

Some of the observed exceptions occurred because of technology issues, such as a defective scanner or improper technology integration (resulting in poor quality scans or no scans at all). The heterogeneity of technology configurations for any given activity also exacerbated the situation (see Table 10.1-3 for an illustration of some technologies used at EMC). Other causes of exceptions included coordination issues with other individuals involved in the revenue cycle (for example, the physician offices sometimes did not send orders for patients and, as a result, the registration clerk could not seek pre-authorization approval from the insurance companies). This represents overlapping, but unaligned, governance mechanisms, which increased transaction costs for EMC's registration staff.

Interpretation of interventions and outcomes

Intervention A addressed the problem situation relating to registration exceptions by identifying a standard EMR report (Registration Census Quality Report) and setting up a process by which each registration clerk ran the report at the end of their shift and fixed any exceptions that showed up. In doing so, the intervention created a governance mechanism to control and measure performance of the registration staff. This mechanism allowed them to review and correct their own errors, and thereby improved the quality of the patient-related information collected during registration. In effect, the intervention enabled a context-dependent governance mechanism—a self-governing community—that developed appropriate standards of behavior in the registration staff's interactions with other centers of authority within EMC.

Intervention B created the Exception Management System—an IT-based system to manage exceptions created during the health delivery transaction at every stage of EMC's revenue cycle. The system highlighted the transactional nature of information and emphasized the multiple hand-offs required to deliver health services to any patient. The system overcame the problems created by fragmented decision making in the revenue cycle and provided a governance mechanism that helped to coordinate information processing related to the transaction across multiple centers of decision making. The Exception Management System reduced transaction costs, as the following examples suggest:

- *Search costs*: the billing clerk could now easily identify and communicate with the originator of an exception and not have to call or walk over to their desk;

- *Contracting costs*: the registration clerks understood the delivery expectations and information requirements to close an exception ticket;
- *Control and regulation costs*: the registration clerks had to respond to an exception ticket within reasonable time, for delays and open tickets were monitored by supervisors; and
- *Maintenance costs*: the billing and registration clerks developed an understanding of how to address the issues relating to incorrect information in some patient accounts.

Intervention C developed a process of exception re-allocation, thereby providing a governance mechanism to monitor and regulate exceptions created during the health delivery transaction. Over time, the process improved information quality (as seen in the increased proportion of clean claims during billing review: from 50–60% in 2008, to more than 80% in June 2011). This also helped to improve coordination and relationships among different functional groups (for example, the billing staff had fewer complaints about “having to fix” the issues generated during registration stage). Thus, the intervention helped to develop context-dependent governance mechanisms to facilitate patterns of cooperation (instead of conflict, as evidenced in the initial hesitation in allocating exceptions) among actors.

Overall, Case 1 relates to the positively reinforcing cycles of production and consumption. In the original arrangements, several actors individually were part of a massive information production effort, without any sense of participation in the subsequent consumption (turning information about patient encounters into reimbursement for the hospital). The reorganization (through interventions, A, B, and C) represented attempts to take shared responsibility for the information production through shared appreciation of the need for effective information consumption.

10.2.2 Case 2: Improving Clinical Documentation

CASE DESCRIPTION

Intervention E

The coding team occasionally found errors in physician orders. Most of the errors resulted from entering insufficient information rather than by issuing a wrong diagnosis (for example, ordering diabetes tests without specifying the diabetic condition of the patient). The extent of this problem was unknown, since no formal auditing of clinical documentation existed. To address this, EMC engaged an external clinical consultant and initiated the Concurrent Documentation Review Program. As part of the program, the consultant directly linked to the EMR system, reviewed patient discharge documentation, and sent detailed reports stating errors (such as incomplete physician orders). The consultant sent queries to relevant physicians requesting review, and the physician's response (or lack of it) became part of the consultant's monthly reports. We tracked these reports and participated in quarterly review meetings organized by the clinical utilization review manager. The results showed that some physicians (2 out of the 12 physicians on medical staff) consistently ignored the auditor's recommendations and did not correct the errors even a month after receiving the audit report. Considering the unique position of physicians in a hospital—especially in rural hospitals where the dependence on existing specialist physicians is greater as replacements are difficult to attract and retain—EMC's management did not take any action against these physicians.

During our follow-up visit in June 2011, we noted that EMC had implemented CPOE (in September 2010) to improve encounter-related clinical documentation. We collected data for CPOE usage by the physicians on EMC's medical staff. The data showed that the overall usage had improved gradually, but on average, the physicians had used CPOE in only 27.1% of all clinical orders during May 2011.

Intervention G

From our discussions with the steering committee and revenue cycle stakeholders, it was apparent that missed charges resulted in substantial loss of revenue to EMC. In the existing system, the nursing staff used paper-based charts to record clinical documentation after each

patient encounter. The coding team occasionally found instances where the clinical staff had provided medical services to patients but missed mentioning them in the patient charts. Because there was no standardized way to capture and monitor such missed charges, it was difficult to estimate the extent of this problem. In collaboration with the director of coding and documentation, we initiated a process whereby nurses would use an available module (CPOE) in the hospital's EMR to capture the patient encounter- and charge-related information at the time of service. However, this intervention did not proceed beyond the planning stage as it faced resistance from nursing staff who did not want to use CPOE to record patient encounters. As per a nurse manager, a couple of them "came to tears" at the prospect of mandatory CPOE use. As a substitute, the director of coding and documentation designed standardized, paper-based charge checklists, which the nursing staff began to use.

During a follow-up visit in June 2011, a nurse manager noted that more than 80% of nurses had now started using CPOE. Some nurses were still hesitant to adopt CPOE, as they missed the "feel or touch" of paper-based patient charts. The nurse manager (who later joined the IT department as the clinical IT supervisor) showed us commonly used CPOE forms (called eForms) that she had customized in collaboration with nursing supervisors. For example, the eForm for a patient with diabetes was different from that of a patient with chest pain. This customization improved adoption among nurses, as they had to spend less time entering encounter-related information into the system. While specific data about improvements in charge capture for nurses was unavailable, the chief financial officer shared financial data that suggested that per-patient recovery had improved since September 2010, when the physicians and nurses began using CPOE.

Table 10.2-3 Summary of Interventions in Case 2

Stage	Intervention	Rationale	Implemented In ▼	Participants	Outcomes
Clinical documentation	E. Identify and address errors in clinical documentation by creating an IT-enabled process	The coding team occasionally found errors in physician orders and patient discharge documents.	Apr-09	Utilization review staff	<p><i>Partially successful</i></p> <ul style="list-style-type: none"> • EMC engaged an external agency to audit clinical documentation by directly linking to the EMR system. • Some physicians do not respond timely to queries sent by the clinical auditor. • As of June 2011, physicians had not fully adopted CPOE, for they used the system in only 27.1% of all clinical orders in the previous month.
Clinical documentation	G. Engage nurses in capturing the patient encounter information at the time of service directly into EMC's EMR system	Nursing staff uses paper-based charts to record the patient encounter information, often missing charges for some medical services.	Jul-09	Nursing staff	<p><i>Partially successful</i></p> <ul style="list-style-type: none"> • This intervention initially did not proceed beyond the planning stage due to resistance from nursing staff to use an existing module in the EMR system. Instead, they used a charge checklist to assist them in documentation. • As of June 2011, more than 80% of nurses had started using CPOE for clinical documentation.

CASE INTERPRETATION

Interpretation of problem situation

Errors (mostly missing information, not wrong diagnosis) in physician orders resulted from many sources. The primary goal of the physicians and nurses at EMC was to deliver quality care

to patients. The physicians were less concerned³¹ about the hospital receiving reimbursement for medical services provided to the patient (although, it was the primary concern of the billing department and the business office). This divergence of interests led to situations in which the physicians and nurses focused on delivering patient care and paid less attention to documenting charges for the procedures and medical services provided to the patient. If there was no clinical documentation, the coding team could not apply standardized codes for the procedures and, consequently, EMC could not claim any reimbursement from payers. These missed charges resulted in substantial loss of revenue to EMC.

Multiple nested decision-making centers and heterogeneous technology configurations exacerbated this problem. The physicians, nurses, and other revenue cycle staff constitute independent centers of authority that are part of the nested set of arrangements within EMC (the situation becomes more complex if we include the nested set of arrangements in relation to external partners). This is clearly a situation of polycentric fragmented authority, which creates coordination issues across the different decision-making centers. Although the nurses used an electronic system for ordering medications from EMC's pharmacy, they preferred paper-based charts for recording clinical documentation after each patient encounter. In some cases, the patient charts were misplaced; in other cases, the information in the charts was incomplete, incoherent, or wrong. The coding team translated the charge-related information in these handwritten patient charts into standards-based codes in the hospital's EMR system. Using an available CPOE module in the EMR system to electronically capture the patient encounter- and charge-related information at the time of service could resolve (or at least, lessen) many of these problems as the information processing (and errors) during coding would have reduced. However, the majority of nursing staff initially resisted CPOE adoption as they felt that entering the patient data into the system increased their workload (or that they missed the "feel or touch" of paper-based patient charts). The adoption improved gradually, in large part as the clinical IT supervisor and the nursing supervisors designed custom eForms for data entry, which reduced the required time and effort.

³¹ In fact, hospital reimbursement for medical services was not the primary concern for most physicians (as they were not direct employees of the hospital but were on the medical staff and used the hospital resources). The reimbursement for these physicians was independent of hospital reimbursement. Here, the divergence of interests is a byproduct of the unique arrangement between a physician and a hospital.

Interpretation of interventions and outcomes

EMC developed an audit system (Intervention E) in which an external clinical consultant asynchronously reviewed patient discharge documentation and sent detailed reports highlighting missing information in the physician's order. This system provided a governance mechanism—thus providing a system to develop appropriate standard of behavior—through which EMC could monitor whether the physicians were doing patient discharge documentation appropriately. Although the system developed another center of authority and increased transaction costs (for example, in engaging an external auditor and developing data transfer interfaces), overall, it helped by developing measures of performance of clinical documentation and increasing commitment of physicians to improve revenue cycle performance. The feedback from the external clinical auditor helped the physicians to review their work processes during the patient encounter. In this, the technology configurations played an important role in facilitating the governance mechanism: the auditor directly connected to the hospital's EMR system remotely and used manual and automated procedures to identify clinical documentation errors.

To improve clinical documentation, the director of coding and documentation designed standardized, paper-based charge checklists (Intervention G). The nursing staff began to use these checklists while capturing patient charges. This was not an ideal solution, because the physicians still used paper-based charts for ordering. However, the checklists at least provided some governance mechanism between the nurses and the coding team, which provided some assurance to the coding team that the patient charges in the paper-based charts were more accurate. The introduction of CPOE in September 2010 and its adoption further improved the process of clinical charge capture and documentation. Here again, the technology configurations facilitated information processing (of patient charges) and governance of the relationship between the nurses and coders. By improving information exchanges, it reduced the transaction costs between the involved centers of decision making (such as physicians, nurses, and coders).

10.2.3 Case 3: Improving Interactions with Patients and Payers**CASE DESCRIPTION***Intervention F*

The objective of this intervention was to verify credit-worthiness of uninsured patients, an issue that affected EMC's revenue in two ways. First, some self-paying patients (the majority of them were uninsured) told the registration clerk that they had no cash at hand (or another form of payment, such as check or credit card) to pay. The registration clerk had no system to verify credit-worthiness of such patients in a timely manner and, therefore, could not collect appropriate co-payments. Second, upon receiving a bill for medical services provided during hospital stay, some patients claimed that they could not afford to pay balance amounts. The business office staff, unable to verify actual financial position of the patient, had to discount, or completely write-off many such accounts. To address this problem, EMC implemented a new module in the EMR system that allowed registration clerks to check (in real time) credit-worthiness of all non-ER, self-paying patients during registration. The business office clerks also used this credit verification system to negotiate discounts and payment terms with patients. We tracked the impact of this intervention. During a follow-up visit in June 2011, the chief financial officer informed us that the front-desk collection (of co-payments) had increased from about \$3,000 per month in 2008 to an average of over \$9,000 per month in 2011. This improvement was significant, considering the continued economic slowdown in the community. EMC plans to implement the system for ER patients too.

Intervention H

This intervention resulted from our discussions with billing specialists who had sometimes noticed discrepancies between the amount actually paid by an insurance payer for a particular claim and the contractual amount agreed to by the payer for a specified procedure. EMC had no system of account reconciliation to verify that the amount received for each patient billed matched the anticipated collectable amount based on the contractual relationship with the payer. To address this problem, EMC implemented a new software module in the existing EMR to verify each payment against the contractual amount. An EMR-generated report listed all cases involving a discrepancy. A billing specialist would then use this report to review involved patient accounts and, if appropriate, submit additional claims. This new system also helped improve revenue recovery. The billing clerk who maintained this data and coordinated follow-ups with insurance payers told us that the biggest benefit of the system was not noticed in terms of dollars but by the fact that the payers knew that EMC was monitoring the reimbursements. The cases of

discrepancies reduced from an average of 2–3 identified³² patient accounts per month in 2008 to only about one patient account every other month in 2011.

Intervention I

The objective of this intervention was to improve the follow-up process with patients whose accounts remained unpaid beyond a certain period after discharge. EMC had outsourced the follow-up responsibilities for accounts up to 120 days³³ after discharge to an external service provider. Working with the director of the business office, we created a process by which business office specialists used EMR-generated custom reports to identify late accounts and follow up sooner (typically, 60 to 90 days after patient discharge). If needed, the specialists offered some discount or easier payment terms to such patients. The new process improved revenue recovery and allowed timely corrective action (for example, resubmission with additional documentation for claims denied by insurance payers). During a follow-up visit in June 2011, the chief financial officer informed us that the account receivable days³⁴ had gradually reduced from 88.0 days in June 2007, to 61.6 days in September 2008, to 59.0 days in July 2010, to 54.6 days in May 2011. The average account receivable days fluctuated from month to month, but the general downward trend is apparent. This has improved EMC's cash flow situation and overall revenue collection.

Intervention J

This intervention sought to improve the process of initiating patient contact before the patient-physician encounter. During our interviews and discussions with the steering committee, it became apparent that lack of pre-registration verification—pre-authorization approval from Medicaid and commercial insurance payers, and medical necessity certification from Medicare—for patients was a major factor resulting in delay or denial of claims submitted to payers by the billing department. We proposed a dedicated coordinator to verify all pre-authorization approvals and medical necessity certifications from payers prior to a patient's arrival at EMC. The senior

³² The actual cases of discrepancies earlier were likely more, but manual reconciliation was very tedious and therefore done only on a sample of patient accounts.

³³ A clerk in the business office conducted a follow-up of accounts beyond 120 days and typically engaged a collection agency to recover the balance amount.

³⁴ It measures the number of days after a patient discharge that the account is fully paid.

management at EMC decided to create a new position for a patient access coordinator who would take on the dual responsibility of scheduling and pre-registration verification for all patients. The coordinator used an intranet application to schedule appointments for all new patients and a web-based service and phones to obtain pre-authorization or medical necessity certifications for patients that needed them.

During a follow-up visit in June 2011, the patient access coordinator—who had previously been the registration supervisor—noted that they were in the process of implementing an enterprise-wide scheduling system to centralize all admissions and related verifications. Currently, all inpatient and outpatient admissions (but not ER patients) underwent pre-registration verification. The coordinator emphasized, “I have told the registration and nursing folks clearly. I will not let a procedure be done without a pre-authorization or medical necessity certification.” During 2010, in only two instances a patient had received a procedure without pre-registration verification (for which EMC could not claim reimbursement from payers). In contrast, as the patient access coordinator noted, there had been at least 5–6 cases per month in 2008 where lack of insurance eligibility led to denials from insurance payers.

Table 10.2-4 Summary of Interventions in Case 3

Stage	Intervention	Rationale	Implemented In ▼	Participants	Outcomes
Patient registration	F. Verify credit-worthiness of uninsured patients by using an IT-enabled system	EMC had to write-off the balance amounts of some patients because they could not pay after receiving costly treatment.	May-09	Registration and business office clerks	<p><i>Successful</i></p> <ul style="list-style-type: none"> • New module implemented in the EMR system, which checks credit-worthiness of all non-ER, self-paying patients during registration. • The business office uses this system to negotiate discounts and payment terms on late accounts.

Billing	H. Evaluate payments from insurance payers against contractual amount by using an IT-based solution.	EMC had no system to verify that a payer had actually paid according to the contractual amount.	Oct-09	Billing clerks	<p><i>Successful</i></p> <ul style="list-style-type: none"> • New software module implemented in EMR to verify each payment against contractual amount. • The cases of discrepancies (between actual paid and contractual amount) reduced from an average of 2–3 identified patient accounts per month in 2008 to only about one patient account every other month in 2011.
Revenue recovery	I. Improve follow-up of accounts that remain unpaid after 60 days of discharge by creating new reports in EMR to identify them.	EMC had previously outsourced the function of following up for accounts up to 120 days after discharge.	Nov-09	Business office clerks	<p><i>Successful</i></p> <ul style="list-style-type: none"> • Customized reports allow early identification of late accounts, which has improved revenue recovery. • The reports also allow timely corrective action on denied claims (e.g., through resubmission with additional documentation).
Patient scheduling	J. Verify insurance pre-authorizations prior to patient arrival at hospital by using IT-based systems.	Lack of pre-authorizations was a major reason for denial of claims by payers.	Apr-10	Patient access coordinator	<p><i>Successful</i></p> <ul style="list-style-type: none"> • EMC has created a new position, patient access coordinator, to schedule appointments for all patients. • EMC has implemented an enterprise-wide scheduling system. • The coordinator uses a new web-based service to obtain pre-authorization certifications for patients that need them. As a result, the cases of delays or denials by payers due to missing insurance eligibility have reduced (only 2 cases observed in 2010, as against 5–6 cases per month in 2008).

CASE INTERPRETATION

Interpretation of problem situation

Intervention F was required because the registration and business office clerks had no way to verify credit-worthiness (and, at times, even identity) of uninsured patients who arrived at EMC. The underlying problems related to diverging interests between patients and the provider (EMC); extreme economic hardship faced by a large population in the area; and opportunistic behavior of some patients who changed addresses, did not have or provide proper identification, or did not have enough cash or other means to fulfill co-payment requirements. As a result, the registration clerks failed to collect appropriate co-payments from such patients (the majority of whom were self-paying). The business office clerks also faced a similar problem: they had to discount or completely write off some accounts because they could not ascertain the financial position of patients who had unpaid balances more than 120 days after discharge. Lack of appropriate technological configurations exacerbated the problem: there was no easy way to verify identity, address, or credit-worthiness in a timely manner for any patient.

Intervention H was required because sometimes the insurance payers did not actually pay the full amount for a particular claim (as agreed to by the payer for a specified procedure). Thus the payers, on some occasions, did not abide by their contractual agreement with EMC. This too suggests diverging interests between payers and the provider (EMC) and opportunistic behavior of some payers. This led EMC to incur additional transaction costs, for example, in deputing a billing clerk to verify whether a payer had remitted payments as per the contract. The complexity of the contract also played a role: several dozen payers represented the patient population that received medical services at EMC, and EMC had to sign a separate contract with each payer. Further, each contract specified a reimbursement amount for each service that EMC provided. Lack of appropriate technological configurations made it near impossible to verify whether a particular payer had actually paid the specified amount for a particular procedure for a patient.

Intervention I was required because some patient accounts remained unpaid even beyond 120 days. Many of these accounts had to be written-off, which adversely affected EMC's financial balance sheet. The primary reasons were, of course, that some self-pay patients did not pay their balance to the hospital for the services provided due to economic hardship or opportunistic

behavior. Another reason was that EMC had outsourced the responsibility of following up with these self-pay patients to an external billing service provider for the first 120 days after patients' discharge. This external service provider was paid commission on all collected totals; therefore, spending time and effort to contact patients with delinquent accounts was probably not worth it. This divergence of interest meant that a large proportion of self-pay accounts remained unpaid. For example, in March 2009, although self-pay patients constituted only about 16% of patient accounts, they represented more than 50% of all claims that were unpaid (see Appendix B.4). Typically, after 120 days, a business office clerk engaged a collection agency to recover the due balance from a patient (this agency also received a commission based on the amount collected). The billing service provider and the collection agency represented multiple centers of decision-making. They had no technological systems that shared real-time status information with EMC, which made it difficult for EMC to determine the actual status of any patient account until it was too late to recover the balance without costly litigation.

Intervention J was required because, at the time of registration, the registration clerk noticed that many patients did not obtain pre-authorization approval or medical necessity certification from their payers for a particular procedure. This delayed the registration process, and if the registration clerk forgot to request it from the payer within 24 hours (of the patient's arrival), the payer would not pay for the procedure. As result, the payers delayed or denied many claims. This reflects the overall complexity of the revenue cycle, but more importantly, it reflects a lack of coordination because of multiple nested decision-making centers.

Interpretation of interventions and outcomes

To address the problem of opportunistic behavior by some patients, EMC implemented a new EMR module (Intervention F) that allowed registration clerks to check credit-worthiness of all non-ER, self-paying patients during registration. The new system provides the clerks with sufficient information to check a patient's credit-worthiness. The business office clerks also use this application to negotiate discounts and payment terms with patients. Thus, the IT-based system reduced transaction costs for EMC's staff involved in registration and account recovery by providing them with a suitable mechanism for information processing. This technological configuration allowed real-time verification of identity, address, and credit-worthiness for any patient. This mechanism also helped to reduce opportunistic behavior by some patients.

To address the problem of opportunistic behavior on the payer side, EMC implemented a new software module in the existing EMR (Intervention H) that verified each payment against the contractual amount. This IT-based system provided a monitoring mechanism to control and regulate the transactions with payers and thereby reduced overall transaction costs. The technological solution also reduced the complexity of monitoring the contract.

Intervention I allowed the business office specialists to use EMR-generated custom reports to identify late accounts, follow up sooner (typically, 60 to 90 days after patient discharge), and, if needed, to offer some discount or easier payment terms to the patient. The new process improved revenue recovery by reducing opportunistic behavior. By directly contacting the patient earlier, EMC overcame the issue of divergence of interests with the billing service provider and the collection agency. It also reduced the effect of multiple nested centers of decision making by streamlining patient engagement after discharge.

Intervention J involved creating a new dedicated position—patient access coordinator—to verify insurance approvals prior to a patient’s arrival at EMC. The coordinator used an intranet application to schedule appointments for all new patients and a web-based service to obtain pre-registration approvals for patients that needed them. The intervention shows how IT-enabled solutions reduced the effect of multiple nested centers of decision-making by streamlining patient engagement before the patient encounter. By creating this position, EMC also reduced the information requirements during registration: the clerk now only had to verify patient identity, collect appropriate co-payment, and upon registration, release the patient for clinical encounter with physicians.

10.2.4 Case 4: Improving Revenue Cycle Management

CASE DESCRIPTION

Intervention D

This intervention focused on identifying key indicators to evaluate revenue cycle performance at EMC. Our initial objective was to measure progress and impact of the interventions in the revenue cycle. However, EMC’s representatives on the steering committee suggested that their managers and staff could also use these performance indicators. Accordingly, we worked with

key stakeholders to identify key indicators, such as exceptions found during coding or billing each month. We created a Microsoft Excel-based matrix to track these indicators. A major factor in selection and retention of any indicator was that ongoing data collection for it should take minimal effort from EMC's staff. Accordingly, the list of indicators changed considerably initially as we reviewed the effort required in data collection.

Creating the indicators was an immensely demanding exercise, largely owing to the complexity of the revenue cycle. For example, there was no easy way to calculate how many patients of each type (such as inpatient, outpatient, and nursing home patients) had past due payments (say, 60 days after discharge). We collected baseline data between February and April 2009 and continued to update on a monthly basis thereafter. I circulated the matrix to the steering committee and other revenue cycle managers at regular intervals. Many revenue cycle managers used the matrix to track relevant measures.

Table 10.2-5 Summary of Intervention in Case 4

Stage	Intervention	Rationale	Implemented In ▼	Participants	Outcomes
Entire revenue cycle	D. Identify key revenue cycle indicators and track them by using an IT-based application	New system required to track effect of the various interventions that we initiated in collaboration with EMC	Apr-09	Revenue cycle managers	<p><i>Successful</i></p> <ul style="list-style-type: none"> • We created a Microsoft Excel-based matrix to track impact of various interventions on key indicators. • Many revenue cycle managers used the matrix to track relevant indicators.

CASE INTERPRETATION

Interpretation of problem situation

A consequence of the complexity of the overall revenue cycle was the difficulty in determining appropriate measures of performance (of not only health outcomes, but also financial outcomes). Several standard (and a few custom) reports were available in the hospital's EMR system. These could provide information such as the number of patients admitted or discharged during any

given month or revenue collected per month. In fact, the chief financial officer shared such statistics with managers and department heads every month. The EMR system afforded creation and printing of numerous reports. However, it was difficult to extract specific information (such as a list of all unpaid claims that were more than 60 days old). If available, the billing and business office staff could benefit from such information by contacting payers and self-pay patients to remind them (and clarify any issues) about outstanding payments. Similarly, identification of bad debts (accounts that were over 120 days past due) was not easy—it required extracting data from many different reports. No trends for any of these measures were available. Furthermore, data was available in different technology systems in billing, nursing, coding, registration, and other departments. This heterogeneity of technological configurations created issues relating to coordination among these multiple centers of decision-making. Consequently, EMC’s managers could not evaluate financial performance for different patient types over an extended period or make informed decisions about strategic interventions.

Interpretation of intervention and outcomes

To address the problem situation, we identified key performance indicators and created an IT-based solution (a Microsoft Excel worksheet) to track data on a monthly basis. The matrix contained data that required coordination among individuals involved in different stages of the revenue cycle. The trended data improved information processing and decision making among the involved actors. For example, the matrix data showed that in March 2009, although self-pay patient constituted only about 16% of patient accounts, they represented more than 50% of all claims that were unpaid (see Appendix B.4). What really caught the attention of EMC’s managers was the fact that more than 70% of self-pay accounts were outstanding even 60 days after patient’s discharge. This insight helped to organize an effort by the business office staff to begin follow up on these patient accounts earlier (rather than waiting for 120 days for the accounts to become delinquent). Thus, the performance indicator matrix provided a governance mechanism among different decision-making centers to control and monitor key performance indicators related to EMC’s revenue cycle.

► PART E: THEORY EVALUATION

This part presents a discussion of our research, and includes the following:

- **Evaluation of IPF (Chapter 11):** This chapter evaluates IPF based on the empirical results from the action research interventions at EMC and as a conceptual foundation for new theory.
- **Contributions and Limitations (Chapter 12):** This chapter discusses the contributions of the study to theory and practice. It also discusses the limitations of the study.

11 EVALUATION OF IPF

In this section, I assess the proposed conceptualization of information management—IPF—based on established criteria. First, I evaluate IPF based on the empirical results: how well the framework helped to understand and explain the problem situation and interventions at EMC. Second, I discuss the nature of theory and criteria for theoretical contributions and use these criteria to evaluate IPF's four components.

11.1 Empirical Evaluation of IPF

11.1.1 Understanding Governance at EMC

IPF proposes that complex organizational settings have multiple nested decision-making centers that exist within and across functional and organizational boundaries. To set up and manage transactions across these decision-making centers, actors enact context-dependent governance mechanisms to determine appropriate community standards of behavior and focus on collective action. These governance mechanisms relate to searching, contracting, controlling, and maintenance for the transaction and they manifest at the transactional, informational, and technological layers (representing first-, second-, and third-order governance respectively).

Multiple nested decision-making centers were apparent in EMC's revenue cycle. These decision-making centers existed side-by-side (for example, EMC and its external partners) and within centers of decision-making (for example, the various functional units within EMC). Case 1 describes the efforts to improve exception management in the health delivery transaction at EMC. It highlights the role of the multiple centers of decision making within EMC (such as registration and billing departments) and how they enacted separate governance mechanisms to organize and control the transaction (first-order governance), the related information processing (second-order governance), and the involved technological configurations (third-order governance). Similarly, Case 2 discusses different governance mechanisms enacted by physicians, nurses, and coders for improving clinical documentation, which is integral to the health delivery transaction. Case 3 discusses the governance mechanisms enacted by external centers of decision-making (such as patients and payers) to manage relationships related to the health delivery transaction.

11.1.2 Understanding Transactions at EMC

IPF considers a transaction as the basis of organizational analysis (Coase 1937; Williamson 1975; 1981), and it occurs when a good or service is transferred across a technologically separable interface (Williamson 1981). Further, drawing on Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961), IPF considers transactions as multiple nested arrangements of human activity. This formulation emphasizes that 1) a transaction is the basis of organizational activity enacted through the decision making of involved actors and 2) transactions occur as embedded exchanges in multiple levels of relationships between the involved actors. Typically, any transaction would involve several actors, each playing some role in the overall exchange.

The health delivery transaction at EMC involved delivery of medical services by a provider to a patient and reimbursement for those services by the patient. Figure 10.1-1 represents this basic transaction. The transaction between a patient and EMC usually involves multiple partners within and outside the hospital who are all directly or indirectly involved in the delivery of medical services to the patient. The external partners include laboratories, payers, specialists, collection agencies, credit rating agencies, and other service providers. Within the hospital, the transaction involves multiple partners, including clinicians, nurses, and the staff in the registration, billing, and coding departments. The transaction results in information processing and decision making for all the involved parties related in their overall goal of delivering medical services to the patient.

11.1.3 Understanding Information Processing at EMC

Drawing on information processing theories (Daft and Lengel 1986; Galbraith 1974; 1977; Mintzberg 1979; 1980) and on Ciborra's transactional view of information (1981; 1993), IPF suggests that information processing occurs in response to information requirements of a transaction and its related governance mechanisms. Further, information processing occurs through two complementary mechanisms: information production and information consumption (Ramaprasad and Rai 1996). Actors produce information about transactional phenomena by deriving meaning from stimuli in the transaction and its governance mechanisms, and consume information when they transform it into stimuli that lead to changes in the organizational activity and structure related to the transaction. These changes represent the ordering effects of

information, which can lead to new information processing. Moreover, IPF posits that information enables mutual adjustments (through information exchanges) among the involved actors in multiple decision-making centers (Ostrom 1972; Polanyi 1951). Accordingly, the ordering effects of information also manifest in multiple centers of decision making in an organization.

At EMC, clinical and non-clinical staff produced information that supported patient care (and related financial activity) by deriving meaning from stimuli that resulted from activities within the hospital and with external partners. At the same time, the clinical and non-clinical staff consumed information when they transformed it into stimuli that supported and guided activities at the hospital to deliver patient care. Further, information led to ordering effects, which reflected in changes in EMC's structure and behavior. Table 10.1-2 shows the information requirements, the information production and consumption, and the ordering effects of information at EMC. In Case 1, information processing relates to exception management associated with the health delivery transaction in various stages of the revenue cycle. Case 2 relates to production and consumption of information associated with clinical documentation. Case 3 relates to information processing in EMC's interactions with patients and payers. Case 4 relates to information processing to improve management of the entire revenue cycle.

11.1.4 Understanding Technology Configurations at EMC

The final component of IPF considers the role of technology in organizational transactions and suggests that actors process information enabled by evolving configurations of technology in response to the requirements they face (Daft and Lengel 1986; Galbraith 1974; 1977; Mathiassen and Sørensen 2008; Mintzberg 1979; 1980). Moreover, these technology configurations are typically heterogeneous as they arise from the multiple levels of decision making involved in a transaction and from the needs for context-dependent governance of the many actors and their unfolding relationships (Ostrom 1972; Ostrom et al. 1961). The heterogeneity of the technology configurations manifests itself through planned managerial interventions and improvisational adoption of technology (Ciborra et al. 2000).

At EMC, the technology configurations supported information processing (and the resulting decision-making) for the health delivery transaction. Specifically, they supported exchanges

within the provider organization and between the provider and its external partners. The technology configurations focused on clinical and non-clinical support, although, as Table 10.1-4 shows, the clinically focused technologies clearly outnumbered other technologies (such as for billing). The technology configurations required a multiplicity of governance mechanisms to support the overall health delivery transaction, related information processing, and the increasing heterogeneity of technology solutions.

11.1.5 Overall Empirical Evaluation

Overall, the application of IPF helped to develop an understanding of information management at EMC that clearly reveals the complex nature of the revenue cycle in a hospital and the consequential challenges in supporting it with appropriate information processing and use of technology. On the one hand, we found that specific arrangements at EMC make information management complex and ineffective. These include, but are not limited to, the inherent heterogeneity (and occasional divergence) of interests in a health delivery transaction; the increasing complexity and variety of technology configurations; and the lack of focus on governance mechanisms for transactions, information processing, and technology configurations. Through our interventions (refer discussion of individual interventions, and related cases, in Chapter 10), we sought to address these dysfunctionalities in information processing and use of technology.

On the other hand, and more importantly, the application of IPF to the situation at EMC helped us understand the inherently complex nature of information management as it relates to the revenue cycle in a hospital. Most importantly, we found that multiple nested arrangements of information exist within the hospital and in the relationships with external partners. The revenue cycle constitutes an important backbone of all information management in a hospital. As such, it reflects both the opportunities and the limitations of improving information processing in these contexts through technological interventions. From this perspective, our application of IPF to the situation at EMC offered initial empirical validation of the constructs as they helped us understand and explain the experiences from our interventions over the past couple of years.

11.2 Theoretical Evaluation of IPF

As Susman and Evered (1978) have suggested, “action research generates theory grounded in action: while theory provides a guide for diagnosis of a problem situation and appropriate action taking, the actions themselves can inform theory through evaluation of action.” Therefore, a major goal of the action research engagement at EMC was to develop new theory of information management in complex organizations, such as hospitals.

Bacharach (1989) defines a theory as a statement of relationships between constructs, variables, and relationships observed or approximated in the empirical world. In relation to IPF, the core constructs, or components, are 1) governance, 2) transaction, 3) information processing, and 4) technology configurations. Figure 9.2-6 shows the relationships between these four components of IPF as a first step towards developing a Polycentricity Theory of information management. Bacharach (1989) also emphasizes the underlying assumptions that define the boundaries of a theory. This research defines the boundaries of IPF by specifying the context of the research—information management in a complex organization—and through definition of key components and premises based on selected theoretical frameworks. Specifically, IPF defines the variables for each of the core constructs as expressed through the four components of the framework and the underlying premises: 1) polycentric conditions, 2) a transactional view of information, 3) the ordering effects of information, and 4) heterogeneous configurations of technology.

Table 11.2-1 summarizes the proposed foundation for a new theory based on Bacharach’s framework (1989).

Table 11.2-1 Summary of IPF based on Bacharach's Framework

Theory Element (Based on Bacharach (1989))	Proposed Theory Elements in IPF
Boundaries	<ul style="list-style-type: none"> • Information processing in transactions in complex organizational settings • Definition of basic terms • Premises based on existing theoretical frameworks: <ol style="list-style-type: none"> 1. Polycentric conditions 2. Transactional view of information 3. Ordering effects of information 4. Heterogeneous configurations of technology
Constructs (i.e., components)	<ol style="list-style-type: none"> a. Governance b. Transaction c. Information processing d. Technology configuration
Variables	<ol style="list-style-type: none"> a. First-order / second-order / third-order governance b. Ongoing / one-time transactions c. Information production / consumption d. Heterogeneous / homogeneous technology configurations
Relations	<ul style="list-style-type: none"> • Relationship between and within the four components (Figure 9.2-6) <div style="text-align: center;"> <p>The diagram illustrates the relationships between four components. At the top, there are three boxes: 'Governance for information processing' (vertical text), 'Information processing' (vertical text), and 'Governance for the transaction' (horizontal text). Below 'Governance for the transaction' is a transaction between 'Party A' and 'Party B', represented by two ovals connected by a double-headed arrow, with the word 'Transaction' below it. Below this entire top section is a box containing 'Technology configuration' and 'Governance for technology configuration' (horizontal text). A thick black arrow points upwards from this bottom box towards the 'Information processing' component of the top section.</p> </div>

For assessing theories, Bacharach (1989) applies two criteria: falsifiability and utility of the proposed constructs, variables, and relationships. Falsifiability determines whether the theory allows empirical evaluation. Utility refers to the usefulness of the theory. Regarding falsifiability, IPF relies on established concepts within information systems: information, information processing, information management, and information requirements (Daft and Lengel 1986; Galbraith 1974; 1977; Mintzberg 1979; 1980) and on notions of information production and consumption (Mathiassen and Sørensen 2008; Ramaprasad and Rai 1996). IPF also relies on the basic constructs—transaction, transaction cost, and governance—of the Transaction Cost Theory (Coase 1937; Williamson 1981; 1985), particularly as they apply to information systems (Ciborra 1981; 1993). Most importantly, IPF draws on the core principles—multiple centers of decision making and context-dependent governance mechanisms—of Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961). Section 11.1 demonstrates the falsifiability of the proposed theory by presenting an empirical evaluation of the four components of IPF based on its theoretical foundations.

Regarding the utility of IPF, Chapter 10 illustrates how the four components of IPF apply to information management at EMC and to make sense of the problems situations we faced and the interventions in which we engaged. These deliberations provide a first basis for assessing the utility of IPF. The suggested conceptual foundation offers to researchers and practitioners a language for understanding and discussing information management in organizational settings with multiple centers of decision-making and context-dependent governance mechanisms. Applying this vocabulary can help to understand the general role of contractual arrangements in transactions as well as in information processing in complex organizational contexts.

12 CONTRIBUTIONS AND LIMITATIONS

Action research serves multiple interests: it seeks to address practical concerns of people in an immediate problematic situation as well as the goals of social science through research orientation (McKay and Marshall 2001; Rapoport 1970, p499). Accordingly, this study seeks to address the concerns of research and practice in a number of ways. First, I discuss the contributions to the health-IS literature. Next, I discuss how this study contributes to our understanding of information management in complex organizations and, in particular, how Polycentricity Theory can help to improve our understanding of information management challenges in such contexts. Subsequently, I discuss the practical implications of this research: how IT can support improvements in a hospital revenue cycle. Finally, I discuss this study's limitations.

12.1 Contribution to Health-IS

Information management is fundamental to healthcare delivery and plays a critical role in preventing and minimizing errors, coordinating care among settings, and ensuring that relevant and accurate healthcare information is available when needed (Chassin and Galvin 1998; Chaudhry et al. 2006). Current health-IS literature offers no insight into the complexity of information management across all parts of a hospital revenue cycle. In particular, our knowledge is still limited about how hospitals—with their multiple actors who often have diverging interests—manage information. By investigating IT-enabled information management in a hospital revenue cycle, this research contributes to our understanding of how information processing occurs in this important context through production and consumption of information, and enabled by heterogeneous technology configurations.

Further, extant health-IS literature has reported mostly on clinical decision-making systems, including EMR (Davidson and Chiasson 2005; Hanseth et al. 2006; Lapointe and Rivard 2005), CPOE (Davidson and Chismar 2007), PACS (Paré et al. 2005), clinical decision support (Devaraj and Kohli 2000), and telemedicine (Cho and Mathiassen 2007; Paré et al. 2007; Paul and McDaniel Jr. 2004). Few IS studies have focused on applications related to the revenue cycle such as billing and registration systems, and fewer still have investigated how IT can support the transformation of the revenue cycle and thereby improve a hospital's financial performance. By

focusing on IT-enabled transformation of the revenue cycle at EMC, our research has gone beyond the focus of studies that emphasize how clinical IT has a significant positive impact on a hospital's operational performance (Bhattacharjee et al. 2007).

12.2 Contribution to Information Management Theory

Although the literature on information management in organizations has provided significant insights into the nature and process of information management in general (Daft and Lengel 1986; Galbraith 1974; 1977; Mathiassen and Sørensen 2008; Mintzberg 1979; 1980; Ramaprasad and Rai 1996), information management in complex organizational contexts is largely unexplored. As such, one objective of this research was to start developing a new theory that concerns itself with information management in these challenging contexts. The proposed view focuses on how organizations exchange transactional, financial, and administrative information with internal and external partners in contexts with multiple centers of decision making that constitute an inter-related system of relations (Malvey 1981; Rouse 2008). As a result, this research contributes to the information management literature by developing Polycentricity Theory as a conceptual lens to explain information management in complex organizations.

Specifically, the research draws on two core concepts of Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961; Polanyi 1951)—multiple nested centers of decision making and context-dependent governance—to explain how complex organizations act informally but collectively in determining community standards of behavior and focus of collective action (Ostrom 1972). This polycentric decision-making approach is different from that of Arrow (1974), Simon (1981), and Wiseman (1988) who assume a central decision-making authority in organizations. The approach stresses that organizations exist not only as large pyramidal structures that are managed as a bureaucracy (which may justify a monocentric decision-making structure), but also as networks of firms, functional departments, work groups, teams, and informal peer groups (Piore and Sabel 1984) with multiple centers of decision making supported by polycentric structures.

In doing so, the research develops a new conceptual foundation—the Information Polycentricity Framework (IPF)—that combines information management theories (Daft and Lengel 1986; Galbraith 1974; 1977; Mathiassen and Sørensen 2008; Mintzberg 1979; 1980; Ramaprasad and Rai 1996), Transaction Cost Theory (Ciborra 1981; 1993; Coase 1937; Williamson 1975; 1981),

and Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961; Polanyi 1951). IPF provides analytical support for investigating information management in complex organizational settings through four specific components—governance, transaction, information processing, and technology configurations. Figure 9.2-6 shows the relationships among these components and Table 11.2-1 summarizes its basic characteristics.

The research also contributes to IS literature by further developing the three-layered architecture of IT-enabled information management suggested by Mathiassen and Sørensen (2008). These include: 1) the transactional layer, where the organizational business processes execute; 2) the informational layer, where the information processing relating to the transaction and its governance occurs; and 3) the technological layer, where IT artifacts combine to support the transactional and informational layers through capture, processing, storage, and sharing of information within and across organizational boundaries. Accordingly, IPF differentiates between first-, second-, and third-order governance mechanisms. Actors within and across organizational boundaries enact a) first-order governance mechanisms to manage the transaction, b) second-order governance mechanisms to manage the information produced and consumed during the transaction, and, c) third-order governance mechanisms to manage the technological configurations for the transaction and related information processing. IPF further suggests that these partly overlapping contractual arrangements are context dependent—the nature of transaction, the information produced and consumed, and the technology configurations determine the governance structures. Figure 9.2-6 describes relationships among these governance mechanisms.

Finally, by describing and designing specific IT artifacts (for example, the Exception Management System—see snapshot in Appendix B.2) to improve information management at the hospital, and by describing the relationship of the artifacts to revenue cycle related business processes, the research contributes to the under-emphasized area of IT artifact-related IS literature (Benbasat and Zmud 2003; Orlikowski and Iacono 2006).

12.3 Contribution to Practice

Scholars who function in an applied setting, such as information systems, must demonstrate their value in both theoretical and practical arenas (Baskerville and Myers 2009; Taylor et al. 2010).

Therefore, they must conduct research that advances academic knowledge while at the same time enlightening professional practices (Van de Ven 2007). Accordingly, one of the objectives of this research was to develop a new theory that could help improve the revenue cycle of a hospital by intervening in its information management practices.

The current practitioner-oriented literature has paid little attention to IT-enabled transformation of a hospital's revenue cycle, including management of clinical, administrative, and financial information within and across organizational boundaries. In our action research engagement at EMC, we collaborated with key stakeholders to improve information management throughout the revenue cycle. In all, we implemented 10 interventions over a two-year period, most of which involved improving financial, clinical, and administrative information exchanges related to health delivery transaction. The success of most of these interventions was apparent when we completed our engagement in spring 2010. We made a follow-up visit in June 2011 to ascertain the latest status of these interventions. As discussed in Chapter 10 and summarized in Table 12.3-1, EMC's revenue cycle situation had generally improved or stabilized since 2008. There were now fewer cases of denials by payers for non-availability of pre-authorization or medical necessity; exceptions originating in the registration department had reduced significantly; the account receivable days had reduced from 88.0 days in June 2007 to 54.6 days in May 2011; and, the payment by payers now matched the amount payable as per contract. The performance was remarkable considering that economic indicators in the county had worsened during the period (for example, the 12% unemployment rate in April 2011 was almost double the rate in April 2008). Reflecting on the current performance of EMC's revenue cycle, the chief financial officer noted,

The revenue cycle has improved substantially over the last three years. Our main concern now is not the internal revenue cycle, but the overall socio-economic issues in the community. We have an ageing population, continued high unemployment, and slow economic recovery.

Thus, our interventions at EMC produced tangible outcomes relating to revenue cycle performance. The research also provided some important learning. The outcomes of this research will be of interest to other healthcare organizations, as it will help to focus their IT budget and resources to support or reorganize the revenue cycle. It will also help healthcare organizations

consider how their technological configurations can help to overcome the challenges of coordination among actors with often diverging interests. More importantly, since IT applications that can enable improvements in information management across the revenue cycle require fewer resources to implement and maintain (as compared to setting up infrastructure for supporting clinical IT), this research will be of interest to resource-constrained healthcare organizations such as rural hospitals, ERs, community health centers, and non-profit hospitals.

Table 12.3-1 Summary of Contributions to Practice

Revenue Cycle Stage (Interventions)	Contributions to EMC's Revenue Cycle Performance
Scheduling (J)	<ul style="list-style-type: none"> The intervention reduced rejections due to missing insurance eligibility from at least 5-6 cases per month in 2008 to only 2 cases during 2010.
Registration (A, F)	<ul style="list-style-type: none"> The interventions reduced the open registration-related errors (identified using available EMR reports) from an average of more than 80 per month in 2008 to less than 10 per month in 2009 (see Appendix B.1).
Clinical documentation (E, G)	<ul style="list-style-type: none"> The interventions provided a feedback system to the physicians on medical staff, which helped them to reduce errors in clinical documentation. EMC implemented CPOE system in September 2010. As of June 2011, more than 80% of nurses were using the system. The physicians were also gradually adopting the system; in May 2011, 27.1% of all clinical orders were created using CPOE.
Billing (C, H)	<ul style="list-style-type: none"> The interventions reduced the number of exceptions identified during billing review (see Appendix B.3). The proportion of clean claims (i.e., without any errors) received in billing increased from 50–60% in 2008 to more than 80% in 2011.
Revenue recovery (I)	<ul style="list-style-type: none"> The intervention improved the account receivable days—from 88.0 in June 2007, to 54.6 in May 2011. The intervention reduced cases of discrepancies between amount payable and actually paid by insurance payers from an average of 2–3 identified cases per month in 2008 to only 0.5 cases per month in 2011.
Overall revenue cycle (B, D)	<ul style="list-style-type: none"> The interventions improved total profit margin (-3.76% to +3.91%) and cash flow margin (3.73% to 12.75%) between 2008 and 2010. These improvements occurred despite reduced revenue (\$62.0M to \$50.78M - down 18%) between 2008 and 2010 (see Appendix C.1).

12.4 Limitations

While the proposed framework offers a rich, yet parsimonious basis for developing a Polycentricity Theory of information management, it also has clear limitations that call for further research. In this research, the limitations relate to the generalizability of the research and the choice of theoretical foundations. Accordingly, I present directions for future research, in which I discuss the status of the suggested framework and present ideas on how to develop it further.

12.4.1 Generalizability

The research draws on a single longitudinal field study (Miles and Huberman 1994; Pettigrew 1990), limiting our ability to conduct comparisons or generalize findings to other contexts. However, the limited generalizability of a single study should be balanced against the advantages of its attention to context, dynamics, and multiple stakeholder perspectives (Mason 2002). To document such effects, I have provided a rich description of the situation at EMC and of the interventions involved. These will help other researchers assess our findings and their transferability to other contexts (Lincoln and Guba 1985). To ensure rigor, we designed this research by applying established principles of canonical action research (Davison et al. 2004; McKay and Marshall 2001). Further, to gain an unbiased understanding of the problem situation, especially “sensitive” issues such as the resistance of nurses to adopt EMR-facilitated clinical documentation, we asked multiple interviewees to reflect on the same issue. We further sought to minimize this effect by triangulating between different data sources, checking against public data, Government reports and internal communications, using multiple methods and investigators to interpret the data, and by iteratively seeking feedback on our interpretations from key stakeholders at EMC (Miles and Huberman 1994, p267; Yin 2003).

Although our empirical descriptions are limited to the EMC context, this does not rule out the possibility of generalizing from description to theory (Lee and Baskerville 2003; Yin 2003). Following Mason (2002, p196), our argument for generalizability draws on the quality of our analyses: “Whatever else you do, you should make some claims for the wider resonance or generalizability of your explanations which are based on the rigor of your analysis.” Still, the theoretical generalization from our engagement at EMC and the components of IPF should be

limited to conditions similar to those of EMC—using IT to transform information management in complex organizations.

12.4.2 Theoretical Framing

Following Poggi's (1965) dictum that "a way of seeing is a way of not seeing," we accept a second limitation of the research that relates to the choice of underlying theory. This choice can limit our empirical explanations and our attempts to develop IPF as a new theoretical framework. In all likelihood, other theories exist that can serve as foundations for examining and explaining the situation at EMC. However, after a systematic review of the problem situation, we realized that EMC's major challenge lay in managing information in its revenue cycle. Therefore, it seemed appropriate to explore existing information management theories to help understand the challenges of information management in EMC's revenue cycle. After extensive review of the literature, we decided to select theories of information management that proffer a subjective view of information and focus on information processing in organizational decision making (Daft and Lengel 1986; Galbraith 1974; 1977; Mathiassen and Sørensen 2008; Mintzberg 1979; 1980; Ramaprasad and Rai 1996).

As we gained further understanding of the context of EMC's health delivery, it became apparent that a healthcare organization represents a very complex organizational setting. Several studies have discussed the complexity of healthcare service delivery (Plsek 2001; Rouse 2008; Tan et al. 2005; Wim Van Lerberghe et al. 2008). They draw on Complexity Theory, which defines a complex system as having large number of interdependent parts, which together work as a whole and are interdependent with larger organizational structures or external environments (Simon 1981; Thompson 1967). Taking this view allowed us to appreciate the considerable challenges of decision making and information management in hospitals. Thus, a combination of existing theories of information management and a complex system view of a hospital provided our primary theoretical lens as we began preparations for interventions to improve EMC's revenue cycle performance.

During the two-year period of action research engagement at EMC, we explored the workflows and exchanges of clinical, financial, and administrative information within the hospital and with external partners. Many of these exchanges involved multiple centers of decision making within

EMC and its external partners. We observed centers of decision making existing side-by-side (such as EMC and its external partners) and centers of decision making existing *within* centers of decision-making (such as the various functional units within EMC, represented by clinicians, nurses, registration clerks, and billing staff). Our review of the current literature on information management did not provide sufficient theoretical anchoring for such multiple nested centers of decision making, as most of the existing literature assumes a hierarchical decision-making authority in organizations (Arrow 1974; Simon 1981; Wiseman 1988). But, as we noticed in the context of EMC, organizations exist not only as large pyramidal structures that are managed as a bureaucracy (which may justify a hierarchical decision-making structure), but also as networks of firms, functional departments, work groups, teams, and informal peer groups (Piore and Sabel 1984) with multiple centers of decision making. The current literature on information management fails to account for these distributed, multiple levels of decision making in complex organizational settings. We initially considered Hypercomplexity Theory (Qvortrup 2003)—which deals with complexity inscribed within complexity—as a framing choice. Qvortrup’s theory explains the complexity of current post-industrial information society. However, his framing does not concern itself with multiple decision-making levels. In contrast, Polycentricity Theory (Ostrom 1972; Ostrom et al. 1961; Polanyi 1951) applies well to fragmented, multi-level decision making in complex human action situations as demonstrated by the work of Vincent Ostrom (1962; 1972; 1961), Elinor Ostrom (2009), and others (Sproule-Jones et al. 2008). Although we found very few applications of Polycentricity Theory in the IS, healthcare, or organizational literature—with the notable exception of Perlmutter (1969)—we selected the theory as it offers a promising framework for understanding information management in complex organizations.

The choice of Transaction Cost Theory, developed by Coase (1937), Williamson (1975; 1981), Ouchi (1980) and others, was a consequence of selecting Polycentricity Theory as our theoretical lens. From a transaction cost perspective, workflows (and related information exchanges) in complex organizational contexts can be better understood as transactions (as compared to tasks) across functional and organizational boundaries. This conceptualization allows IPF to consider multiple nested human transactions as the basic context for theorizing information management in complex organizational settings, such as hospitals. In particular, we followed Ciborra (1981; 1993), who emphasized the potential of the transaction cost approach to build IS theory. Another

advantage of taking this approach is that it allows for the three-fold governance mechanisms—relating to transactions, information processing for the transactions, and the supporting technological configurations—that form a key component of IPF.

12.5 Future Research

This research has taken initial steps towards developing a new theory of organizational information management. Although IPF draws on investigation of information management in a complex organizational context, we believe that the framework can also apply to understanding information management in any organizational context. The four components of IPF—governance, transaction, information processing, and technology configurations—are not specific to complex organizations. Any organizational context will have at least two parties, internal or external, who engage in a transaction (that is, exchange goods, services, information, or money). The involved parties in an exchange will likely enact appropriate governance mechanisms to set up and manage the transaction. The transaction will require information processing (to make decisions, such as what goods or services to provide, when, and at what cost). The transaction will typically require some technological configuration to facilitate information processing and related decision making. Therefore, future research can explore the application of IPF across many different organizational contexts. In doing so, researchers can further explore the three levels of governance suggested in IPF: first-order (relating to transaction), second-order (relating to information processing), and third-order governance (relating to technological infrastructure). These three levels are often overlapping, and together enable efficient execution of the transaction.

Future researchers can also explore the consequences of imposing a monocentric technological solution (such as an enterprise resource planning system) on a polycentric organization. As previously discussed in Chapter 9, enforcing a monocentric approach in the form of a common technological solution or structure without respecting the heterogeneous requirements of individual centers of authority can be self-defeating. Most organizational contexts involve networks of firms, functional departments, work groups, teams, and informal peer groups (Piore and Sabel 1984) with multiple centers of decision making (Ostrom 1972; Polanyi 1951). Therefore, a system designed (or implemented) with monocentric assumptions may not be suitable for a polycentric reality, making it necessary to consider technological solutions that

support fragmented decision making. Failure to do so can have adverse outcomes, both in economic terms as well as in terms of overall governance. However, a system designed with polycentric considerations will require greater coordination (as compared to a system designed with monocentric considerations that follow a centralizing and standardizing approach). Future researchers can explore the combinations of these two strategies in designing IS artifacts.

Researchers can also draw on contingency theory (Daft and Lengel 1986; Galbraith 1974; 1977; Mintzberg 1979; 1980) and on Mathiassen and Sørensen (2008) to explore IPF in different contexts based on the levels of uncertainty and equivocality of information requirements. Thus, based on IPF, one may presume that the level of uncertainty of information requirements will determine the emphasis on information production or consumption. Thus, in case of high uncertainty requirements, information production is likely to be the appropriate response as new information can help reduce the uncertainty (Mathiassen and Sørensen 2008). In contrast, in case of low uncertainty requirements, information consumption is likely to be the appropriate response as organizational actors translate readily available information into stimuli (Mathiassen and Sørensen 2008). Further, based on IPF, one may presume that the level of equivocality of information requirements will determine the appropriate organization of information processing. Thus, in case of low equivocality requirements, information processing is likely to be organized as encounters (Mathiassen and Sørensen 2008) that allow organizational actors to use straightforward approaches based on available standard operating procedures and routines. In contrast, in case of high equivocality requirements, information processing is likely to be organized as relationships (Mathiassen and Sørensen 2008), emphasizing the role of context and the need to create bonds of trust in evolving interactions between actors over time. These relationships can help to address informational ambiguities and bridge diverging interests between the involved actors.

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APPENDIX A: DIAGNOSTIC MAPPING AT EMC

A.1 – Diagnostic Mapping of Problem Situation

1. Patient Scheduling				
#	What happened?	Why?	What are the consequences?	What can be done?
1.1	<p>Before scheduling any procedure on an outpatient, a nurse needs to receive a clinical pre-authorization or medical necessity certification from the patient's insurance company.</p> <p>The precertification authorizes EMC to proceed with the required clinical procedure on the patient.</p> <p>Sometimes, EMC conducts procedures without receiving the precertification.</p>	<p>A clerk conveys the precertification request over the phone, and sometimes the insurance company's phone lines are busy.</p> <p>Upon shift change, the incoming clerk may not know the status of a particular precertification.</p> <p>Each insurance company has a different precertification format, making the process error-prone. Therefore, precertifications are sometimes missed, particularly when new clerks join the registration team.</p> <p>There is no automated way to send request for (and receive) precertifications from insurance companies.</p>	<p>If the nurse fails to obtain precertification from the insurance company before conducting a procedure on an outpatient, then the insurance company denies claims for such services.</p> <p>The precertification requirement also increases the training burden for new registration clerks.</p>	<p>Schedule a procedure for a patient after receiving clinical precertification from the patient's insurance company.</p> <p>Standardize the clinical precertification process.</p> <p>Employ a dedicated person who can coordinate scheduling for all patients (including referrals). This will also allow this person to oversee the precertifications for all patients before they arrive at EMC.</p> <p>Obtain software for sending automatic precertification requests to insurance companies.</p>
2. Patient Registration				
#	What happened?	Why?	What are the consequences?	What can be done?
2.1	<p><i>"Most of our problems begin at registration."</i></p> <p>When a patient arrives at EMC, the</p>	<p>This happens particularly when the clerks are very busy, or when a new clerk joins</p>	<p>If a clerk does not fax the notification within 24 hours of patient's arrival, the insurance company denies the</p>	<p>Send patient notification at the time of admissions itself.</p> <p>Require sending the</p>

	<p>registration clerk needs to send a patient notification (in the form of a “face sheet” containing non-clinical, demographic data about the patient) to the patient’s insurance company.</p> <p>Current procedure requires faxing this information within 24 hours, but that does not always happen.</p>	<p>the registration team.</p> <p>The process support is very weak: the clerk receives no prompt from the EMR system to send the information.</p> <p>There is no automated way to send notifications.</p> <p>There is no audit.</p>	<p>related claims. As a result, EMC does not receive payment for the services provided to the patient.</p> <p>In addition, this creates an exception in the revenue cycle, requiring extra attention and rework.</p>	<p>notification as a prerequisite for finalizing admission.</p> <p>Require software to support the activities, with possible automatic sending of notification before completing an admission.</p>
2.2	<p>When a patient arrives at EMC, the registration clerk verifies insurance eligibility for the patient (for example, to check if the patient has active insurance, or to determine the coverage and deductibles).</p> <p>However, the clerks fail to conduct the verification consistently for all patients.</p>	<p>For every patient, the registration clerk is supposed to go to the website of the patient’s payer and verify coverage. This process is often time-consuming, and newer clerks sometimes forget to do that.</p> <p>In addition, sometimes the updates in the insurance payer’s systems are very slow and do not reflect changes in patient’s coverage in a timely manner.</p>	<p>EMC routinely admits patients assuming that their insurance coverage is active and covers the planned procedure.</p> <p>However, sometimes when EMC bills the patient’s insurance provider, the provider refuses payments indicating that the patient has insufficient coverage or no coverage at all.</p> <p>In such cases, EMC seeks to recover the amount directly from the patient who might refuse or be unable to pay that amount. At times, it leads to litigation.</p>	<p>Require an automated, real-time system to access a patient’s insurance eligibility, co-pay, and self-pay deductibles.</p> <p>Require insurance verification a prerequisite for finalizing admission.</p>
2.3	<p><i>“Sometimes we are unable to contact self-pay patients after discharge. We may have an address in our records, but cannot</i></p>	<p>Inability to independently verify patient information</p> <p>Patient information not updated in a timely manner in the EMR</p>	<p>A payer may delay, or deny a claim if the insurance information or key contact information is wrong.</p> <p>If the contact</p>	<p>Obtain correct insurance information before admission and keep it up to date.</p> <p>Verify all the important patient-</p>

	<p><i>contact the patient for months or until they show up in the ER.</i></p> <p><i>“We may still be using their last insurance because we have not asked for their current information. This comes to attention only when we get a claim denial.”</i></p> <p><i>“Sometimes patients do not know who their insurance provider is!”</i></p>	<p>system.</p> <p><i>“Some patients are fast-tracked for admission. We often have problem getting or verifying their insurance information.”</i></p>	<p>information is wrong, the hospital cannot contact the patient for follow-up in case of delayed payments.</p>	<p>related information (such as patient’s address or phone number) during patient registration.</p>
2.4	<p><i>“We scan the patient’s insurance card as part of the registration process. Sometimes the scanned images do not make it to the hospital’s EMR system.”</i></p>	<p>The scanners (hardware or software) are not always working properly.</p> <p>The IT support is sometimes slow or lacking.</p>	<p>If a registration clerk identifies a problem with a scan while the patient is still present, she can scan the insurance card again. Otherwise, the problem remains in the system (i.e., missing insurance card information) until the billing department identifies it as a billing edit.</p> <p>If the issue escapes notice during billing review, the insurance payer may deny the claim.</p>	<p>Prioritize IT support.</p> <p>Update scanners and resolve networking issues.</p>
3. Patient Encounter				
#	What happened?	Why?	What are the consequences?	What can be done?
3.1	<p><i>“Some physicians enter their orders in CPOE and some of them enter in paper-</i></p>	<p><i>“We do not have a standardized way to enter orders.”</i></p>	<p>This increases work for the coding team and increases the potential for errors</p>	<p>Each participant (front-desk, physician, and nurses) should understand their role in</p>

	<i>based charts. The information in these charts then must be keyed into the system by another person.”</i>		due to media breaks.	revenue cycle. Receiving the money for the service provided is everyone’s responsibility.
3.2	Missing encounter documentation	Some outpatients unknowingly walk out with encounter form.	The hospital cannot claim reimbursement without a charge sheet.	Collect charge sheet at the end of each patient encounter with provider.
3.3	Physician soften address unrelated health issues	<i>“Diagnosing diabetes during a worker compensation visit will not get you reimbursement for diabetes.”</i>	The hospital does not receive reimbursement for additional medical conditions identified in certain visits.	The physicians need to understand the scope of patient visits.

4. Clinical Documentation

#	What happened?	Why?	What are the consequences?	What can be done?
4.1	<p>Often there is little documentation for tests ordered by a physician. The physicians write too little, or what is written down is imprecise in relation to the services that were actually provided during the patient encounter.</p> <p>In some cases, such as diabetes, the physicians do not use the label “diabetes” in the charts unless tests confirm such a diagnosis, as it has many social and work-related consequences.</p>	<p>The physicians sometimes do not write an exact diagnosis as they are waiting for confirmatory tests.</p>	<p><i>“This problem trickles down; then someone has to resolve it later. For example, a physician may send a patient for a CT scan of chest, and mention a ‘cough’ in the diagnosis. Medicare would not cover a CT scan for a cough. When this happens, the coders have to call the physician to clarify.”</i></p> <p>In case of festering infections, some physicians may not write “diabetes” but still order diabetes tests, suspecting that the patient might be diabetic and they</p>	<p>Need to create a standardized way to capture clinical documentation.</p> <p>Use software (e.g., CPOE) to capture clinical documentation at the time of service delivery.</p> <p>Engage physicians to help them understand their role in the revenue cycle, not only in care delivery. They need to write detailed symptoms (in lieu of an exact diagnosis) to enable successful claims to payers.</p>

			want to test to rule out or confirm this diagnosis. Medicare would not reimburse unless the diagnosis mentions diabetes.	
4.2	<i>“We are not capturing all charges for each encounter. We do not know if we have entered the charges for all the services provided to the patient. In addition, we do not have any way to monitor it except for checking a randomly selected account. We get to know about it only when we do not get a payment.”</i>	<i>“It is possible that more services are performed on a patient than what they are billed for, but we do not know how prevalent the problem is.”</i> The physician and nurses do not always document the procedures or examinations for a patient.	The hospital loses revenue if a claim does not include charges for all the services provided to a patient.	Educate physicians and nurses to document everything at the time of service. Develop a system for automatic charge audit that can associate certain procedures with commensurate charges. Example: If the radiologist performs an X-Ray, there should always be an X-Ray charge in the system.
4.3	<i>“Sometimes the coders receive documentation several months late. For example, in April they may get documents for an encounter in December of previous year. This creates a backlog.”</i>	The physicians and nurses do not document charges at the time of service. Later they may forget about it.	The hospital loses revenue if a claim does not include charges for the services provided to a patient. If the hospital does not file a claim timely, the payer may even deny such claims.	Educate physicians and nurses to send clinical documents to coding staff immediately after a patient’s discharge.

5. Medical Charge Coding

#	What happened?	Why?	What are the consequences?	What can be done?
5.1	<i>“Discharge summaries and procedure notes are not timely. They (nurses) have 30 days to get it done, and though the turn-around has improved, it is still late</i>	<i>“The outpatients need to be turned around quickly, although for inpatients it may take a few days to get the discharge summary.”</i>	<i>“If the coding does not happen, then billing does not happen, and that has a ripple effect to the entire reimbursement cycle.”</i>	Encourage CPOE adoption by all clinicians, so that the clinical staff can transmit discharge summaries electronically to the

	<i>sometimes.”</i>		This delays the reimbursements to the hospital.	coding staff.
5.2	<i>“There are significant changes (in specific coding standards), at least once every quarter, and we need to keep track of those changes.”</i>	The codes change frequently, and the coding staff is unable to keep track of the changes.	If the coding clerks do not use correct (and updated) codes, the payers may deny the claims, resulting in loss of revenue to the hospital.	Require software to check automatically for updated codes.
5.3	<i>“We do not audit whether the coding was correct or we made other errors that could cause denials.”</i>	Most of the coding is done manually.	Some claims are denied or delayed because of inaccurate coding. Revenue loss occurs if claims are denied.	Develop an audit system for coding. Conduct training workshops to share best practices in coding.
5.4	Physicians do not use the highest code for the work they have performed.	The physicians may not realize the impact of their (faulty or defensive) practice.	Revenue loss occurs because highest code (that could give higher insurance reimbursement) was not applied.	Engage physicians to understand coding appropriately and how it affects the hospital’s bottom-line.
5.5	<i>“We have an EMR, but we also have charts. Therefore, the physician sends information via EMR as well as through paper charts. Sometimes the EMR shows \$300 charges, and the paper chart shows only \$100—the coding person has to decide which one to bill to the patient and sometimes bills only \$100. This creates a balancing problem at the end of the day.”</i>	Heterogeneity of technology systems to collect charges Lack of standard protocols for charge capture	Revenue loss to EMC because code with lower amount was applied	Encourage CPOE adoption by all clinicians.

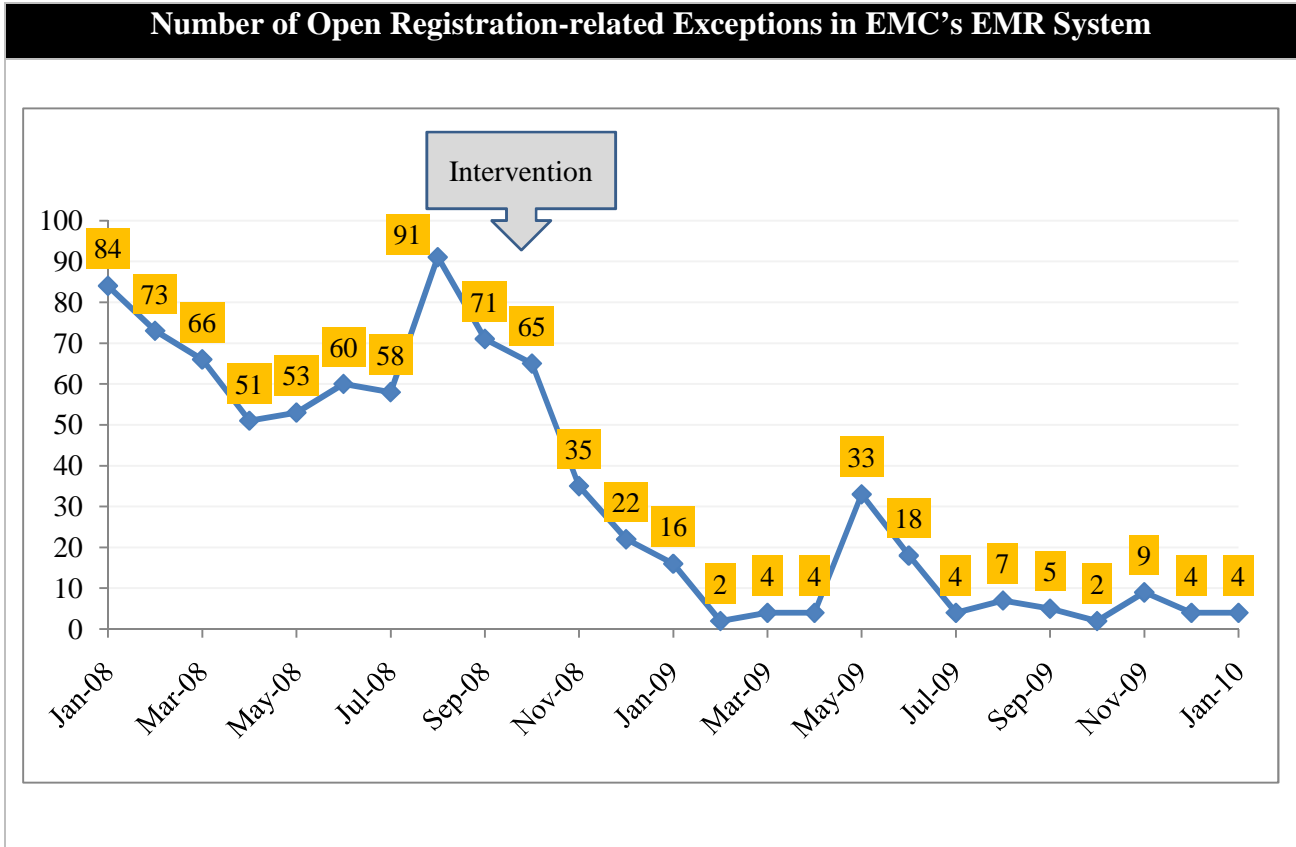
6. Billing				
#	What happened?	Why?	What are the consequences?	What can be done?
6.1	<p>A billing specialist uses billing edit software to identify missing information or other inaccuracies in claims before submitting claims to insurance payers.</p> <p>A billing specialist prints and reviews the billing edit report for all claims every day. The printout often runs into nearly 100 pages.</p> <p>Many inaccuracies in claims remain even after the billing edit is completed.</p>	<p>The billing edit software can only identify items that it is configured to identify. The master list of edits (in the software) is outdated, and hence the billing edit process misses critical errors or finds extraneous ones.</p>	<p>If the billing specialist does not correct these billing edits, it is likely that the insurance company will deny the claim (resulting in loss of revenue).</p> <p>At best, the payer returns the claim for rectification of the errors. The billing specialist will then have to “fix” the errors. This rework delays payment of claims by at least six weeks after the patient’s discharge.</p>	<p>Obtain latest software updates for billing edits.</p> <p>Create a formal system of frequent reviews of billing edits and update master list of edits as required.</p>
6.2	<p><i>“We need to make sure we watch closely on what we are getting paid for. We would like to know what % of our claims are denied or rejected. We are unable to learn from our problems in the past consistently so next time we could learn from our mistakes in the billing process.”</i></p>	<p>The hospital has no system to track whether actual payments are as per the contractual agreement with the payer.</p>	<p>The hospital loses revenue.</p>	<p>Require revenue management system that can help to track denials and rejections.</p>
6.3	<p><i>“Sometimes we do not know precisely where to send a claim.”</i></p>	<p><i>“All this information should be captured at admission.”</i></p>	<p>Such claims are delayed, or denied, if sent to the wrong payer.</p>	<p>Verify the patient’s payer information during registration.</p>

7. Payment Posting				
#	What happened?	Why?	What are the consequences?	What can be done?
7.1	<p><i>“We would like to see all standardized remits. Every insurance company has different remits. We are always trying to capture the actual payment received vis-à-vis the contractually allowed adjustments after considering the co-payment, deductible, etc. There are only a few fields that we need to see—we should be able to receive the information electronically.”</i></p>	<p>Some payers (such as Medicare) post electronically. However, most commercial payers post payments via postal service.</p>	<p>It takes a lot of time and effort from business office staff to track non-electronic payment postings.</p> <p><i>“They are all paper-based, and they all look different—so we have to look at different places.”</i></p> <p><i>“This is a big training issue—we have to process those remits manually.”</i></p>	<p>Encourage electronic posting of payments to the patients’ accounts.</p> <p>Encourage standardized remits (in case of paper-based remits).</p>
8. Revenue Recovery				
#	What happened?	Why?	What are the consequences?	What can be done?
8.1	<p><i>“We have a self-pay problem. Collections from self-pay patients are often a problem—they pay little, or sometimes nothing at all.”</i></p> <p><i>“We have many self-pay collections, and we spend a lot of time and money to collect the outstanding amounts.”</i></p> <p><i>“At this time, we do not know what % of total patients this problem represents.”</i></p>	<p><i>“Sometimes patients have high deductibles, and then do not pay when they get the bill.”</i></p> <p>Some patients (the majority of them are self-pay patients) are skeptical to give their correct address. They may not have a permanent address (as they may be living with relatives) or they move often, and EMC cannot locate them for</p>	<p>Since EMC is unable to collect reimbursement for medical services provided, it faces financial pressures.</p> <p>This also creates a vicious circle, as EMC attracts more self-pay patients. A physician who was familiar with the problem explained, <i>“If you get a reputation that you do not collect your bills,</i></p>	<p>Focus on improving collection at admission of co-payments prior to the patient receiving services.</p> <p>Many patients choose higher deductible policies, and the hospital needs to collect more up front before it turns to self-pay.</p> <p>Require real time access to verify if the patient is eligible for Medicaid or other</p>

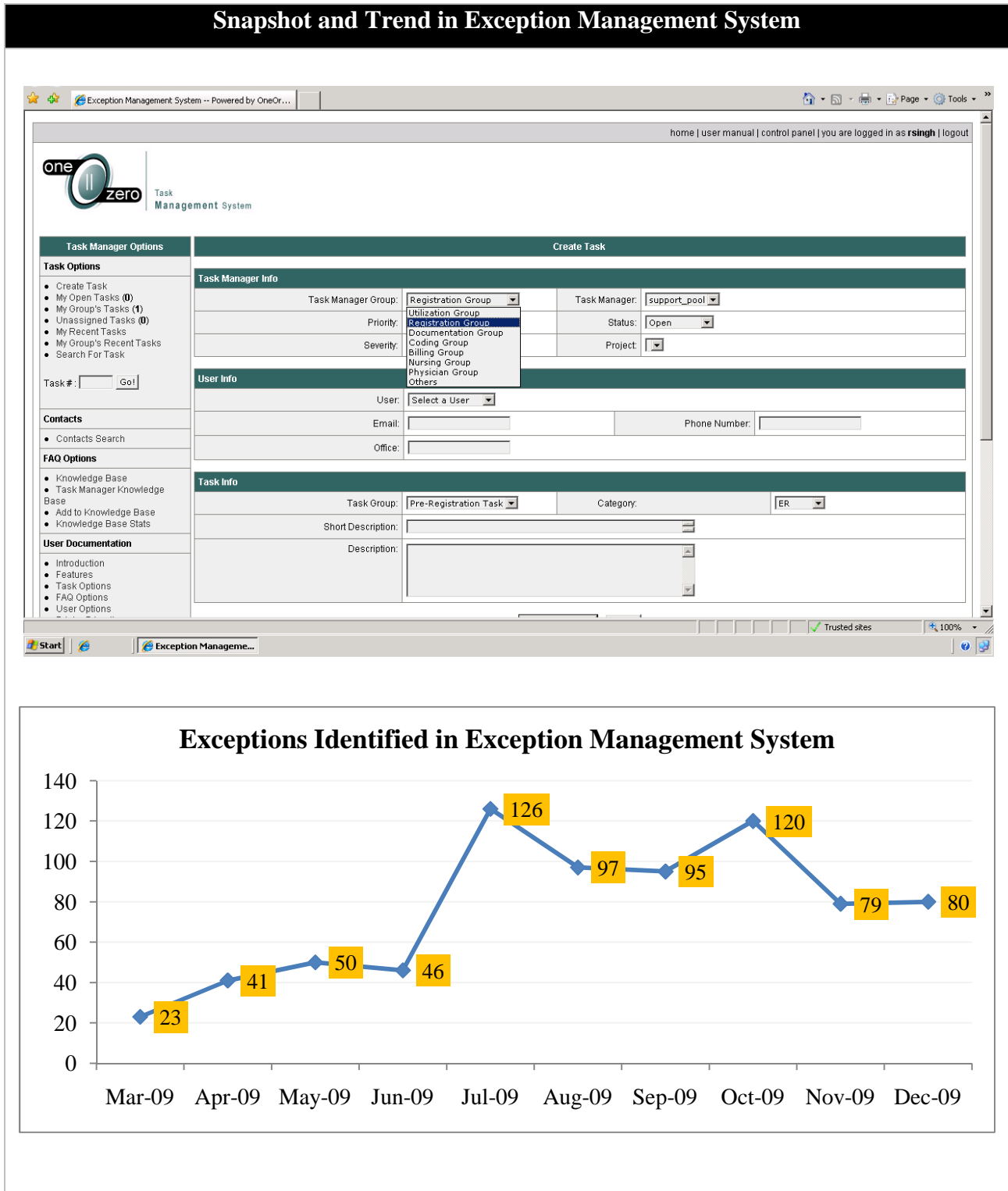
		<p>follow-ups or payments.</p> <p>The managers do not have sufficient overview and so cannot look into problems in a systematic way and know exactly where the issues are and resolve those issues.</p>	<p><i>then more and more (self-pay) patients come to you and do not pay their bills. Then you have to write it off.</i></p>	<p>insurance.</p> <p>Educate community on collecting co-payments and deductible for self-pay patient.</p>
8.2	<p><i>“We work with collection agencies, particularly for self-pay cases once we have not been able to collect. We send those cases to collection agencies for further collection. We need to call them on the phone and ask them each time we want to know the status.”</i></p>	<p><i>“We do not have an interface of systems with collection agencies charged with collecting outstanding amounts.”</i></p>	<p>The business office clerks spend significant time and effort trying to know the status of any case sent to a collection agency.</p>	<p>Require interface between EMC’s EMR system and the collection agency’s database.</p>

APPENDIX B: INTERVENTIONS AT EMC

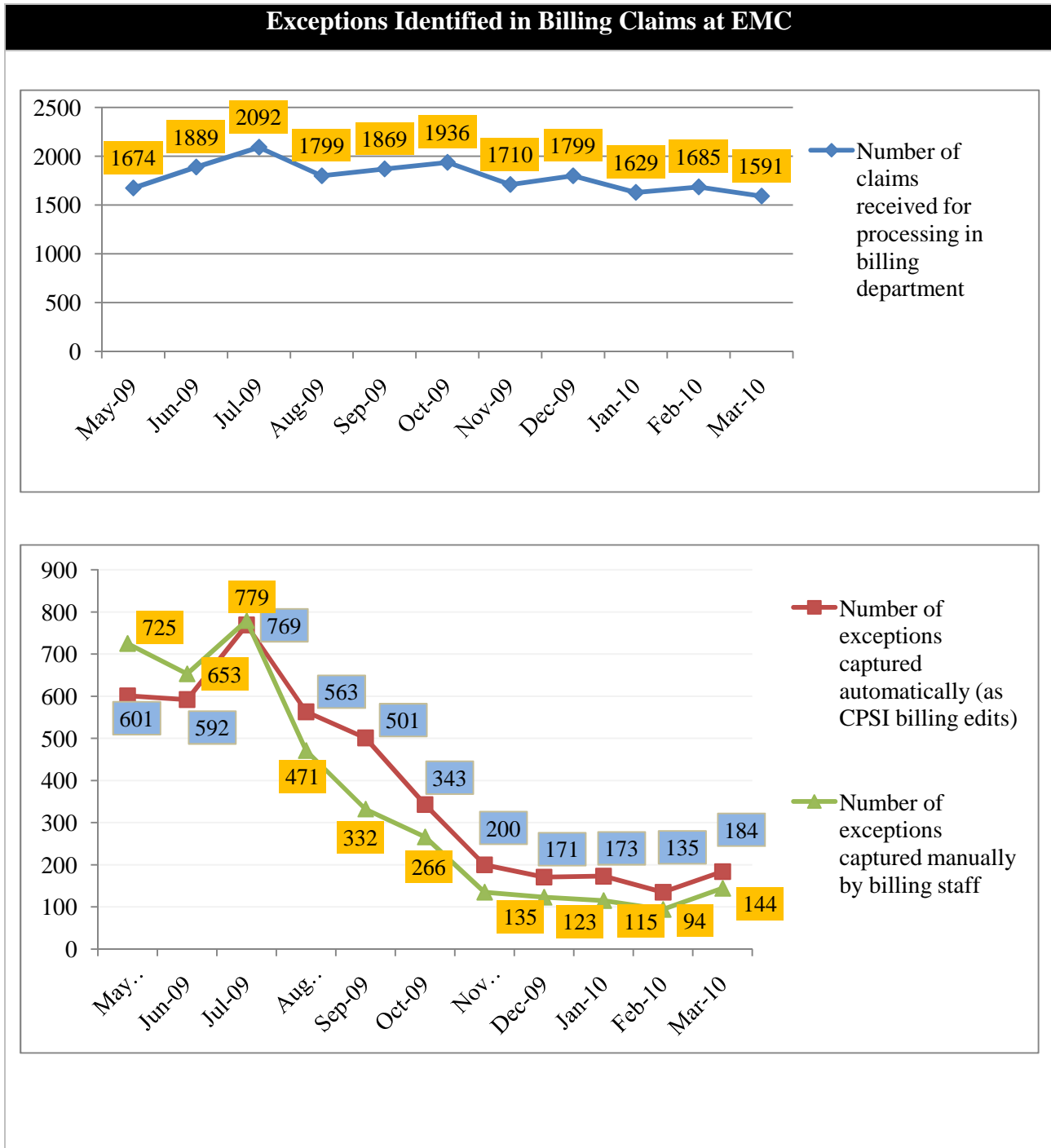
B.1 – Intervention A: Registration Exception Trend



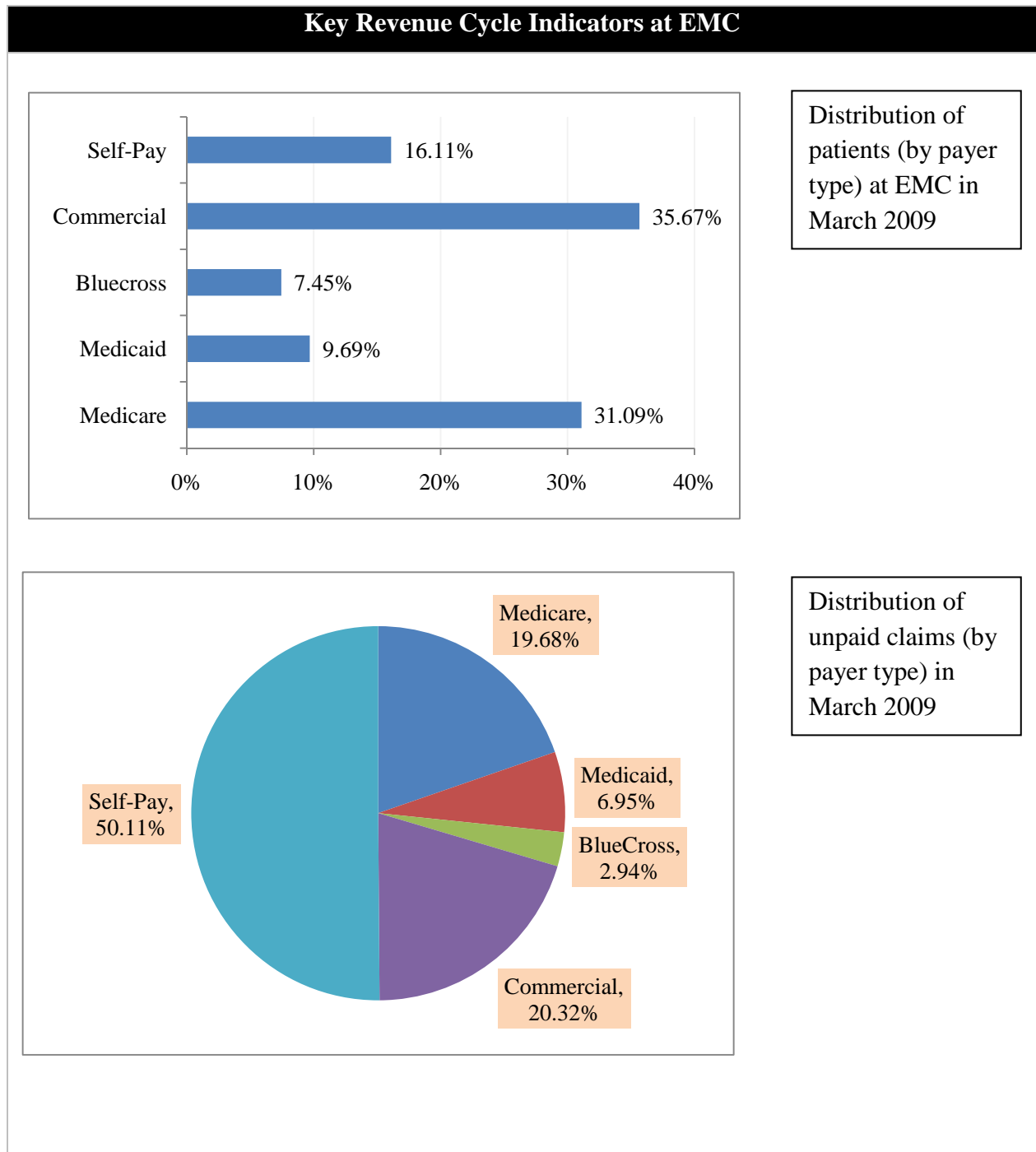
B.2 – Intervention B: Exception Management System



B.3 – Intervention C: Billing Exception Trend



B.4 – Intervention D: Key Revenue Cycle Indicators



APPENDIX C: EMC'S FINANCIAL PERFORMANCE

C.1 – Financial Performance Data during 2008-2010

Financial Data for EMC during 2008-2010				
	2008	2009	2010	Change
Inpatient Revenue	\$28,328,684	\$21,502,877	\$18,295,557	-35%
Outpatient Revenue	\$30,812,048	\$30,350,851	\$29,661,758	-4%
Long Term Care Revenue	\$2,936,720	\$2,894,632	\$2,819,669	-4%
Total Gross Patient Revenue	\$62,077,452	\$54,748,360	\$50,776,984	-18%
Net Patient Revenue*	\$24,488,757	\$21,420,165	\$19,949,756	-19%
Other Operating Revenue	\$628,657	\$571,577	\$538,695	-14%
Total Operating Revenue	\$25,117,414	\$21,991,742	\$20,488,451	-18%
Total Operating Expenses	\$26,233,669	\$22,663,543	\$20,826,354	-21%
Net Operating Surplus/Loss	-\$1,116,255	-\$671,801	-\$337,903	
Total Non-operating Revenue	\$171,299	\$782,587	\$1,138,999	
Total Net Surplus/Loss	-\$944,956	\$110,786	\$801,096	
Operating Margin	-4.44%	-3.05%	-1.65%	
Total Profit Margin	-3.76%	0.50%	3.91%	
EBIDA**	3.05%	5.27%	7.19%	
Cash Flow Margin	3.73%	8.83%	12.75%	

Note: Key financial data highlighted.

* After discounts, contractual allowances to insurance payers, bad debts, and charity care

** Earnings Before Interest, Depreciation, and Amortization