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Assessing the Impact of Electronic Health Record Systems Implementation on Hospital Patient Perceptions of Care

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ASSESSING THE IMPACT OF ELECTRONIC HEALTH RECORD SYSTEMS IMPLEMENTATION ON HOSPITAL PATIENT PERCEPTIONS OF CARE

by

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ABSTRACT

ASSESSING THE IMPACT OF ELECTRONIC HEALTH RECORD SYSTEMS IMPLEMENTATION ON HOSPITAL PATIENT PERCEPTIONS OF CARE

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The delivery of health care services has been impacted by advances in Knowledge Management Information Systems (KMIS) and Information Technology (IT). The literature reveals that Electronic Health Records Systems (EHRs) are a comprehensive KMIS. There is a wide recognition in the body of knowledge that demonstrates the potential of EHRs to transform all aspects of health care services and, in consequence, the performance of Health Care Delivery Organizations (HCDO). Authors of published research also agree that there is a need for more empirical contributions that demonstrate the impact of EHRs upon HCDO. It is argued that in most cases, studies have been deployed with very limited data or in a specific health care setting. Small gains in performance and mixed results have made difficult to conclusively demonstrate a significant effect of EHRs on the quality of health care services. This study contributes to the knowledge base by empirically assessing the link between a hospital's level of implementation of EHRs and patients' perceptions of the quality of health care services through the analysis of 2,036 hospitals. Findings reveal that the level of implementation of EHRs has a positive impact, both on the percentage of patients who are willing to recommend the hospital to family and friends, and on the percentage of patients who give high ratings based on their last stay in the hospital.

This dissertation is dedicated to God,

because his grace and mercy were the only things I needed

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INTRODUCTION

Background

The health care services sector is considered one of the most important sectors in any industrialized economy in terms of employment, research, development and exportation activities (Barton, 2007; Chaudhry et al., 2006). Health care spending in the United States is the highest in the world, particularly showing $2.5 trillion, or $8,086 per capita, in 2009 (Martin, Lassman, Whittle, & Catlin, 2011); but in contradiction, the health care system reveals a lack of financial access (Barton, 2007), as well as escalating costs and poor quality (A. Jha et al., 2009).

Health Care Delivery Organizations (HCDO) possess distinctive characteristics that are significantly different from those of manufacturing companies (Nicolini, Powell, Conville, & Martinez-Solano, 2008; Shortell & Kaluzny, 2007). HCDO can be composed of a broad range of health care institutions that vary in size and complexity such as hospitals, home and rehabilitative care facilities, clinics, community health centers, nursing homes, hospice centers, and ambulatory surgery centers, among others (Shortell & Kaluzny, 2007).

Each HCDO operates strategically to assure the fulfillment of the essential aims for improvement and to achieve its particular strategic goals; however, by doing so, these organizations undergo multiple challenges. Table 1 summarizes the six desired essential aims identified by the Institute of Medicine (IOM) (2001) that have been also recognized as the core objectives (Ramanujam & Rousseau, 2006) and common areas for improvement for the 21st-century health care system. These aims are related to two critical aspects: the quality and the efficiency of care.[1]

[1] This dissertation uses APA style

Table 1.

Health System Essential Aims

Aim	Description
Safe	Assuring a safety environment of care avoiding iatrogenic injuries and illnesses
Effective	Providing services based on scientific knowledge and avoiding providing services to those not likely to help
Patient-centered	Providing care based on individual patient's preferences, needs, and values
Timely	Reducing waits and harmful delays for both patients and caregivers
Efficient	Avoiding waste of equipment, supplies, ideas, and energy
Equitable	Providing care on an evenhanded basis across gender, ethnicity, geographic location, and socioeconomic status

In particular, HCDO are examples of a complex Information Intensive Organization (IIO) (Detmer, 2003; Suomi, 2001) and Knowledge Intensive Organization (KIO) (Reese & Majzun, 2001; Wickramasinghe, 2006). The most exemplifying aspects of this complexity are the proliferation of knowledge, information, and data related to the patients, diseases, protocols, drugs, procedures, health conditions, risk factors, and biomedical advances, and the operations and management of the health care services (Nicolini et al., 2008).

The Knowledge Management (KM) paradigm, applied to the HCDO complexity and to the areas for improvement in HCDO presented in Table 1, brings together the integration of the original and innovative contributions and applications of KM initiatives. Knowledge Management Systems (KMS) are an example of such initiatives that enable

knowledge generation, organization, transfer and application processes, and organizational learning.

Particularly, Information Technology (IT) has an important and growing role in the development of KMS and in the way in which health care services are delivered. IT-based KMS or KMIS in HCDO are referred to as "Health IT" which are understood as "the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making" (Thompson & Brailer, 2004, p. 38). *Based on this definition, Electronic Health Record (EHR) systems are recognized in this investigation as an example of a KMIS.*

In the light of the ongoing Health IT transformation and the recent national interest in EHR systems during the Bush and Obama administrations, EHR systems implementation and their meaningful use have become a mandatory strategy in the improvement of the quality and efficiency of care. However, the US Government's goal of providing most Americans with access to an interoperable Electronic Medical Record (EMR) by 2014 has issued a new and big challenge for the HCDO: to effectively face the multiple barriers of Health IT adoption.

As a result, promoting the implementation and use of EHR systems is a major priority for U.S. policy makers (A. Jha, DesRoches, Kralovec, & Joshi, 2010). Proof of this is the recently enacted Health Information Technology for Economic and Clinical Health (HITECH) Act, as a part of the American Recovery and Reinvestment Act of 2009 (ARRA) which makes available a $19 billion program to support the adoption process and "meaningful use" of EHR systems.

In the US, even though the implementation of these KMIS has increased during the last year, more work is needed to achieve what is called a "universal adoption" that is consistent with the meaningful program (C. M. DesRoches et al., 2013). The process is

more critical for inpatient settings, given the complexity of these organizations, especially for rural and non-teaching hospitals. DesRoches and her colleagues affirm that just around 40 percent of hospitals have implemented and are using basic EHR systems, and that among those, 16.7 percent have implemented a comprehensive system. Landaeta & Kotnour (2005) observed that organizations struggle with effectively designing, implementing, and adopting single and multiple knowledge processes and initiatives, mostly because these organizations are complex knowledge systems.

With the complex process of technology adoptions in HCDO, the enormous investments made by these organizations, and the two billion dollars in incentives to promote adoption and meaningful use, the question of the actual impact of these KMIS on HCDO health care quality improvements is of top interest to researchers, policy makers, and health care managers, and it is the driving rationale of the recent studies found in the literature.

Particularly, there is a growing attention to the provision and improvement of the highest quality of care according to patient needs (A.S. Kazley, Diana, Ford, & Menachemi, 2011). One of the current research areas supported by the Agency for Healthcare Research and Quality (AHRQ) and the National Institutes of Health (NIH) is the adoption of Health IT to support quality, medication management, health care decision making, and patient-centered care (AHRQ, 2008). When the quality of the health care service is under study, the attention is focused on clinical outcomes, quality processes, and patient experience and satisfaction indicators. Improvements to these important and critical aspects need to be analyzed when assessing the capabilities and impact of KMIS (EHR systems) on HCDO performance measures.

Until 2008, patients' perceptions of the health care experience provided in inpatient settings and overall satisfaction measures had been nationally assessed through the Hospital Consumer Assessment of Healthcare Providers and Systems

(HCAHPS) survey and reported thanks to the Hospital Quality Alliance Program (Ashish K. Jha, Orav, Zheng, & Epstein, 2008). Consequently, research including these measures to explore relationships between quality and Health IT is scarce in the literature.

Problem and Purpose Statement

It is considered, based on the Institute of Medicine (1994), that research in Health Care Knowledge Management (HCKM) should provide the scrutiny required for evaluating technology transfers and new procedures and practices that are often put into place before valid outcome evaluations have been done. In particular, the mandatory but slow adoption process of EHR systems in inpatient settings demands evidence that demonstrates the value and impact of such systems on the critical areas for improvement. In response to this need, research about the impact on quality of care of these KMIS in the health care sector is now at the center of attention among policy makers, the academy, and HCDO.

There is a wide recognition in the literature that demonstrates the potential of EHR systems to transform all aspects of health care services and in consequence, the performance of the HCDO (Bates, Ebell, Gotlieb, Zapp, & Mullins, 2003; Bates & Gawande, 2003; Buntin, Burke, Hoaglin, & Blumenthal, 2011; Chaudhry et al., 2006; Institute of Medicine, 1997, 2001, 2003; Jamal, McKenzie, & Clark, 2009). However, the need for assessments of the impact of Health IT on HCDO outcomes of care, and particularly, of the implementation of EHR systems on quality and efficiency, is a need which several authors have emphasized (Chaudhry et al., 2006; Grieger, Cohen, & Krusch, 2007; Abby Swanson Kazley & Ozcan, 2009; N Menachemi, Randeree, Burke, & Ford, 2008; Nicolini et al., 2008). Authors have also agreed that there is a need for more empirical contributions that demonstrate the impact of EHR systems on

organizational performance and across different health care settings (Chaudhry et al., 2006; N Menachemi et al., 2008; Nicolini et al., 2008). It is argued that, in most cases, studies have been deployed with very limited data or in specific health care settings that are not generalizable to the broad set of HCDO in the larger health care system. This affirmation is also supported by the funding opportunities released since 2008 (still in effect) by the NIH. The purpose of these initiatives is to support studies "that will inform larger scale real world health IT implementation and use or the conduct of more comprehensive health IT implementation research" (AHRQ, 2008, pp. Executive Summary, Pt. 1) to improve quality-related aspects in the American Healthcare System. Only few empirical studies for EHR evaluations on quality of care have been developed (R. Amarasingham, L. Plantinga, M. Diener-West, D. J. Gaskin, & N. R. Powe, 2009b; C. DesRoches et al., 2010; Garrido, Jamieson, Zhou, Wiesenthal, & Liang, 2005; S. S. Jones, J. L. Adams, E. C. Schneider, J. S. Ringel, & E. A. McGlynn, 2010; J. Linder, Ma, Bates, Middleton, & Stafford, 2007; N Menachemi et al., 2008; S. Parente & J. McCullough, 2009), and these are mostly based on clinical measures of care in common health conditions. From this relative handful of empirical studies, either very few small gains in performance or mixed results have been found, making it difficult to conclusively demonstrate a significant effect on quality.

Patients' perceptions of health care, an important element in the evaluation of quality of care and performance, it seems, have been overlooked in Health IT evaluations at the hospital level. There appears to be just one empirical study published which addresses this topic with promising results (A.S. Kazley et al., 2011), however much remains unknown when assessing the impact of EHR systems. Better understanding of the impact of this KMIS on the quality of healthcare inpatient settings through patient's perceptions of quality of care measures can be used as a mechanism for better decision-making processes regarding Health IT adoption projects, to help

HCDO to plan for a complete EHR system transition, to take advantage of incentive opportunities, and consequently, to improve performance.

This study attempts to contribute to the knowledge base by empirically assessing the link between a hospital's level of implementation of EHR systems and patients' perceptions of the quality of healthcare through secondary data and across a large array of hospitals. While empirical results demonstrate mixed results and small gains in quality of care, it still stands to reason that this KMIS could improve both patients' perceptions of quality of care and overall hospital performance.

Research Questions

To achieve the purpose of this investigation, this research aims to answer the general research question:

To what extent does the implementation of KMIS (EHRs) in HCDO impact the quality of the health services from the patients' perspective?

Research Sub-questions

To address the original research question, the following research sub-questions are derived:

1. How are KMIS classified in the health care sector?
2. How is quality of health services measured through the patients' perspective in HCDO?
3. Which contextual elements need to be considered to assess the impact of KMIS (EHRS) on patients' perceptions of quality of healthcare?

Conceptual Model

The conceptual model that includes the elements that are going to be investigated in this work is presented in Figure 1. This model constitutes the building blocks that will direct and represent this research.

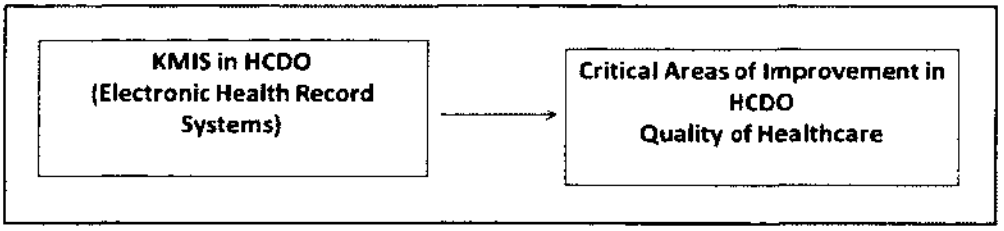


Figure 1. Conceptual model of the impact of KMIS on HCDO.

Methodological Framework and Proposed Research Method

The planned methodological framework in this investigation adapts the high level proposed methodology performed by Landaeta (2003), based on the research process proposed by Miller and Salkind (2002). As shown in Figure 2, this methodology is composed by 10 phases that are depicted as follows:

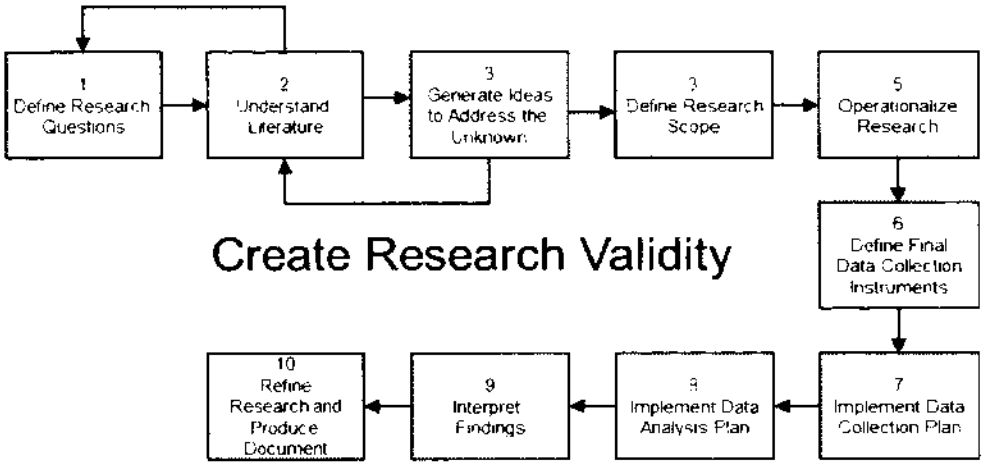


Figure 2. High level methodology
Note: From Knowledge management across projects (p. 18), by Landaeta, R., 2003. University of Central Florida, United States, Florida.

Definition of Basic Terms

Health Care Delivery Organizations (HCDO)

Health Care Delivery Organizations (HCDO) are organizations such as hospitals, home and rehabilitative care facilities, clinics, community health centers, nursing homes, hospice centers, ambulatory surgery centers, and others which are directly involved in health services to patients (Shortell & Kaluzny, 2007).

Health Informatics

Based on Shortliffe, Perreault, Wiederhold, and Fagan (1990), Health or Medical Informatics is defined as a scientific field closely tied to modern information and communication technologies which deals with the storage, retrieval, and optimal use of biomedical information, data, and knowledge to support problem-solving and decision-making processes.

Health Information Technology

A frequently cited definition of health information technology (Health IT) was articulated by Thompson and Brailer (2004): "the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making" (p. 38).

Knowledge Intensive Organization

A Knowledge Intensive Organization (KIO) is that one that can produce results based on intellectual work carried out by a workforce composed of well-educated, qualified employees on whom there is an important reliance (Alvesson, 1995, 2000, 2001; Robertson & Swan, 1998; Starbuck, 1992).

Knowledge Management

Knowledge Management is understood as the initiatives, tools, and techniques to design and implement knowledge processes in organizations to improve performance and develop capabilities (Davenport, De Long, & Beers, 1998; Drucker, 1993, 1999; Landaeta, Pinto, Kotnour, & Peterson, 2006; Lubit, 2001)

Knowledge Management Information System

Knowledge Management System (KMIS) are understood as a set of information systems (IS) that are developed and applied to support and enhance organizational knowledge processes, and consequently, to manage organizational knowledge (Alavi & Leidner, 2001).

Knowledge Worker

The term "knowledge worker" was first introduced by Peter Drucker in 1959 in his work *Landmarks of Tomorrow* (Nonaka & Takeuchi, 1995). An individual knowledge worker (or team) (Alvesson, 2004) is a member of an organization who has the best general insights and expertise to solve specific problems, and whose role relies on his or her ability to acquire, allocate, and use knowledge productively (Bali, 2005).

LITERATURE REVIEW

The following section will review the literature in the field of Health Knowledge Care Management that is relevant to the research problem stated earlier in this study. The general purpose of this section is to understand the body of knowledge and to provide a framework to deduct research questions and hypotheses from the theory, and to explain expected relationships (J. W. Creswell, 2009). This section presents ideas derived from the Knowledge Management school of thought applied to Health Care Management, followed by the critical review of current studies on the relationship of implementation of EHR systems and aspects of quality of care. In particular, it reviews patients' perceptions of quality of care. Furthermore, the literature review will provide the evidence that recognize the importance of the study of EHR systems, such as KMIS.

Knowledge Management Overview

The study of EHR systems and their impact in HCDO leads to a review of how Knowledge Management is applied and understood in the health care sector. Under the Knowledge Management paradigm, KM initiatives and projects are implemented to assist organizations to improve performance. Health Care Knowledge Management foundations are presented in this section:

Knowledge Taxonomies

The concept of knowledge has been viewed by different authors (Alavi & Leidner, 2001; Glazer, 1991; Nonaka, 1994; Nonaka & Takeuchi, 1995; Spender, 1996; Turban & Frenzel, 1992; Wiig, 1993). Different definitions, dimensions, and typologies have been proposed by researchers dedicated to the study of KM, based on their positions and world views. Alavi & Leidner (2001) particularly, analyzed the different perspectives on

knowledge and presented a summary of definitions. Based on their work, knowledge definitions are classified as (1) personalized information (i.e. knowledge in relation to data and information), (2) the state of knowing and understanding (state of mind perspective), (3) an object to be stored and manipulated (i.e. object perspective), (4) a process of applying expertise (i.e. process perspective), (5) a condition of access to information (access to information perspective), or (6) the potential to influence action (i.e. capability perspective). These perspectives influence the way in which KM strategies are developed within the organizations.

For the purposes of this investigation, the perspective of knowledge based on information and data is used as groundwork to understand and analyze the knowledge processes and knowledge management initiatives in HCDO.

It is understood that knowledge is information that has been given meaning (Glazer, 1991) through processes in the minds of individuals' reflection, interpretation, or learning (Alavi & Leidner, 2001). Furthermore, knowledge can reside in individuals, organizations, physical documents, and computers (J. Liebowitz, 1999). Classifications of knowledge have been made, based on different characteristics. Based on the work of Polanyi (1966), Nonaka (1994) explained two types of knowledge: tacit and explicit. Tacit knowledge has a personal quality; it is difficult to formalize and communicate, and it involves cognitive and technical elements. Its cognitive aspect implies mental models, such as paradigms, schemata, beliefs, and viewpoints; and the technical aspect implies concrete know-how, craft, and skills. Explicit knowledge is articulated and expressed in formal and systematic ways. It is easily processed, transmitted, and stored (Nonaka, 1994; Nonaka, Toyama, & Byosière, 2001). In addition, Alavi & Leidner (2001) recognized other distinctions based on Norton's (1998) and Zack's (1998) works, namely:

- Declarative or "know-about": This refers to knowing facts (e.g. what drug is appropriate to treat a particular infection).
- Procedural or "know-how": how particular tasks can be done. This refers to skills and capabilities to perform an activity (e.g. how to treat a particular infection).
- Causal or "know-why": understanding of particular events. This refers to knowledge of principles and laws that govern processes (e.g. knowing why the drug works when treating a particular infection).
- Conditional or "know-when": when particular events or phenomena may happen. This also refers to when to apply declarative and procedural knowledge (e.g. knowing when administer a drug to treat a particular infection)
- Relational or "know-with": understanding the relationships between elements, occurrences or events (e.g. knowing how the drug interacts with other drugs or health conditions).
- Pragmatic: knowledge useful for an organization (e.g. clinical protocols and best practices, safety programs, etc.).

An additional category, which is also called "relational knowledge" in the literature, refers to knowing "who" knows the strategic declarative of procedural knowledge for a specific situation (e.g. who knows how to deal with critical cases related to a disease). This category is based on the relationships established among people (Antal, 2000).

Regarding the level of analysis, knowledge can also be viewed as created in the individual or the collective (i.e. in society) (Nonaka, 1994). Alavi & Leidner (2001) pointed out that knowledge at the individual level is created by and inherent in the individual, and at the social level is created by and inherent in the collective action of a group.

Each of these categories of knowledge (know-about, know-how, know-why, know-when, know-with, and know-who) may be explicit or tacit and individual or social and can fluctuate from tacit to explicit or from explicit to tacit, as well as from individual to social or social to individual.

The work of Alavi and Leider (2001) suggests that this distinction provides the basis for developing initiatives for Knowledge Intensive Organizations (KIO) which use "knowledge" as a vital asset and need to promote the flow among the different types of knowledge. Making the distinction among these knowledge dimensions and taxonomies can allow organizations to understand and evaluate a variety of theoretical and technological contributions and developments in the Knowledge Management (KM) arena. In this era of knowledge economy, in which knowledge is a valuable asset for any organization (Davenport & Prusak, 2000), KM and its effective implementation is critical in order to remain and improve the ability of these KIO to develop a sustainable competitive strategy (Drucker, 1993; J. Liebowitz, 1999; Nonaka & Takeuchi, 1995).

Knowledge Management and Knowledge Management Processes

KM is often regarded as an emerging discipline (J. Liebowitz, 1999; Rus & Lindvall, 2002; Wiig, 2000) which involves many perspectives, beliefs, concepts, processes, structures, technologies, methods, models, approaches and frameworks. Although there is no universally accepted definition, KM is understood as the initiatives, tools, and techniques to design and implement knowledge processes in organizations in order to improve performance and develop capabilities (Davenport et al., 1998; Drucker, 1993, 1999; Landaeta et al., 2006; Lubit, 2001). Several authors have developed KM studies that comprise KM processes as a part of models, frameworks, and methodologies. Table 2 summarizes representative studies (Alavi & Leidner, 2001;

Dave, 1998; Landaeta & Kotnour, 2005; Mertins, Heisig, & Vorbeck, 2003; G. Probst, 1998; Rastogi, 2000; Ruggles, 1997; P. Tyndale, 2002) of KM processes.

Table 2

Knowledge Management Processes Literature

Study	Knowledge Processes			
Ruggles (1997)	1. Knowledge Generation • Acquisition • Synthesis • Creation	2. Knowledge Codification • Auditing • Categorization	3. Knowledge Transfer	
Probst (1998)	1. Knowledge Goals	2. Knowledge Identification	3. Knowledge Acquisition	4. Knowledge Development
	5. Knowledge Distribution	6. Knowledge Use	7. Knowledge Preservation	8. Knowledge Measurement
Dave (1998)	Primary Activities			Secondary Activities
	1. Knowledge Acquisition (external sources) 2. Knowledge Selection (internal sources)	3. Knowledge Internalization	4. Knowledge Use	1. Knowledge Leadership
	• Identification – Locating – Accessing – Valuing – Filtering	• Assessing • Targeting	• Generation: Derivation or Discovery – Monitoring – Evaluating – Producing o Creating o Synthesizing o Analyzing o Constructing – Transferring	2. Knowledge Coordination 3. Knowledge Control
	• Capture	• Structuring	• Externalization	4. Knowledge Measurement

Continued

Study	Knowledge Processes			
	– Extracting – Collecting – Gathering • Organizing – Distilling – Refining – Orienting – Interpreting – Packaging – Assembling – Transforming • Transferring	• Delivering – Depositing – Storing – Updating – Disseminating – Distributing – Sharing	– Targeting – Producing – Transferring	
Rastogi (2000)	1. Knowledge Identification 5. Knowledge Storage	2. Knowledge Mapping 6. Knowledge Sharing • Accessing • Distribution • Transferring • Diffusion	3. Knowledge Capture 7. Applying Knowledge • Retrieving • Using	4. Knowledge Acquisition 8. Knowledge Creation • Generation • Discovery
Alavi & Leidner (2001)	1. Knowledge Creation	2. Knowledge Storage and Retrieval	3. Knowledge Transfer	4. Knowledge Application
Tyndale (2002)	1. Knowledge Creation	2. Knowledge Organization	3. Knowledge Distribution	4. Knowledge Application

Continued

Study	Knowledge Processes			
	• Capture • Generation • Gathering • Absorption • Assimilation	• Interpretation • Filtering • Codification • Categorization • Amalgamation	• Publishing • Meeting face-to-face • Dissemination • Transmission	• Processing • Change • Revision • Amendment • Revision
Mertins, Heisig & Vorbeck (2003)	1. Knowledge Identification	2. Knowledge Generation	3. Knowledge Storage	4. Knowledge Distribution
	5. Knowledge Application			
Landaeta & Kotnour (2005)	1. Knowledge Identification	2. Identification of Sources of Knowledge	3. Knowledge Transfer	4. Knowledge Verification
	5. Knowledge Creation	6. Knowledge Validation	7. Knowledge Assimilation	8. Knowledge Organization
	9. Knowledge Storing	10. Knowledge Protection	11. Knowledge Application	

The studies listed are representative rather than exhaustive. Some recent studies have been chosen.

Ruggles (1997) identified three primary KM processes with supporting activities. On the other hand, based on his former work (Probst & Romhardt, 1997), Probst (1998) developed a KM model seen as building blocks of knowledge (i.e. logical phases representing each knowledge process) that constitute a dynamic cycle. Similarly, Dave (1998), provided a comprehensive knowledge chain model based on a descriptive and generic KM framework developed via a Delphi-study in which he identified and validated primary and secondary KM processes with their corresponding subactivities. Rastogi (2000) affirmed that, for meeting the knowledge requirements to support strategic goals, there is a set of basic knowledge operations which he condensed into eight processes. Alavi and Leidner (2001) developed a framework for the analysis of the role of information systems based on four primary KM processes. Then again, Tyndale (2002) presented the set of processes for KM and subsequently broke them down into subactivities. Based on an empirical study, Mertins, Heisig, & Vorbeck (2003) presented four knowledge activities that have been assessed as essential and important. Finally, Landaeta and Kotnour (2005) provided a set of knowledge processes based on the development of a generic model of a knowledge system.

Although the aim of presenting the different KM processes was not to perform an exhaustive review of models, the review of some available examples from the literature indicates that it is evident that some set of KM processes converge to capture similar attributes. Still, some models are more detailed than others, providing a comprehensive group of KM processes to further develop activities. In addition, the names of certain activities may differ, depending on the approach followed by each researcher. In most cases, the set of activities is assumed "often concurrent, sometimes repeated and not always in linear sequence" (J. Liebowitz, 1999, p. 7), as well as interconnected and intertwined (Alavi & Leidner, 2001), allowing for different sequences of the execution (i.e. KM methodologies) (Landaeta & Kotnour, 2005). As Probst (1998) argued, there is no

single correct KM model, and yet none of the knowledge activities should perform independently from one another. Instead, organizations should adapt KM's proposed models to their organizational needs and objectives, integrating a set of identifiable and operational KM processes that make sense in their contexts.

Building upon the research summarized in Table 2, a set of primary KM processes is synthesized, based on the primary and complementary KM activities identified by the authors. The analysis suggests that the majority of the models specify knowledge capture, knowledge generation, knowledge transfer, and knowledge application as a set of core and operational KM processes. In addition, knowledge identification, storage, and assimilation, commonly embedded in other KM processes, are identified as critical knowledge processes for this study. Figure 3 illustrates different sequences of the execution of identified KM processes.

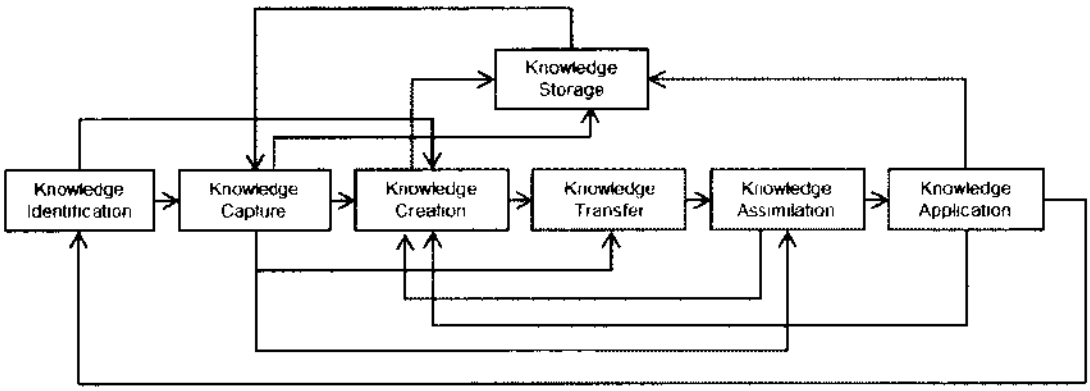


Figure 3. Knowledge management cycle
Note: The continuous lines represent the flow of knowledge through the different sequences of the execution of processes.

Knowledge Identification

As we can see in Figure 3, knowledge identification is the starting point of the KM activities. It involves the recognition and identification of the knowledge needed at the

different organizational levels to accomplish their particular goals (G. J. B. Probst, 1998). Considering the different perspectives and types of knowledge, the critical knowledge needed to perform a process might be variable across different organizational levels and functions. Landaeta (2003) noted that to know what the critical knowledge is to be acquired or selected, it is necessary to understand what is known and what is unknown. In addition, this stage involves the use of knowledge seeking activities (G. J. B. Probst, 1998) outside or inside the organizational boundaries. It implies the identification of the nature, characteristics, and modes of knowledge required (Rastogi, 2000) according to the knowledge perspective adopted by the knowledge seeker. Dave (1998) recognized that as a part of this process, the knowledge seeker needs to locate the sources of knowledge from which knowledge is to be acquired or selected and to determine its access; to value the knowledge costs and quality; and to filter non-relevant knowledge. The researcher also proposed pushing strategies to alert the knowledge seeker about the existence of beneficial knowledge about her/his work. Landaeta (2003) emphasized the need to detect reliable sources of critical knowledge and recognized external and internal sources of knowledge.

In healthcare settings, one mechanism to identify the critical knowledge needed in an specific situation (e.g. treatment, therapy, diagnosis) and its appropriate knowledge source (e.g. patient records, medical research literature, medical procedures, medical experts) is to execute a knowledge audit process (Metaxiotis, 2006). Knowledge audit steps (J. Liebowitz et al., 2000) comprise: (1) the identification of the knowledge that exists in a specific setting, (2) the identification of the knowledge that is needed in the specific setting, (3) the provision of recommendations to further progress of KM processes in the specific setting.

Knowledge Capture

Knowledge acquisition and selection can be found in the literature as a part of the knowledge transfer process (Landaeta, 2003) or the generation / creation processes (Ruggles, 1997; P Tyndale, 2000). Although Dave (1998) identified sub-activities such as knowledge identification, capture, organization and transfer within knowledge acquisition (i.e. from external sources) and selection (i.e. from internal organizational sources), it refers here to knowledge acquisition and selection as the processes of capturing the existing knowledge by an individual, group or organization (Ruggles, 1997). This knowledge comes from identified external or internal sources and channels respectively (Dave, 1998; Probst & Romhardt, 1997; Rastogi, 2000). Dave (1998) recognized that the process of knowledge capture is performed through the functionalities of retrieving and/or gathering knowledge from knowledge resources. "Retrieval refers to extraction of knowledge from an identified knowledge resources, and collection or gathering from a variety of resources" (Dave, 1998, pp. 221-222). Furthermore, Dave emphasized that different functionalities are implemented depending on the type of knowledge resources involved in the process (e.g. capture knowledge from an individual or from a computer system). The use of pull-and-push strategies for knowledge acquisition from computer-based systems or selection processes is useful. In the pull case, the knowledge flow is generated by the knowledge seeker's request; in the push case, there is no an explicit request from a knowledge seeker, but from the publisher. Figure 3 represents this knowledge flow through the continuous line from knowledge storage to knowledge capture.

Abidi (2008) explained that healthcare knowledge artifacts are "objects that allow knowledge to be captured and communicated independently of its holder" (p. 6). These knowledge artifacts can be documents, medical records, knowledge bases, communications between colleagues, and care workflows. Narratives, such as

physician notes, nursing assessments, and discharge summaries that contain patient and practitioner knowledge, for example, are captured through Electronic Clinical Documentation. In the HCDO, web-based technologies (i.e. internet, intranet, search engines, portals) are basic tools to support the process of knowledge acquisition and selection of explicit knowledge from external and internal repositories. In addition, clinical workers acquire tacit and explicit knowledge through internship, practices, and learning by doing, observations, among other mechanisms. Likewise, communities of practice allow practitioners to capture tacit knowledge from other clinical knowledge workers.

Knowledge Creation

Knowledge creation refers to the activity that generates knowledge by processing the already existing knowledge that comes from acquisition, selection, and/or prior generation processes (Dave, 1998). According to this researcher, this new knowledge is a result of two types of generation process: derivation and discovery. Derivation involves analytical, logical, and constructive techniques by using procedures, methods, and rules to process data and information to generate new knowledge. Conversely, discovery involves creativity, imagination, and synthesis, as less structured ways to generate knowledge. Dave also affirmed that the exact path from the initial knowledge toward the discovered knowledge cannot be fully preconceived or even traced. The knowledge path can be defined through R&D, experimentation, lessons learned, creative thinking, or innovation (Rastogi, 2000). Figure 3 shows the different sequences that may lead to the knowledge creation process.

On the other hand, Nonaka and Takeuchi's (1994; 1995) model of knowledge creation illustrated how this process is a result of different social modes of conversion through different organizational levels and based on the tacit and explicit dimensions of

knowledge. In this model, four modes of knowledge conversion are presented: socialization, externalization, internalization, and combination. The socialization mode refers to the conversion of tacit knowledge to new tacit knowledge through interaction between individuals (i.e. observation, imitation, and practice). The combination mode refers to the creation of new explicit knowledge by social processes that allow individuals to merge, categorize, recategorize, add and recontextualize existing explicit knowledge. Externalization refers to the conversion of tacit knowledge to new explicit knowledge by the articulation of metaphors, successive rounds of meaningful dialogue, and collective reflection that can lead to revealing hidden tacit knowledge that is hard to communicate. Internalization refers to creation of new tacit knowledge from explicit knowledge by activities such as learning by doing or understanding and internalizing what the tacit knowledge is embedded on manuals or documents.

Metaxiotis (2006) affirmed that knowledge creation in HCDO means "improved organizational processes and systems in hospitals, advances in medical methods and therapies, better patient relationship management practices, and improved ways of working within the healthcare organization." New healthcare knowledge is a result of both technological and non-technological related activities. Examples of technology-based activities range from the use of data and text mining systems and techniques to information visualization technologies. On the other hand, patient-healthcare provider encounters, communities of practice, healthcare team interactions, personal experiences, and self-generated knowledge are examples of non-technological related activities.

Knowledge Transfer

Knowledge transfer is commonly found throughout the literature as knowledge dissemination, distribution, generalization, or sharing (Landaeta Feo, 2003; G. J. B.

Probst, 1998; Rastogi, 2000; P Tyndale, 2000). Ruggles defined knowledge transfer as a process that "involves the movement of knowledge from one location to another and its subsequent absorption" (1997, p. 2). As it was stated earlier, Dave (1998) identified transferring activities as a part of the knowledge acquisition and selection, and additionally, of the processes of internalization and externalization (i.e. disseminating, distributing and sharing). Figure 3 depicts these sequences.

In terms of transferring activities, Dave (1998) stated that knowledge transfer denotes externalizing existing or new knowledge to produce organizational outputs that impact the environment. This process involves the transfer of captured, created, and/or organized knowledge to knowledge seekers for the execution of subsequent knowledge processes. In turn, Rastori considered knowledge transfer as the "sharing process through its automatic access and distribution to users on the basis of their need and interest" (2000, p. 41). Consecutively, Alavi and Leidner (2001) considered knowledge distribution in organizational settings as the transfer of knowledge to locations where it is needed and where it can be used by communication means and information flows. In addition, based on the work of Nonaka and Takeuchi, Alavi and Leidner recognized that the transfer process is performed at the different organizational levels: "transfer of knowledge between individuals, from individuals to explicit sources, from individuals to groups, between groups, across groups, and from the group to the organization" (2001, p. 119).

Although knowledge transfer is carried out by different technological means (e.g. communication and collaboration technologies) and non-technological means (e.g. communities of practice, training) in HCDO, these organizations are not embedded in a sharing culture. Metaxiotis (2006) affirmed that a HCDO is "a collection of professional specialists who contribute to the delivery of patient care, but also often act competitively

inside the organization, without being willing to transfer knowledge because of associated status and power within the organization and the society" (p. 207).

Knowledge Storage

The knowledge that is acquired, selected, generated, and/or learned has to be preserved and properly organized and stored to build the organizational memory and to guarantee its future usage through knowledge repositories (Alavi & Leidner, 2001; G. J. B. Probst, 1998; Rastogi, 2000). Beforehand, knowledge needs to be organized for subsequent storage, retrieval and use. Dave (1998) provided an extensive description of the knowledge organization activity. According to his work, this process is part of the knowledge acquisition and selection processes. In this investigation, knowledge organization is distinguished as a part of the knowledge storage process, which involves the functionalities which Dave identified as: interpreting, distilling, refining, assembling, transforming, orienting, and/or packaging captured knowledge into representations necessary for subsequent knowledge manipulation activities (e.g. knowledge transfer, assimilation, or application). Dave emphasized that "distilling, refining, assembling, and transforming are concerned with revamping the internal organization (i.e. content) of captured knowledge. Orienting and packaging are concerned with rearranging the outward organization (i.e., appearance) of captured knowledge" (Dave, 1998, p. 222). Additionally, Tyndale (2000) identified the sub-activities of interpretation, filtering, categorization, codification, and amalgamation.

Knowledge storage for future retrieval and use is a continual process which includes individual versions (i.e. a person's observations, experiences, and actions), collective versions (i.e. organizational culture, formal organizational roles and work procedures), and electronic versions (i.e. advanced computer storage technology) (Alavi & Leidner, 2001; G. J. B. Probst, 1998) of organized and retained knowledge. Figure 3

shows the sequence of activities among knowledge capture, knowledge creation, and storage.

In healthcare settings, a health or medical informationist plays an important role in the technical aspects of knowledge organization and storage. "A clinical informationist is a professional member of the healthcare team who focuses on the intersection between clinical care and the evidence base contained in the literature and in biomedical databases and resources" (Giuse et al., 2005, p. 249). These support workers, with medical and informatics qualifications, work collaboratively with clinical personnel in decision making and development projects related to health informatics.

Knowledge Assimilation

This process involves the internalization activities of acquired knowledge by analysis, interpretation, comprehension, and understanding (Landaeta, 2003; Zahra & George, 2002). Cohen and Levinthal (1990) indicated that an organization needs previous related knowledge to assimilate and use new acquired knowledge. Zahra and George's (2002) research on absorptive capacity (ACAP) indicated that past experiences increase the capability to assimilate acquired knowledge. Figure 3 illustrates how knowledge captured or created needs to be assimilated to finally be applied to a specific domain.

The vast explosion of data information and knowledge in healthcare settings makes the assimilation process almost impossible. Different strategies are adopted to overcome this problem, including the adoption of health information technology. Electronic learning systems, telehealth, and clinical decision support systems are examples of these adoptions.

Knowledge Application

Rastogi (2000) affirmed that applying knowledge means "retrieving and using knowledge including best practices, in support of decisions, actions, problem-solving, automating routine work, providing job aids, and training" (p. 41). Probst (1998) affirmed that knowledge use refers to "the productive deployment of organizational knowledge in the production process" (p. 25).

The applied knowledge has to generate action within the organization through its internal processes, services, and products, with the final goal of improvement (Landaeta, 2003). Figure 3 also represents the change generated through the application of knowledge, and thus through the continual execution of knowledge processes. A learning loop is closed and new insights and knowledge are gained thorough learning by doing.

The analysis above encourages reflection on the genesis of organizational learning (OL) thorough the cyclic practice of executing KM processes that lead an organization to continue innovating products and services, encompassing "both processes and outcomes" (Dodgson, 1993, p. 377). The literature indicates that the principal goal of OL is to improve productivity and competitiveness through innovation in order to continually adapt the organization to uncertain and changing environments. This distinction reveals that the innovation that comes from knowledge creation is the key to building a sustainable competitive advantage (Meso & Smith, 2000), followed by the assimilation and then the application of the newly acquired and/or created knowledge (Alavi & Leidner, 2001). Therefore, the effective implementation of knowledge processes is critical, in order to remain and enhance the ability of these organizations to develop a sustainable competitive strategy (J. Liebowitz, 1999; Meso & Smith, 2000; Nonaka & Takeuchi, 1995).

The nature of the work done in HCDO is based on the application of clinical knowledge in decision making and problem solutions. Knowledge application-enabling technologies are commonly used in healthcare settings to support this processes. Clinical Decision Support Systems (CDSS), Telehealth systems, and groupware technologies are examples of knowledge application support systems.

The Nature of Knowing in Health Care Delivery Organizations

HCDO are composed of a broad range of health care institutions that vary in size and complexity, such as hospitals, home and rehabilitative care facilities, clinics, community health centers, nursing homes, hospice centers, and ambulatory surgery centers, among others (Shortell & Kaluzny, 2007), whose medical services are intended to influence a population's health through operations carried out by educated personnel (Gummesson, 2000).

HCDO can be categorized depending upon their geographic location (e.g. rural, urban); level of care (e.g. primary care, secondary care, long-term care); ownership (e.g. for-profit, non-profit, public); government sector (e.g. federal, state or local); and specialty type (e.g. cancer center, children's hospital, psychiatric center), among other designations (Barton, 2007). Their workforce is composed of direct clinical workers (i.e. physicians, midlevel practitioners, nurses, and therapists); management workers (i.e. administrators and managers at the board, senior, and department levels); and support workers for clinical and management work (i.e. pharmacists, hospital porters, laboratory technicians, manager assistants, parallel teams) (Shortell & Kaluzny, 2007).

Based on Welton (2004) and Shortell & Kaluzny (2007), a model to describe the HCDO system is illustrated in Figure 4, depicting its principal elements and processes. This model indicates that patients have their first contact with physicians either in their offices, clinics, hospitals, or emergency rooms. Physicians determine the type of health

services required, and direct, control, and evaluate the delivery of care, assuring the best possible outcomes based on patient's needs, values, and preferences. The HCDO provides the services within different integrated and coordinated clinical systems by using health care personnel (i.e. clinical workers). These clinical systems are the clinical and technology-based production systems (Shortell & Kaluzny, 2007) that can include a long chain of linked processes and services, such as admission, patient assessment, and diagnostic, therapeutic, and rehabilitative activities, either in inpatient or outpatient settings, across the clinical disciplines, and within the internal environment of the organization.

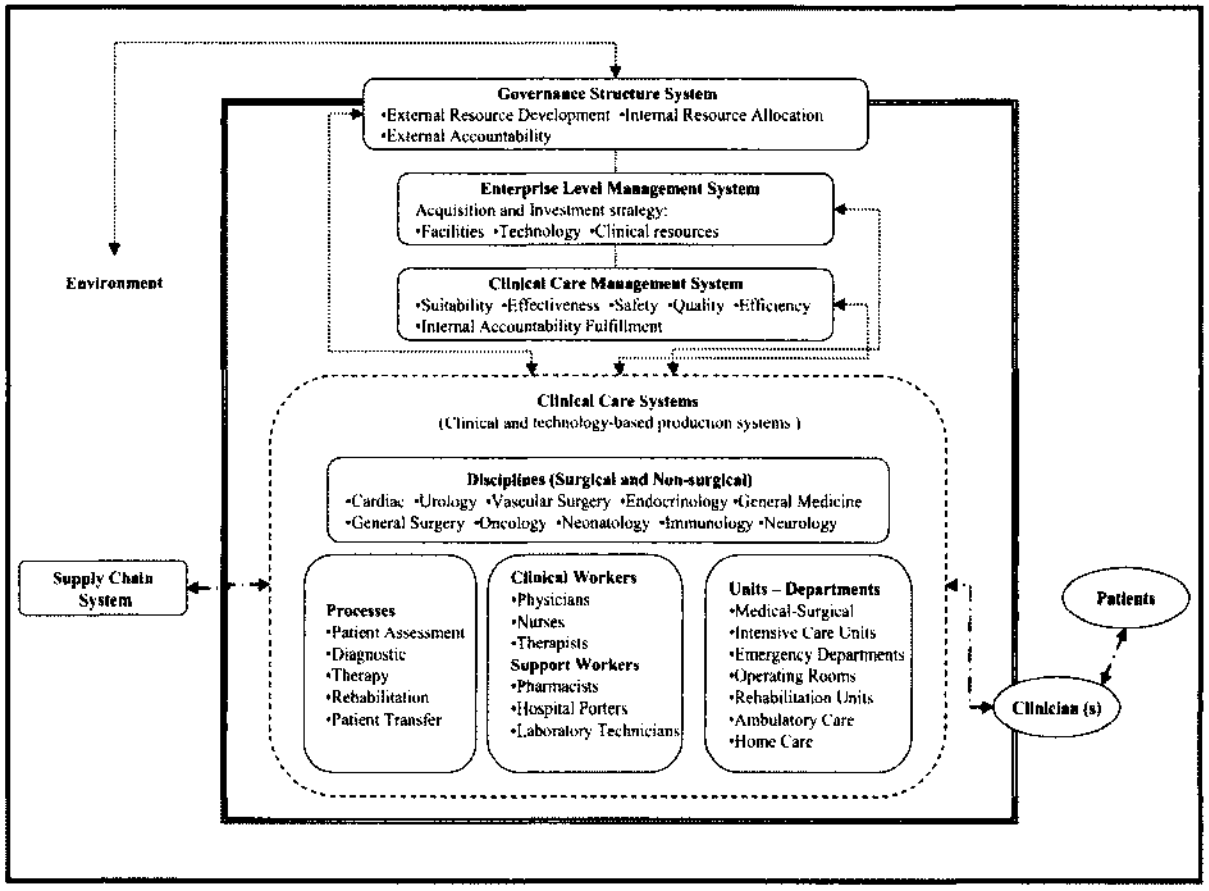


Figure 4. Health care delivery organization system model
Note. Adapted from *Health Care Management: Organization, Design and Behavior* (p.49), by S. M. Shotell and A. D. Kaluzny, 2007, Albany, N.Y.: Delmar Publishers.

The supply chain system provides services (i.e. human resources, supplies and equipment, technical systems and services and financial services, among others) that are needed for the effective achievement of the clinical work from the organization to patients. On the other hand, the clinical care management system is responsible both for assuring the suitability, effectiveness, safety, quality, and efficiency of the services delivered to patients and for the internal accountability fulfillment. The enterprise level management system provides the technology acquisition strategy, facilities investment, and clinical resources, and the governance structure system assures access to critical elements of the environment (i.e. institutional licensure, Medicare certification, among others). Each subsystem inside a HCDO relies on information and knowledge as the principal means of the clinical and management practices on an ongoing basis.

A great deal of attention has been dedicated to analyzing the nature of knowledge in HCDO (Nicolini et al., 2008). Basically, the medical domain is based on a formal body of knowledge and on operative knowledge from the daily practice, expertise, and skills with both tacit and explicit aspects (Montani & Bellazzi, 2002). In addition to the classification of types of knowledge made by Alavi and Leidner (Alavi & Leidner, 2001), Abidi (2008) specifically identified and classified different categories of healthcare knowledge depending upon the orientation and the domain of knowledge. Abidi labeled these distinctive knowledge types. Table 3 summarizes a list of knowledge categories and their descriptions, based on Abidi's distinctions.

Table 3

Type of Knowledge in Healthcare Delivery Organizations according to the Orientation and Domain of Knowledge.

Domain	Description
Patient knowledge	Detailed description of the patient's health status. It represents the relationships between the observations and perceptions given by the patient and the inferences drawn by physicians based on those observations.
Practitioner knowledge	Tacit knowledge related to the practice and expertise of the practitioner that is applied while delivering the patient care. It is acquired through active learning, internship, observations and experiences.
Medical knowledge	Formal knowledge that describes the theories about health and healthcare delivery and processes.
Resource knowledge	Assortment and quantification of the healthcare delivery resources and infrastructure within specific settings and locations that are necessary for the healthcare provider to make decisions. These resources include medical diagnostic devices, drugs, services, support staff, and surgical facilities, among others.
Process knowledge	Healthcare organization workflows that stipulate the standard way to treat a specific medical condition within a specific setting, taking into account the resources engaged in different pathways.
Organizational knowledge	Specific organizational structures and policies of a healthcare organization. They represent the different information and knowledge flows within the organization that need to be congruent with the resource and process knowledge. Organization knowledge involves, for instance, the composition of care teams, the roles of the different team members, or who is required to report to whom.
Relationship knowledge	The social capital held within an organization, a community of healthcare providers or individuals. It refers to who knows how or about a specific aspect of the healthcare processes and the communication mechanisms in order to share and transfer that knowledge or information.
Measurement knowledge	Metrics, standards and criterion to assess and measure outputs and outcomes of the delivery of healthcare.

Note: Adapted from Abidi, S. (2008). Healthcare Knowledge Management: The Art of the Possible · Lecture Notes in Computer Science, Knowledge Management for Health Care Procedures (Vol. 4924, p. 5-6)

These categorizations provide an understanding of the nature of knowledge in healthcare, the input for the decision making processes, and a direction for developing KM initiatives.

Traditionally, explicit healthcare knowledge is given more importance in the the literature, while valuable and hard-to-capture experience and tacit knowledge is undercapitalized (S. Abidi, Yu, & Curran, 2005; Friedman & Bernelt, 2006). Friedman and Bernell (2006) emphasized that in the HCDO clinical practice, tacit healthcare knowledge is critical for teams' performance, but is often unacknowledged. According to the authors, a vividly example of this is the work carried out by a cardiac surgery team which can develop, through the clinical practice for a long period of time, a particular style, and the ability of the team members to anticipate each other's decisions in the operating room, even in the most critical situations. It is recognized that, in healthcare, tacit knowledge as a source of experiential know-how emerges not only from the interaction among healthcare team members, but also from the encounters between healthcare providers and their patients (Bali & Dwivedi, 2007; Sheffield, 2008), but this tacit knowledge is difficult to formalize and transfer.

The recent exponential proliferation of medical knowledge, information, and data (Davenport & Glaser, 2002; Nicolini et al., 2008) that are necessary for the clinical decision making process has reached the healthcare sector, generating new problems for healthcare providers and impacting patients' healthcare. A real life case of a healthcare provider is noted by Davenport and Glaser (2002), who posit that it is understood that is impossible for a physician to absorb all of the knowledge available to perform his work: "He needs to know something about almost 10,000 different diseases and syndromes, 3,000 medications, 1,100 laboratory tests, and many of the 400,000

articles added each year to the biomedical literature." It is believed that "typically physicians used to reason by recalling past situations similar to the current one. The process is often biased by the tendency of recalling only more recent cases" (Montani & Bellazzi, 2002, p. 82). The result is that the effort to absorb and incorporate existing and new healthcare explicit knowledge into practice at the point of care and at the right time becomes a complex work that demands KM initiatives. The technical perspective of KMS has emerged to support the different KM processes in HCDO. The need for KM and integration becomes very clear when the nature of medical decision making based on the nature of knowledge in these organizations is taken into consideration.

Health Care Delivery Organizations as Knowledge Intensive Organizations

In the literature, although the distinction between knowledge-intensive and non-knowledge-intensive organizations may not be evident, and the concept may be a bit vague (Alvesson, 1993, 2004), an implicit consensus of the principal characteristics of the knowledge intensive organizations (KIO) or firms (KIF) is recognized. (In this investigation, the term KIO will be used for consistency.) In a KIO, most of the work done is of an intellectual nature, and the major part of the workforce is composed of well-educated, qualified employees on whom there is an important reliance (Alvesson, 1995, 2000, 2001; Robertson & Swan, 1998, 2004; Starbuck, 1992). In addition, the uncertain and complex context of these organizations is dealt with by experienced personnel who solve complex problems through applied knowledge and creative and innovative solutions (Hedberg, 1990; Sveiby & Risling, 1986). In this context, the expertise of the bearers of knowledge (i.e. knowledge workers) is related not only to the more objective aspects, but also includes rationality, wisdom and intelligence (Starbuck, 1992). Swart

and Kinnie (2003) indicated three key differentiators of a KIO: 1) highly skilled human capital; 2) the way in which human capital is applied to complex work processes that involve problem solutions; and 3) the deployment of knowledge to generate innovation, initiative, and competence building in the provision of tailored services. Alvesson (2004) offered a broad review of the characteristics that distinguish KIO in terms of the work and how it is managed and organized. In addition to the elements mentioned above, Alvesson pointed out that the offer of idiosyncratic client services and the presence of information and power asymmetry are characteristics relevant for KIO.

Analysis of past research on KIO reveals that the link to analyze the "knowledge intensiveness" distinction of an organization relies on the nature of the human capital and the work processes. Furthermore, although researchers tend to identify particular sectors or types of industries, or, to be even more specific, professional services firms (e.g. law and accountancy firms, advertising agencies, management, engineering, or computer/software consultancy firms) (Alvesson, 1993, 2001; Starbuck, 1992; Winch & Schneider, 1993) McGrath, 2005; Morris, 2001) as examples of KIO, the concept of knowledge intensiveness cannot be reduced to include merely those organizations.

Even though there is great debate in the literature regarding the ambiguity of the KIO concept and of course, the categorization of sectors, subsectors, industries, and types of organizations or activities, it is noticeable that HCDO are among the organizations that exhibit characteristics of information and knowledge intensiveness, but have just recently been recognized in the literature as KIO and have not been extensively documented. Until recently, the literature has affirmed that health care services are not considered to be knowledge intensive (Miles et al., 1995); medical procedures are chosen from standardized solutions and options without introducing

creative and complex problem solving solutions (Alvesson, 1995). However, as Alvesson (2004) recognized later, the idea of knowledge intensiveness cannot be applied to the whole organization; rather, knowledge intensive units, departments, or work groups have to be substantial in order for an organizationto be considered to be knowledge intensive. For instance, Reese and Majzun (2001) indicated that the health care industry is a knowledge-intensive service arena in which intellectual capital is the critical resource to success. Berg (2001) considered core health care processes in HCDO as highly knowledge intensive professional work in which complexity challenges the need to standardize services. Nursing processes are recognized as complex and intensive knowledge activities (Hsia, Lin, Wu, & Tsai, 2006). In the same way, Khatri (2006) recognized health care services as highly knowledge-intensive.

Based on these assertions, the distinctive elements of HCDO are analyzed, related to the human capital and to the work processes that characterize them, as knowledge intensive. Various dimensions are mentioned as follows:

- Regardless of the pressure to standardize services in HCDO, medicine is highly localized (Ramanujam & Rousseau, 2006); health services are very heterogeneous (Orava & Tuominen, 2000) and are highly dependent on the human factor and its expertise to provide high quality services (Khatri, 2006; Kottow, 2002).
- Healthcare givers have to deal with many elements from standard treatments such as the potential exceptions, interactions, and unintended consequences. Such complexities require local flexibility and adaptability in determining appropriate care, while adding to the variability that makes defining, measuring,

and evaluating successful performance difficult (Ramanujam & Rousseau, 2006; Shortell & Kaluzny, 2007).

- The work activities to solve complex and uncertain problems within health care teams require a high level of coordination, communication, and collaboration (Khatri, 2006; Paul, 2006; Shortell & Kaluzny, 2007).
- The delivery of care in HCDO is carried out by individuals, formal work groups, and teams of health care professionals, specialized in knowledge disciplines whose work can be self-managed or directed by a specialist leader. The knowledge work of health care professionals is developed based on an individual patient's diagnosis, condition, values, preferences, and in general, a set of unique characteristics that call for an adaptive response. The goal of these clinical workers is to provide care at the most appropriate point and according to the best medical knowledge (Ramanujam & Rousseau, 2006; Shortell & Kaluzny, 2007; Stefanelli, 2001).
- Health care givers are the most highly qualified professionals, and are specialized researchers whose intellectual abilities and skills are used for and applied to medical knowledge to deliver health care and to develop and use new technology and techniques (Miles et al, 1995).
- The challenge of the proliferation of medical knowledge, information, and data (Nicolini et al., 2008) makes healthcare work in HCDO a highly complex effort. The information intensiveness characteristic of these organizations (Detmer, 2003; Suomi, 2001) means that emergent information and communications technologies become part of the HCDO not only for clinical purposes to improve health care delivery (Bose, 2004), but also for the creation, use, and

development of service and product innovation that allows healthcare workers to interact not as information but as knowledge workers (Brooks & Scott, 2006).

- Health care services (e.g. surgical services) are linked to the development of scientific knowledge within a discipline or area of medical expertise, offering a high degree of customization (Orava & Tuominen, 2000) to fit patients' needs and conditions.
- Traditionally, in the delivery of health care, there has been asymmetric information and power between the health care provider and patients (Angst & Agarwal, 2006); healthcare givers have specific knowledge and skills acquired throughout their medical education and practice to make decisions about individuals' health care. Although the proliferation of different mechanisms (e.g. Health IT and shared decision making initiatives) have decreased the asymmetry of information and have allowed patients to have a participative role regarding their health, the delivery of health care has multiple constraints. These constraints (i.e. costs, risks, policies, uncertainty, and the complexity of the information) about what is best for, or detrimental to, most patients when evidence supports that perspective.
- Although hierarchical structures and lines of authorities are present in HCDO, autonomy is granted to clinical professionals, given the complexity and magnitude of the work they execute; their loyalty belongs to their profession rather than to the organization (Shortell & Kaluzny, 2007).

Building upon the different examinations of the literature as summarized above, it is clear that the operations and services that HCDO provide are, in general, highly

complex and knowledge-intensive ones carried out by clinical knowledge workers in which medical knowledge, both tacit and explicit, is both an input and an output of their work. In other words, HCDO are an example of a KIO, and as Shortell & Kaluzny (2007) recognized, HCDO are KIO because they are immersed in a labor-intensive industry with characteristics that make it distinctive from other organizations. The contribution of the acknowledgment of such a label implies the recognition of both the principal challenges of HCDO as KIO and the strategies to overcome them.

Knowledge Management Information Systems in Health Care Delivery Organizations

Past Research on Knowledge Management Systems

Research on how knowledge gets managed in organizations through knowledge management projects and initiatives (Alavi & Leidner, 2001; Davenport et al., 1998; Earl, 2001; Liao, 2003b; P. Tyndale, 2002) offers insights into the study of KMIS in HCDO. In an effort to support undertaking the KM as a source of competitive strategy, organizations develop and/or implement KM initiatives or projects that combine organizational and managerial, and in most of the cases, technological initiatives (Marwick, 2001). Knowledge Management Systems (KMS) are an example of such initiatives that enable knowledge generation, organization, transfer and application processes, and organizational learning. Meso and Smith defined the term "Organizational Knowledge Management Systems" (OKMS) and provided a general definition of these systems based on a knowledge work perspective: "an OKMS is a system that provides for the creation of new knowledge, the assembly of externally created knowledge, the use of existing knowledge, and the finding of knowledge from

internal and external sources" (2000, p. 226). Moreover, Quin et al. (1996) define intellectual capital as an organization's specific knowledge and skills, information, intellectual property, and experience, and note that "an OKMS can be seen as that which organizes a firm's know-what, know-how, and know-why into explicit knowledge resident in the firm's databases and operating technologies" (Meso & Smith, 2000, p. 227). In particular, these researchers argued that organizations have different perceptions of OKMS: the technical perception and the socio-technical perception. The technical perception defines an OKMS as being technology-centered. The socio-technical perception defines an OKMS as being more people-centered than technology-centered (Meso & Smith, 2000).

In the technical perspective, KMS are understood as a set of information systems (IS) that are developed and applied to support and enhance the organizational knowledge processes, and consequently, to manage the organizational knowledge (Alavi & Leidner, 2001). They are seen as IT-based initiatives (Alavi & Leidner, 2001); KM technologies and applications (Liao, 2003b); as KM tools (Ruggles, 1996; Tyndale, 2002); or as a conglomeration of various information and communication technologies (ICT) (Feliciano, 2006) that support the performance of knowledge processes through organizational strategies, practices, and projects. Although KMS are more than IS, they are not expected to produce immediate benefits. Unlike IS, KMS are not used only for operational functions; they are intended to support knowledge processes within the organizations.

On the other hand, based on the socio-technical perspective, KMS are seen as more than technology. KMS are "complex combinations of technology infrastructure, organizational infrastructure, corporate culture, knowledge, and people" (Meso & Smith,

2000, p. 229). Becerra-Fernandez and Sabherwal (2006) provided a working definition of KMS applications based on the integration of the most recent technologies and social or structural mechanisms. They called KMS to serve as the synergy between these two aspects (i.e., social mechanisms and technologies).

Although it is unquestionable that the socio-technical perspective provides a comprehensive and systemic set of elements to study the impact of KMS in HCDO, greater importance is placed on illustration and analysis of ICT systems as a result of their capabilities and their potential impact on organizations (Nicolini et al., 2008; P. Tyndale, 2002). This investigation will focus on the technical perspective, and it will refer to the term Knowledge Management Information Systems (KMIS) to provide consistency throughout the manuscript.

KMIS Classification and their Applications in HCDO

Attempts to classify and study KM tools, technologies, initiatives, and projects in organizations have been made throughout the literature (Jackson 1999; Wensley & Verwijk-O'Sullivan, 2000; Alavi & Leidner, 2001; Tyndale, 2002; Liao, 2003). Table 6 summarizes the different classifications made by these authors.

Jackson (1999) investigated different KM tools and presented a classification based on software systems. His classification encompasses small and large component technologies. Wensley & Verwijk-O'Sullivan (2000) made an extensive description of IT-based KMS. They focused principally on web-based knowledge management tools. Alavi & Leidner (2001) offered the most widely cited definition of KMIS and classified information technologies based on the processes they support: knowledge creation, storage and retrieval, transfer, and application. Tyndale (2002) reviewed the different

KM models proposed by different authors and categorized the technology types that are most frequently utilized within KM. He also offered a distinction analysis between new or old KM tools. Liao (2003) classified KM technologies based on seven categories with their applications on different domains. Specifically, he differentiated knowledge-based systems from other technologies. Finally, Becerra-Fernandez and Sabherwal (2006) provided four types of KM systems based on the KM processes they serve (i.e. knowledge-discovery systems, knowledge-capture systems, knowledge-sharing systems, and knowledge-application systems) taking into consideration the latest technologies used as organizational or structural means to promote KM.

As summarized in Table 4, the classifications by these researchers comply with the different perspectives and paradigms related to the use of different technologies and their applications, the knowledge processes they support, the objectives for which they were implemented, or the complexity of the tools. This affirmation was supported by Maier and Thomas when they stated that "many authors provide more or less extensive lists of individual tools or technologies that can be used to support KM initiatives as a whole or for certain processes life-cycle phases, or tasks thereof" (2006, p. 442). Moreover, as Wensley & Verwijk-O'Sullivan (2000) pointed out, these systems can only be understood in the context in which they are used and by the methodologies that are associated with them. The functionality of these systems depends in great part on the context in which they are applied and used. In general, not all of the initiatives described in the literature are computer-based, but as it was stated earlier, greater interest is placed on these technologies as enablers for KM initiatives.

Although different ways of classifying the KMIS have been found, a common tendency is to categorize these systems according to their functions or to the knowledge

processes they support (e.g., a KMIS that focuses only on collecting and disseminating near misses). Still, there is not always one relationship between the KMIS and a proposed framework for classification. A KMIS can be classified in more than one category depending on its functionalities or on the perspective of the analysis. This task is even more complex when the tendency is to incorporate extra features from other categories for the development of new systems in order to make them more competitive, and to fit them into the organizations' needs.

Table 4

Classifications of Technologies / Tools /Systems for Knowledge Management

Jackson (1999)	Wensley & Verwijk-O'Sullivan (2000)	Alavi & Leidner (2001)	Tyndale (2002)	Shu-hsien Liao (2003)	Becerra-Fernandez, I., & Sabherwal, R. (2006)
Document Management Systems	Traditional Data based tools	Knowledge Creation	Intranet	Knowledge based systems	Knowledge Discovery Systems
Information Management Systems	Process Modeling and Management Tools	• Data mining	Web Portals	Data mining	• Combination
Searching and Indexing Systems	Workflow Management Tools	• Learning tools	Content Management	Information and Communication Technologies	Databases, web-based access to data, data mining, repositories of information, Web portals, best practices and lessons learned databases
Communication and Collaboration Systems	Enterprise Resource Management Tools	Knowledge Storage and Retrieval	Document Management System	Artificial Intelligence/Expert Systems	• Socialization
Expert Systems	Agent tools	• Electronic Bulletin boards	Information retrieval engines	Data base technology	Video-conferencing, electronic discussion groups, e-mail
Enterprise Systems	Search Engines, Navigation Tools, and Portals	• Knowledge repositories	Relational and object Databases	Modeling	Knowledge Capture Systems
Intellectual Asset Systems	Visualizing Tools	• Databases	Electronic publishing systems		• Externalization
	Collaborative Tools	Knowledge Transfer	Groupware and workflow systems		Expert systems, chat groups, best practices, and

Continued

Jackson (1999)	Wensley & Verwijk-O'Sullivan (2000)	Alavi & Leidner (2001)	Tyndale (2002)	Shu-hsien Liao (2003)	Becerra-Fernandez, I., & Sabherwal, R. (2006)
					lessons learned databases.
	Virtual Reality	• Electronic bulletin boards	Push technologies		• Internalization
		• Discussion forums	Agents		Computer-based communication, AI-based knowledge acquisition, computer-based simulations
		• Knowledge directories	Help-desk applications		Knowledge Sharing Systems
		Knowledge Application	Customer relationship management		• Socialization
		• Expert Systems	Data warehousing		Video-conferencing, electronic discussion groups, e-mail
		• Workflow systems	Data mining		• Exchange
					Team collaboration tools, web based access to data, databases, and repositories of information, best practices databases, lessons learned systems, and expertise locator systems
			Business process re-engineering		
			Knowledge creation applications		Knowledge Application Systems

Continued

Jackson (1999)	Wensley & Verwijk-O'Sullivan (2000)	Alavi & Leidner (2001)	Tyndale (2002)	Shu-hsien Liao (2003)	Becerra-Fernandez, I., & Sabherwal, R. (2006)
					• Direction Capture and transfer of experts' knowledge, troubleshooting systems, and case-based reasoning systems; decision support systems • Routines Expert systems, enterprise resource planning systems, management information systems

Classifying the KMIS based on the knowledge processes being primarily supported (Alavi & Leidner, 2001; Becerra-Fernandez & Sabherwal, 2006) provides a theoretical foundation to develop a framework that can assist in the study of the impact of KMIS in HCDO. In health care, under the technical perspective, KMIS refer to the term "Health IT" which comprises "the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making" (Thompson & Brailer, 2004, p. 38). In pursuit of the study of KMIS in HCDO, a classification framework is proposed. This framework consists of identifying KMIS used in HCDO, taking into account the KM technologies described through the literature. A special interest is focused on the most frequently used KMIS within healthcare settings presenting the interaction of the applicable knowledge processes that they support, the type of knowledge that they use, and their impact on organizational performance outcomes. An overview of the abbreviated literature of KMIS in HCDO is provided in Table 5. This review is intended to describe the findings from representative literature and to help to understand the impact of these systems in healthcare settings.

Table 5

Abbreviated Literature Review of Knowledge Management Systems in Health Care Delivery Organizations

Knowledge Management Information Systems	Definition	Principal KM processes	Type of Knowledge	Potential Benefits in HC and Key Findings	Illustrative Literature of KMIS in HCDO
Document Management Systems	IT applications that store documents in a central library and enable activities of access, organization, auditing and retrieval of highly structured documents (Celentano, Pozzi, & Toppeta, 1992; Paganelli & Pettenati, 2006).	Organization -Storage/ Capture	Explicit	• Provision of a paperless environment • Improvement in the operational efficiency of the organization • Quality Assurance • Cost reduction associated with paper records	(De La Torre, 2002; Kohn, 2002; Mahoney, 2002).
Workflow Management Systems	A system that defines, creates and manages the execution of workflows through the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of IT tools and applications (Workflow	Capture, Organization -Storage/ Application	Explicit	• Improvement in the operational efficiency of the organization • Better decision making • Help in dealing with uncertainty of healthcare complex environments • An increase in flexibility in healthcare activities	(Dazzi, Fassino, Saracco, Quaglini, & Stefanelli, 1997; Quaglini et al., 2000; Vautier et al., 2003)

Continued

Knowledge Management Information Systems	Definition	Principal KM processes	Type of Knowledge	Potential Benefits in HC and Key Findings	Illustrative Literature of KMIS in HCDO
	Management Coalition, 1996, p. 9).				
Groupware systems	Category of software that supports group and team collaboration. Some applications are: electronic discussion groups, group support systems, desktop conferencing software, shared screen systems, video conferencing, email (Coleman, 1999; Maier, 2004).	Transfer/ Application	Explicit & Tacit	• Provision to healthcare teams: innovative forms of collaborative work in the delivery of patient care at both the clinical and managerial levels • Promotion of the efficiency and quality of the interventions made by teams • Improvement in the accuracy of group outcome (e.g. collective judgment) • Reduction of information overload	(Conner & Finnemore, 2003; Househ & Lau, 2005; Rao & Turoff, 2000; Weng, McDonald, Sparks, McCoy, & Gennari, 2007)

Continued

Knowledge Management Information Systems	Definition	Principal KM processes	Type of Knowledge	Potential Benefits in HC and Key Findings	Illustrative Literature of KMIS in HCDO
Telehealth	Use of communication technology to support the delivery of health care and health-related services (e.g. training) over large and small distances (Office of Health and the Information Highway, 2000).	Application/ Transfer	Explicit & Tacit	• Allowing physicians to train in their local hospitals • Expansion of health care service access in remote and underserved areas • Anticipation of problems and generation of solutions • Cost reduction of health care services and clinical system training • Allowing a safe and effective development of surgical skills (safer training)	(Gambadauro & Magos, 2008; Vautier et al., 2003; Whitten, 2006)
Search Engines	Programs that use intelligent algorithms to find and retrieve documents, information, images or web sites through an organization's intranet or in the internet (Maier, 2004). As a difference from Document Management Systems, these engines do not organize or audit an organization's material.	Capture/ Transfer	Explicit	• Better informed patients, clinicians, managers, teachers and trainers. • Improvements in patient health and healthcare delivery • An increase in patient choices and awareness regarding therapies, treatments, and costs. • Better informed decision making process. • Promotion of maintaining the level of clinical skills • Improved access to recent advances in medical diagnosis and therapy	(Bin & C Lun, 2001; Gray & de Lusignan, 1999; Ilic, Risbridger, & Green, 2004)

Continued

Knowledge Management Information Systems	Definition	Principal KM processes	Type of Knowledge	Potential Benefits in HC and Key Findings	Illustrative Literature of KMIS in HCDO
Web Portals	A portal is a virtual single entry point used to collect content from many different sources for enabling members of an organization / a community to share and exchange information via a Web-based interface. A portal can be internal or external to the organization (Steven, Stephen, Anne, & Lesley, 2006).	Capture/ Transfer	Explicit	• Facilitation of access and dissemination of high quality and relevant information to the whole organization and patients • Support to overcome suddenly emerging healthcare crises • Improvement in the operational efficiency of the organization	(Chou & Chou, 2002; Von Lubitz & Wickramasinghe, 2006)
Knowledge Base Systems - Expert Systems	Systems that use or manipulate complex data or knowledge structures applying AI techniques to automate the human intelligent behavior for problem solving processes (LLX Li, 2000; Wallace, Ippolito, & Cuthill, 1998).	Application/ Transfer/ Storage/ Assimilation	Explicit & Tacit	• Reduction in medical errors • Improvement in health care service coverage and efficiency in clinical processes • Cost-effective management procedures • Improvement of healthcare quality and in general, practitioners' performance	(Chi, Street, & Ward, 2008; LLX Li, 2000; Liao, 2003a; Payne, 2000; Uzoka & Famuyiwa, 2004; Wang, Nayda, & Dettinger, 2007)

Continued

Knowledge Management Information Systems	Definition	Principal KM processes	Type of Knowledge	Potential Benefits in HC and Key Findings	Illustrative Literature of KMIS in HCDO
Knowledge Repository	Computerized systems that store information, expertise, experiences, lessons learned, best practices and documents from a specific domain of knowledge. They serve as the knowledge sources to support decision making processes (Rastogi, 2000).	Capture/ Organization -Storage/ Transfer/ Application	Explicit	• Better informed decision making process • Improvement in healthcare quality and patient safety • Facilitation of the reuse of knowledge • Use of clinical knowledge about the patient at the appropriate point of his care	(Isern & Moreno, 2008; Wright et al., 2009)
Data mining Systems	Data mining (DM) is an interdisciplinary field used to extract knowledge from large amounts of data stored in databases, data warehouses or other type of information-data repositories, through the use of intelligent methods (Han & Kamber, 2006).	Creation	Explicit &Tacit	• Prediction of events in uncertain health care settings • Detection, prevention and control of adverse problems • Improvement in understanding of clinical processes and the complex dynamics of diseases transmission • Support for cost-effective decision making • Increased efficiencies and effectiveness • Cost reduction	(Desouza, 2000; Harper, 2005; Kraft, Desouza, & Androwich, 2003; Lee, 2005; Peterson & Brossette, 2002; Wilson, Thabane, & Holbrook, 2004)

Continued

Knowledge Management Information Systems	Definition	Principal KM processes	Type of Knowledge	Potential Benefits in HC and Key Findings	Illustrative Literature of KMIS in HCDO
E-learning support systems	Use of a virtual environment mediated through Internet and Intranet platforms to support teaching activities and distance learning. The learners interact with electronic material, laboratories, software, and computer devices (Shyamala, 2006, p. 160).	Transfer Assimilation	Explicit Tacit	• Support workforce development across professional, organizational,temporal, and geographic boundaries • Increased motivation to continue learning • Improvement in time management, work/life balance, and motivation of clinical care providers • Self-directed learning in a non-threatening environment for patients and clinicians • Increase the performance of medical students • Increase of knowledge of diseases, medications, and adherence to protocols and desired behaviors	(Allan & Lewis, 2006; Brock & Smith, 2007; Chang, Hsiao Sheen, Chang, & Lee, 2008; Smolle, Prause, & Smolle-Jüttner, 2007; Vautier et al., 2003)

Continued

Knowledge Management Information Systems	Definition	Principal KM processes	Type of Knowledge	Potential Benefits in HC and Key Findings	Illustrative Literature of KMIS in HCDO
Electronic Health Records Systems	Integrated information systems and technologies that: collect electronic health information for and about persons, allow immediate electronic access to health information, and support provision of knowledge and decision-support efficient processes for health care delivery (Institute of Medicine, 2003). These ICT can include: databases, communication and collaboration technologies, document management systems, and knowledge based systems.	Capture/ Organization -Storage/ Transfer/ Application	Explicit Tacit	• Enhancement of the quality, safety, and efficiency of patient care • Support for cost-effective decision making and coordination of health care among different settings • Provision of a paperless environment • Improvements in the operational efficiency of the organization • Promotion of a patient safe environment • Reduction in prescription errors, test duplications, and costs • Enhance an effective communication environment.	(Barlow, Johnson, & Steck, 2004; Bates et al., 2003; Bates & Gawande, 2003; Buntin et al., 2011; Chaudhry et al., 2006; Garrido et al., 2005; Grieger et al., 2007; Institute of Medicine, 1997, 2001, 2003)

The studies listed are representative rather than exhaustive. Some recent studies have been chosen.

Table 5 highlights eleven distinct but complementary systems/technologies that provide abundant utilities to support KM processes in healthcare settings. It is important to emphasize that these systems are found throughout the literature as commonly used, and that the findings are representative, rather than exhaustive.

Most of the described Health IT relies on data, information, and knowledge repositories (i.e. databases and data warehouses) to pull all of these resources together in order to support the delivery of health care and health self-management. In addition, these systems utilize a variety of platforms (i.e. computers, personal digital assistants, touch-screen kiosks, cell phones) that enable the accessibility of these systems at the point of care, and generally work under architectures such as Internet and Intranets. It is recognized that one of the most important technological changes in healthcare has been the explosive growth of the internet and communication devices (A. N. Dwivedi, Bali, Naguib, & Nassar, 2005; Wickramasinghe, Geisler, & Schaffer, 2006) along with health information systems. Bali and Dwivedi (2007) affirmed that all of these applications have brought about significant changes in the way work is carried out, creating new opportunities, supporting vital business operations, and allowing consistency, efficiency, and efficacy. However, these technologies cannot stand alone and these systems need to be implemented with KM strategies both to maximize their potential and to add value to current and future services (Feliciano, 2007; Wickramasinghe et al., 2006).

Analysis of the literature summarized in Table 5 indicated the following findings:

- Despite the fact that most of the literature is largely anecdotal, consisting of single projects, individual case studies, and few empirical investigations, potential benefits of the impact of Health IT on HCDO are recognized. These include: improvement in

the quality of health care interventions; in operational efficiency, patient safety, and cost-effective decision making; in the ability for expansion of access of care, in safer environments, better informed patients, and health personnel; in detection, prevention, and the ability to control adverse events; in support of learning environments; and in a lessening of medical errors and information overload; and in cost reduction.

- The common type of knowledge being managed by the Health IT and technologies is explicit.
- Principally, Health IT tends to support processes of knowledge, capture, storage, transfer. and application.
- Specific knowledge processes can be associated with the different technologies; however, depending upon the context in which they are used and applied, they may have many purposes and may support different activities.
- Hybrid systems such as Electronic Health Records Systems that have Knowledge Based Systems functionalities are developed given the advances in information and communication technologies and exhibit the characteristics of comprehensive KMIS. These systems are of top interest to multiple stakeholders in the national healthcare system.
- Building upon the findings stated above and the scope of this investigation, a special interest is placed on EHR systems for further study. These KMIS are described in detail as follows.

Electronic Health Record Systems and the Process of Adoption in HCDO

In much of the mainstream Health IT literature, authors provide different, ambiguous, or sometimes incomplete definitions of Electronic Health Records (EHR) systems. This is because of the interchangeable use of the terms Electronic Medical Records (EMR), EHR, and Personal Health Records (PHR).

The National Alliance for Health Information Technology (NAHIT) presented a conceptual foundation to understand the characteristics of EHR systems and defined associated "building blocks." These are "an electronic medical record (EMR) and/or electronic health record (EHR) for health care professionals, personal health record (PHR) for individuals, and health information exchange (HIE) to tie the infrastructure together" (NAHIT, 2008, p. 4). Different distinctions, summarized in Table 6, have been offered nationally to provide consistency to HCDO stakeholders.

Table 6
Health Record Terms

Electronic Medical Record	Electronic Health Record	Personal Health Record
An electronic record of health-related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within one health care organization.	An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be created, managed, and consulted by authorized clinicians and staff across more than one health care organization.	An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be drawn from multiple sources while being managed, shared, and controlled by the individual.

Note: From NAHIT (2008). Defining key health information technology terms: NationalAlliance for Health Information Technology. p. 6

The IOM (2003) presented, in a letter report for the Agency for Healthcare Research and Quality (AHRQ), a detailed description of the core functionalities of EHR systems. The letter report stated that an EHR system includes four key aspects:

(1) A longitudinal collection of electronic health information for and about persons, where health information is defined as information pertaining to the health of an individual or health care provided to an individual; (2) immediate electronic access to person- and population-level information by authorized, and only authorized, users; (3) provision of knowledge and decision-support that enhance the quality, safety, and efficiency of patient care; and (4) support of efficient processes for health care delivery (p. 1).

In addition, the IOM also provided a detailed guidance on the functionalities that an EHR system should possess for HCDO. Table 7 summarizes the core EHR system functionalities and the knowledge processes that they can support. These aspects of the EHR systems when integrated should promote the achievement of the desired aims for HCDO.

Table 7

Health Record System Functionalities

Functionality	General description	Knowledge Processes
Health Information and Data Management	A repository of key data and information about patients to support clinical decision making. Examples: procedures, medication list, diagnosis, allergies, diagnosis results, minimum dataset (MDS) for nursing homes, clinical and patient narratives, identifiers (people and roles, addresses, products), among other aspects.	K. Organization K. Storage K. Capture
Results Management	Management of new and past tests results at the point of care (i.e. access, consult, report and notification) in different forms (e.g. pictures, sounds, images, text) to a cost-efficient decision making and coordination of health care among different settings. Examples: results reporting from laboratory, microbiology, pathology, or cardiology.	K. Identification K. Transfer
Order Entry Management	Management of medication orders, tests, and other services in a computer-based system (i.e. enter and store processes) to improve legibility and coordination and reduce prescription errors, test duplications and costs. Examples: electronic prescribing, laboratory, microbiology, radiology, nursing, supplies, among other orders.	K. Storage
Decision Support	Support for decision making through CDSS linked to the EMR. Access to knowledge sources, computer reminders and prompts, drug checking, allergy checking, drug interaction, diagnosis and chronic disease management, detection of adverse events and near misses, among other clinical decision support features.	K. Identification K. Capture K. Application K. Transfer K. Assimilation
Electronic Communication and Connectivity	Effective communication services among clinical workers and support workers, and with patients. Examples: use of e-mail and secure web messaging within and cross settings and across organizational boundaries.	K. Transfer K. Capture K. Application

Continued

Functionality	General description	Knowledge Processes
Patient Support	Patient and family education, access to and reporting of information through PHR, home monitoring, and self-testing.	K. Capture K. Transfer K. Assimilation
Administrative Processes	Electronic scheduling management for health care procedures and other services in a timely manner. Billing and claim management support and insurance eligibility determination.	N/A
Reporting and Population Health Management	Report of requirements at the federal, state, and local levels for patient safety and quality, as well as for public health. Report of internal quality indicators.	K. Identification K. Creation K. Capture K. Transfer

Note: Adapted from Institute of Medicine (2003) Key capabilities of an electronic health record system. Committee on Data Standards for Patient Safety. Washington, DC. (p.7-19)

Even though EHR systems are not widely recognized in the literature as KMIS, but as data and information management systems, the broad functionalities specified by the IOM provide the evidence to conclude that these capabilities support KM processes in healthcare settings. Nicolini, Powell, Conville and Martinez-Solano's work justifies this claim by affirming that despite the fact that EHR systems are seldom recognized in the literature as KM tools, "there is an emerging consensus that an efficient management of knowledge in the healthcare sector requires the integration of this class of tools with more proper KM technologies, such as scientific repositories, e-libraries and clinical decision support systems" (2008, p. 251).

A recent study that assesses the state of the of HIT adoption in seven nations in ambulatory and hospital settings (A. K. Jha, Doolan, Grandt, Scott, & Bates, 2008) revealed that, in most countries, high levels of EHR system adoption have been

achieved. In particular, this study also revealed that the US process of adoption in ambulatory settings lagged behind other industrialized countries; it is likely to be between 24% to 28%. Regarding inpatient settings, although authors did not find reliable data on EHR use, the study concluded that this process is in its infancy for the set of industrialized countries studied. Just recently, national data on adoption of EHR systems in inpatient settings has become available (C. DesRoches et al., 2010; A. Jha et al., 2010; Abby Swanson Kazley & Ozcan, 2009). After all, in the literature of hospital settings, there is no consensus of the essential elements that constitute an EHR (A. Jha et al., 2009) and no standard measure of EHR capability (S. S. Jones et al., 2010).

In order to study the process of adoption of EHR in hospitals, Jha and his colleagues, with the support of federally sponsored expert consensus panel, developed a national standard of what constitutes a comprehensive and a basic EHR system. The American Hospital Association (AHA), with the support of the Office of the National Coordinator for Health Information Technology (ONC), administers and collects data related to the adoption of EHR systems since 2008. An EHR is classified as comprehensive or basic by considering its standardized functions:

- Comprehensive EHR: full implementation of twenty-four clinical functions across all major clinical units in the hospital.
- Basic EHR: full implementation of a set of ten clinical functions deployed in at least one hospital unit.

Full implementation is defined as the complete replacement of the paper record for the function. These functions are identified in Table 8.

Table 8

Comprehensive and Basic Electronic Health Records

Functionalities	Comprehensive EHR system	Basic EHR system
Electronic Clinical Documentation		
Patient demographics	x	x
Physician notes	x	x
Nursing assessments	x	x
Problem lists	x	x
Discharge summaries	x	x
Advanced directives	x	
Results Viewing	x	
Lab reports	x	x
Radiology reports	x	x
Radiology images	x	
Diagnostic test results	x	x
Diagnostic test images	x	
Consultant reports	x	
Computerized Provider Order Entry	x	
Laboratory tests	x	
Radiology tests	x	
Medications	x	x
Consultation requests	x	
Nursing orders	x	
Decision Support	x	
Clinical guidelines	x	
Clinical reminders	x	
Drug allergy alerts	x	
Drug-drug interactions alerts	x	
Drug-lab interactions alerts	x	
Drug dosing support	x	

From Technical Appendix, DesRoches CM et al. Electronic health records' limited successes suggest more targeted uses. Health Aff (Millwood). 2010;29(4):639-46.

Based on this definition of EHR systems, Jha and his colleagues presented (2010) a study challenging results in the face of the call from the US Government to provide most Americans access to EHR by 2014. From the 69% of acute hospitals surveyed in 2009, fewer than 2.7% had completely implemented EHR. Only 11.9% of the surveyed hospitals had implemented either basic or comprehensive EHR systems, and 2.1% met the Stage 1 meaningful use criteria established by the government. Blavin, Buntin, and Friedman (2010) later followed that work with a focused evaluation of the national standard measures and developed continuous scales of EHR adoption as an attempt to accurately reflect the full continuum of this process in hospitals. Overall, the results indicate that in 2009 "9.8% of all hospitals have fully implemented 20 or more of the functions included in the definition of a comprehensive EHR system. In addition, 11.4% of hospitals met all and 48.3% met half or more of the core meaningful-use criteria that are available on the AHA IT supplement survey" (Appendix A). Recent results from DesRoches and colleagues' (2013) longitudinal study indicate that the adoption is growing, but that fewer than 50 percent of acute care hospitals had a basic EHR in 2012. 42.2 percent met the Stage 1 meaningful-use standards and just 5.1 percent met the Stage 2 standards.

Although this study shows a better picture of the process, the studies confirm that the adoption process requires effort, principally in inpatient settings (rural and nonteaching). This slow adoption is attributable to the different contextual aspects of HCDO (i.e. human, systemic, methodological, technical and environmental elements) that interact and are influential in constraining the success of Health IT adoptions.

Electronic Health Record Systems and the Impact on Quality

Given the interest of this research on empirical studies and the overview of the EHR systems and their quality improvement potential for HCDO, a review of the results in ambulatory and inpatient settings is presented in this section. These studies are considered to represent the state of the art of empirical assessments of the impact of EHR on quality of health care.

Although defining the concept of quality of care is complex and remains a challenge in the literature (Barton, 2007), leaders and different organizations in the fields of social science and medicine have contributed to the body of knowledge with definitions and approaches to measure it. "Quality of care" is a broad term and encompasses different elements and perspectives from which it can be assessed (i.e. health care processes, medical conditions, outcomes of care, patients' perceptions, and health care providers' perceptions, among others).

This investigation subscribes to the report provided by the Institute of Medicine (IOM): "Quality of care is the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" (Lohr, 1990). Unquestionably, quality of care is a distinctive characteristic or property of the health care service. Chassin and Galvin and the National Roundtable on Health Care Quality (1998) analyzed this widely accepted definition and the issues related to its measurement and assessment. They stated the following:

- The term "health service" denotes a wide variety of services (i.e. those for physical and mental illnesses, and those to prevent and/or promote health and well-being, including acute, long-term, rehabilitative, and palliative care).

- The definition applies to all kinds of health care professionals and settings.
- Individuals and populations refer to the fact that the assessment of quality is a concern at a specific episode of care and across the entire system.
- The desired health outcomes refer to the outcomes that the patient expects from the service, with an emphasis on patient and family satisfaction with respect to the health care services.
- The increase in the likelihood of desired health outcomes implies that a high quality service does not always provide positive outcomes and vice versa. Therefore, it is important to assess processes and outcomes of care.
- Current professional knowledge implies that knowledge in health care is in constant evolution and that any quality assessment must go hand in hand with these improvements.

One important conclusion of this work is that the processes or outcomes of care are considered valid measures of quality of care. The outcome of care must be related to a process of care that can be modified to affect the outcome, and the process of care must be related to an outcome of interest.

The qualitative and economic benefits of quality among EHR systems and their functionalities within HCDO are well documented. There is a common agreement in the body of literature citing Health IT, EMR, and EHR systems and their capabilities that notes that these systems are key tools for providing a reliable, high quality, efficient, timely, and cost-effective healthcare in different settings (Bates et al., 2003; Bates & Gawande, 2003; Buntin et al., 2011; Chaudhry et al., 2006; Institute of Medicine, 1997, 2001, 2003). Ultimately, as it was stated earlier in this work, the functionalities of EHR

systems support KM processes in healthcare settings with final goal of improving performance.

Favorable evidence results from systematic examinations of the literature regarding the benefits of using Health IT in different health care settings. It showed that EHR systems impact positively on the processes of healthcare delivery, identification, and reduction of adverse drug events; increase clinicians' adherence to guidelines; and strengthen quality assessment, utilization of healthcare services, and financial outcomes, among others (Buntin et al., 2011; Chaudhry et al., 2006; Jamal et al., 2009).

A retrospective, serial, and cross-sectional study in an ambulatory healthcare setting found that the implementation of EHR reduced the use of ambulatory care while the quality of the health care service was maintained (Garrido et al., 2005). Menachemi and colleagues (2008) explored the relationship between Health IT and quality of care measures in acute care hospitals in Florida. Their work differentiated among clinical, administrative, and strategic Health IT capabilities and found that hospitals that adopted more functionalities were more likely to have better quality outcomes. In addition, their report showed that the adoption of EHR systems can reduce information duplication and medical errors, and can provide faster access to patient information.

Amarasingham and colleagues (2009b) conducted a cross-sectional study of hospitals in Texas and evaluated the impact of level automation of the hospital information with a set of hospital quality and efficiency outcomes (i.e. inpatient mortality rates, complications, costs, and length of stay for patients older than 50 years). The level of automation of the hospital was calculated through a tool called the Clinical Information Technology Assessment, which estimates the physician interactions with the information system. This work indicated that hospitals with automated notes and records, order

entry, and clinical decision support functionalities had fewer complications, lower mortality rates, and lower costs.

In aspects such as patient safety, Parente and McCullough (2009) studied the impact of different Health IT on three patient infection rates provided my HIMSS and by the Agency for Health Care Research and Quality (AHRQ) respectively. Their assessment was based on a difference in difference approach and found that from the evaluated technologies, the EHR systems with clinical decision support capabilities had a clear and statistically significant effect on patient safety in hospitals. These authors pointed out that although the results were promising, the evidence was small, considering the effect on the infection rates.

A recent study by Kazley, Diana, Ford, and Menachemi (2011) examined the relationship between hospital EHR use and patients' perceptions of quality of care measures by the AHA and Hospital Compare data, respectively. From the 10 measures related to quality, only three were hypothesized to be correlated with the use of EHR systems in hospitals. These measures are related to hospital rating, willingness to recommend the hospital, and discharge information. Kazley and colleagues observed that the use of EHR is positively and significantly associated with these aspects of patients' perceptions. The remaining seven measures were not conceptually associated with EHR use and were used as refutation tests. The limitations noted in this work included the need of further analysis of the impact of different features of EHR on patients' perceptions of care measures. In addition, the authors recognized that the potential for unobserved variables that were not hypothesized in the study may have influenced the relationship of the variables.

Conversely, a retrospective and cross-sectional analysis of national visits in the 2003 and 2004 in ambulatory settings assessed the relationship between the use of EHR systems and the quality of processes of care in ambulatory settings (J. Linder et al., 2007). The results showed that EHR systems were not associated with improvements in the quality of process measures in ambulatory care.

A recent work by DesRoches and colleagues (2010) assessed the impact of EHR adoption on the quality of processes and outcomes of care and efficiency. Using a large set of quality and efficiency metrics and comprehensive and basic levels of adoption of EHR from national hospital data, they found that the relationship between the adoption of EHR and quality was not notable and lacked statistical and clinical significance. DesRoches et al. used the definition of EHR systems proposed by Jha and colleagues and the AHA database for their analyses. However, the relationship between the presence of a computerized physician order entry for medications and some functionalities of the clinical support system influenced small gains in quality.

Jones, Adams, Schneider, Ringel, and McGlynn (2010) followed up the results of these studies to further study the impact of EHR on quality over time. They evaluated longitudinal data with a different approach in order to measure EHR adoption by using secondary survey data from the Health Information and Management Systems Society (HIMSS). This approach was less restrictive, in order to allow the study of typical adopters, and included four typical functionalities of an EHR (i.e. clinical data repository, electronic patient record, clinical decision support systems, and computerized provider order entry). This work revealed that during the study period, certain healthcare conditions (i.e. AMI, heart failure, and pneumonia) improved. Particularly, improvements

in heart failure quality scores were found among hospitals that maintained a basic EHR in comparison with those that had not adopted EHR. Similar improvements were not found on the other set of quality scores among basic or advanced adopters. On the contrary, this work indicated that new adopters and those adopters who upgraded their systems experienced smaller gains in quality scores.

Comparing financial and efficiency aspects of care, the results of these studies are similar. Positive results were also found in studies focused on the financial aspects. For example, a pilot project using an EHR system to evaluate the return on investment revealed a positive results when this system was implemented in ambulatory settings (Grieger et al., 2007). Similar results were found in Barlow and colleagues' work where benefits in terms of increased revenues and savings in an ambulatory setting could be found (Barlow et al., 2004).

Likewise, a recent study examined the relationship between EMR system use and efficiency based on a national sample of acute care hospitals (Kazley & Ozcan, 2009). Results revealed that small hospitals may have improvements in efficiency while medium and large hospitals generally do not. In addition, there was not a significant improvement in efficiency over time between hospitals with EMR systems and hospitals without such systems.

An important aspect in understanding the results from recent studies is the ambiguity surrounding the concept of the EHR system and the method to measure adoption. As mentioned earlier, there is no consensus in the literature regarding these aspects, and only just recently, a national standard was developed. Despite the work of Jha and colleagues (2009) which describes a standard for assessment studies and adopters, some authors consider this a restrictive approach (S. S. Jones et al., 2010). As

noted across the studies reviewed, the different terms "adoption", "use", and "Health IT capability" are used to define the implementation of the EHR, which results in different conclusions. Certainly, the presence or absence of an EHR system in a HCDO does not necessarily imply the effective use of the system by caregivers and staff. While studies placed HCDO into three groups: those with comprehensive electronic health records, those with more basic ones, and those without computerized records, others subscribed to the presence or absence of fully operational EHR systems being more restrictive in the analysis.

In addition, it is recognized that there are two distinctive sources of data for EHR adoption measures (i.e. AHA and HIMSS). Discussions about the measures of EHR adoption used in these recent studies and the national data sources are presented by Kazley, Diana, and Menachemi (2011). They assessed the data sets of hospitals that reported the presence of EHR in 2007 and 2008 provided by AHA and HIMSS, and concluded that even though both datasets have internal consistency, there is poor agreement between them with respect of EHR use. It is worth mentioning that this research did not use the recent AHA EHR Adoption database from the annual survey IT supplement for this analysis. Despite the results found in this work, it is recognized that the AHA data has more face and content validity. The authors emphasized that the items related to EHR adoption had been carefully developed and pilot tested. In contrast, the methodology used by HIMSS to collect the data is less clear.

When it comes to exploring the impact of EHR on the quality aspects of care in inpatient settings, nationally approved processes and outcomes of care of common conditions are the chosen metrics (A.S. Kazley et al., 2011; N. Menachemi, Chukmaitov, Saunders, & Brooks, 2008; S. T. Parente & J. S. McCullough, 2009). These measures

have been widely accepted and presented in the literature as valid measures to assess quality of care. As a part of the Hospital Quality Alliance (HQA) (A. Jha, Li, Orav, & Epstein, 2005), data on quality measures of care are collected and reported by the CMS through Hospital Compare, a consumer-oriented website that provides information on how well hospitals perform according to critical and common clinical conditions.

Particularly, the relationship between the adoption of EHR technology in hospitals and patients' perceptions of the quality of healthcare has not been not substantively evaluated in the literature. The study carried out by Kazley, Diana, Ford, and Menachemi (2011) was the first attempt to assess the impact of EHR on quality across different aspects of patients' experiences in hospitals. In this study, there are two methodological aspects that need consideration. First, each item of the survey is evaluated independently with respect to EHR system adoption. Although not all the items of the survey were conceptually expected to be influenced by EHR systems, this study failed to evaluate patient's perspectives of care as a construct. It is assumed that a different approach to measure the variables might lead to different results. Second, this study correlated the presence or absence of an EHR system in the hospital, not the actual use of the system or different levels of adoption and/or functionalities of EHR. Although the study revealed promising results, important aspects need to be further studied.

Much of the work reviewed here considered control variables to explain better the circumstances that might cause a weak or ambiguous association between the variables of interest. These control variables are hospital characteristics that have been found to influence HCDO behavior and performance (Ashish K. Jha et al., 2008; A.S. Kazley et al., 2011). These studies suggested that these variables might influence the adoption of

Health IT (Burke, Wang, Wan, & Diana, 2002; A. Jha et al., 2009; S. S. Jones et al., 2010), as well as differences in outcomes of care measures, patient satisfaction (Hall, Elliott, & Stiles, 1993; A. Jha et al., 2005; Lehrman et al., 2010), and patient safety measures (Brennan et al., 1991).

The great majority of these studies relied on cross-sectional secondary data; actual causality cannot be stated.

Table 9 summarizes the representative studies associated with common variables and hypotheses found in the literature of EHR systems in health care. This table also identifies whether the variable has been a control variable, an independent variable, a dependent variable, and/or a moderating variable.

Table 9

Variables Studied Empirically in Healthcare Environments

Variable/ Construct	Associated Variables	Type	Definition	Hypotheses	Health Care Environment	Representative Literature
Health Care Quality	Inpatient Hospitals Process of Care Measures Percentage of applicable visits receiving recommended care	DV		H1: There is a relationship adoption of electronic health records and key individual functions, and available measures of health care quality and efficiency (adjusting for hospital characteristics) H8: As implemented, the use of EHR is associated with better quality ambulatory care.	Hospitals - Nationwide / Patients Ambulatory Setting	(C. DesRoches et al., 2010; Garrido et al., 2005; J. A. Linder, Jun, Bates, Middleton, & Stafford, 2007; N. Menachemi et al., 2008)
Hospital Efficiency	Risk-adjusted length of stay Risk-adjusted 30-day Readmission rates Risk-adjusted inpatient costs.	DV		H10 H1, H7	Hospitals - Nation wide	(R. Amarasingham, L. Plantinga, M. Diener-West, D.J. Gaskin, & N.R. Powe, 2009a; C. DesRoches et al., 2010)
Adoption/Use of EHRs		IV DV	Federally Sponsored Panel Definitions: "Comprehensive"	H1 H2: There a substantive statistical difference in the adoption of EHR between	Hospitals - Nationwide/ Patients Ambulatory Setting	(C. DesRoches et al., 2010; Elnahal, Joynt, Bristol, & Jha, 2011; A. Jha et

Continued

Variable/ Construct	Associated Variables	Type	Definition	Hypotheses	Health Care Environment	Representative Literature
			electronic health record as adoption of twenty-four clinical functions across all *major* clinical units in the hospital, and a "basic" one as adoption of ten key functions in at least one major clinical unit of the hospital (C. DesRoches et al., 2010, p. 640).	high-quality hospitals and poor-quality hospitals in the United States. (Adjusting for hospital Characteristics) H3: There a substantively statistical difference between high-quality hospitals in the United States and poor-quality hospitals regarding the fulfillment of the meaningful use criteria of EHR (adjusting for hospital characteristics) H4, H5 H6: there is a positive relationship between EHR adoption and quality improvement for acute myocardial infarction, heart failure, and pneumonia process of care measures H8 H13, H14		al., 2009; S.S. Jones, J.L. Adams, E.C. Schneider, J.S. Ringel, & E.A. McGlynn, 2010; A.S. Kazley et al., 2011; J. A. Linder et al., 2007)
Hospital Characteristics	Size, region, profit status, membership in the Council of Teaching Hospitals, location, membership in a	Moder ator IV		H1, H2, H3, H4, H6, H13, H14	Hospitals - nationwide	(C. DesRoches et al., 2010; Elnahal et al., 2011; A. Jha et al., 2009; S.S. Jones et al.,

Continued

Variable/ Construct	Associated Variables	Type	Definition	Hypotheses	Health Care Environment	Representative Literature
	multihospital system, and presence of a cardiac intensive care unit					2010; A.S. Kazley et al., 2011; N. Menachemi et al., 2008)
High/Intermediate/Low-Quality Hospital		IV	Classification of a hospital based on the quality performance on 1) Care for acute myocardial infarction, 2) Congestive heart failure, 3) Pneumonia, and 4) Prevention of surgical complications (Elnahal et al., 2011).	H2, H3	Hospitals - nationwide	(Elnahal et al., 2011)
				H4: There is relationship between the adoption of EHRs and hospital characteristics.		
Barriers and Facilitators of Adoption		DV		H5: There is relationship between the adoption of EHRs and reported barriers and facilitators of adoption (adjusting for hospital characteristics)	Hospitals - nationwide	(A. Jha et al., 2009)

Continued

Quality	Acute myocardial	DV	Quality	H6	Hospitals -	(S.S. Jones et al.,

Continued

Variable/ Construct	Associated Variables	Type	Definition	Hypotheses	Health Care Environment	Representative Literature
Improvement	infarction, heart failure, and pneumonia process of care measures		differential of quality outcome measures		nationwide	2010)
Hospital's level of automation of EHR		DV	Not provided	H7: Greater automation of hospital information is associated with reduced rates of inpatient mortality, complications, costs, and length of stay.	Urban Hospitals - Texas	(Amarasingham et al., 2009a)
	Total number of office visits and use of primary care, specialty care					
Use of Ambulatory Care	Use of clinical laboratory	DV		H8: The use of EHR is associated with reduced use of ambulatory care.		(Garrido et al., 2005)
	Use of radiology Services					
	Use of telephone contact.					
Hospital financial performance	Inpatient revenue	DV	Firmperformance outcomes based on monetary terms.	H9: There is significant positive relationship between increased levels of IT use and various measures of financial performance, controlling for case-mix acuity and bed size.	Hospitals-statewide	(Barlow et al., 2004; N. Menachemi, Burkhardt, Shewchuk, Burke, & Brooks, 2006; Thouin, Hoffman, & Ford, 2008)
	Net patient revenue					
	Hospital expenses					
	Total expenses					
	Cash flow ratio					
	Operating margin			H11		

Continued

Variable/ Construct	Associated Variables	Type	Definition	Hypotheses	Health Care Environment	Representative Literature
Information Technology Adoption	Total margin	IV	Adoption of Clinical IT, Administrative IT and Strategic IT capabilities	H10: Hospitals that adopted a greater number of IT applications are more likely to have desirable quality outcomes.	National and statewide	(N. Menachemi et al., 2006; N. Menachemi et al., 2008; S. Parente & J. McCullough, 2009)
IT Investment	IT budget IT outsourcing Number of IT personnel	IV	The purchase of HIT	H11: IT investment is associated with increases in the profitability of Integrated Healthcare Delivery Systems	National and statewide	(Barlow et al., 2004)
Patient Safety	Infection due to medical care Postoperative hemorrhage or hematoma Postoperative pulmonary embolism Deep vein thrombosis (DVT).	DV	Adverse events in the medical practice	H12: EMR have a positive effect on patient safety.	Nationwide	(S. Parente & J. McCullough, 2009)
Patient Satisfaction	Communication with Nurses Communication with Doctors Responsiveness of Hospital Staff	DV	Assessment of critical aspects of patients' hospital experiences.	H13: EHR use has a positive impact on patient perceptions of discharge Information, hospital ratings, and willingness to recommend the hospital controlling for hospital characteristics H14: EHR use is not	Nationwide	(A.S. Kazley et al., 2011)

Continued

Variable/ Construct	Associated Variables	Type	Definition	Hypotheses	Health Care Environment	Representative Literature
	Pain Management Communication About Medicines Discharge Information Recommend the Hospital Overall Hospital Rating Cleanliness of Hospital Environment Quietness of Hospital Environment			correlated to patient perceptions of: communication with nurses and doctors, responsiveness of hospital staff, pain management, communication about medicines and cleanliness and quietness of hospital environment, controlling for hospital characteristics.		

Table 9 highlights important variables related to HCDO processes and outcomes of care related not only to quality, but also to financial aspects that were empirically studied in the literature of KMIS in health care environments. These studies predominantly used multivariate regression approaches to test the hypotheses.

Electronic Health Record Systems and the Impact on Patients' Perceptions of Care

Patient-centered care is acknowledged to be an essential aim and area for improvement in order to achieve highest levels of quality within the health care system (Institute of Medicine, 2001). As a result, patients' perceptions of quality of care and patient satisfaction measures have gained more attention in recent years (A.S. Kazley et al., 2011) and have a meaningful value for different stakeholders either "to identify better performers or to identify where improvements in quality are needed" (Sofaer & Firminger, 2005, p. 519). These two important interrelated aspects of patient-centered care are central to this investigation.

Based on the work of Sitzia and Wood (1997), Sofaer defined patient satisfaction as "fulfilling expectations, needs, or desires" (p. 518). These authors argued that patient satisfaction is one example of perception, but not the only example.

An examination of Chassin and Galvin's work (1998) indicates that when evaluating the multidimensional aspects of quality of care, the importance of the "desired outcomes of care" expected by the patients is emphasized. In this sense, patient satisfaction is another critical element of the quality of care that must be considered as a part of the equation to be assessed in the light of the recent Health IT transformation. Similar to the concept of quality, patient satisfaction is a multidimensional construct. These dimensions, as well as their measurement instruments, have been studied and

evaluated throughout the literature (Brian, 1994; Zabada, Singh, & Munchus, 2001). Although patient satisfaction is considered to be an important outcome of the process of care and it is recognized as a valid measure in quality evaluations in the services sector (Brian, 1994), Sofaer and Firminger (2005) found that multiple perspectives of patient satisfaction, issues in its conceptualization, and measurement throughout the literature have led researchers to consider both patients' experiences and patient satisfaction in order to assess quality from the patients' perspective. Therefore, patient perceptions of quality of care are a function of patient's experiences and expectations. These authors established its distinction from patient's perceptions of quality of care.

As a part of the Quality Alliance program, the Agency for Healthcare Research and Quality developed a set of reliable and valid measures to allow consumers to make quality comparisons among hospitals (Sofaer & Firminger, 2005). These metrics comprise the first national, standardized instrument used to measure patients' perspectives on health care quality: the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS). HCAHPS provides three important measures related to patient's perceptions of quality care: quality of health services in seven important domains (i.e. communication with doctors, communication with nurses, communication about medications, quality of nursing services, adequacy of planning for discharge, pain management, and hospital environment), hospital overall ratings of the hospitals and willingness to recommend the hospital (Ashish K. Jha et al., 2008).

It is worth mentioning that, in this instrument, two aspects are recognized: 1) the items that show hospital experience and patient evaluation of those critical aspects of hospital experience and 2) loyalty and patient overall satisfaction ratings as outcomes of the experience.

Table 10 summarizes some important findings applicable to this investigation related to patient perceptions of care:

Table 10

Findings Related to Patient Perceptions of Care

Author	Finding applicable to this study
(Brian, 1994)	Customer satisfaction is a valid measure in the service sector.
(Anderson, Fornell, & Roland, 1997)	Customer satisfaction is a valid indicator of the overall evaluation of the organization and influences customer loyalty and reputation. It is influenced by the perception of quality.
(A.S. Kazley et al., 2011)	In inpatient settings, EHR systems have been shown to influence aspects such as patient perceptions of discharge information provided by the hospital, hospital ratings, and willingness to recommend the hospital, controlling for hospital characteristics.

Gap Analysis

In this work, several findings and conclusions have been presented, based on the review of relevant literature in Health Care Knowledge Management. In brief, the analysis of the literature summarized in this section indicated the following conclusions that support this investigation:

- Traditionally, explicit healthcare knowledge is given more importance in the literature while the valuable and hard-to-capture experience and tacit knowledge are undercapitalized (S. Abidi et al., 2005; Friedman & Bernell, 2006).
- Operations and services that HCDO provide are, in general, highly complex and knowledge-intensive ones carried out by clinical knowledge workers in which medical knowledge, both tacit and explicit, is an input and an output of their work.
- The recent exponential proliferation of medical knowledge, information, and data necessary for the clinical decision making process has reached the healthcare sector, generating new problems for healthcare providers and impacting patient's healthcare. Absorbing and incorporating existing and new healthcare explicit knowledge into practice at the point of care and at the right time turns into a complex work that demands KM initiatives (Davenport & Glaser, 2002; Nicolini et al., 2008).
- The assessment of the adoption of EHR systems in HCDO is identified as a KM initiative in order to understand the impact of these KMIS, and thus to assist healthcare managers and practitioners in identifying and adopting those applications and functionalities that make sense in their environments. However, the use of KMIS assessment in health care is in its infancy. The following statements that were presented previously support this affirmation:
    - There is a need of empirical research on KM in the healthcare sector to guide healthcare stakeholders' decisions (A. Dwivedi, Bali, & Naguib, 2005).
    - Although the impact of Health IT is highly recognized in healthcare in the literature, empirical research of this impact is limited (Angst & Agarwal, 2006;

Detmer, Bloomrosen, Raymond, & Tang, 2008; N Menachemi et al., 2008) or reveals mixed results (N. Menachemi et al., 2008).

- It has been difficult to generalize the impact of Health IT to specific healthcare sectors (Parente & Van Horn, 2003) and across different HCDO (N. Menachemi et al., 2008).
- There is a minimum of empirical work on assessing the effectiveness of Health IT and its potential to address the current challenges in the US Healthcare System (Nicolini et al., 2008).
- There is a need to understand the complex relationship between the organizational adoption of Health IT and the performance improvements related to this adoption, and to incorporate the use of these technologies in the analysis (N. Menachemi et al., 2008).
- The literature related to successful implementation of Health IT across the hospital industry is yet to be empirically to be explored (AHRQ, 2008).
- Despite the need for improvement not only in quality of care, but also in the efficiency and efficacy in the healthcare service sector and the potential of EHR systems to transform all these aspects of care, this type of KMIS has been implemented and used in a slow manner. Adoption rates in inpatient settings reveal that this process is in its infancy (C. DesRoches et al., 2010; C. M. DesRoches et al., 2013; A. Jha et al., 2010; Kazley & Ozcan, 2009).
- There is common agreement among authors that there is still a large amount of the literature of EHR systems and their impact on different aspects of care that is largely anecdotal, documented based on case studies of individual institutions, meta-analysis using trials, or empirical studies with limited data.

However, the literature evidences positive outcomes from EHR system adoption.

- Until recently, empirical studies have involved large samples of data from multiple HCDO to assess the impact of EHR systems on quality of care. However, these works reveal mixed results and much remains unknown. There is an urgent need for empirical studies that demonstrate the value of EHR across multiple settings and that use large sample sizes to support the generalizability of the benefits of EHR systems (Chaudhry et al., 2006; Grieger et al., 2007; Kazley & Ozcan, 2009; N Menachemi et al., 2008).
- The literature related to successful implementation of Health IT in a large number of hospitals has not been widely studied; few studies have been developed across multiple hospitals (Amarasingham et al., 2009b).
- Particularly, the relationship between the adoption of EHR technology in hospitals, patient satisfaction and patient's perceptions of the services received is not substantively evaluated in the literature.

Research Model and Hypotheses

The conceptual research model that will be used in this research is presented in Figure 1. Based on the literature, the implementation of EHR systems as a KMIS is expected to affect patient's perceptions of quality of care experiences. Consequently, implementation of EHR is expected to affect overall hospital ratings due to its effects on patient´s perceptions of hospital. The independent variable in the research model is the implementation of EHR, and the dependent variables are patients' perceptions of quality of care, the hospitals ratings, and the patients' willingness to recommend the hospital.

The relationship between the dependent and the independent variables will be explored controlling for different hospital characteristics.

A high level set of hypotheses are drawn from the elements of the conceptual model and the gaps found in the literature. These hypotheses are:

- H1: The higher the level of implementation of EHR, the better the patients' perceptions of hospital care, when controlling for hospital characteristics.
- H2a: The higher the level of implementation of EHR, the higher the hospital's ratings, when controlling for hospital characteristics.
- H2b: The higher the level of implementation of EHR, the higher the percentage of patients who are willing to recommend the hospital, when controlling for hospital characteristics.
- H3a: The better the patients' perceptions of hospital care, the higher the hospital's ratings, when controlling for hospital characteristics.
- H3b: The better the patient´s perceptions of hospital care, the higher the percentage of patients who are willing to recommend the hospital, when controlling for hospital characteristics.
- H4: The higher the level of implementation of EHR, the higher the overall hospital ratings mediating by patient perceptions of hospital care, when controlling for hospital characteristics.
- H5: The higher the level of implementation of EHR, the higher the percentage of patients who are willing to recommend the hospital mediating by patient perceptions of hospital care, when controlling for hospital characteristics.

These hypotheses are presented in the research model depicted in Figure 5.

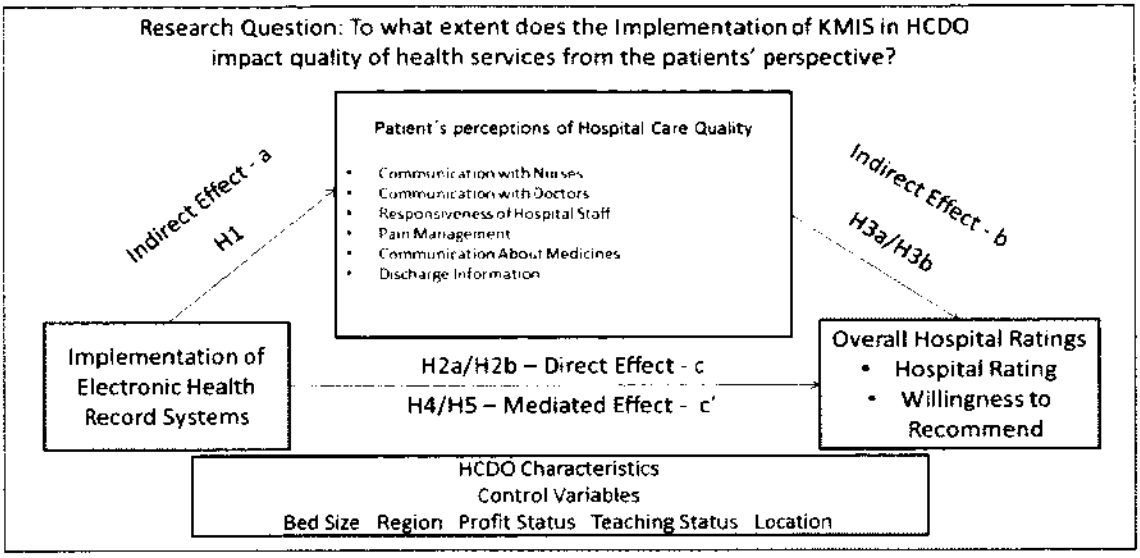


Figure 5. Research model

In addition, the analysis will examine whether there is part of the overall hospital ratings score which is predictable from the path ab (mediated path from indirect effects), that is large enough to be of a practical implication. Whether or not there is a significant mediated path, the second examination checks whether there is a significant direct path from the implementation of EHR and overall hospital ratings. If there is no a significant direct path or if it is too small, then the effect of the level of implementation on overall hospital ratings is completely mediated by patients' perceptions of care. If there is a statistically significant direct path and it is large enough to show practical implications, then the influence of the level of implementation on overall hospital ratings is only partially mediated by patients' perceptions of care, and that level of implementation has some additional effect on overall hospital ratings that is not mediated by patients' perceptions of quality of care.

The Relevance of this Research

The relevance of assessing the impact of EHR on patients' perceptions of quality of care is evaluated taking into consideration both the relevance from an academic's and practitioner's perspective within the area of Health Care Management.

The Relevance for Practitioners in Health Care Management

As Horak stated, "KM must be shown to be worth the effort" (2001, p. 11). This assertion leads to the affirmation that understanding the impact of the implementation of EHR on critical aspects of care has the value to assist engineering managers and healthcare managers with the scrutiny required for KMIS projects and to help strategize towards quality improvements. It is expected that from the knowledge gained from this work, engineering and healthcare managers can have a set of unbiased expectations regarding patients' perceptions of quality of healthcare and overall hospital ratings.

The Relevance for Academics

The importance of this research for academics is based on the relevance of the use of KMIS in organizations as a source of competitive strategy, and on the gaps existing in the current Healthcare Knowledge Management literature: 1) to guide healthcare stakeholders' decisions (A. Dwivedi et al., 2005); 2) to generalize the impact of Health IT to specific healthcare sectors (Parente & Van Horn, 2003) and across different HCDO (Chaudhry et al., 2006; Grieger et al., 2007; N Menachemi et al., 2008); and 3) to understand the complex relationship between the organizational adoption of Health IT and the performance improvements related to this adoption (N Menachemi et al., 2008).

METHODOLOGY

Overview

This chapter presents and evaluates the research methodology and the methods for the purposes of this investigation. The general methodology in this investigation follows an empirical approach with an exploratory and inferential purpose to address the research problem and to answer the research questions. The post-positivist worldview of the researcher guides the empirical approach that defines the research technique and methods to build knowledge (i.e. quantitative research).

As Creswell explains (2009), this post-positivist worldview holds a deterministic and reductionist philosophy that is observed by "the need to identify and assess causes that influence outcomes....to reduce the ideas into small, discrete set of ideas to test" (p. 7).

Following this approach and for the purpose of this investigation, phenomena must be observed either directly or indirectly with the aid of instruments, and new knowledge must be reached through verified facts that expand our theoretical body of knowledge. These facts are hypotheses that are established in advance from theories and are submitted to testing, implying that the form of reasoning is deductive in nature. Particularly, the impact of this approach entails that technical requirements of operationalization, specifically validity and reliability, are paramount (Devers, 1999).

The planned methodological framework in this investigation adapts the high level proposed methodology performed by Landaeta (2003), based on the research process proposed by Miller and Salkind (2002). This research was designed around the ten phases represented in Figure 2 in Chapter I and is explained in the subsequent sections.

A quantitative, non-experimental, and cross-sectional design for data collection and analysis will be used for the purpose of this investigation. Non-experimental research is needed because the researcher cannot manipulate the independent variable of this study and because its manifestations have occurred in the past. Given the availability of valid and reliable instruments to collect data related to the variables in this study and the availability of the cross-sectional databases, secondary data will be used for this investigation. The relationships among the independent and dependent variables will be assessed using Structural Equation Modeling (SEM) techniques. SEM exhibits unique characteristics that that allow: 1) the estimation of multiple and interrelated dependent relationships; 2) the ability to represent latent variables in these relationships and to correct for measurement error in the estimation process; and 3) the ability to define a model to explain an entire set of relationships (p. 711).

Research Methodology Purpose

Landaeta (2003) emphasized in his work the importance of creating validity throughout the different processes of the proposed methodology and, as a consequence, in the results and the conclusions of the investigation. Table 11 presents an overview of the validity checks that will be evaluated throughout the deployment of the research methodology and the tests and methods performed to verify them.

Table 11 Validation Checks

Validation Checks

Validity Indicator	*Definition*	*Method/Test*
Research topic Validity	Extent to which the research's objectives fill the current gaps in the literature and are aligned to practitioners' needs, concerns and challenges (Landaeta, 2003)	Gap analysis of the literature review and statements from experts
Research Model Validity	Extent to which research model and research methods support the achievement of the research objectives	Alignment among research model, method and objectives.
Face Validity	Extent to which the variables of an instrument and the concepts intended to be measure are aligned (Hair, Black, Babin, Anderson, & Tatham, 2005).	Literature Review and experts' judgment.
Content validity	"Extent to which that important dimensions of a concept and their categories have been taken into account and appropriately operationalized" (Shi, 1997).	Prior literature. Evaluation of the survey instruments
Construct Validity	"Extent to which a set of measured variables actually represent the theoretical latent construct they are designed to measure" (Hair et al., 2005).	Convergent validity: factor loadings, variance extracted, construct reliability.
Nomological Validity	"Whether the correlations among constructs in measurement theory make sense"	Matrix of construct correlations / Structural equation modeling
Internal Validity	Ability to draw accurate conclusions from the data about the population in the study from the relationships within the data (J. Creswell, 2009; Leedy & Ellis, 2001).	Outliers' evaluation Data collection plan that takes into account sampling methods from the data bases to increase variability of the data from different types of hospitals

Continued

Validity Indicator	*Definition*	*Method/Test*
		Power analysis
External Validity	The generalizability of the findings to other groups, individuals, settings and times (Calder, Phillips, & Tybout, 1982).	Sharing the results with experts in the research area

Note: Adapted from Knowledge Management Across Projects (p. 129), by Landaeta, R., 2003. University of Central Florida, United States, Florida.

Research Process Steps

1. Define the Problem – Research Questions

The objective of this phase is to state the research problem and research questions to clarify the goals and directions of the research effort (Leedy & Ellis, 2001). To find a legitimate problem, this phase involves the following steps:

1.1. Determine an area or a topic of interest that motivates the research efforts. Strategies to determine the area or topic are:

- Self-assessment of the areas/sectors of personal interest
- Assessment of knowledge areas that are considered important and need investigation for Engineer Managers
- Evaluation of the researcher knowledge in the areas/sectors of interest
- Alignment of the identified areas with those that need to be strengthened and developed in the country
- Literature review

1.2. Identify disciplines related to the chosen research area through literature review.

- Gathering of insights from experts, the literature, and personal experiences about the research area.

The study of EHR systems and their impact on quality outcomes of care, such as patients' perceptions of the health care service and overall satisfaction ratings started as a very broad topic and a set of vague questions about Knowledge Management (KM) in the Health Sector. Specifically, the direction of the investigation was driven by the following general questions:

What is KM? How is KM understood and applied in the health care sector in the United States? How complex is the health care sector in the United States? What are the current challenges in the Health Care Sector in the United States and Colombia? Is KM a common practice in the health care organizations? What is a Knowledge Management System (KMS)? From a technical perspective, what is a KMS? These questions were further refined to a general question: What is the impact of Knowledge Management Information Systems (KMIS) in HCDO? and two specific research questions: How does the implementation of EHR systems in hospitals impact Patient Satisfaction? Are there certain components of an EHR system that are associated with better patient satisfaction?

Given the interest in these topics and areas, but with limited experience and knowledge on cumulative theories and studies, an extensive literature review was necessary to answer these key leading questions.

2. Understanding the Literature

In quantitative research, understanding the body of knowledge is essential, in order to provide both a framework to deduct research questions and hypotheses from the theory and an explanation for expected relationships. (J. Creswell, 2009). However, this understanding has general multiple purposes:

- Due to the fact that research generally starts with a broad topic or with vague questions, the literature review can help to narrow down the research topic and find gaps or areas to be researched (Shi, 1997). Specifically, this phase is essential to find out what is known and what still needs to be done to help to formulate a specific and legitimate problem (Leedy & Ellis, 2001) and to achieve topic validity.
- To establish the importance of the study.
- To identify some theories and concepts related to the topic that need to be understood in order to address the research problem and questions.
- To suggest research procedures, designs, and analysis methods to solve the problem or research questions.
- To evaluate the face and content validity of the instruments used to collect the data.

The strategies used to execute these actions are:

- Perform a review of previous valid and reliable research findings relevant to the area research problem and questions.
- Attend conferences and meetings related to the area in order to get insights from experts and colleagues.

Chapter II summarizes the reviewed literature regarding KMIS and their impact on HCDO. Under the KM theory premises, EHR systems are recognized as an important KM strategy in the health service sector. By understating of the body of knowledge (what is known and not known) related to EHR records, different objectives were accomplished:

- Recognize the importance of KMIS in HCDO.
- Determine the KM processes and type of knowledge the KMIS support and use in HCDO.
- Provide insights into identifying the impact of EHR systems in the HCDO to meet specific performance goals (patient satisfaction/patient's perceptions of the service received).

From the iterative process of literature review, the following research problem and questions are formulated:

- Research problem: Assessments of the impact of Health IT on HCDO outcomes of care, and particularly of the implementation of EHR systems on quality and efficiency, is a need which several authors have emphasized (Chaudhry et al., 2006; Grieger et al., 2007; Abby Swanson Kazley & Ozcan, 2009; N Menachemi et al., 2008; Nicolini et al., 2008). The few empirical studies have revealed either rather small gains in the quality of health care or mixed results. In most cases, studies have been deployed with very limited data or within specific settings. Patients' perceptions of health care, an important element in the evaluation of quality of care and performance seem to have been overlooked in Health IT evaluations at the hospital level.

- Research question: To what extent does the Implementation of KMIS (EHRs) in HCDO impact the quality of the health services from the patients' perspective?
- Research sub-question:
  - How are KMIS classified in the health care sector?
  - How is the quality of health services measured through the patients' perspective in the HCDO?
  - Which contextual elements need to be considered to assess the impact of KMIS on patients' perceptions of the quality of their healthcare?

3. Generate Ideas to Address the Unknown

The objective of this phase is to develop a conceptual model that includes the elements that are going to be investigated and that are associated with the literature gaps. This conceptual model constitutes the building blocks derived from the ideas generated from the literature review. The theory will to be tested based on this conceptual model which has to be specified in understandable terms (Shi, 1997). Chapter I presented the conceptual model that directs and represents this research. See Figure 1

4. Define the Research Scope

The objective of this phase is to narrow the purpose of the investigation taking into consideration the different constraints the researcher may have. In addition, this phase involves the identification of the variables, constructs, and relationships between

variables, and consequently, the hypotheses which delimit the purpose towards the solution of the research problem (J. Creswell, 2009; Leedy & Ellis, 2001). This process is achieved by:

- Recognizing the independent and dependent variables and the direct relationship or inverse relationship between these variables. It is also important to recognize potential interactions or effects from other variables "that may cause a weak or ambiguous association between the interest variables of the study" (Bennett, 2000, p. 415).
- Stating the set of hypotheses:
    - Identifying the specific predictions based on the relationship of the variables.

Following these guidelines, the following outputs were obtained from the process:

- Independent variables: Level of Implementation of EHR systems in hospitals.
- Dependent variables: Patient Perceptions of Care, Hospital Ratings and Willingness to recommend the hospital.
- Control Variables: Hospital characteristics (i.e. bed size, region, profit status, teaching status and location). Consideration of hospital characteristics may allow for a more precise description of the relationship between the Implementation of EHR systems and their impact on patient safety and quality of health care.
- Hypotheses:

These hypotheses are:

- H1: The higher the level of implementation of EHR, the better the patient´s perceptions of hospital care, when controlling for hospital characteristics.

- H2a: The higher the level of implementation of EHR, the higher the hospital ratings, when controlling for hospital characteristics.
- H2b: The higher the level of implementation of EHR, the higher the percentage of patients who are willing to recommend the hospital, when controlling for hospital characteristics.
- H3a: The better the patient's perceptions of hospital care, the higher the hospital's ratings, when controlling for hospital characteristics.
- H3b: The better the patient's perceptions of hospital care, the higher the percentage of patients who are willing to recommend the hospital, when controlling for hospital characteristics.
- H4: The higher the level of implementation of EHR, the higher the overall hospital ratings mediated by patient perceptions of hospital care, when controlling for hospital characteristics.
- H5: The higher the level of implementation of EHR the higher the percentage of patients who are willing to recommend the hospital mediated by patient perceptions of hospital care, when controlling for hospital characteristics.

These elements, which constitute the research model, were presented in Chapter II, in Figure5.

5. Operationalize Research

This phase presents essential steps in designing the quantitative method for the research study, and in determining how the set of hypotheses will be tested. To perform this objective, different actions are required in this phase. These actions are described as follows:

5.1. Operationalization

From the conceptualization attributed to Percy W. Bridgman (1927), an operational definition is understood as the description of fuzzy or unobservable variables (i.e. constructs) by explicitly stating the exact manner in which they are measured. Operationalization is therefore related to the process in which unobservable variables or constructs are defined by specifying the procedures used to measure them. Variables and constructs need to be operationalized in order to obtain useful and meaningful results from the study. This process begins with a definition of the constructs and variables involved in the study, based on conceptualizations of the variables and constructs made in previous studies. Consequently, these concepts are translated to a set of operations or indicators used to measure the constructs (Hair et al., 2005). This phase also includes the literature review of sources of reliable and valid instruments to measure the variables.

The operationalization of the constructs in any quantitative research is a necessary condition to enable the study to bear useful and valid results. In this study, four major variables have been identified: 1) Implementation of EHR, 2) Patient's perception of quality of care, 3) Hospital Rate, 4) Willingness to recommend, and 4) Hospital characteristics.

Although operationalization of these variables is the decision of the researcher, one of the important efforts in the research design is to find not only links between the theoretical definition of the variables to the operational definitions, but also an operational definition that is suitable to the types of data sources available.

Interpretations and meanings for the variables used in the hypotheses are defined as:

- Implementation of EHR

In the literature, the implementation of a KMIS tool is understood as the installation of a system that involves hardware and software which integrates data, information, and knowledge, and the appropriation of new procedures related to the system.

To operationalize the concepts of implementation of an EHR system and the functionalities, this study examines the IOM's definition (2003) of an EHR system and the national standard provided by Jha and colleagues (2009) of what constitutes a comprehensive and basic EHR system in a hospital setting. When assessing the level of adoption of EHR in the literature, the variable level of implementation is operationalized considering three levels: 1) comprehensive implementation: complete replacement of the paper record for the twenty-four clinical functions across all major clinical units in the hospital; 2) basic implementation: complete replacement of the paper record for a set of ten clinical functions deployed in at least one hospital unit; and 3) no implementation. These functions are identified in a previous section in Table 8.

However, it is noticeable the different levels of EHR adoption that represent real hospital stages of implementation are not fully captured by the dichotomous definition that is widely used in the current literature (Blavin et al., 2010). To safeguard the validity of the findings of this study, two different approaches to operationalizing the independent variables will be used, in order to run and analyze two different models. Two views of the EHR level of implementation will be considered: 1) a conservative continuous measure of the level of implementation, adding up each fully implemented function across all units (variable ranging from 0 to 24 functions), and 2) a less conservative continuous

measure, adding up each function implemented in at least one unit (variable ranging from 0 to 24 functions).

- Patients' perception of quality of care, Hospital Rate, and Willingness to recommend

When it comes to measuring quality, patient satisfaction surveys of the service of care provided by the HCDO are one of the most valid approaches that can be used (Johansson, Oleni, & Fridlund, 2002; Mahon, 1996; Merkouris, Papathanassoglou, & Lemonidou, 2004).

As was mentioned in Chapter II, patient satisfaction is being nationally measured and assessed by the Centers of Medicaid and Medicare Services (CMS) through a hospital survey that uses the patients' evaluation of the critical aspects of care: The Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS). Patient satisfaction has multiple components that refer to their perception of the care they received. This investigation subscribes to HCAHPS in order to conceptualize and operationalize the patients' perceptions of quality of care. The HCAHPS survey is the first national, standardized instrument to measure patients' hospital experiences in inpatient settings (i.e. short-term, acute care hospitals). This measurement instrument allows quality comparisons among acute care hospitals.

The 27 items that encompasses a set of ten measures related to critical aspects of care are described as follows (CMS, 2011):

- Six Composite Measures:
  - Communication with Nurses
  - Communication with Doctors
  - Responsiveness of Hospital Staff

- Pain Management
- Communication About Medicines
- Discharge Information

- Two Individual Items:
  - Cleanliness of Hospital Environment
  - Quietness of Hospital Environment
- Two Global Items:
  - Recommending the Hospital
  - Overall Hospital Rating

Patients' perception of quality of care is conceptualized as the patients' evaluation of the critical aspects of their care. These components are:

- Communication with Nurses: How often nurses communicate well with patients
- Communication with Doctors: How often doctors communicate well with patients
- Responsiveness of Hospital Staff: How often patients receive help quickly from the hospital staff.
- Pain Management: How often the pain was well-controlled
- Communication about Medicines: How often the staff explains about medicines before giving them to patients
- Discharge Information: Whether or not patients were given information about what to do during their recovery at home

Patients' perception of quality of care is measured at the individual level using a 4 rating Likert scale and then is nationally reported at an aggregate level. These levels

are: 1) top box (i.e. most positive response: always); 2) middle box (i.e. intermediate responses: usually); 3) and low (i.e. least positive responses: sometimes and never) boxes. Hospital Compare reports the percentage of patients that agreed with the statements for each of the aspects to be evaluated (e.g. Nurses 'sometimes' or 'never' communicated well).

As it is noted, aggregated data may lead to ceiling effects, which have the unfortunate consequence of making it difficult to distinguish those providing simply adequate services from those providing superior or inferior care.

To have a score for each hospital that contains the patients' responses at all levels and to discriminate among hospitals with respect to each critical aspect of care, a weight that represents the social cost of different performance levels is assigned to each box level. The four Likert responses are represented equidistantly in Figure 6. It is expected that a hospital always performs well; therefore, that box level has a weight of 1 in the scale. The percentage of responses at the lowest box level (sometimes and never responses) indicates poor quality, therefore the results in that level have to be adjusted with the lowest weight in the scale. Given the uncertainty of the values aggregated at the lowest box level (sometimes and never), an intermediate weight of 1/6 in the scale is assigned to those responses. The percentage of responses at the middle box level (usually) is represented in the scale with a weight of 2/3.

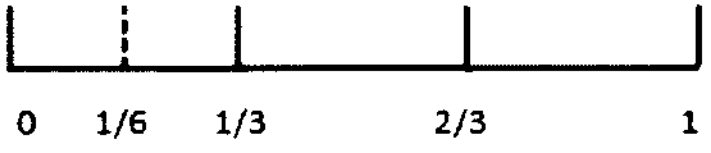


Figure 6. Weight scale for HCAHPs responses – Patients' perceptions of hospital care quality

Therefore, for each aspect of care, the following equation measures the hospital score with respect to the evaluation given by the surveyed patients to a specific aspect of care.

- Hospital Rating for Communication with Doctors = 1 x (% of surveyed patients who agreed with the statement: doctors 'always' communicated well) + (2/3) x (% of surveyed patients who agreed with the statement: doctors 'usually' communicated well) + (1/6) x (% of surveyed patients who agreed with the statement: doctors 'sometimes' or 'never' communicated well).

Willingness to Recommend the hospital represents patient loyalty towards the HCDO. It is measured as the percentage of surveyed patients who indicate that they would recommend the hospital to family and friends. Following the same approach presented above, Willingness to Recommend is operationalized as follows:

- Willingness to Recommend the hospital rate = 1 x (% of surveyed patients who agreed with the statement: 'YES', patients would definitely recommend the hospital) + (2/3) x (% of surveyed patients who agreed with the statement: 'YES', patients would probably recommend the hospital) + (1/6) x (% of surveyed patients who agreed with the statement: 'NO', patients would not recommend the hospital (they probably would not or definitely would not recommend it)).

On the other hand, Hospital Rate is conceptualized as the overall hospital rating received from surveyed patients. It is operationalized as the percentage of surveyed patients who rate the hospital at a high level (rating of 9 or 10), medium level (rating of 7 or 8) and low level (rating of 6 or lower).

To consider the same social cost associated with hospitals that did not perform well, three different weights are given to the different boxes. Possible sets of answers are represented in the scale presented in Figure 7. Given the same uncertainty of the number of patients who rate the hospital with each value, the average of each set of rates is assigned. The three levels are represented in the scale with 3 (rating of 6 or lower), 7.5 (rates of 7 or 8), 9.5 (rates of 9 or 10) and 1.

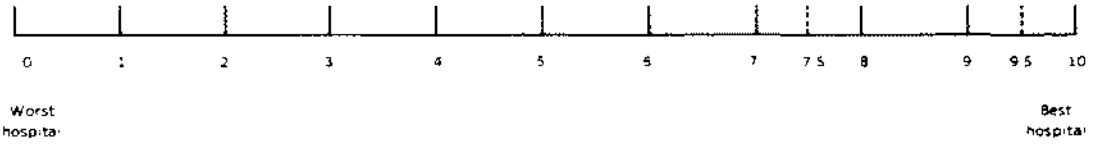


Figure 7. Weight scale for HCAHPs responses – Overall hospital rate

Therefore, the following equation is applied to calculate each hospital rate:

- Hospital Rate = [9.5 x (% of surveyed patients who gave a rate of 9 or 10) + (7.5) x (% of surveyed patients who gave a rate of 8 or 7) + (3) x (% of surveyed patients who gave a rate of 6 or lower)]/10.

With this approach, the objective is to include favorable and non-favorable responses for each hospital and to provide an accurate representation of the hospital performance based on patients' perceptions of the experience.

- Hospital Characteristics

Despite the fact that this investigation targets acute care hospitals, this type of HCDO varies in relation to different organizational and geographical factors including size, region, ownership, teaching status, and location. The role of these variables is to

explain the circumstances that may cause a weak or ambiguous association between the variables of interest in this study.

Hospital Characteristics are operationally defined as those unique attributes that differentiate one organization from another. Table 12 lists these categorical variables and their corresponding operational definitions.

Table 12

Hospital Characteristics

Characteristic	Categories
Bed size	Small (6-99 beds) Medium (100-399 beds) Large (400+ beds)
Region	Northeast Midwest South West
Ownership	Government no-federal Nongovernment, not-for-profit Investor-owned, for-profit government, federal
Teaching Status	Teaching Nonteaching hospital
Location	Urban hospitals Rural hospitals

5.2. Define the Research Method

This phase focuses on designing how the variables and constructs of the study are going to be measured. The best quantitative method that can be used to measure the variables of the study is the survey method. The rationale behind the selection of survey method is based on the following aspects:

- Surveys do not require visual observations from the researcher and can economically expand the sample size and geographical coverage to collect data from hospitals.
- The need for a macro study across hospitals that evaluate the impact of the implementation of EHR systems on patient satisfaction in this type of HCDO.
- The need of standard, reliable, and valid measures of patient satisfaction in hospitals.
- The nature of the questions and the research problem.

5.2.1. Design the data collection plan

The data collection plan specifies the strategies and steps that need to be in place in order to collect data for the variables in the study. For doing so, the following actions are suggested:

- Identify the unit of analysis: One of the paramount ideas in a research design is the unit of analysis. "The unit of analysis is the unit to which results apply" (Hair et al., 2005, p. 845). The unit of analysis is the major entity of analysis in the study and is determined by the research objectives, questions, and specified hypothesis.

  The conceptualization and operationalization of the variables of this study are circumscribed to acute level hospitals which provide inpatient hospital care. Specifically, at the acute care level, there is limited literature that explores the relationship of the variables established in the present study.
- Identify appropriate measurement instruments: Even though surveys are identified as the best method to achieve the objectives of this investigation, they

have their limitations. Particularly, the researcher needs to overcome the challenges related to obtaining a representative sample size, missing data, and/or a high response rate. In addition, it is expensive and difficult to access data from the unit of analysis chosen in this investigation. Having stated these limitations, this phase focuses on identifying measurement instruments and their corresponding sources of survey data. Weisberg, Krosnick, and Bowen (1996) also suggest that aggregate data can be used as an alternative to surveys. The strategies in this phase are:

- Exploration of free historical data of the variables of the study, reports, databases used and reported by healthcare providers, and governmental and profit and not-for-profit organizations related to healthcare information technology data, quality of health care, and patient safety.
- Evaluation of the quality of both the source of the data and the data itself. Different aspects have to be evaluated in order to choose sources of surveys and databases. A checklist for designing survey methods provided by Creswell (2009) is used to evaluate and choose the databases. The following is a subset of questions that guide the assessment of the surveys and databases:
    - What was the purpose of the survey?
    - Is it aligned to the variables chosen in the study?
    - Is the nature of the survey cross-sectional?
    - Did the survey provided a reliable methodology to collect the data and to validate it?
    - Is the population and sample size mentioned?

- Are the surveys related to the same unit of analysis?
- What was the procedure for sampling?
- Who developed the instruments to measure the variables?
- Were the scales used to measure the variables reliable?
- What was the procedure to collect the data? (p. 147)

The health care sector in the United States provides to the community a wide range of databases related to its services which are specifically used to assess the quality of care and patient safety. The process of operationalization of the variables and constructs has led to the identification of sources of secondary data. Given the availability of valid and reliable instruments to collect data related to the variables operationalized in this study and the availability of the cross-sectional databases, secondary data will be used for this investigation. Other studies reviewed in this in work relied on secondary databases (C. DesRoches et al., 2010; A. Jha et al., 2009; A. Jha et al., 2010; S. S. Jones et al., 2010; A.S. Kazley et al., 2011; S. T. Parente & J. S. McCullough, 2009). The sources of these data are government source (CMS), and leading commercial providers of data and statistics in the health care sector (AHA organizations). These organizations develop and test the surveys, and report the surveys methodologies that validate the responses. The design of the surveys and the process of data collection reveal a rigorous scientific process.

The Hospital Consumer Assessment of Healthcare Providers and System (HCAHPS), as mentioned earlier, allows quality comparisons among acute care hospitals. The HCAHPS survey collects data from discharge patients about 27 items that encompasses a set of ten measures related to critical aspects of care based on their recent visit at the hospital (CMS, 2008). It is administered between 48 hours and six

weeks past discharge to a random sample of adults with certain conditions using four modes of administration (i.e. mail, telephone, active interactive voice recognition, or mixed modes). The survey management, sampling protocol, details of survey administration, data specifications and coding, data preparation, submission guidelines, exceptions processes, and data reporting can be found in the Quality Assurance Guidelines at hcahpsonline.org.

Data regarding the Implementation of EHR systems in hospitals were obtained from the AHA organization. Since 1980, AHA has collected data from more than 6,500 hospitals about services, utilization, personnel, and finances. Since 2008, AHA has collected data about the level of adoption of EHR systems at more than 3,600 acute care hospitals and surgical centers through its Annual Survey Information Technology Supplement. It is currently considered the most reliable source of Health IT implementation information. This supplement was developed with the support of a federally sponsored expert consensus panel through a rigorous process. The survey is completed by the chief information officer or his/her equivalent at the hospital who is the most knowledgeable person about the system. The AHA data collection procedure involves data validation at several levels as well as consistency and internal edit checks to assure the integrity of the submitted data (AHA, 2009; A. Jha et al., 2009).

Data on hospital characteristics were obtained from the Medicare costs reports that are available for researchers in a relation database for fiscal years 1996-2011, and also from AHA database. Hospitals that are part of the Medicare/Medicaid program are required to file a cost report after the end of the fiscal year. As part of the process, the cost report goes through a series of edit checks and validation testing before being

added to the database. Cost reports include detailed and reliable data used to classify hospitals.

A temporal sequence of events will be included in this study to provide support to mediation analysis. Data from the implementation of EHR will be from 2009 and data for patients' perceptions of quality of care variables will be from 2010 period. Temporal precedence or sequence of variables and time lags between variables are important aspects to consider in mediation studies. Based on the literature and on the challenges in implementing and adopting (meaningful use) EHRs and achieving quality improvements, this investigation uses a year lag between the measures, deeming it appropriate for the implementation of EHR to show its apparent effects on hospital performance. Table 13 presents the information related to the sources of surveys and databases.

Table 13

Sources of Surveys and Databases

Constructs/Variables	Associated Variables	Measurement Instrument	Source
Patient Experience of Care	Patient Perceptions of Care, Hospital Rating, and Willingness to Recommend	Consumer Assessment of Health Plans Surveys (CAHPS).	CMS
Continued			
Implementation of EHR	Level of Implementation of a EHR / Level of Implementation of Functionalities of an EHR system	National Survey of Adoption of Electronic Health Records in acute care hospitals.	American Hospital Association
		Cost Reports	CMS

Continued

Constructs/Variables	Associated Variables	Measurement Instrument	Source
Hospital Characteristics	Bed size, region, profit status, teaching status and location		

Weisberg, Krosnick, and Bowen (1996) recognize that one of the main challenges of using secondary data analysis in quantitative research is the validity of the adopted measures to operationalize the variables. The authors point out that "the process of operationalization using instruments designed from other researches is more complex" (p. 180). This problem lies in the fact that surveys are often designed to answer different research questions or to measure different concepts. In addition, the second analyst does not have any connection with the process of measurement and data collection. Therefore, that analyst cannot implement strategies to minimize the error measurement.

Measurement error is another problem that derives from this type of studies. It is defined as "inaccuracies of measuring the 'true' variables due to the fallibility of the measurement instrument (i.e. inappropriate response scales), data entry errors or respondent error" (Hair et al, 1998, p. 2). Hair and his colleagues explain that that this error impacts the results by distorting the relationships between the variables and making the statistical techniques for the data analysis less powerful.

Recent studies using empirical research with secondary data sources have provided some methodological bases to assess the impact of EHR systems on patient perceptions of care. However, they have received strong criticism due to limitations that

are inherent to the observational, correlational, and point in time nature of the data. In health care settings, evidence-based medicine indicates that the best study design to assess causality (i.e. that the adoption of EHR improves perceptions of quality of care) is an experimental randomized controlled trial. However, the external validity of these studies is limited and studies are extremely expensive.

Although the limitations of cross-sectional quantitative research using secondary data are acknowledged, some strategies are considered to preserve the possibility that the study would benefit greatly from this approach:

1. The iterative process of the literature review to understand the body of knowledge not only focused on defining the research problem and the theory that supports this investigation, but also on identifying sources of reliable measurement instruments and databases that were related to the variables of interest.

2. The database chosen in this study was evaluated based on the report provided by the agencies and organizations that publish the data. Aspects such as study design, sampling, questionnaire construction, process of data collection and report, coding. and validation were evaluated to check for the reliability and validity of the instruments.

3. Given the unit of analysis in this study, it is virtually impossible to run controlled experiments to study the impact of EHR on patients' perceptions of the quality of care. To account for this limitation, the data of the independent variable (i.e. Implementation of EHR) and the control variables (i.e. Hospital Characteristics) will reflect the adoption of year 2009. Consequently, the data of the dependent variables will

be extracted from the CMS reports of patients' perceptions of quality of care during the year 2010. This approach will not allow total causality but it will provide more valid results in assessing the impact of the implementation of EHR on hospitals' performance.

It is important to mention that as this study will use only secondary data sources that were publicly available with no patient-identifiable aspects. It met the exemption criteria on the Application Form For Exempt Research and it will not be directly subject to Institutional Review Board (IRB) scrutiny.

5.2.2. Define Data Collection Model:

The objective of this phase is to relate the variables to the specific questions or hypotheses on the instruments (J. Creswell, 2009) to determine how the researcher will use the measurement instruments. See Figure 8.

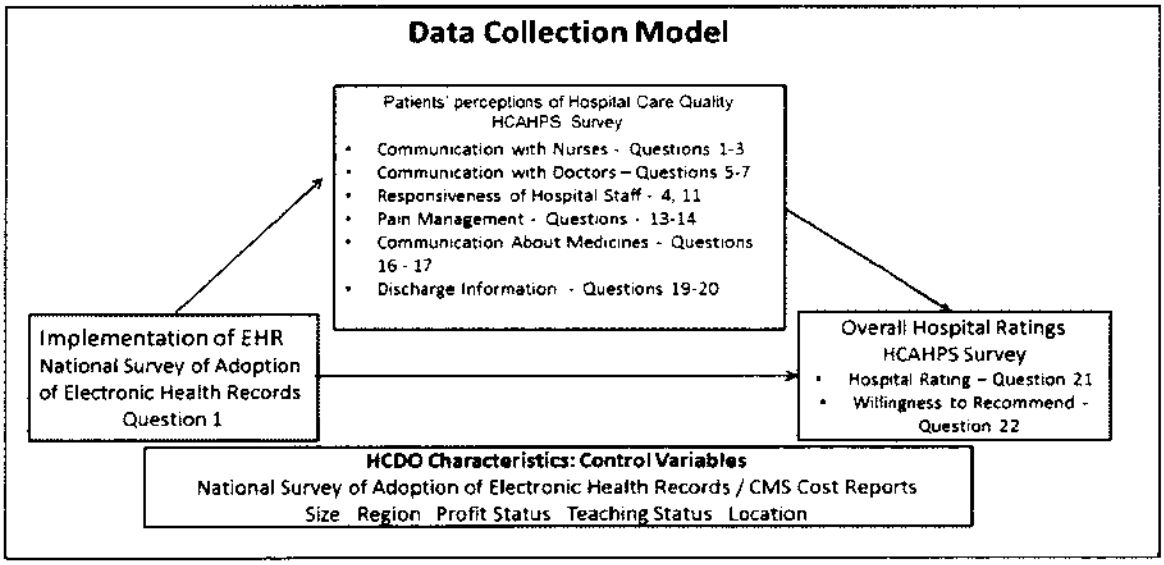


Figure 8. Data Collection Model

The actions in this phase include linking the variables and questions of the surveys with the aggregated data provided by AHA and CMS. The data collection model in Figure 8 makes explicit the set of questions that will be used in the analysis. In this phase, the set of questions from the patient satisfaction survey that makes more sense for the purposes of this study are chosen. This action is required because this survey was not designed to study the impact of EHR on patient satisfaction. Irrelevant questions will be removed from the analysis. For this study, the two individual items (cleanliness of hospital environment and quietness of hospital environment) are not theoretically related to the implementation of EHR systems and consequently, are not expected to be related. These two items are excluded from the analysis. Table 14 provides examples of the survey questions to illustrate the instruments:

Table 14

Example of Survey Questions

Variable	Survey Question Example	As reported in the Database
Implementation of Electronic Health Record		Raw Data
	Question 1: Does your hospital have a computerized system which allows for: Electronic clinical documentation / Results Viewing/ CPOE / Decision Support Answers: (1) Fully Implemented Across All Units, (2) Fully Implemented in at least one unit, (3), Beginning to implement in at least one Unit, (4) Have resources but considering Implementing, (5) Not in place and not considering implementing	
Patients' perceptions of		Aggregated Data

Continued

Variable	Survey Question Example	As reported in the Database
quality of care		
	Communication with nurses: Question 1: During this hospital stay, how often did nurses treat you with courtesy and respect? Question 2: During this hospital stay, how often did nurses listen carefully to you? Question 3: During this hospital stay, how often did nurses explain things in a way you could understand? Answers: (1) Never, (2) Sometimes, (3) Usually, (4) Always	How often did nurses communicate well with patients? Answers: 1) % Patients that answered Nurses 'always' communicated well, 2) % Patients that answered Nurses 'usually' communicated well, 3) % Patients that answered Nurses 'sometimes' or 'never' communicated well
	Willingness to recommend : Would you recommend this hospital to your friends and family? Answers: 1) Definitely no, 2) Probably no, 3) Probably yes, 4) Definitely yes	Would patients recommend the hospital to friends and family? Answers: 1) % patients that answered 'YES', patients would definitely recommend the hospital, 2) % Patients that answered 'YES', patients would probably recommend the hospital, 3) % Patients that answered 'NO', patients would not recommend the hospital (they probably would not or definitely would not recommend it)
	Hospital overall rating *: Using any number from 0 to 10, where 0 is the worst hospital possible and 10 is the best hospital possible, what number would you use to rate this hospital during your stay?	How do patients rate the hospital overall? Answers: 1) % Patients who gave a rating of 9 or 10 (high), 2) % Patients who gave a rating of 7 or 8 (medium), 3) % Patients who gave a rating of 6 or lower (low).

Continued

Variable	Survey Question Example	As reported in the Database
Hospital Characteristics	Teaching status: Is this a teaching hospital or affiliated with a teaching hospital? Answer: (Y/N) Location : Indicate if this hospital is either (1) Urban or (2) Rural	Raw Data

* The remainder of the survey questions for patients' perceptions of quality of care can be found in Appendix B

5.2.3. Deploy the Data Collection Plan

The objective of this phase is to guarantee a successful collection of data from the databases. The following actions are identified within the data collection plan in order to guarantee consistency and completeness:

1. Check for inconsistencies in each data file. The database from HCAHPS contains measures from a collection period of 12 months (Jan 1, 2010 - Dec 31, 2010). The database provider includes footnotes associated with the quality measures. To collect data from the database that is reliable to predict the hospital's performance, several footnotes from the database have to be considered within the process. These are:
    (1) The number of cases is too small to reliably be sure how well a hospital is performing.
    (6) Fewer than 100 patients completed the HCAHPS survey. Use these scores with caution, as the number of surveys may be too low to reliably assess hospital performance.
    (8) Survey results are not available for this reporting period.

(9) No or very few patients were eligible for the HCAHPS Survey.

(11) There were discrepancies in the data collection process.

(12) Very few patients were eligible for the HCAHPS survey

2. Perform the corresponding operations with the raw data to calculate the data for the variables in each data set. As mentioned earlier, levels of hospital adoption are not fully captured by the dichotomous definition that is widely used in the current literature (i.e. comprehensive and basic implementation of EHR) (Blavin et al., 2010). Two different independent variables will be calculated from the AHA raw database: 1) a conservative continuous measure of level of implementation adding up each fully implemented function across all units (ranging from 0 to 24 functions), and 2) a less conservative continuous measure adding up each function implemented in at least one unit (ranging from 0 to 24 functions). These two measures will allow for the interpretation of two different models.

   For the dependent variables, each measure must be calculated based on the top, middle, and lowest boxes provided in the HCAHPS database. The HCAHPS table reports the percentage of patients who agreed with the statements for each of the aspects to be evaluated. To ensure proper assembly, a different transformation of this dataset has to be performed. Corresponding operations with the raw data on the 29 pieces of data provided for each hospital have to be calculated to generate the eight dependent variables of the study. Categorical and ordinal control variables provided by AHA and the CMS costs reports will be codified accordingly. The variables used in this study and their abbreviation in the database are summarized in Table 15.

Table 15
Coded Variables

Variable	Abbreviation	Type
Level of Implementation of EHR-Conservative	IMP_CONS	Independent-continuous (1 to 24)
Level of Implementation of EHR-Non Conservative	IMP_N_CONS	
Communication with Doctors	Com_Doc	Independent-continuous (1 to 24)
Communication with Nurses	Com_Nurs	Dependent-continuous (0-100)
Communication about Medicines	Com_Med	
Discharge Information	Disch_Info	Dependent-continuous (0-100)
Pain Management	Pain_Mngt	Dependent-continuous (0-100)
Responsiveness of Hospital Staff	Respons	Dependent-continuous (0-100)
Willingness to Recommend	Recomend	Dependent-continuous (0-100)
Hospital Rating	Hosp_Rate	Dependent-continuous (0-95)
Teaching Hospital (base case=teaching hospital)	Teaching	Independent-binary
Location (base case=urban)	Urgan_Hosp	Independent-binary
Size	Bed Size	Independent-ordinal (1-3)
Ownership (base case=government nonfederal/ nongovernment, not-for-profit/Investor-owned, for-profit)	Gov_nonfed Non_Gov_notprofit Invest_profit	Independent-binary
Region (base case=Northeast/ Midwest/South)	Neast Mwest South	Independent-binary

3. Link secondary data sets. The data were taken from three databases. The first corresponds to the survey "HCAHPS" and has the questions regarding patients' perceptions. The second corresponds to the survey "2008 AHA Annual Survey Information Technology Supplement" and has the data regarding Implementation of EHR and Hospital. The third database corresponds to the Medicare costs report and has the information of Hospital Characteristics. It has questions n to z. The scores for each question were calculated as explained in previous sections. There is a table on each database that holds the answers to the questions under

study. In order to unify the data from the three databases, the corresponding tables were linked by the Provider Number field by a SQL query. The provider number corresponds to the Medicare provider identification. At this step, to guarantee integration of the databases, missing Medicare provider identification numbers in any of the databases have to be included manually. The resulting data has the following structure in Table 16:

Table 16
Example of Final Database

Provider Number	Region	BTOT	Bed size	...	Com_Doc

4. Determine missing values. Two important questions must be addressed in order to proceed analyzing missing data. Hair and colleagues (2005) suggest: 1) Are the missing data scattered randomly throughout the observations or are distinct patterns identifiable?, and 2) How prevalent are the missing data? Hair and colleagues proposed a four-step process for identifying missing data and applying remedies. This process will be used in this work.
5. Determine the size and content of the sample. This phase is important to safeguard for aspects that impact the type, level, and generalizability of the research findings (Brewerton & Millward, 2001). Conducting a power analysis is imperative to achieving significance accurately of the statistical methods used to analyze the data. Power analysis entails the analysis of the desired power, type

of the statistical test employed, sample size, and effect size (Cohen, 1988; Brewerton & Millward, 2001; Hair et al, 2005). Li, Markowski, Xu, and Markowski (2008) identified that the number of constructs, number of observed variables per construct, estimation method, magnitude of the standardized loading estimates, and any other approaches for missing data must be considered simultaneously to determine sample size. Hair et al. (2005) give a review of these aspects and recommend models with few underidentified factors (variables with one indicator) and minimal sample sizes. Also, they indicate that in the case of lower communalities, the sample size should be increased. To safeguard in case data deviates from assumption of multivariate normality, they recommend a large sample size to allow for the sampling error's impact to be minimized. This means less variability and increased stability in the solutions. Tabachnick and Fidell (2001) suggest a 1000 sample size as a general rule of thumb for factor analysis. Based on these assertions, to capture small effects (weaker relationships) in this investigation, with alpha of 0.01 and power of 0.8, a large sample size are needed. However, large sample sizes (more than 1000 observations which is the case of this study) can be overly sensitive and any relationship can be detected with any degree of certainty. This can affect the estimation technique, making goodness-of-fit measures suggest poor fit in multivariate data analysis. For example, the Chi-square goodness-of-fit statistic used in SEM is a measure that is sensitive to the sample size and model complexity. To safeguard for these implications, other statistics will be used in this investigation to reinforce the model evaluation and practical significance must be met, along with statistical significance (Hair et al., 2005).

6. Extract the data that are needed and subset the dataset. Based on the secondary source, define the population and structure the sample to be taken. Different methods for sampling can be found in the literature (Kalton, 1983; Brewerton & Millward, 2001; Trochim, 2001; Babbie, 2005) that vary between probability sampling (i.e. random selection) and non-probability sampling. These two types of sampling depend on whether the sampling techniques are impractical, unnecessary, cheaper, or less resource-intensive. Among probability sampling techniques, to achieve a representative sample of all the population of acute care hospitals as well as subgroups (i.e. states), stratified random sampling will be used in this investigation. In case post hoc structural analyses are needed to specify potential model improvements, a subset of data should be extracted from the database.

6. Define Data Analysis Plan

The objective of this phase is twofold: to verify the data collection instrument and to choose the statistical tool that tests the hypotheses established in the investigation. In most social research, the data analysis involves major steps described as follows (Brewerton & Millward, 2001):

- Examine the data: This systematic process ensures that statistical and theoretical foundations on which data are based are also supported (Hair et al., 2005). Principally, the researcher has to screen to assure that all requirements of the statistical methods (i.e. missing data, outliers, testing assumptions of multivariate analysis – normality, homoscedasticity, linearity) are met. This

process can be carried out graphically or analytically using statistical software packages (e.g. SPSS).

- Make data transformations: This phase provides the means to modify data in order to: correct violations of the statistical assumptions, or improve the relationship (correlation) between variables.

- Observe the features of the collected data: Through descriptive statistics, this phase provides the basic attributes of the data in a study to see what the data shows.

- Testing Hypotheses and Models: In this phase, questions, models, and hypotheses are investigated through multivariate data analysis methods. Based on Hair (Hair et al., 2005), three judgments have to be made about the research objective and the nature of data. Selection of the suitable technique depends on the answer to these questions:

    - Can the variables be divided into dependent and independent classifications based on some theory?

    - How many variables are treated as dependent in a single analysis?

    - How are the variables, both dependent and independent, measured?

In addition, the general and specific purpose and the type of question/hypothesis lead to the selection of the statistical method.

The characteristics of our set of variables (i.e. continuous independent variable, latent dependent variable with continuous indicators, dependent variable with continuous

indicators, and categorical and ordinal control variables), the access to a large sample size (i.e. more than 1000 data points), and the type of relationships to be tested in this investigation indicate that the suitable statistical methods are Exploratory Factor Analysis and Structural Equation Modeling.

In order to build construct validity, Factor Analysis will be used to refine the set of indicators that will be used to build the independent variable Perceptions of Hospital Care (i.e. latent variable).

To test the hypotheses, Structural Equation Modeling (SEM) is considered a robust technique for theory testing procedures that allow researchers to deal with a series of multiple regression equations that can be estimated simultaneously in the appropriate and most efficient manner. SEM can be described as the amalgamation of two techniques: multiple regression analysis and factor analysis (i.e. dependence and interdependence techniques). It can be used for both latent and observed variables.

The use of SEM allows for the drawing of more accurate conclusions about relationships between constructs and observed variables because this technique specifies error variables that correspond to the measurement error portions of observed variables. The use of the large data points provided by AHA and CMS will guarantee a large sample size appropriate for SEM. Model identification and specification will be evaluated first, to guarantee that enough information exists to identify the covariance matrix. To estimate the mediation model, the AMOS 22 software package and Maximum Likehood Estimation normal method will be used. Several steps take place when performing model estimation. Based on Kline (2005):

a. Assessment of reliability and validity of the scores analyzed in SEM. Reliability for individual and set of indicators will be revised. A minimum Cronbach's alpha of 0.7 will be considered for acceptable internal consistency of the measurement part of the model (i.e. Patients' Perceptions of Hospital Care Quality). For SEM purposes, variables with single indicators are assumed to be measured without error. Validity will be assessed including three categories: 1) face and content validity will be assessed by evaluation of the literature review and expert judgment (See Chapter II of this document); 2) Convergent validity will be assessed with the magnitude of the factor loadings and the variance extracted. Factor loadings should be significant and standardized factor loadings should be at least 0.7. Variance extracted should be equal to or greater than 0.5 for establishing convergent validity; 3) Nomological validity will be investigated by finding the estimated correlations among the variables. Confirmatory factor analysis will be used to test what is indicated above. If the measures are inexact, the seriousness of the problem will be evaluated to study how transformations of the variables can be made.
b. Model fit evaluation based on how well model (i.e. mediation model) explains the data. If the model does not fit the data, a respecification and evaluation of the revised model with the same data is necessary. This step has to be guided by the hypotheses.
c. Interpretation of the parameter estimates, once the fit of the model to the data is adequate. In this step, attention is paid to whether estimates of its parameters are meaningful and findings related to the hypotheses are analyzed.

7. Implement Data Collection Plan

This phase addresses the implementation of the data collection plan with the objective of collecting data for further analysis and hypothesis testing.

8. Implement Data Analysis

The goal of this phase is to statistically analyze the data by implementing the data analysis plan. This phase has major actions: to verify the items (i.e. items and questions) that will be used to measure the dependent variables and to test the hypotheses. For doing so, factor analysis will be carried out by first selecting a random sample size from the databases. Subsequently, SEM analysis will be conducted.

9. Interpret Findings:

The objective of this phase is to explain the results found in the data analysis and to accept or reject the hypotheses. Landaeta (2003) suggests that to interpret findings, the following strategies can be performed:

- Inductive reasoning
- Sharing results with experts
- Literature review

10. Refine and produce final research results

This phase focuses on the improvement of the analysis and results by integrating the insights obtained through the strategies presented in the previous phase. In addition, weaknesses and opportunities of the study are identified.

RESULTS

This chapter reports the results of the quantitative analyses indicated above in the methodology sections. The outline of the chapter is divided into the following subsections: (1) Analysis of the Missing Data; (2) Descriptive Statistics; (3) Validation of the Measurement Model; (4) Structural Model Results; (5) Findings Related to Hypotheses; (6) Validity Checks,

Analysis of Missing Data and Outliers

The analysis of missing data was limited to the observed variables from the 2008 AHA Annual Survey Information Technology Supplement (Q1_A1 to Q1_F4), which are used to operationalize the independent variable of Level of Implementation. See Appendix A for the Survey File Layout. The dependent and control variables of the study did not exhibit missing data. Table 17 contains the summary for missing data by observed variables among 2456 hospitals. All of the variables had less that 3% missing data and were not candidates for deletion.

Table 17

Missing Data by Observed Variable in AHA Database

Observed variable	Number of Hospitals with complete data by Variable	Missing	
		Data by Variable	Percent
Q1_A1	2450	6	0.2
Q1_B1	2431	25	1
Q1_C1	2441	15	0.6
Q1_D1	2407	49	2
Q1_E1	2434	22	0.9
Q1_F1	2426	30	1.2
Q1_G1	2409	47	1.9
Q1_A2	2434	22	0.9
Q1_B2	2451	5	0.2
Q1_C2	2440	16	0.7
Q1_D2	2445	11	0.4
Q1_E2	2440	16	0.7
Q1_F2	2430	26	1.1
Q1_A3	2402	54	2.2
Q1_B3	2440	16	0.7
Q1_C3	2438	18	0.7
Q1_D3	2427	29	1.2
Q1_E3	2434	22	0.9
Q1_A4	2384	72	2.9
Q1_B4	2423	33	1.3
Q1_C4	2434	22	0.9
Q1_D4	2444	12	0.5
Q1_E4	2423	33	1.3
Q1_F4	2420	36	1.5

Table 18 summarizes the number of missing data by hospital. Fifty hospitals have more than 10% of missing data. Twenty hospitals had more than 20% of missing data, and that made them likely to be deleted. From a practical perspective, the missing data in this set of observed variables was not a problem in terms of reducing the sample size. Eliminating all the hospitals with missing data (367), the sample was reduced to 2089 hospitals. This amount of missing data is low enough to not affect the results, even if it does not operate in a random manner. The final decision was to use only cases of

hospitals with complete data. Eliminating all cases of duplicated hospitals, the sample size was reduced to 2036 hospitals.

Table 18

Missing Data by Hospital

	Number of Hospitals	Number of Variables Missing	% of Variables Missing	% of the Sample
	2089	0	0	85.06
	259	1	4.2	10.55
	58	2	8.3	2.36
	24	3	12.5	0.98
	6	4	16.7	0.24
	5	5	20.8	0.20
	7	6	25	0.29
	2	7	29.2	0.08
	2	8	33.3	0.08
	3	17	70.8	0.12
	1	18	75	0.04
Total of Cases	2456			100.00

However, large sample sizes can be overly sensitive and any relationship can be detected with some degree of certainty. To safeguard for these implications, a subsample that contains the 50% of hospitals using a stratified random sampling process was selected.

A subsample of 1017 hospitals was analyzed for outliers and duplicated hospital results. Using standardized residuals, outliers where found in the y direction (dependent variables). An analysis of influential points in the x direction using mahal distance did not reveal outliers. No evidence was found that indicated error in data recording. Cases with

outliers were removed when found in two or more dependent variables. After eliminating influential observations, the study sample totaled 996 hospitals.

Descriptive Statistics

A summary of the hospital characteristics of this data set is presented as a part of the discussion of study results. Table 19 summarizes these characteristics.

Table 19

Demographic characteristics of hospitals of the sample

Characteristic	Categories	Number of Hospitals
Bed size	Small (6-99 beds)	331
	Medium (100-399 beds)	514
	Large (400+ beds)	151
Region	Northeast	160
	Midwest	313
	South	369
	West	154
Ownership	Government	194
	Nongovernment, not-for-profit	673
	Investor-owned, for-profit	129
Teaching Status	Teaching Hospital	342
	Nonteaching hospital	654
Location	Urban hospitals	653
	Rural hospitals	343

For the 996 hospitals in the sample size, the percentage of hospitals' number of EHR applications fully implemented in all units in 2009 in individual hospitals varied widely from 1 to 13 in the study population. A small proportion of hospitals had three or

fewer EHR applications in use (145 hospitals, 5.1%). At the other end of the distribution, a larger proportion of hospitals were using more than ten of the applications examined in this study (776 hospitals, 27.1%). A frequency distribution of hospitals with the number of applications in use is presented in Table 20.

Table 20

Frequency Distribution of Hospitals with Number of EHR functionalities implemented

Number of EHR functionalities fully implemented in all units (Conservative)	Number of Hospitals	% of Sampled Hospitals	Number of EHR functionalities fully implemented in at least one unit (Non Conservative)	Number of Hospitals	% of Sampled Hospitals
0	58	5.8%	0	24	2.4%
1	20	2.0%	1	8	0.8%
2	22	2.2%	2	18	1.8%
3	20	2.0%	3	13	1.3%
4	42	4.2%	4	22	2.2%
5	46	4.6%	5	25	2.5%
6	63	6.3%	6	19	1.9%
7	48	4.8%	7	28	2.8%
8	49	4.9%	8	33	3.3%
9	54	5.4%	9	43	4.3%
10	58	5.8%	10	34	3.4%
11	39	3.9%	11	37	3.7%
12	56	5.6%	12	55	5.5%
13	50	5.0%	13	48	4.8%
14	38	3.8%	14	42	4.2%
15	41	4.1%	15	56	5.6%
16	53	5.3%	16	61	6.1%
17	40	4.0%	17	61	6.1%
18	39	3.9%	18	69	6.9%
19	31	3.1%	19	49	4.9%
20	25	2.5%	20	34	3.4%
21	15	1.5%	21	35	3.5%
22	22	2.2%	22	49	4.9%
23	25	2.5%	23	66	6.6%
24	42	4.2%	24	67	6.7%

The descriptive statistics for each continuous variable (both independent and dependent) are shown below in Table 21.

Table 21

Descriptive Statistics of Continuous Variables

Variable	Minimum	Maximum	Mean	Std. Deviation
Communication with Doctors	84.500	98.000	91.25351	2.341911
Communication about Medicines	62.833	90.166	76.59772	3.880384
Communication with Nurses	79.999	96.333	89.66198	2.546119
Discharge Information	64.000	95.000	82.79417	4.185018
Hospital Rating	75.050	92.299	84.86902	2.896789
Pain Management	77.833	93.166	86.39257	2.462494
Willingness to Recommend	76.000	97.166	87.70180	3.866395
Responsiveness of Hospital Staff	66.666	95.833	82.89407	4.563206
Level of Implementation of EHR-Conservative	0	24	11.34	6.615
Level of Implementation of EHR-Non Conservative	0	24	14.58	6.451

The histogram of standardized residuals for dependent variables showed that they fit well in the normal distribution. The scatter plot indicated there was no violation of the assumption of homocedasticity. The plots of dependent variables vs. each independent variable did not reveal violations of linearity. Therefore, the graphical assessment of normality, homoscedasticity, and linearity assumptions did not reveal potential violations.

Data from 996 hospitals meet the guidelines for SEM. To address any possibility, maximum likelihood estimation was utilized for all SEM analysis, which has been shown to provide robust parameter estimates.

Validation of the Measurement Part of the Model

The research model involves the relationships among one observed exogenous variable, eight observed control variables, one endogenous latent variable, and two endogenous observed variables. Content validity for each measure of the construct was assessed by a comprehensive literature review. Evidence has been provided that the measurement of the construct has been effective in terms of reliability and validity.

To validate the latent variable, only the variables that measure the patient evaluation of those critical domains of quality of health service were included in the factor analysis. Outcomes of the hospital experience (i.e. loyalty and hospital rating) were not included. To ensure that the data matrix has sufficient correlation to justify the application of factor analysis, the model was evaluated by analyzing the anti-image correlation (negative values of partial correlation) matrix, KMO, the Bartlett test of sphericity and the measure of sampling adequacy (MSA).

The visual inspection of the correlation matrix revealed a few correlations around 0.5, with the major portion greater than 0.6. Only Discharge Information revealed poor correlation with the other variables. The KMO (.904) indicated the correlations were large enough to conduct factor analysis. See Appendix C.

When analyzing the test for the presence of correlation among the variables (Bartlett test of sphericity), it was observed that the correlation matrix had significant correlations among the variables, however this test is very sensitive in detecting correlations.

Finally, when inspecting the MSA, it was noticed that all of the measures in the anti-image matrix were greater than 0.7. All of the items showed relevance, so we could continue with the factor analysis.

The validation process followed an Exploratory Factor Analysis through SPSS on a total of 6 variables for a sample of 996 hospitals to assess reliability and convergent validity of the factor "Patients' Perceptions of Hospital Care Quality."

The principal concern is to summarize most of the original information (variance) in a minimum number of factors for prediction proposes. For this reason, *Component Analysis* with varimax rotation was conducted, with six variables

We conducted a Principal Component Analysis with the six variables. The scree test showed that the cutoff point may be two factors. 53% of nonredundant residuals did not suggest the presence of another factor. When assessing communalities, communalities greater than 0.5 were considered for practical significance in this analysis. Cromrey and Lee (1992) suggested that loadings in excess of 0.71 (50% overlapping variance) are excellent. Based on these criteria, Discharge Information (with a communality of .372) and Communication with Doctors (factor loading of 0.6) were deleted in the stepwise analysis of the factor. A construct that was internally consistent and well defined by the variables was obtained from the process. Communality values as seen in Table 23 tended to be significant.

Reliability was assessed using Cronbach´s alpha. The requirement was met with the generally agreed-upon lower limit of .7 (Hair, 2006). Strong empirical support concerning a single factor structure based on the sample is shown by a Cronbach alpha of .909. In addition, the average squared multiple correlations (SMC) for the five variables was .84. Convergent validity was evaluated through the factor loadings and the

assessment of the correlations between each measure of the factor and the summated scale for that factor. High and significant correlations indicated a strong convergent validity. Loadings of variables on the factor, communalities, reliability, and the percent of variance extracted are shown in Table 22.

Table 22

Structure Matrix

Variables	Component F1*	Communalities h2
Communication about Medicines	.881	.776
Communication with Nurses	.952	.907
Pain Management	.904	.817
Responsiveness of Hospital Staff	.927	.859
KMO	.848	
Variance Extracted	83.98%	
Construct Reliability	.909	
*Factor Labels:		
F1	Patients' perceptions of Hospital Care Quality	

The composition of the structural model after validation is as follows (Figure 9):

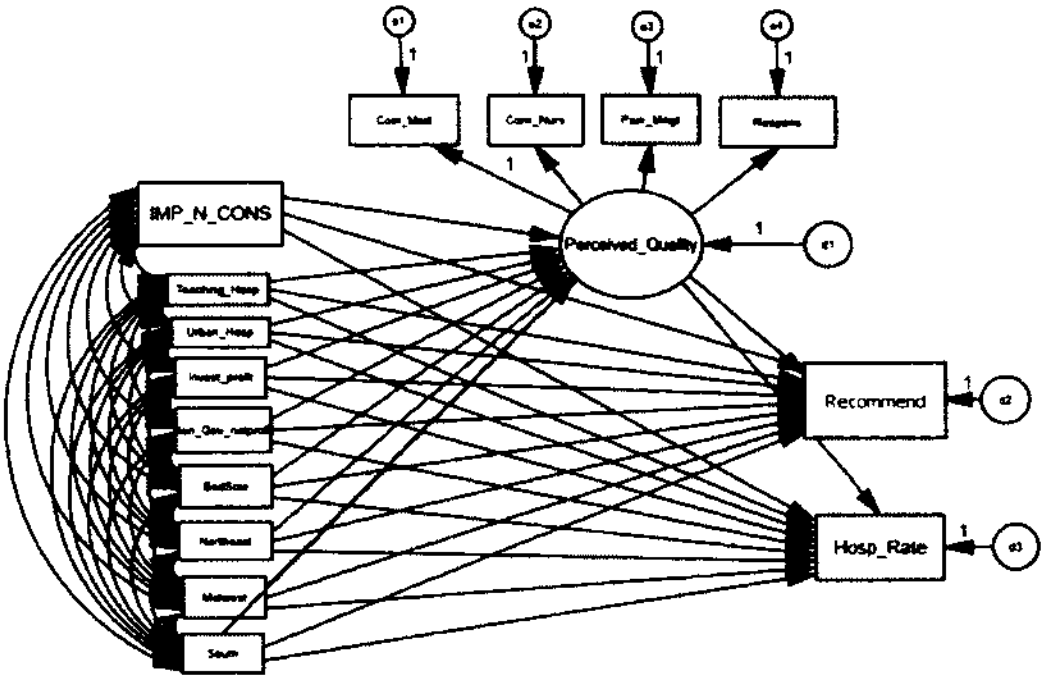


Figure 9. Structural Model

- Perceived_Quality: A latent variable that is composed by 4 observed variables (i.e.: Com_Med. Com_Nurse. Pain_Mngt_ Response)
- Hospital_Rate: Observed variable that is measured by the weighted average of responses of Question 21 of HCAHPS
- Recommend: Observed variable that is measured by the weighted average of responses of Question 22
- IMP_CONS / IMP_N_CONS: Observed variables that are measured by the number of functionalities 1) Fully Implemented across All Units; and 2) Fully Implemented in At Least One Unit respectively. These variables are included as independent variables in the model.

- Northeast, South, Midwest, Teaching_hosp, Urban_Hosp, Non_Gov_notprofit, Invest_profit: Observed categorical variables that are measured as dummy variables and represent the hospital characteristics. These variables are included as independent variables in the model.
- Bedsize: Observed ordinal variable that represents the size of the hospital. This variable is included as an independent variable in the model.
- e1 to e4: measurement error terms associated with observed variables.
- d1 to d3: residual terms (disturbances) that represent the error in the prediction of the dependent variables from the independent variables.
- One way arrows: represent the structural regression coefficients and the impact of one variable on another.
- Two-way arrows represent the correlations or covariance between pair of variables.

Structural Model Results

Structural equation modeling techniques were used to evaluate the mediating role of Patients' Perceptions of Hospital Care Quality between the level of Implementation of EHR on Hospital Rating scores and Willingness to Recommend, controlling by hospital characteristics. Maximum likelihood (ML) method was used with the software package AMOS.

The sample size met the minimum for SEM (200 to 400) and the model was identified, meaning that there was enough information in the data to estimate the unknown parameters.

Goodness-of-fit was assessed in order to interpret the results from the estimation process.

Model Fit Evaluation

Goodness-of-fit (GOF) indexes are used to establish the acceptability of a SEM model (Hair. 2006) and compare the theory to the reality, as represented by the data. The closer the values to the desirable ones, the better the model.

Evaluating the structural model, it was found that the GOF indexes for the specified mediation model revealed lack of fit. The chi-square value obtained from AMOS was 1198.983(DF=36) and the p value was .000. Such significant chi-square value is not desirable for mode fitting. However, the chi-square statistic is sensitive to the sample size used in the model. Assessment of different indexes widely used throughout the literature was conducted. The Comparative Fit Index (CFI) was .881 (<.95). Non-Normed Fit Index (NFI) was .879 (<.95). Goodness of Fit Index (GFI) was .850 (<.95) and Root Mean Square Error of Approximation (RMSEA) was .18. (>.1). Evidence of missfit was also provided through modification indexes (MI) which reflects the extent to which the hypothesized model is appropriatately described. For each fixed parameter in the model, AMOS provides a MI, the value of the expected drop in chi-square if the parameters were freely estimated by the model (Byrne, 2001). MI were explored, and only the parameters that represent error variances between errors were evaluated. Correlated measurement errors of Willingness to Recommend and Hospital Rate had strong substantive sense and therefore, were included in the model. See Figure 10. They were expected to be correlated because they are assessing outcomes of hospital experience and share the measurement method.

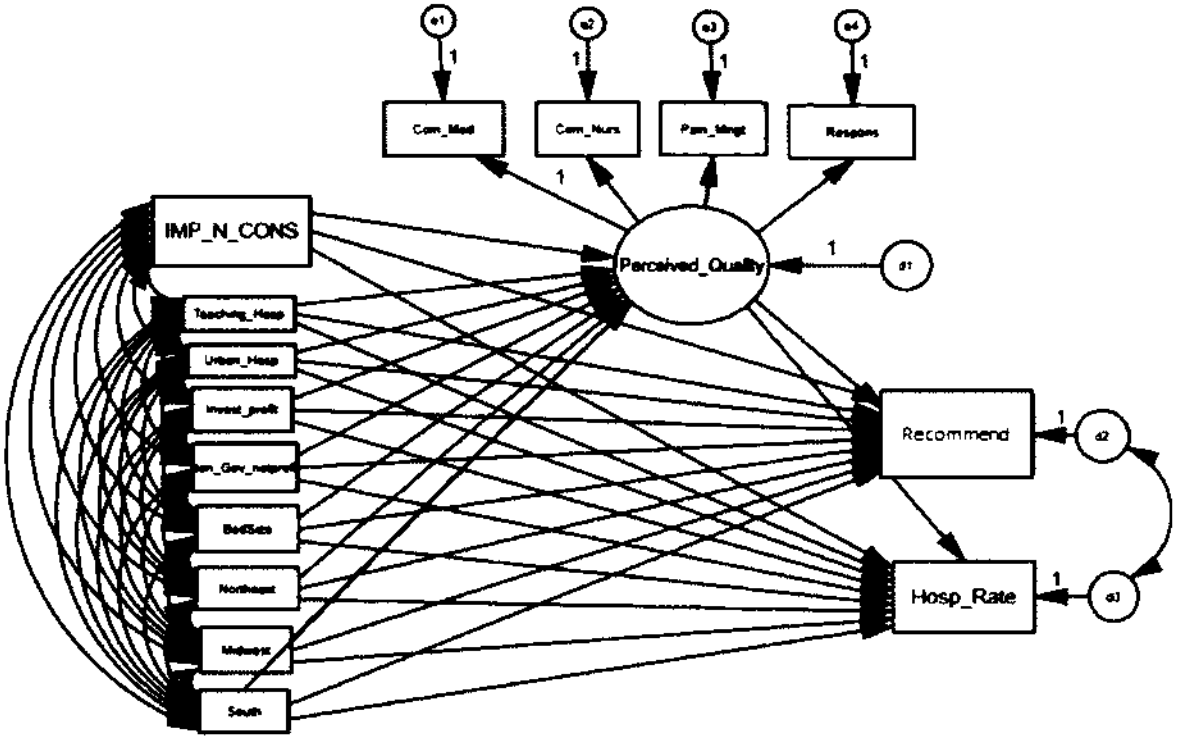
After correlating d2 and d3, the chi-square value of the structural model was 409.338 (DF=35). CFI was .962, GFI was .952, NFI .959, and the RMSEA was .104. Table 23 presents a summary of the GOF indexes of the initial and corrected model.

Table 23

Model Fit Indices

	Initial Indexes	Corrected model Indexes
X^2 and degrees of freedom	1198.983	409.338
DF	36	35
Root mean square error of approximation (RMSEA)	.18	.104
Comparative-fit index (CFI)	.881	.962
Goodness-of-fit index (GFI)	.850	.952
Normed-fit index (NFI)	.879	.959

Based on the theory, to draw accurate conclusions of the model, it is desirable to have a RMSEA below .1. It represents how well the individual covariance matrix is predicted by the model, taking into account the error in that prediction (Hair, 2006). It is discussed in the literature that even though the RMSEA attempts to overcome the issue of rejecting a SEM model given its large chi-square (explained by the large sample size), its thresholds for this GOF are questionable. Breivik and Olson (2001) noted that in small models that have few factors, which is the case in this study, RMSEA tends to impose a penalty to model size. Based on these assertions, and with the GOF achieved for the different GOF indexes, conclusions can be drawn from the parameters' estimates of the structural equations.



The results of the parameter estimates are summarized in Tables 24 to 27:

Figure 10. Specified Model

Table 24

Structural Regression Coefficients without Control Variables

path	Independent Variable		Dependent Variable	Path coefficient	C.R.	P
a	IMP_CONS	->	Perceived_Quality	-0.046	-2.977	0.003
b1	Perceived_Quality	->	Recommend	0.857	25.251	0.000
b2	Perceived_Quality	->	Hosp_Rate	0.751	31.346	0.000
ab1	IMP_CONS	->	(mediated) Recommend	-0.039		0.000
ab2	IMP_CONS	->	(mediated) Hospital Rate	-0.035		0.000

Continued

path	Independent Variable		Dependent Variable	Path coefficient	C.R.	P
c1	IMP_CONS	->	Recommend	0.101	7.54	0.000
c2	IMP_CONS	->	Hospital Rate	0.043	5.17	0.000
a'	IMP_N_CONS	->	Perceived_Quality	-0.048	-3.015	0.003
b1'	Perceived_Quality	->	Recommend	0.854	25.108	0.000
b2'	Perceived_Quality	->	Hosp_Rate	0.750	31.33	0.000
ab1'	IMP_N_CONS	->	(mediated) Recommend	-0.041		0.000
ab2'	IMP_N_CONS	->	(mediated) Hospital Rate	-0.036		0.000
c1'	IMP_N_CONS	->	Recommend	0.092	6.676	0.000
c2'	IMP_N_CONS	->	Hospital Rate	0.042	4.895	0.000

Table 25

Structural Regression Coefficients with Control Variables

Path	Independent Variable		Dependent Variable	Path coefficient	Standardized path coefficient	CR	p
a	IMP_CONS	->	Perceived_Quality	0.012	0.024	0.818	0.413
b1	Perceived_Quality	->	Recommend	1.088	0.899	29.732	0.003
b2	Perceived_Quality	->	Hosp_Rate	0.864	0.953	33.128	0.000
ab1	IMP_CONS	->	(mediated) Recommend	0.013		*	0.419
ab2	IMP_CONS	->	(mediated) Hospital Rate	0.010		*	0.429
c1	IMP_CONS	->	Recommend	0.036	0.062	2.984	0.003
c2	IMP_CONS	->	Hosp_Rate	0.012	0.027	1.470	0.142
a'	IMP_N_CONS	->	Perceived_Quality	0.010	0.19	0.646	0.518
b1'	Perceived_Quality	->	Recommend	1.089	0.9	29.724	0.000
b2'	Perceived_Quality	->	Hosp_Rate	0.864	0.953	33.151	0.000

Continued

Path	Independent Variable		Dependent Variable	Path coefficient	Standardized path coefficient	CR	p
ab1'	IMP_N_CONS	->	(mediated) Recommend	0.010		*	0.517
ab2'	IMP_N_CONS	->	(mediated) Hospital Rate	0.008		*	0.517
c1'	IMP_N_CONS	->	Recommend	0.030	0.051	3.026	0.014
c2'	IMP_N_CONS	->	Hosp_Rate	0.016	0.036	1.999	0.046

Table 26

Parameter estimates for Control Variables

Control Variables		Dependent Variables	Path Coefficient	Standardized path coefficient	C.R.	P
Teaching_Hosp	->	Perceived_Quality	-0.677	-0.101	-2.844	0.004
Urban_Hosp	->	Perceived_Quality	-1.036	-0.154	-4.446	0.000
Invest_profit	->	Perceived_Quality	-0.58	-0.061	-1.743	0.081
Non_Gov_notprofit	->	Perceived_Quality	0.497	0.073	2.036	0.042
BedSize	->	Perceived_Quality	-1.371	-0.288	-7.642	0.000
Northeast	->	Perceived_Quality	0.523	0.06	1.586	0.113
Midwest	->	Perceived_Quality	1.53	0.222	5.338	0.000
South	->	Perceived_Quality	0.648	0.098	2.318	0.02
Teaching_Hosp	->	Recommend	0.63	0.077	3.15	0.002
Urban_Hosp	->	Recommend	2.201	0.271	11.184	0.000
Invest_profit	->	Recommend	0.511	0.044	1.828	0.068
Non_Gov_notprofit	->	Recommend	0.445	0.054	2.168	0.03
BedSize	->	Recommend	0.983	0.171	6.398	0.000
Northeast	->	Recommend	-1.736	-0.165	-6.271	0.000
Midwest	->	Recommend	-1.41	-0.169	-5.804	0.000
South	->	Recommend	-1.03	-0.129	-4.384	0.000
Teaching_Hosp	->	Hosp_Rate	0.176	0.029	1.352	0.176
Urban_Hosp	->	Hosp_Rate	1.062	0.174	8.289	0.000
Invest_profit	->	Hosp_Rate	0.903	0.105	4.961	0.000
Non_Gov_notprofit	->	Hosp_Rate	0.243	0.039	1.821	0.069
BedSize	->	Hosp_Rate	0.556	0.129	5.561	0.000
Northeast	->	Hosp_Rate	-1.431	-0.181	-7.943	0.000
Midwest	->	Hosp_Rate	-0.731	-0.117	-4.627	0.000
South	->	Hosp_Rate	-0.604	-0.101	-3.951	0.000

Table 27

Intercepts for Predicting Dependent Variables

Dependent Variables	Intercepts	S.E.	C.R.	P
Com_Med	78.799	0.418	188.382	0.000
Com_Nurs	91.339	0.313	291.437	0.000
Pain_Mngt	87.863	0.278	316.34	0.000
Respons	85.733	0.534	160.646	0.000
Hosp_Rate	85.17	0.401	212.575	0.000
Recommend	86.944	0.542	160.439	0.000

Findings Related to Hypotheses

Hypothesis 1: The higher the level of implementation of EHR, the better the patient's perceptions of hospital care, when controlling for hospital characteristics.

The initial finding when the relationship between Level of Implementation and Patients' Perceptions of Hospital Care was assessed without the confounding effects from Hospital Characteristics revealed a detrimental impact. See path a and a' in Table 24. When confounding effects were included in the estimation, the level of the Implementation of EHR systems (fully implemented in all units or in at least one unit in a hospital) had a positive impact on the quality perceived by patients through their experiences. Table 25 shows that the standardized path coefficients for the Level of Implementation and the Perceived Quality are .024 and 0.19 respectively. However this relationship is not statistically significant and H1 is not supported by the data (p=0.413).

Hypothesis 2a: The higher the level of implementation of EHR, the higher the overall hospital ratings, when controlling for hospital characteristics.

The analysis without controlling for confounding effects revealed a positive and

statistically significant relationship between these two aspects. However, when controlling for Hospital Characteristics, the level of implementation, understood as the number of functionalities fully implemented in all units in the hospital (IMP_CONS), did not revealed a statistical significant impact (path c2 in Table 26) (p=0.142). When the Level of Implementation for a hospital is measured through a less restrictive approach (fully implemented in at least one unit), a positive and statistically significant relationship is found at the 0.05 level (p=0.046); therefore the hypothesis was supported by the data when implementation is a less restricted measure.

Hypothesis 2b: The higher the level of implementation of EHR, the higher the percentage of patients who are willing to recommend the hospital when controlling for hospital characteristics.

The analysis without controlling for confounding effects revealed a positive and statistically significant relationship between these two aspects. When controlling for hospital characteristics, the level of implementation, understood as the number of functionalities fully implemented in all units in the hospital (IMP_CONS), also revealed a statistical significant positive impact (see path c1 in Table 25 (p<0.003). When the Level of Implementation for a hospital is measured through a less restrictive approach (fully implemented in at least one unit), a positive and statistically significant relationship different from 0 is found at the 0.05 level (p=0.014) (See path coefficients of c1 and c1' from Table 25). The intercept for predicting Willingness to Recommend is 86.944, as seen in Table 27. The multiple regression model to estimate the Willingness to Recommend from the Level of Implementation for a hospital is:

Willingness to Recommend = 86.944 + *0.036 (Imp_Cons)* + 0.63 (Teaching_Hosp) + + *2.201 (Urban_Hosp) + 0.983 (Bedsize) - 1.736 (Northeast) - 1.41 (Midwest) – 1.03 (South)*

To interpret these findings for a given hospital, when the hospital increases by one the number of functionalities fully implemented in all units, the percentage of patients that would rate the hospital as the best hospital increases by 0.036%.

Hypothesis 3a: The better the patients' perceptions of hospital care, the higher the hospital ratings, when controlling for hospital characteristics.

The results obtained from the analysis revealed that this relationship is positive and statistically significant without and with controlling for confounding effects of Hospital Characteristics, as shown by the path coefficients b2 and b2' (p=0.000) from Table 24 and Table 25.

Hypothesis 3b: The better the patients' perceptions of hospital care, the higher the percentage of patients who are willing to recommend the hospital when controlling for hospital characteristics.

The results obtained from the analysis reveal that this relationship is positive and statistically significant without and with controlling for confounding effects of Hospital Characteristics as shown by the path coefficients b1 and b1' from Table 24 and Table 25. *Hypothesis 3b accepted.*

Hypothesis 4: The higher the level of implementation of EHR the higher the overall hospital ratings, mediated by patient perceptions of hospital care, when controlling for

hospital characteristics.

The initial findings when the analysis was run without control variables revealed that a paths and b paths were statistically significant (hypotheses 1 and 3a). Mediation analysis was tested using bootstrapping methods through AMOS. Results of the mediation analysis confirmed the mediation role of Patients' Perceptions of Hospital Care quality in the relation between the Level of Implementation of EHR and Hospital Ratings. However, the relationship has to be controlled by confounding effects. In order to test mediation, a and a' path must be significant when controlling for hospital characteristics. Given that hypothesis 1 was not supported by the data, mediation influence could not be assessed.

Hypothesis 5: The higher the level of implementation of EHR, the higher the percentage of patients who are willing to recommend the hospital, mediated by patient perceptions of hospital care, when controlling for hospital characteristics.

Similar to the results provided for hypothesis 4, mediation analysis using bootstrapping methods confirmed the mediation role of patient perceptions of hospital care quality in the relation between the Level of Implementation of EHR and Willingness to Recommend, when control variables are not included in the analysis. Given that hypothesis 1 was not supported by the data when controlling for hospital characteristics, mediation influence was not assessed.

Validity Checks

Different validity checks were assessed throughout the deployment of the research methodology. Based on Table 11, a summary of the results is presented in Table 28.

Table 28

Validation Results

Validity Indicator	Method/Test
Research topic Validity	Gap Analysis of the Literature Review and statements from experts
Research Model Validity	Alignment among research model, method, and objectives.
Face Validity	Literature Review and experts' judgment that developed AHA IT Supplement and HCAHPAS surveys
Content validity	Literature Review Evaluation of the Survey Instruments. See Data Collection Plan: Appropriateness of measurement instruments
Construct Validity	Convergent Validity: factor loadings, variance extracted, construct reliability. See Table 23
Nomological Validity	Structural Equation Modeling estimates. See Table 26 and 27
Internal Validity	Analysis of Missing Data and Outliers Data collection plan that takes into account sampling methods from the data bases to increase variability of the data from different types of hospitals. Stratified Random Sampling. Rules of thumb for determining size and content of the sample. Analysis of GOF Indexes
External Validity	Sharing the results with experts in health care management and engineering management

DISCUSSION

Analysis from Hypotheses Testing

A summary of the results of hypotheses testing is presented in Table 29.

Table 29

Summary of Hypotheses Testing Results

Hypothesis	Supported with IMP_CONS at α = . 05	Supported with IMP_N_CONS at α = . 05
H1: The higher the level of implementation of EHR, the better the patient's perceptions of hospital care, when controlling for hospital characteristics	No	No
H2a: The higher the level of implementation of EHR, the higher the overall hospital ratings, when controlling for hospital characteristics	No	Yes
H2b: The higher the level of implementation of EHR, the higher the percentage of patients who are willing to recommend the hospital, when controlling for hospital characteristics	Yes	Yes
H3a: The better the patients' perceptions of hospital care, the higher the hospital ratings, when controlling for hospital characteristics.	Yes	Yes
H3b: The better the patients' perceptions of hospital care, the higher the percentage of patients who are willing to recommend the hospital, when controlling for hospital characteristics.	Yes	Yes
H4: The higher the level of implementation of EHR, the higher the overall hospital ratings, mediating by patient perceptions of hospital care,when controlling for hospital characteristics.	No	No

Continued

Hypothesis	Supported with IMP_CONS at α = . 05	Supported with IMP_N_CONS at α = . 05
H5: The higher the level of implementation of EHR, the higher the percentage of patients who are willing to recommend the hospital, mediating by patient perceptions of hospital care, when controlling for hospital characteristics.	No	No

Evaluation of H1 (not supported by the data at 0.05), H2a (not supported by the data with IMP_CONS at 0.05 and supported by the data with IMP_CONS at 0.05) and H2b (supported by the data at 0.05) arrived somewhat at the same results of Kazley et al. (2011). Unlike in the work of Kazley and colleagues, to test the hypotheses in this study, a construct was created for patients' perceptions of hospital care, and two variables (i.e. communication with doctors and discharge information) were dropped off the factor analysis. In addition, the implementation of EHRs in hospitals was operationalized with a different approach, allowing the independent variable to be more sensitive and to capture a better picture of the hospital status (level of implementation of EHRs vs. presence or not of the EHRs). The work of Kazley found the relationship between discharge information and the presence of an EHR to be statistically significant; however discharge information was not included in this study because of its low correlations with the other variables of patient's perceptions of care. Since H1 was not supported by the data, the mediation role was not able to be tested, and then H4 and H5 were not supported by the data. What it can be inferred from this results is that implementation of EHRs has a neutral impact on patients' perceptions of quality and is not a negative influence, as some critics of this technology affirm.

One explanation for the lack of a significant relationship of the Level of Implementation and Patients' Perceptions of Hospital Care quality is that definitely the approach used to operationalize Patients' Perceptions of Hospital Care by CMS and AHRQ is not capturing this impact. HCAHPS was not designed to assess the capabilities of EHRS and their impact on patient satisfaction, therefore other aspects of the hospital care experience might be more suitably used to assess the quality improvements derived by the EHRS implementation. In addition, it is again important to mention that Implementation does not capture adoption and meaningful use of EHRS. Implementation is capturing the presence or non-presence of the functionalities fully implemented either in all units or at least in one unit. The positive results from meaningful need to be explored in future research.

Another possible explanation that needs to be further explored is the learning curve of the EHRS in hospitals in order to obtain improvements in performance (e.g. perceived quality from hospital experiences). In this study, a year gap between the data collection of the IV and the DVs was found to be reasonable. However, further studies need to assess greater gaps or differences in performance between one year and another.

The possible explanations for the observations found by H2a (not supported by the data when a restrictive measure of Level of Implementation) are compounded as well. As mentioned above, investigations that have assessed the relationship between the level of implementation and the different performance outcomes in HCDO have operationalized implementation as a dichotomous variable. Clearly, this operationalization lacks the ability to capture the actual hospital stages of

implementation as well as the restrictive operationalization of this study. In addition, recall that the Level of Implementation does not imply proper adoption and use. For this reason, the assessment might not be capturing all of the potential impacts on outcomes such as patient satisfaction scores.

Evaluation of H2a (supported by the data when less restrictive measures of level of implementation) and H2b (supported by the data with both measures of level implementation) arrived at the same results of Kazley and colleagues (2011). The implications of these findings can be seen from different perspectives. Investments in the adoption of EHR can positively impact the percentage of patients that rate the hospital as the best hospital and the percentage of patients that are willing to recommend. These small gains observed from the path coefficients might have a multiplying effect on loyalty, good will, incomes, new clients, new investments, etc. The challenge for health care managers is to quantify those impacts that become motivators for early adopters or non-adopters, health care providers who resist change, or those ones not using the system properly.

Assessment of H3a/H3b is consistent with the literature (Anderson et al., 1997; Boudreaux & O'Hea, 2004). The relationship between the evaluations of the patients' experience in a hospital stay is positively related with outcomes such as Hospital Ratings (reputation) and Willingness to Recommend (loyalty).

Most common cofounding effects that weaken the relationships between the Level of Implementation and the Patients' Perception of Hospital Care, as seen in Table 27, were the location of the hospital (i.e. rural or urban), bed size and region. Teaching

status and ownership did not confound the relationships. Ownership only confounded the relationships with hospital ratings.

Limitations and Recommendations for Future Work

The results of this research come with certain limitations. These are indicated as follows:

- The use of secondary data implied challenges for this investigation. Although methodological bases were implemented to safeguard for potential pitfalls using data from other sources, measurement error could not be controlled.
- The only source of secondary data that is available for online purchasing and that was used to measure the level of implementation does not allow for completely capturing all of the possible phases of implementation of EHRS in acute care hospitals.
- Although this study hypothesized mediation based on theory, data for independent and dependent variables were collected in a sequential manner, and although the method for data analysis is robust enough to test multiple regressions, this study cannot test total causality of the impact of EHRS on hospitals' performance.
- Even though SEM is a robust technique, model complexity entails implications for the goodness-of-fit indexes.

There is still a need to assess the relationship of EHR systems and its potentialities as a KMIS with performance outcomes. Recent national surveys have included in their questions measures of meaningful use of the EHR. This study can be

replicable with more recent data that also captures the whole the IT learning curve of hospitals.

In addition, the following enhancements are recommended:

- To run the study with a delta of perfomance. This means to measure the change from one year to another of the percentage of people who recommend the hospital or rate the hospital as the best hospital, and capture the change in the level of implementation from one year to another.
- To study the multiplier effect of willingness to recommend and loyalty given the implementation of a EHR. An approach to studying patients' behavior related to satisfaction is agent-based modeling.
- To investigate which set of functionalities of EHR explain better the Willingness to Recommend and Hospital Ratings and other outcomes of the process of care such as safety, efficiency, access of care, and quality of life impacts, among others.
- To better measure the mediator (perceived quality from patients) to assess the relationship between implementation of EHRS and outcomes of care related to patient satisfaction.
- To use the same approach proposed in this investigation to measure the level of implementation to replicate other studies that revealed mixed results or small gains in improvements of quality and effciency.
- To find through a literature review other potential mediating variables or confounding effects that predict Hospital Rating and Willingness to Recommend more accurately.

CONCLUSIONS

This research investigation was proposed to identify to what extent Implementation of KMIS in HCDO impacts the quality of the health services from the patients' perspective. To solve the research problem and to answer the research question, three sub-questions were derived: (1) How are KMIS classified in the health care sector? (2) How is the quality of health services measured through the patients' perspective in HCDO? and (3) Which contextual elements need to be considered to assess the impact of KMIS on patients' perceptions of quality of healthcare? In order to answer the first question, a literature review provided the foundations and key concepts to understand Knowledge Management and its contextualization in health care settings. In addition, HCDO were recognized as unique knowledge-intensive organizations with multiple challenges that KMS can overcome through their adoption. This investigation referred to the technical perspective of KMS, which as understood as KMIS. To answer the first research sub-question, Section 2.4.2. of this work provided a classification framework of technologies with their applications on HCDO and their impact on performance (See Table 5). These tools are IT-based KMS in HCDO and are understood as "the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making" (Thompson & Brailer, 2004, p. 38). The classification captured different perspectives and paradigms related to the use of technologies, but basically captured the knowledge processes they support, the type of knowledge they are able to manage, and their potential benefits in HCDO performance. Analysis of the information collected in this classification allowed the researcher to recognize hybrid systems (i.e. Electronic Health

Records Systems) as comprehensive KMIS. With this finding in mind, the assessment of the impact of implementation KMIS on the quality of the health services from the patients' perspective was conducted through the impact of EHR systems on these critical aspects of care. The gap analysis revealed an important finding: The assessment of the implementation of EHR systems on HCDO performance is understood as a KM initiative to address the challenges of the areas of improvements for the health care system (i.e. quality and efficiency). However, KMIS assessment in health care is in its infancy. The following statements that were previously presented support this affirmation:

Key findings are summarized as followed:

- EHR adoption rates in inpatient settings indicate that this process is in its infancy (C. DesRoches et al., 2010; C. M. DesRoches et al., 2013; A. Jha et al., 2010; Abby Swanson Kazley & Ozcan, 2009).
- Successful implementation of Health IT in a large number of hospitals has not been widely studied; few studies have been developed across multiple hospitals (Amarasingham et al., 2009b), and yet it needs to be empirically explored. (AHRQ, 2008)
- The relationship between the adoption of EHR technology in hospitals and patient satisfaction and patients' perceptions of services received is not substantively evaluated in the literature.
- Until just recently, empirical studies have involved large samples of data from multiple HCDO to assess the impact of EHR systems on quality of care. However, these works reveal mixed results and much remains unknown. There is an urgent need for empirical studies that demonstrate the value of EHR across

multiple settings and using large sample sizes to support the generalizability of the benefits of EHR systems (Chaudhry et al., 2006; Grieger et al., 2007; Abby Swanson Kazley & Ozcan, 2009; N Menachemi et al., 2008).

Based on these findings, among others stated in the literature review, the assessment of the impact of EHR was conducted at the hospital level (acute care hospitals).

It was found that patient satisfaction is a critical element of the quality of care that needs to be assessed in the light of the recent Health IT transformation. One important finding from the literature was that multiple perspectives of patient satisfaction, and issues in its conceptualization and measurement have led researchers to consider both patients' experiences and patient satisfaction measures to assess quality from the patients' perspective. By answering the second sub-question, it was found that, in the US, the set of reliable and valid measures to allow consumers to make quality comparisons among hospitals (Sofaer & Firminger, 2005) is the survey developed by Agency for Healthcare Research and Quality. These metrics comprise the first national, standardized instrument to measure patients' perspectives on health care quality: the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS). HCAHPS provides three important measures related to patients' perceptions of quality care: quality assessment of health services in 7 important domains (i.e. communication with doctors, communication with nurses, communication about medications, quality of nursing services, adequacy of planning for discharge, pain management, and hospital environment), hospital overall ratings of the hospitals, and willingness to recommend the hospital (Ashish K. Jha et al., 2008). In addition, the literature provided evidence that patient evaluation of the health care experience influences customer loyalty and

reputation (Anderson et al., 1997) providing the theoretical support of the research model. Recent complementary studies have helped to answer the third sub-question by providing the evidence to consider hospital characteristics as the contextual elements that need to be controlled in the study to better predict the association between the variables of interest (Hall, Elliott, & Stiles, 1993; A. Jha, et al., 2005; Ashish K. Jha, et al., 2008; Lehrman et al., 2010; A.S. Kazley, et al., 2011).

Important contributions of this work include the operationalization of the variables of the study and the integration of three databases (i.e. AHA IT supplement, HCAHPS, and CMS cost reports). The AHA IT supplement is available online for purchasing and the HCAHPS and CMS cost reports are publicly available online form the CMS. This study proposed a different approach to operationalize implementation as a continuous variable from two different points of view, and can be used to replicate other studies to explore different results. Similarly, patients' perceptions of the hospital care experience for the different aspects of care were operationalized differently. In the last work of Kazley (2011) related to patient´s perceptions of care, these variables were operationalized using only the data form patients at the highest level (e.g. % of patients who rate the hospital with 9 or 10). To consider the social costs that represent that even a small percentage of the patients assert that the hospital sometimes or never perform well, three different weights were given to the different box levels for each composite reported by HCAPS; therefore, the score for a hospital for a particular aspect of care is a weighted average of the box levels.

To answer the research question, a research model that hypothesized the mediation role of patient´s perceptions of hospital care quality in the relation between the level of implementation of EHR and hospital ratings and willingness to recommend controlling for

hospital characteristics is tested using Structural Equation Techniques. It is important to note that the set of structural equations represented in the model does not tell the whole story about the dependent variables. The researcher is mindful in establishing the set of path diagrams in building the model but there are relationships captured by AMOS that were not previously hypothesized (e.g. curved arrow between d2 and d3).

Testing the hypotheses stated in the research model revealed key findings supported by the data that answers the research question To what extent does Implementation of KMIS (EHRs) in HCDO impact quality of the health services from the patients' perspective?

Findings revealed that the level of implementation of EHRS in hospitals does not have an impact on patients' perceptions of the health care quality (i.e. communication with nurses, communication about medications, quality of nursing services (responsiveness of the hospital staff) and pain management) when hospital characteristics have been controlled. This finding did not support a mediating role of patients' perception of health care quality. Still, there is a need to better measure patients' perceptions of hospital care as a mediator of the relationship of implementation of EHRS and outcomes of care. It is suggested that other aspects of the hospital care experience might be more suitable to assess the quality improvements derived by the EHRS implementation. However, findings suggest that the level of implementation has a positive impact on the percentage of patients who are willing to recommend the hospital to family and friends and the percentage of patients who rate the hospital high (9-10) based on their last stay in the hospital. Although gains could be too small for practical implications (between 0.12 to .036%), this percentage of patients calculated over a year may represent a large number of people. These findings revealed a potential effect on

"hospital good will" and "patient loyalty." Future research is recommended to analyze the multiplier effect of these findings and the income impact for hospitals, given the investments on EHR.

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APPENDIX A: 2008 AHA Annual Survey

2008 AHA Annual Survey
Information Technology Supplement
Health Forum, L.L.C.

Please return to:
AHA Annual Survey
Information Technology
Supplement
One North Franklin, 29th Floor

1. Does your hospital have a computerized system which allows for:
(Fully implemented means it has completely replaced paper record for the function.)

	(1) Fully Implemented Across All Units	(2) Fully Implemented in At Least One Unit	(3) Beginning to Implement in At Least One Unit	(4) Have Resources to Implement in the Next Year	(5) Do not have Resources but Considering Implementing	(6) Not in Place and not Considering Implementing
Electronic Clinical Documentation						
a. Patient Demographics	☐	☐	☐	☐	☐	☐
b. Physician Notes	☐	☐	☐	☐	☐	☐
c. Nurses Notes	☐	☐	☐	☐	☐	☐
d. Problem Lists	☐	☐	☐	☐	☐	☐
e. Medication Lists	☐	☐	☐	☐	☐	☐
f. Discharge Summaries	☐	☐	☐	☐	☐	☐
g. Advanced Directives e.g. DNR)	☐	☐	☐	☐	☐	☐
Results Viewing						
a. Lab Reports	☐	☐	☐	☐	☐	☐
b. Radiology Reports	☐	☐	☐	☐	☐	☐
c. Radiology Images	☐	☐	☐	☐	☐	☐
d. Diagnostic Test Results (e.g., EKG report, Echo report)	☐	☐	☐	☐	☐	☐
e. Diagnostic Test Images (e.g., EKG tracing)	☐	☐	☐	☐	☐	☐
f. Consultant Reports	☐	☐	☐	☐	☐	☐
Computerized Provider Order Entry (Provider (e.g., MD, APN, NP) directly enters own orders)						
a. Laboratory Tests	☐	☐	☐	☐	☐	☐
b. Radiology Tests	☐	☐	☐	☐	☐	☐
c. Medications	☐	☐	☐	☐	☐	☐
d. Consultation Requests	☐	☐	☐	☐	☐	☐
e. Nursing Orders	☐	☐	☐	☐	☐	☐
Decision Support						
a. Clinical Guidelines (e.g., Beta blockers post-MI, ASA in CAD)	☐	☐	☐	☐	☐	☐
b. Clinical Reminders (e.g., pneumovax)	☐	☐	☐	☐	☐	☐
c. Drug Allergy Alerts	☐	☐	☐	☐	☐	☐
d. Drug-Drug Interaction Alerts	☐	☐	☐	☐	☐	☐
e. Drug-Lab Interaction Alerts	☐	☐	☐	☐	☐	☐
f. Drug Dosing Support (e.g., renal dose guidance)	☐	☐	☐	☐	☐	☐

	(1) Fully Implemented Across All Units	(2) Fully Implemented in At Least One Unit	(3) Beginning to Implement in At Least One Unit	(4) Have Resources to Implement in the Next Year	(5) Do not have Resources but Considering Implementing	(6) Not in Place and not Considering Implementing
Bar Coding						
a. Laboratory specimens	❑	❑	❑	❑	❑	❑
b. Tracking pharmaceuticals	❑	❑	❑	❑	❑	❑
c. Pharmaceutical administration	❑	❑	❑	❑	❑	❑
d. Supply chain management	❑	❑	❑	❑	❑	❑
e. Patient ID	❑	❑	❑	❑	❑	❑
Other Functionalities						
a. Telemedicine	❑	❑	❑	❑	❑	❑
b. Radio Frequency ID	❑	❑	❑	❑	❑	❑
c. Physician Use of Personal Data Assistant	❑	❑	❑	❑	❑	❑

2. Does your electronic system allow you to do the following?

	(1) Yes	(2) No	(3) Do Not Know
a. Develop a list of a patient's current medications	❑	❑	❑
b. Compare patient's inpatient & preadmission medication lists	❑	❑	❑
c. Provide an updated medication list at time of discharge	❑	❑	❑
d. Automatically generate Hospital Quality Alliance measures by extracting data from an electronic record for a Medicare inpatient prospective payment system update	❑	❑	❑

3. Please indicate whether your hospital's electronic system is certified by the Certification Commission for Health Information Technology (CCHIT)?

- Yes ❑
- No ❑
- Don't Know ❑

4. Does your hospital participate in any regional arrangements to share electronic patient level clinical data through an electronic health information exchange, such as an RHIO (Regional Health Information Organization)?

- Participate, we actively exchange data ❑
- Participate, but we DO NOT exchange data ❑
- We do not participate in any regional arrangements for electronic health information exchange ❑

5. Does your hospital electronically exchange any of the following patient data with any of the providers listed below? (Check all that apply.)

	(1) With Hospitals in Your System	(2) With Hospitals Outside Your System	(3) With Ambulatory Providers Outside of Your System
a. Patient Demographics	❑	❑	❑
b. Clinical Care Record (clinical history, exam)	❑	❑	❑
c. Laboratory Results	❑	❑	❑
d. Medication History	❑	❑	❑
e. Radiology Reports	❑	❑	❑

APPENDIX B: HCAHPS Survey Instrument

HCAHPS Survey

SURVEY INSTRUCTIONS

- You should only fill out this survey if you were the patient during the hospital stay named in the cover letter. Do not fill out this survey if you were not the patient.
- Answer all the questions by checking the box to the left of your answer.
- You are sometimes told to skip over some questions in this survey. When this happens you will see an arrow with a note that tells you what question to answer next, like this:

  ☐ Yes
  ☑ No → ***If No, Go to Question 1***

You may notice a number on the survey. This number is ONLY used to let us know if you returned your survey so we don't have to send you reminders.
Please note: Questions 1-22 in this survey are part of a national initiative to measure the quality of care in hospitals. OMB #0938-0981

Please answer the questions in this survey about your stay at the hospital named on the cover letter. Do not include any other hospital stays in your answers.

YOUR CARE FROM NURSES

1. **During this hospital stay, how often did nurses treat you with courtesy and respect?**
   1 ☐ Never
   2 ☐ Sometimes
   3 ☐ Usually
   4 ☐ Always

2. **During this hospital stay, how often did nurses listen carefully to you?**
   1 ☐ Never
   2 ☐ Sometimes
   3 ☐ Usually
   4 ☐ Always

3. **During this hospital stay, how often did nurses explain things in a way you could understand?**
   1 ☐ Never
   2 ☐ Sometimes
   3 ☐ Usually
   4 ☐ Always

4. **During this hospital stay, after you pressed the call button, how often did you get help as soon as you wanted it?**
   1 ☐ Never
   2 ☐ Sometimes
   3 ☐ Usually
   4 ☐ Always
   5 ☐ I never pressed the call button

YOUR CARE FROM DOCTORS

5. **During this hospital stay, how often did doctors treat you with courtesy and respect?**

   [1] ☐ Never
   [2] ☐ Sometimes
   [3] ☐ Usually
   [4] ☐ Always

6. **During this hospital stay, how often did doctors listen carefully to you?**

   [1] ☐ Never
   [2] ☐ Sometimes
   [3] ☐ Usually
   [4] ☐ Always

7. **During this hospital stay, how often did doctors explain things in a way you could understand?**

   [1] ☐ Never
   [2] ☐ Sometimes
   [3] ☐ Usually
   [4] ☐ Always

THE HOSPITAL ENVIRONMENT

8. **During this hospital stay, how often were your room and bathroom kept clean?**

   [1] ☐ Never
   [2] ☐ Sometimes
   [3] ☐ Usually
   [4] ☐ Always

9. **During this hospital stay, how often was the area around your room quiet at night?**

   [1] ☐ Never
   [2] ☐ Sometimes
   [3] ☐ Usually
   [4] ☐ Always

YOUR EXPERIENCES IN THIS HOSPITAL

10. **During this hospital stay, did you need help from nurses or other hospital staff in getting to the bathroom or in using a bedpan?**

    [1] ☐ Yes
    [2] ☐ No → **If No, Go to Question 12**

11. **How often did you get help in getting to the bathroom or in using a bedpan as soon as you wanted?**

    [1] ☐ Never
    [2] ☐ Sometimes
    [3] ☐ Usually
    [4] ☐ Always

12. **During this hospital stay, did you need medicine for pain?**

    [1] ☐ Yes
    [2] ☐ No → **If No, Go to Question 15**

13. **During this hospital stay, how often was your pain well controlled?**

    [1] ☐ Never
    [2] ☐ Sometimes
    [3] ☐ Usually
    [4] ☐ Always

14. **During this hospital stay, how often did the hospital staff do everything they could to help you with your pain?**

    [1] ☐ Never
    [2] ☐ Sometimes
    [3] ☐ Usually
    [4] ☐ Always

15. **During this hospital stay, were you given any medicine that you had not taken before?**
    - [1] ☐ Yes
    - [2] ☐ No → **If No, Go to Question 18**

16. **Before giving you any new medicine, how often did hospital staff tell you what the medicine was for?**
    - [1] ☐ Never
    - [2] ☐ Sometimes
    - [3] ☐ Usually
    - [4] ☐ Always

17. **Before giving you any new medicine, how often did hospital staff describe possible side effects in a way you could understand?**
    - [1] ☐ Never
    - [2] ☐ Sometimes
    - [3] ☐ Usually
    - [4] ☐ Always

WHEN YOU LEFT THE HOSPITAL

18. **After you left the hospital, did you go directly to your own home, to someone else's home, or to another health facility?**
    - [1] ☐ Own home
    - [2] ☐ Someone else's home
    - [3] ☐ Another health facility → **If Another, Go to Question 21**

19. **During this hospital stay, did doctors, nurses or other hospital staff talk with you about whether you would have the help you needed when you left the hospital?**
    - [1] ☐ Yes
    - [2] ☐ No

20. **During this hospital stay, did you get information in writing about what symptoms or health problems to look out for after you left the hospital?**
    - [1] ☐ Yes
    - [2] ☐ No

OVERALL RATING OF HOSPITAL

Please answer the following questions about your stay at the hospital named on the cover letter. Do not include any other hospital stays in your answers.

21. **Using any number from 0 to 10, where 0 is the worst hospital possible and 10 is the best hospital possible, what number would you use to rate this hospital during your stay?**
    - [0] ☐ 0 Worst hospital possible
    - [1] ☐ 1
    - [2] ☐ 2
    - [3] ☐ 3
    - [4] ☐ 4
    - [5] ☐ 5
    - [6] ☐ 6
    - [7] ☐ 7
    - [8] ☐ 8
    - [9] ☐ 9
    - [10] ☐ 10 Best hospital possible

22. **Would you recommend this hospital to your friends and family?**
    - [1] ☐ Definitely no
    - [2] ☐ Probably no
    - [3] ☐ Probably yes
    - [4] ☐ Definitely yes

ABOUT YOU

There are only a few remaining items left.

23. **In general, how would you rate your overall health?**
    - [1] ☐ Excellent
    - [2] ☐ Very good
    - [3] ☐ Good
    - [4] ☐ Fair
    - [5] ☐ Poor

24. **What is the highest grade or level of school that you have completed?**
    - [1] ☐ 8th grade or less
    - [2] ☐ Some high school, but did not graduate
    - [3] ☐ High school graduate or GED
    - [4] ☐ Some college or 2-year degree
    - [5] ☐ 4-year college graduate
    - [6] ☐ More than 4-year college degree

25. **Are you of Spanish, Hispanic or Latino origin or descent?**
    - [1] ☐ No, not Spanish/Hispanic/Latino
    - [2] ☐ Yes, Puerto Rican
    - [3] ☐ Yes, Mexican, Mexican American, Chicano
    - [4] ☐ Yes, Cuban
    - [5] ☐ Yes, other Spanish/Hispanic/Latino

26. **What is your race? Please choose one or more.**
    - [1] ☐ White
    - [2] ☐ Black or African American
    - [3] ☐ Asian
    - [4] ☐ Native Hawaiian or other Pacific Islander
    - [5] ☐ American Indian or Alaska Native

27. **What language do you mainly speak at home?**
    - [1] ☐ English
    - [2] ☐ Spanish
    - [3] ☐ Chinese
    - [4] ☐ Russian
    - [5] ☐ Vietnamese
    - [6] ☐ Some other language (please print): _____

THANK YOU

Please return the completed survey in the postage-paid envelope.

[NAME OF SURVEY VENDOR OR SELF-ADMINISTERING HOSPITAL]

[RETURN ADDRESS OF SURVEY VENDOR OR SELF-ADMINISTERING HOSPITAL]

APPENDIX C: Factor Analysis Results

Correlation Matrix

		Com_Doc	Com_Med	Com_Nurs	Disch_Info	Pain_Mngt	Respons
Correlation	Com_Doc	1.000	.653	.687	.348	.647	.667
	Com_Med	.653	1.000	.782	.485	.699	.757
	Com_Nurs	.687	.782	1.000	.493	.840	.862
	Disch_Info	.348	.485	.493	1.000	.469	.452
	Pain_Mngt	.647	.699	.840	.469	1.000	.774
	Respons	.667	.757	.862	.452	.774	1.000
Sig.	Com_Doc		.000	.000	.000	.000	.000
(unilateral)	Com_Med	.000		.000	.000	.000	.000
	Com_Nurs	.000	.000		.000	.000	.000
	Disch_Info	.000	.000	.000		.000	.000
	Pain_Mngt	.000	.000	.000	.000		.000
	Respons	.000	.000	.000	.000	.000	

Anti-imagen Matrix

		Com_Med	Com_Nurs	Pain_Mngt	Respons	Disch_Info	Com_Doc
Covarians	Com_Med	,334	-,057	-,011	-,057	-,085	-,084
anti-imagen	Com_Nurs	-,057	,162	-,095	-,092	-,031	-,033
	Pain_Mngt	-,011	-,095	,275	-,034	-,045	-,049
	Respons	-,057	-,092	-,034	,229	-,002	-,042
	Disch_Info	-,085	-,031	-,045	-,002	,723	,028
	Com_Doc	-,084	-,033	-,049	-,042	,028	,473
Correlation	Com_Med	,929[a]	-,247	-,035	-,207	-,173	-,211
anti-imagen	Com_Nurs	-,247	,845[a]	-,450	-,474	-,090	-,119
	Pain_Mngt	-,035	-,450	,907[a]	-,134	-,102	-,136
	Respons	-,207	-,474	-,134	,895[a]	-,004	-,126
	Disch_Info	-,173	-,090	-,102	-,004	,953[a]	,049
	Com_Doc	-,211	-,119	-,136	-,126	,049	,952[a]

(MSA)

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Dean´s assistant, Universidad del Norte, Colombia, 2002-2003

Research Areas:

Knowledge Management, Health Care Management, Strategic Planning, Sustainability,

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