Knowledge Management in Primary Healthcare

by

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ABSTRACT

Canadian healthcare system is confronting some serious challenges. In addition to dealing with aging population with chronic health conditions, it faces the problems related to integration of information technology, uncoordinated care, and waste of valuable resources. There is also pressure on healthcare organizations to reduce cost while improving quality of health services. Since healthcare is a knowledge-intensive industry, appropriate management and use of knowledge can result in improved efficiency of service delivery methods. If implemented well, a proper knowledge management system can educate providers, streamline processes, and bridge care gaps; hence creating and sustaining optimal, cost-effective, and high quality healthcare outcomes.

Our first study is a cross-sectional survey conducted among primary care physicians of Edmonton. Since knowledge and skills of healthcare providers are among core competences of healthcare, the goal of our first study is to assess the effect of physician's personal characteristics (age, gender, years of experience) and practice characteristics (number of patients seen per day and technology usage) on their knowledge management adoption. Statistical results showed that there is no effect of physicians' personal or practice characteristics on their knowledge management adoption. We speculate that physician's attitude towards managing knowledge might be influenced by forces outside of the individual or practice settings. However, the result shows strong association between physicians' knowledge management adoption and their use of information and communication technology, proving that information and communication technology is a strong component of a knowledge management system.

Our second study is focused on the discovery of social and technical factors that affect and impede the coordination of health services. Two qualitative research methodologies, namely, observations and semi-structured interviews are used to understand the workflow related to the management of patient-specific information in a Primary Care Network of Alberta. Results showed there are various technical and behavioural impediments in the smooth transfer of information between clinics. We recommend several knowledge management solutions that have the potential to streamline processes and improve coordination.

Both studies offer some general insights for consideration within the healthcare setting in a direct and/or indirect way. However, exploring adoption of knowledge management in other domain of care is required as well.

PREFACE

This thesis is an original work by Aasia Anwar. The research project, of which this thesis is a part, received two ethics approval from the University of Alberta Health Research Ethics Board (HREB). The name of our first study is “Evaluation of Knowledge and Information Management System” (study no. Pro00021714). The name of our second study is “Adoption of Knowledge Management Activities in PCN” (study no. Pro00034273).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1.

INTRODUCTION

1.1. The Case for HealthCare Knowledge Management

Healthcare organizations are facing various challenges in the 21st century. Increased emphasis on reducing cost while improving quality, increased awareness and empowerment of healthcare consumers regarding the delivery of health services [1], problems in the adoption of health information technology by providers [2], are just a few to name. Aging population with complex health conditions such as obesity and chronic diseases place an increasing burden on primary care systems in many countries including Canada [3,4]. By 2026, seniors are expected to make up 21% of the population and consume a staggering 60% of healthcare expenditures [5]. Adult obesity is not the only concern; obesity is growing in children too [6,7,8]. In 2004, 6.8 million Canadians aged 20 to 64 were overweight and another 4.5 million were obese [9]. These factors are creating a gap between patients' rising demand for primary care and physicians' capacity to supply it. Therefore, there are gaps in care pathways, long wait times for patients, and waste of valuable resources due to duplication of effort.

Several strategies are being implemented to address the supply and demand gap at the primary care level in Canada. *Primary care reform* strategies include disease prevention, health promotion, use of interdisciplinary teams in care delivery, a shift towards integrated and coordinated care, as well as the use of *information and communication technology* (ICT) in primary care [10]. *Knowledge Management* (KM) is a concept that

has been applied in other settings to explain performance differences among organizations and improve outcomes [11]. Evolved from practice associated with reengineering and quality movements [12], yet grounded in theory from social sciences, KM can be a healthcare reform that can assist primary care to meet the challenges of a rapidly changing health care system.

A KM system is generally understood to be ***a set of disciplined actions that aligns people, processes, data, and technologies in order to drive organizational performance*** [13]. In the context of healthcare it can be defined as ***systematic, modeling, sharing, operationalization, and translation of healthcare knowledge to improve the quality of patient care*** [14]. The underlying objective here is to bring the right knowledge to the right person at the right time so he or she can make well-informed decisions and accelerate patient care.

A KM initiative taken by healthcare organizations involves variety of social and technology-oriented activities including but not limited to [15]:

- Creating an information system that can link consumers, providers, and payers across the continuum of care,
- Educating and training providers, patients, and employees,
- Facilitating multiple channels of knowledge transfer to multiple stakeholders,
- Streamlining processes,
- Adopting ICT for capturing and transferring knowledge, and
- Facilitating sharing of knowledge and collaboration among providers.

An efficient KM system has a potential to minimize duplication of medical tests, which is a major problem in Canadian healthcare [16], hence reducing cost. It also allows one to harness the strength of knowledge and then deploy it to decision makers, creating and sustaining optimal and high quality healthcare outcomes. However, KM literature shows that several KM initiatives resulted in implementation failure or unintended consequences [17]. The literature also provides evidence of implementation failures due to lack of adoption by users and various social and technical factors (e.g., [2]). In healthcare, there is a growing emphasis on knowledge, skills, and attitudes of physicians necessary for patient care and are considered as core competences of business. Since physicians are the key players of the healthcare system, adoption of KM system by physicians will determine it's overall success.

1.2. Study Objectives

In the light of the above discussion, principal objectives of this thesis are to:

1. Determine individual and practice characteristics of primary care physicians affecting their KM adoption, and
2. Determine social and technical factors responsible for gaps in care coordination, and potential KM solutions to fill the gaps.

Hence our research questions toward our two goals are:

1. What are some individual and practice characteristics of primary care physicians that can affect their KM adoption? and

2. What are some social and technical factors affecting coordination of health services in primary care, and potential KM solutions to improve coordination?

For study 1, physicians' age, gender, year of experience, and the number of patients they see everyday will be explored among primary care physicians practicing family medicine across Edmonton by using a survey tool for polling sample population. For study 2, workflow regarding patient-related information management, of a *Primary care network* (PCN) in Edmonton, Alberta will be explored.

1.3. Study Approach and Document Structure

This M.Sc. program of study started with participation in several Engineering Management and Public Health courses to inform the author's knowledge of management and healthcare related topics. Courses, seminars, and self-directed study reviewing the topics of KM, healthcare systems, healthcare policy, adoption of ICTs, intellectual property, ethics, and research methods, formed the foundation of this work. The topic of the research is introduced in CHAPTER 1 with specific research objectives. Literature review of relevant academic domains (described in CHAPTER 2) is done first which formed the basis for the study. Statistics, sampling, observation, and other research methods were practiced. Following this, CHAPTER 3 describes the methodology used to conduct our first study. This utilizes a survey tool for polling a sample population. Development, testing, and implementation of the survey instrument are explained. CHAPTER 4 consists of the context and description of our second study. Methods to conduct the research i.e., observations and semi-structured interviews along with the role of observer and interviewer are described. CHAPTER 5 contains the discussion of results

from both studies, contribution of this research to primary healthcare, study limitations, and recommendations for future research. Original questionnaire, study information sheet, and recruitment letter can be found in Appendix A, B, and C respectively.

CHAPTER 2.

BACKGROUND AND LITERATURE REVIEW

This chapter offers a detailed review of the fundamental concepts that were explored in the development of the study and set the stage for it.

Firstly, the basic concept of *knowledge* and *knowledge hierarchy* is explained. The term knowledge is ambiguous and different scholars have explained it in their own context. The process of knowledge conversion is described which is the underlying phenomenon in every activity that involves human interaction. The concept of knowledge management is then explained followed by what constitutes a KM system. Each component of the KM system is then elaborated upon with an emphasis on KM processes; methods by which knowledge is created, categorized, and made accessible in an organization. We concluded by explaining the importance of organizational culture in the creation and transfer of knowledge. To cap off the discussion about KM, we explained the importance of organizational knowledge as a competitive advantage for business, and the problem of knowledge obsolescence associated with it.

Later in the chapter, challenges faced by the Canadian healthcare system in the 21st century are explored, beginning with a discussion of primary care. This is followed by a detailed discussion of the potential benefits of KM system to Canadian healthcare in confronting those challenges.

Through this review process, we were able to formulate hypotheses that not only linked these concepts, but extended the current literature on KM and its role in healthcare sector. The literature review also ensured that the proposed research was novel and unique in terms of direction taken.

2.1. Knowledge

Knowledge is an abstract concept that is related to individual learning as well as social and cultural context. It is the product and capabilities of human mind. It is what people know and can do. Solutions to problems, problem solving skills, scientific theories, engineering designs, software, problems, management skills, work processes, and organizational and professional practices are examples of knowledge. In organizations, knowledge is expected to produce future benefits like economic value or performance improvement.

Here we are presenting multiple definitions of knowledge as described by different scholars:

- "Knowledge is a fluid mix of framed experience, contextual information, and expert insight that provides framework for evaluating and incorporating new experiences and information" [18].
- "Knowledge is the general understanding and awareness gathered from accumulated information, tempered by experience, enabling new contexts to be pictured" [19].
- "Knowledge gives wisdom and the ability to act wisely. Information becomes knowledge when it is interpreted by individuals, given a context, and anchored in the beliefs and commitments of individuals" [20].

2.2. Knowledge Hierarchy

Knowledge hierarchy represents purported structural and/or functional relationships between data, information, and knowledge. To have a complete picture of the concept of knowledge, it is essential to have an understanding of data and information. Data is a raw set of facts, images, and sounds about an event. Data are patterns with no meaning. They are input to an interpretation process, i.e., to the initial step of decision-making. Information is formatted, filtered, and summarized data. When data is contextualized, has meaning, and can be communicated, it becomes information. Information can produce knowledge. It is the output from data interpretation and input to the knowledge-based process of decision-making [21]. For data to become information, an interpreter is required. In the data interpretation process, a human decision maker typically uses his cultural background, unconscious intuitions, concrete memories of similar observations in the past, expectations triggered by the specific context, as well as text book knowledge and domain dependent heuristic rules, to determine the contextual meaning of data [21]. Once the data has been given an interpretation as information, it is elaborated upon in order to be better understood and for deriving new information [21]. The elaboration process is the actual problem solving process, i.e., where the core decision-making takes place [21].

Learning is the integration of new information into an existing body of knowledge that produces new knowledge in a way that makes it potentially useful for later decision-making. Knowledge has, therefore, the potential to change human behaviour. This whole process of transforming data into information and then into knowledge is illustrated in Figure 1.

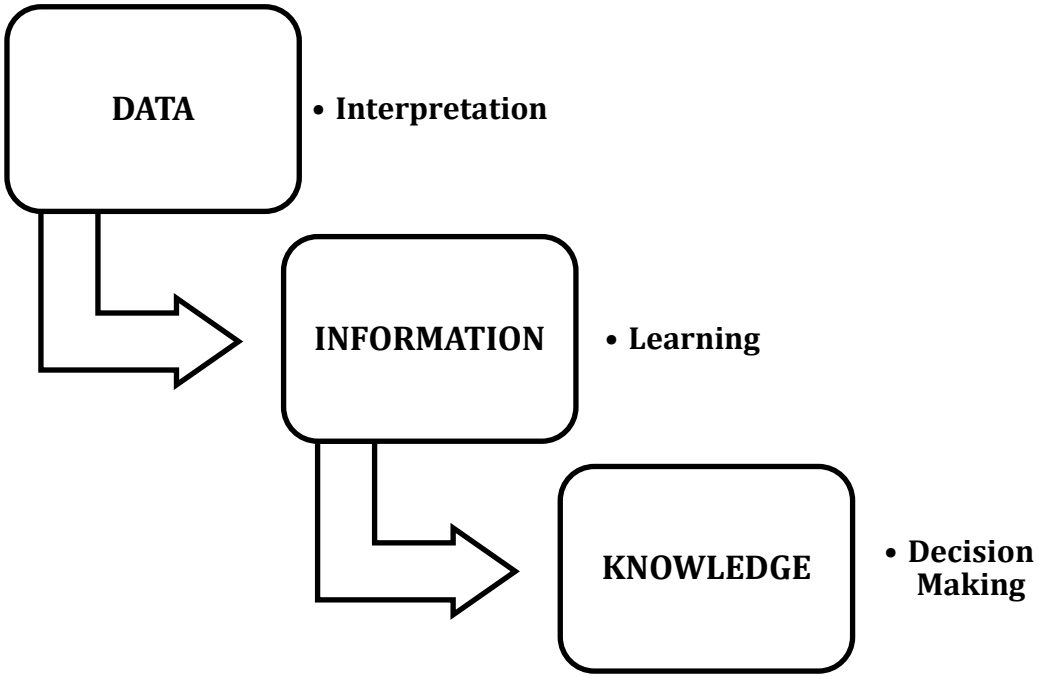

Figure 1: Knowledge Hierarchy (Adapted from [21])

2.3. Knowledge Types and Conversion

Depending on the way it is created and the possible ways of expressing it, knowledge can be categorized as *tacit* and *explicit* [22]. Tacit knowledge includes both the experiences and understanding of the people in the organization. It is embedded in human mind and is often called the "know-how"[23]. Experts display this type of knowledge who makes judgments usually without making direct reference to a framework that can explain what they are doing [24]. It cannot be expressed in words, formulae or in any other way and cannot be easily exchanged through formal processes. In a healthcare setting, it is a meaningful and important source of information that influences the decisions and actions of physicians and surgeons [25].

Explicit knowledge, on the other hand, consists of information artefacts such as documents and reports available within organization and world outside. This knowledge can be described as "know-what"[26]. It can be articulated, codified, and stored in a certain media. It can be easily communicated, processed by a computer, or transmitted electronically. Medical databases, repositories, online and printed journals are examples of this type of knowledge.

Taking into consideration the respective characteristics of both types of knowledge, organizations usually adopt two distinct strategies to manage them: *personalization* and *codification* [27]. Personalization is sharing of knowledge through interpersonal communication, whereas codification is storing and indexing of knowledge in databases for later retrieval and use. In contrast to codification, it is impossible to formalize fully the depth of tacit knowledge through the process of personalization because it is embedded in actions that are not easily communicated [28].

The work in [29] presents the description of knowledge in an organizational context. Its essence is that successful innovation comes from mobilization and conversion of tacit knowledge through four modes of knowledge conversion: *Socialization, Externalization, Combination and Internationalization (The SECI Process).* He argues that all four directions exist in an organization that supports KM. The *knowledge spiral* or the SECI process is shown in Figure 2.

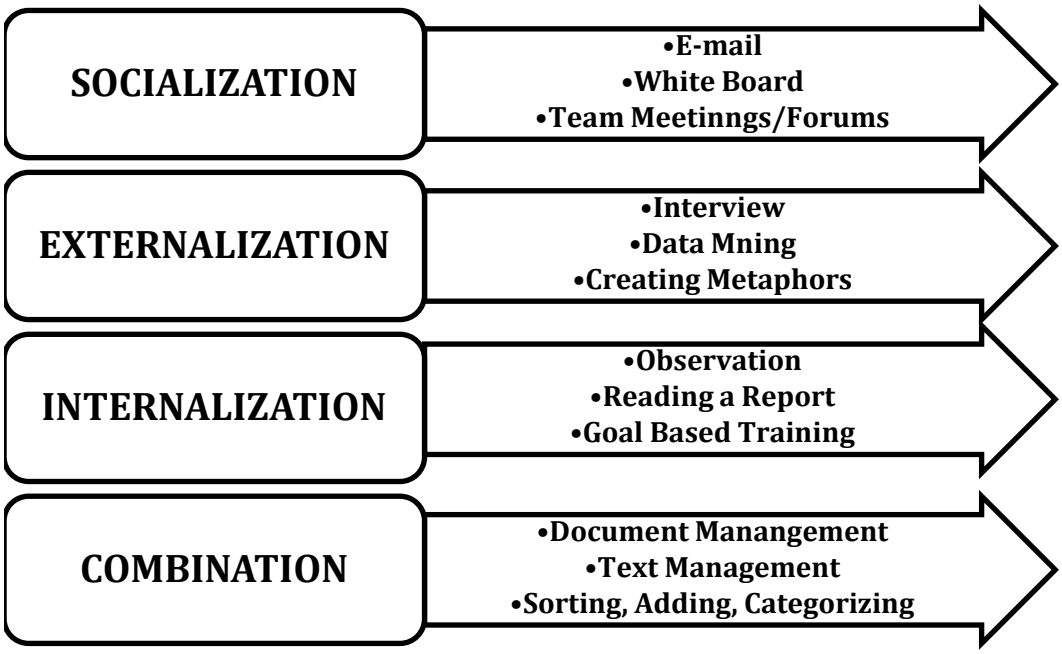

Figure 2: Knowledge Conversion Process (Adapted from [29])

2.3.1. Tacit to Tacit (Socialization)

Socialization takes place as tacit knowledge is transferred from one person to another. This is done through sharing experiences, discussion, debate, and brain storming sessions. Learning skills through observation is an example of tacit-to-tacit conversion.

2.3.2. Tacit to Explicit (Externalization)

When tacit knowledge is articulated and expressed, it becomes explicit. Metaphors, models, and analogies are useful for transferring knowledge from tacit to explicit. In this process people express their knowledge in a new way and thus articulate what they cannot say. When a new innovative approach is developed by an employee based on his/her tacit knowledge gained after years of experience, it is an example of tacit to explicit conversion.

2.3.3. Explicit to Explicit (Combination)

Explicit knowledge can be converted into explicit by collecting and synthesizing existing knowledge. In an organizational context, the exchange can occur through documents or through electronic means. When a manager collects information from throughout an organization and puts it into a financial report, it is an example of explicit to explicit knowledge conversion.

2.3.4. Explicit to Tacit (Internalization)

If articulated, knowledge can be used further by an individual hence it becomes tacit again. This conversion of knowledge takes place through “learning by doing”. When

other members of the organization use an innovation by an employee, as a tool or resource to do their job, internalization or explicit to tacit conversion takes place.

2.4. Knowledge Management (KM)

Knowledge management is a discipline that has emerged in tandem with the establishment of "knowledge economy"; the emergent economic era in which intellectual, rather than physical capital, is the principle source of wealth and power. Researchers and practitioners are motivated to unlock the potential of knowledge supposedly lying dormant within the organization because they believe that if intellectual capital of organizations is put to work effectively it can create unique competitive advantage. KM is the name given to the set of systematic and disciplined actions that an organization can take to capture, distribute, store, and organize its knowledge assets and make it available to others. It is understood to be an umbrella term encompassing the many unique but related facets of knowledge; exchange, transfer and uptake among them. While there is no universally accepted definition of KM, most are extremely similar. Some of which are:

- "KM is a process by which an organization uses its knowledge assets to create value for stakeholders" [30].
- "KM is a practice of aligning people, processes, data and technologies in order to drive organizational performance and growth" [31].
- "Good KM is getting the right knowledge to the right person in the right format and at the right time" [31].

In the context of our research, KM can be defined as ***the systematic process, by which an organization creates, captures, acquires, and uses knowledge to support and improve the performance of the organization*** [32].

In order to build the context in which an efficient healthcare KM framework would exist, an understanding of basic knowledge-related terminologies must be established, as well as some background on the quality of healthcare and the role played by KM.

2.5. Knowledge Management Components

The goal of KM is to implement a process that can deliver the right content to the person who needs it and when they need it. It includes linking individuals to each other through systems and structures that help organizations to recognize, create, transform, and distribute knowledge among all knowledge workers. There are four core components or characteristics of an organization that must be examined as part of the process of embracing a KM approach as shown in Figure 3. These include the:

- Nature of the organizational culture,
- Processes that are used to collect, manage, and disseminate information,
- Condition and availability of the content of the organization, and
- Technology infrastructure.

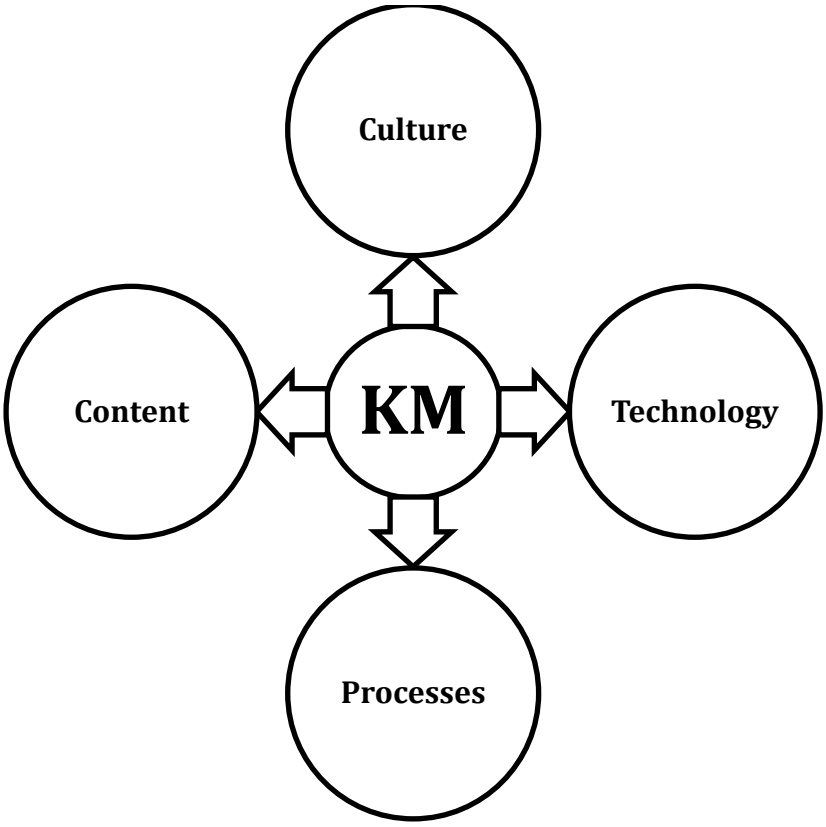

Figure 3: Knowledge Management Components

2.5.1. Content

Content is the knowledge to be managed. Data, information, skills, and expertise can be thought of as the content resources of an organization. Data may need to be reformatted, translated or integrated to optimize use. It should be packaged and presented in targeted ways tailored to the user-specific needs and interests. A good content management ensures that users receive quality information that is relevant, up-to-date, accurate, easily accessible, and well organized. Core to a content management strategy is to develop a centralized knowledge library with various layers of information. Its development

requires a thoughtful plan for determining what types of content to be published, levels of security access, publishing formats, and processes for ensuring that the content posted is accurate, up-to-date, and consistent. It is also required to develop a schedule for refreshing the content so that employees and other associates find a reason to continually refer to the knowledge library as a renewable resource.

According to [33], any KM system has the following activities related to content:

- **Collecting the content.** It should come from both internal and external sources,
- **Using the content**. It includes the technology for finding, accessing, and delivering the content to users (e.g., search engines), and
- **Managing the content**. It involves collecting the right content, finding sources for content, and selecting the best technology to deliver the content.

2.5.2. Processes

KM processes are the activities or initiatives that are put in place to enable and facilitate the creation, sharing, and use of knowledge for the benefit of organization. These processes consist of four steps that are described in the next section and illustrated in Figure 4.

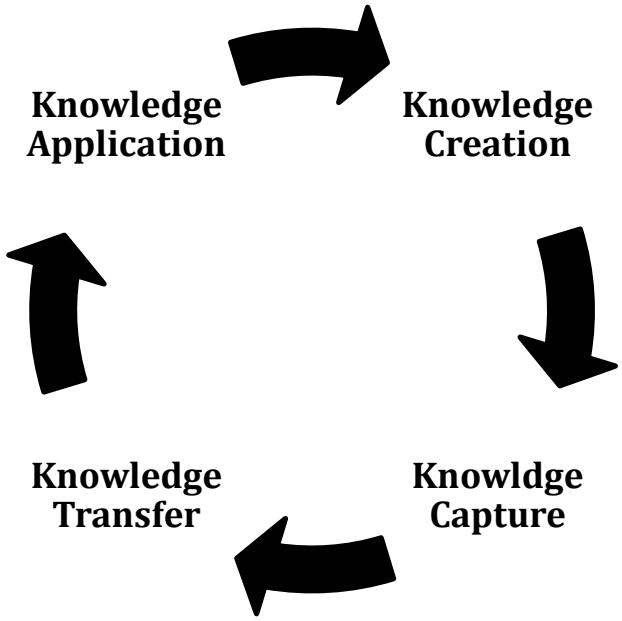

Figure 4: Knowledge Management Processes

2.5.2.1. Knowledge Creation/ Elicitation

Knowledge creation involves two sub processes: Collection of existing knowledge and Development of new knowledge. Collection of existing knowledge consists of establishing a system to discover and gather the knowledge that already exists within the system and organize it to make it accessible, and ensure that the system supports the knowledge base to do the job. It includes processes that allow organizations to make use of the knowledge objects that may be present, but are not codified and are not accessible to members yet. This process concentrates mainly on technical tools, but can also be found in socially directed tools employed to connect individuals with existing knowledge sources or with one another. An example of knowledge collection is recruiting new staff. New staff brings with them their unique knowledge and skills. Buying of book and medical journals also contributes to the collection of knowledge.

Development of knowledge describes processes that allow organizational members to create new understandings, innovations, and a synthesis of what is known already or is new to them. It is carried out by training of staff, conducting courses or seminars and by giving the staff the opportunity to subscribe to specialist journals or other media with the costs reimbursed. However, the organization cannot create knowledge on its own without the initiative of the individual and the interaction that takes place within the group.

This reliance on socialization is what differentiates KM from information management.

2.5.2.2. Knowledge Capture/Storage

The challenge is not just to create new knowledge but to capture, represent, model, organize, and synthesize the different modalities so that they are accessible at the point where they are needed. This process is related to the concept of *organizational memory.* To enable storage, knowledge must be codified in a machine-readable format. Codification of knowledge calls for transfer of explicit knowledge in the form of paper reports or manuals into electronic documents, and tacit knowledge into explicit form first and then to electronic representations [34]. This means that knowledge is extracted from the person who developed it, is made independent of that person, and reused for various purposes. Codified knowledge has to be gathered from various sources and be made centrally available to all organizational members, for instance, in the form of knowledge repositories with search capabilities to enable ease of knowledge retrieval. In a healthcare setting, a repository might include online journals and databases, care protocols, interpretive digests prepared by physicians, formularies of approved drugs, and even online medical textbooks.

2.5.2.3. Knowledge Transfer/Dissemination

Transfer of knowledge takes place at different levels, among individual employees, between an individual and a group, within groups, across groups, from groups to whole organization, and can be formalized and informal. It includes processes to improve the willingness and ability of knowledgeable organizational members to share what they know and to help others expand their own learning and knowing. In a healthcare setting, knowledge transfer/sharing should spark innovation, improve operational processes, and

enhance patient care. It should also minimize medical errors due to learning from one's own and other people's experiences. Thus, related to knowledge transfer is the idea of skills or capability transfer. This suggests that organizations must consider the connection to E-learning, other educational programming tools, leadership development programs, and transfer of best practice [35].

Although technical tools have been utilized to facilitate knowledge sharing, this process involves more social ones directed at encouraging organizational members to talk about things they already know. Because tacit knowledge tends to be more difficult to codify, interaction or personalization tools such as interviews, discussion forums, brown bag lunches, mentorship, etc., are critical.

2.5.2.4. Knowledge Application/Exploitation

The process of knowledge application is the usage of created knowledge in a particular context. A KM system produces value in organizations only when the stored and codified knowledge is used and exploited for decision-making process. These applications can be predefined routines that are repetitive or it can be random decision-making scenarios. In the healthcare context, an example of this process would be the use of current scheduling routine and knowledge of each individual's skill sets for devising optimal scheduling plan for nurses.

2.5.3. Technology

Technology plays an important role in KM systems, although KM is not all about technology. The goals of KM projects emphasize on value-added for users and not simply

delivery and accessibility of information. These projects support an organization's improvement and innovation and not just it's existing operation. Therefore, technology is not the only driving force of KM, but a mix of technology, people, and process are needed for its success.

The most valuable role of technology in KM is broadening the reach and enhancing the speed of knowledge transfer. It acts as a facilitator to assist individuals and groups in the creation, capturing, and distribution of knowledge. In the form of hardware or software, it enables knowledge generation, codification, and transfer. It allows resources to be applied efficiently to the tasks for which they are most suited. For instance, it enables physicians to coordinate the logistics of face-to-face meetings. It can also be used to catalogue expertise of surgeons. Computer-mediated communication such as e-mail or video-conferencing can help to maintain continuity and connection between conversations, especially for healthcare providers in different locations. It is essential that information can be accessed from anywhere in the health system, even in remote locations, to facilitate seamless communication between care providers. Before selecting a solution, organizations need to clearly define their KM strategy, scope and requirements, and should evaluate available technology products to identify those that meet their needs.

From the KM perspective, technology has three primary functions [36]:

- Facilitating communication and collaboration,
- Providing the infrastructure for storing tacit and explicit knowledge, and
- Assisting with mapping of disbursed bits and pieces of tacit and explicit knowledge.

Organizational learning takes place as individuals use ICTs, since by doing so knowledge is shared, articulated, and made available to others. ICTs can be classified by reference to the functions they are able to perform. Some of which are:

- **Content Management.** Content and repository management can be in the form of a content database, content metadata management, and core library services with check-in and security features,
- **Collaboration.** Collaboration of providers beyond physical and geographic boundaries is important for better patient care. This can be supported by technologies like asynchronous collaboration, threaded discussions, calendaring, scheduling, and e-mail. Synchronous collaboration supportive functionalities include chat and instant messaging, white boarding, application sharing, and Web presentations. Blackboard and Healthstream are two examples of collaborative software,
- **Information Organization and Retrieval.** Technology facilitating organization and retrieval of information include functionalities like automated or manual taxonomy creation, automated or manual document categorization, document indexing, and search of various levels of complexity and sophistication. SQL database is one of the examples of such type, and
- **Expertise Location and Management.** Expertise location and management captures content produced by experts as well as users' skills, and connects them to each other. It becomes a major element in supporting and managing dispersed tacit knowledge. One example is Communispace; a software that provides online consumer insights communities for market research ultimately linking consumers to brands.

The adoption of technology by an organization, however, has enormous effect on organizational routines and workflow. In healthcare, the disruption in workflow caused by the intervention of technology is the reason behind lack of engagement of providers in its implementation process. Physicians want to minimize interference in the way they practice medicine, so they require technology to be user-friendly, easy to learn, and secure. When workflow changes, it results in organizational unpredictability and the quality of care may be compromised [37]. According to the *Technology Adoption Model* (TAM) [38], there are two possible reasons for people resisting in adopting technology; when they have little confidence that the intervention will be effective, and when the recommended measures are perceived to be too complicated or difficult to carry out. The corresponding technology should be custom developed specifically to fit the workflow of the organization; otherwise, one, or both the software and the workflow should be modified to optimize the fit. The optimized technology can be envisioned as an extension of the employee's own knowledge and can promote experimentation and mutual learning.

2.5.4. Culture of Organization

Culture of an organization comprises of its employee's beliefs, assumptions, values, norms and patterns of behaviour [39]. Seeing through a KM lens, culture is the employees' mindset about sharing their own knowledge with others, about learning from other's knowledge and experiences, and about maximizing the use of available technology in knowledge transfer process. The aim of a knowledge-friendly culture should be to bridge the knowledge silos within and between specialties and to support their functions. This includes organizational policies about encouraging knowledge

sharing practices through education, rewards for workers, and tolerance for their mistakes. A knowledge sharing culture demands committed and visible leadership with clear communication processes. Leaders are important as role models to exemplify the desired behaviour. They should, for example, exhibit a willingness to share and offer their knowledge freely with others in the organization. They should be open to continuously learn and to adapt to the new system. They need to promote the new vision among their staff by helping them to take ownership of the processes, assisting them to recognize the importance of learning and how it contributes to the overall knowledge integration goal.

Trust is also a fundamental aspect to create a learning culture. Without a high degree of mutual trust, people will be sceptical of the intentions and behaviour of others, and thus, they will likely withhold their knowledge. Building a relationship of trust between individuals and groups will help to facilitate a more proactive and open knowledge sharing process. Organizations with culture that does not value and support knowledge sharing will be less likely to adopt and integrate KM system.

Some of the steps that can be taken by the management in order to flourish a knowledge sharing culture in the organization are [40]:

- Recognizing the value of both generalists and experts,
- Creating position descriptions for people whose job primarily is to administer the process of sharing or distribution of knowledge,
- Implementing informal methods like networking and formal methods like lectures by experts, conferences, and communities of practice,

- Nurturing an environment where sharing knowledge and working across organizational boundaries are seen as enhancing job security,
- Practicing explicit mechanisms for recognizing and rewarding such leadership that reflects understanding and support for knowledge integration,
- Creating environments in which people are encouraged and supported to challenge and change practice based on evidence that they trust e.g. finding mechanisms to give voice to people who are traditionally silent within the system (in a healthcare context, it can represent patients or staff who continue to work in hierarchical working environments),
- Implementing comprehensive communication strategies that support interpersonal interaction (e.g., communities of practice, web-based technologies and video teleconferencing),
- Matching the strategy to the context (e.g., strategies that work well in acute care settings may be ineffective in community care), and
- Embedding research and evaluation in practice settings and strengthening linkages with universities.

2.6. Organizational Knowledge: A Competitive Advantage

The business environment has passed through severe changes, especially during the decades of 1980's and 1990's. The intense global competition and the economic and industrial growth have stimulated the companies to seek and maintain competitive advantages [41]. The resource-based view of the firm has been introduced [42] which

suggests that firms should position themselves strategically based on their resources and capabilities rather than the products and services derived from those capabilities. Researchers have argued that an organization's core competences lay at its centre [43]. Intangible resources such as the firm's organizational knowledge have become increasingly acknowledged as having great strategic importance. This knowledge tends to be context-specific and it is embedded in complex organizational routines and developed from experience. [44]. From this perspective, organization's knowledge is considered to be its core competences and a significant source of advantage for organizations as each company creates its unique knowledge according to its people, structure, culture, history and industry. According to several researchers [45][46], the particular ways in which a firm facilitates and manages its knowledge, both institutional and practical, plays an important part in its long-term capability to achieve sustainable competitive advantage. Competitive advantage is achieved through developing and implementing both creative and timely business solutions that reuse applicable knowledge. For instance, pharmaceuticals like Eli Lilly has led in the area of knowledge sharing by its strategic decision to emphasis alliances with universities and biotechnology firms. They have developed tools that identified gaps in knowledge sharing and allowed effective remedial action to take place; in this case a discussion database that overcame geographic dispersion of partners. Hoffmann-LA Roche and Johnson & Johnson have benefited from their KM projects by hastening the drug approval process, through better documentation [47].

2.7. The Problem of Organizational Knowledge Obsolescence

Organizational knowledge has to be continually expanded and updated in order for the organizations to maintain competitive advantage. The problems imposed by the expansion of new knowledge may also be compounded by the deterioration of previously held knowledge or *knowledge obsolescence*. Likert pioneered the idea of *human asset accounting*, which states that the productivity of an organization's employees should be reflected on the balance sheet of the firm and depreciated over time [48]. Sikula presented the concept of *half-life*. The half-life idea describes the situation that exists when half of the relevant knowledge in a particular area or expertise has eroded away or become obsolete because of scientific innovations and discoveries [49]. Workers experience great loss of value when their knowledge becomes obsolete [50].

The element of continuing education plays its role to avoid knowledge decay, for instance, it is possible to significantly increase a physician's half-life and neutralize the impact of technological advances if relevant continuing education courses are made available to physicians in practice.

Knowledge obsolescence also takes place when organization's ICT environment changes. In the case of change in workplace ICT environment, job-specific obsolescence is the most significant major change that occurs in individuals' work processes. The challenge of adaptation to new technology affects the organization in many ways. It puts great pressure on employees to adapt in all organizational areas. In addition to the initial obstacles of acquiring technological knowledge in the workplace, it is also critical to adapt to the constant change and subsequent knowledge obsolescence that occurs. These

changes can further reduce one's willingness to adapt and thus decrease efficiency of learning. The need is to update the knowledge of people who had worked in an almost constant environment for a long time.

There are various means a company can use to help its employees overcome the difficulties of learning new technologies and overcome knowledge obsolescence. The most obvious means is of corporate training. This can take place through various ways depending on the requirements of the new technology and associated knowledge required. Some examples are classroom training, workplace coaching, and Internet-based self-studies. KM tools like experience-sharing, expert directories, discussion opportunities, codified knowledge repository, blogs, online-communities, and RSS feed are all effective in overcoming the problem of knowledge obsolescence.

2.8. Canadian Healthcare System Challenges

Changes pressurize healthcare organizations to find more effective ways of providing high-quality services to patients, and cost is becoming a critical factor of success. In this context, a proper KM system seems to be useful from the perspective of both the organization and the employees. However, in order to understand the potential benefit that a KM system can provide to the healthcare, it is essential to first recognize the multiple challenges faced by the healthcare organizations in the 21st century.

2.8.1. Paradigm Shift

A paradigm shift is taking place in the methods of healthcare delivery (Table 1). Changes in the infrastructure of healthcare services and health technologies are taking place.

Ubiquity of personal computers and the use of Internet have spread medical information to the general public. Such information was only available to medical professionals in the recent past. This new paradigm has a potential to change awareness, behaviour, and expectations of patients and people related to healthcare service production, provision and consumption [51]. At the same time a higher level of efficiency in healthcare service management is expected, as is a reduction in cost. These factors are responsible for a revolutionary change, from a provider-centred healthcare delivery structure to a patient-centred one that regards patients' expectation and needs as its highest priority.

Table 1: Paradigm Shift in Healthcare (Adapted from [51])

20^{th} Century	21^{st} Century
Professional control and responsibility	Shared control and responsibility
Single professional	Teams
Expertise	Accountability
Institution	Network
Service	System
Paper	Digital
Finance as Key Constraint	Knowledge and People as Key Constraints
Quantity	Quality
Centred on Professionals	Centred on Patients
Care based on visits	Care based on continued healing
Information is a record	Knowledge is shared freely
Decision making is based on experience	Decision making is based on evidence
Safety is an individual responsibility	Safety is a system property

2.8.2. Growth of Medical Knowledge

Healthcare is one of Canada's most knowledge-intensive industries with approximately 2,000 transactions per minute [52], all requiring documentation and information sharing. There are approximately 7,000 prescription drugs based on some 3,500 active ingredients and some 20,000 medical journals available to physicians [53]. This accelerated growth in medical knowledge means that keeping up with rapidly emerging knowledge is challenging and leaves less time for the actual care of patients as it is experiencing an exponential growth in the scientific understanding of diseases, treatments and care pathways. As a consequence, new healthcare knowledge is being generated at a rapid pace and its utilization can profoundly impact patient care and health outcomes. Whereas this speed of scientific discovery poses a great challenge, the evolving knowledge that translates into effective diagnostic and prognostic devices and treatments is important to improve the quality of health services.

Research has shown that the inability of physicians to access and apply current and relevant patient-care knowledge leads to the delivery of suboptimal care to patients. For instance, The Institute of Medicine (IOM) in its report titled "To Err is Human" stated that more than 98,000 deaths each year are attributable to medical errors in USA [54]. The underlying reason is inappropriate drug information. Major initiatives have been undertaken to improve patient safety. The IOM called for the reform of the healthcare delivery system by drawing attention to the alarming rate of medical errors in hospitals, where mistakes are made because of inadequate processing of critical knowledge at the

point of care [55]. In an international survey of adults with health problems, administered by the Commonwealth Fund Canada in 2007, one in six Canadian respondents reported having experienced at least one error in the past two years [56].

These reports show that capturing, cataloguing, and retrieving clinical information that affects patient care is a critical issue faced by the health sector today. Healthcare has not achieved the expected success because of the difficulty of acquiring and delivering relevant and meaningful knowledge and maintaining it up-to-date in a cost-effective manner.

2.8.3. Cost Escalation

One important characteristic of the health care sector resides in the cost escalation challenge. For instance, in U.S., the total health spending was 18.4 percent of GDP in 2013 [57] and in 2006, Canada spent $148 billion on health services which accounts for more than three times the expenditure on health services in 1975 [58]. Worldwide, the rising cost of health care is pushing governments to find more efficient and less costly ways to deliver care. One of the factors contributing to the rise of health care cost is the surge in chronic diseases. Global chronic diseases related deaths were estimated to be 35 million out of 58 million annual global deaths in 2005. The number of people that die annually from cardiovascular diseases is almost twice the number of people who die from all infectious diseases combined (e.g., AIDS, tuberculosis, malaria)[59]. By 2015, Canada alone will have, for the first time in its history, more people having an age of 65 and above than people having an age under pushing the number of patients with chronic diseases to the rise [60].

2.8.4. Gaps in Coordination

Integration of the health system involves coordination of health services, facilitation of collaboration among providers, an effective information system that can link consumers, providers and payers across the continuum of care, and provision of variety of information to multiple stakeholders. Coordinated care appears to be associated with a number of positive outcomes, including improved system performance, better clinical results, enhanced quality, and patient satisfaction. Coordinating services is a necessary part of improving patient care and efficiently using scarce resources. Coordination as a focus of study has been evolving in Canada. In Alberta, the establishment of Alberta Health Services (AHS) in May 2008 created an opportunity to review what had been and could be achieved in integrating health services to improve the quality and outcomes of health services delivered within the province.

However, despite of the efforts towards a coordinated care, there are still gaps in Canadian healthcare. According to a report submitted by Commonwealth Fund [61] in 2012, 50% of Canadian patients experience gaps in coordination of care when they are discharged from the hospital, 25% of them experience problems with availability of their medical tests and records at the point of care, and about 15% of physicians do not communicate with other physicians about the care of the same patient (Figure 5).

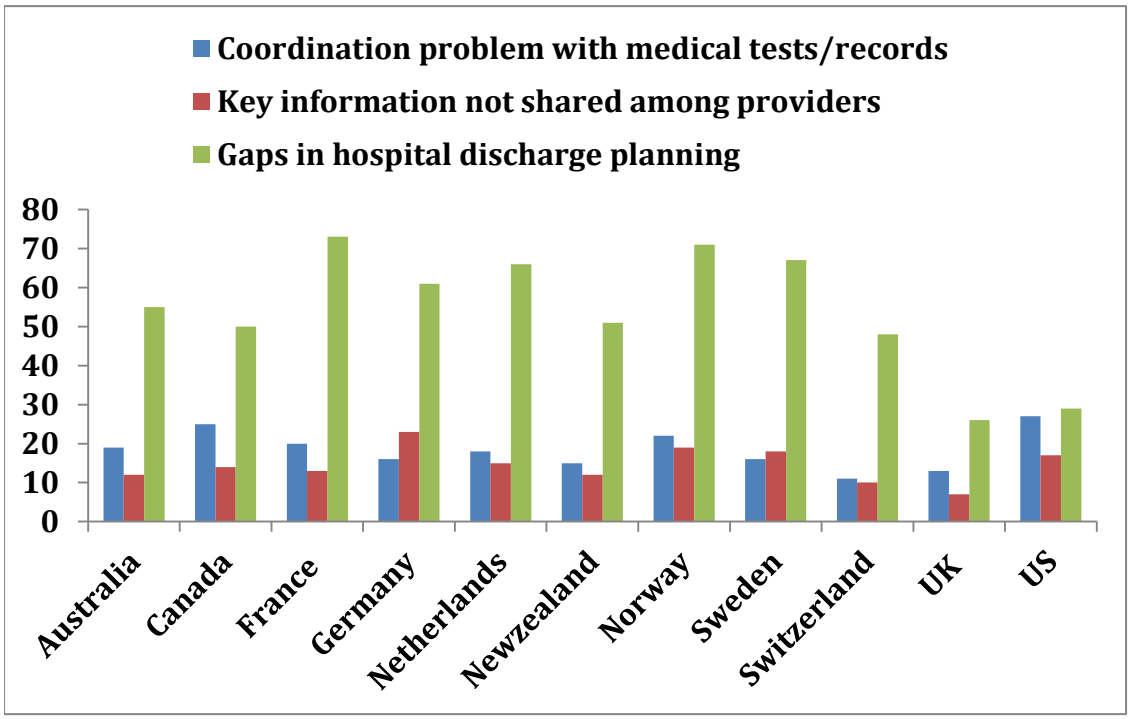

Figure 5: International profile for healthcare system [61]

Primary care and specialty care are not well coordinated, with a little communication between family doctors and specialists. Medical histories of patients discharged from hospitals after treatment are not regularly conveyed to their family doctors, and vice versa. Patients often have to repeat their health history to each provider they encounter, and all too often, a patient undergoes the same test multiple times for different providers [62]. In the Commonwealth Fund report described above, it was revealed that 46% of the problems occur because care is not well coordinated across sites and providers [63]. Furthermore, only 62% of Canadian primary care physicians reported that they receive information back after referrals of patients to other doctors/specialists.

2.8.5. Loss of Tacit Knowledge

There is a growing rate of turnover among doctors, nurses and other healthcare providers who accumulate organization-specific knowledge that is ultimately lost to the healthcare system [64]. When skilled workers retire, they take with them a substantial amount of organization-specific tacit knowledge and information that they acquire on the job and may not have transferred to others. If this knowledge is tapped and make available, new knowledge is created which others can use. This opportunity can only be availed if there is a knowledge capturing mechanism in place for retiring workforce.

The question brought forward by these examples is how do we design an efficient KM system that can fill gaps in care pathways, streamline processes and available information, and assist healthcare providers for continuously upgrading the practice of medicine to provide the best and the safest medical care to the patients. There is a need, therefore, to investigate the enablers and barriers in the adoption of a KM system.

2.9. Potential Contribution of Knowledge Management in Primary Healthcare

In most countries, primary care is where patients engage their health system. Primary care provides patients with their first and continuing direct contact with medical practitioners and often serves as gatekeeper to the health system [65]. It is the domain of care where more people receive care than in any other clinical setting [66]. Primary care physicians, also called family physicians (FPs) or general practitioners (GPs), require broad knowledge of medicine needed to tackle the wide range of health problems their patients present every day.

In Canada, provincial and territorial governments have recognized the need for better quality in their health care system [67] especially primary care, as there has been an increased focus on quality improvement using a wide variety of strategies. There are ten rules or criteria defined by the IOM that should be taken into account to improve quality of health services [68]. They are:

- Care is based on continuous healing relationships,
- Care is customized according to patient needs and values,
- Patients should be given the necessary information and opportunity to exercise the degree of control they choose over health care decisions that affect them,
- Knowledge is shared and information flows freely,
- Decision-making is evidence-based,
- Safety is a system property.
- Transparency is necessary,
- Needs are anticipated,
- Waste is continuously decreased, and
- Clinicians and institutions should actively collaborate and communicate to ensure an appropriate exchange of information and coordination of care.

If KM is aligned to healthcare organization's strategic objective of improving quality, more than 50% of the above-mentioned rules are followed. For instance, a proper KM system advocates empowerment of patients and provision of knowledge to patients so that they can take charge of their health and can make informed decisions. The objective of the KM system is the free flow of knowledge and information. Similarly, decision making of providers can only be evidence-based if published literature is available and

used by providers. Also, proper management of patient-specific information helps to reduce waste by minimizing duplication of medical tests. The last criteria for quality can be met by using technology and social mechanisms of KM.

An efficient KM system has the potential to assist healthcare industry in this journey by providing three types of integration [69]:

- **Functional integration.** It is the coordination of key support functions such as financial management, human resources, strategic planning, marketing, and quality improvement. This is achieved by facilitating the sharing of common policies and practices among these functions.
- **Physician integration**. It is the coordination among physicians when they are linked to a common system and actively participate in its management and governance. This is achieved by creating a common platform for geographically dispersed physicians where they can share information freely and access user-friendly clinical practice guidelines.
- **Clinical integration**. It is the continuity and coordination of care. It is achieved by facilitating good communication among caregivers, smooth transfer of information and records, and elimination of duplicate testing and procedures.

Medical errors can be viewed as a fault of the healthcare system not to provide clinicians with appropriate information when they need it. An effective KM system enables clinicians to more easily apply evidence-based medicine, by providing access to databases and other evidence-based resources right at the point of care, by training physicians to improve their information retrieval skills, and through better use of clinical libraries. KM tools like lessons learned databases and expert directories [70] can help to

make right information readily available to the right people at the right time and can play significant role in minimizing medical errors.

Consequently, the use of KM systems that support decision making in drug prescription and disease management protocols, would have a positive impact on health care delivery since it allows the decrease, if not elimination, of adverse drug effects and medical errors caused by human oversight. It also assists in the decrease of health care cost resulting from medical errors, giving a hand to health care financial resources management.

The Primary Care National Electronic Library for Health (NeLH-PC), created and used by National Health Services (NHS) in UK, has proved to be very useful in providing the most relevant information readily available to providers [71]. The "Just in Time Order Entry System"; a project of Partner's hospital in Massachusetts, USA, is also a good example of a system that can link massive amounts of constantly updated clinical knowledge to the IT systems that support doctors' work processes [72]. The goal of the system is to integrate specialized knowledge into the jobs of highly skilled workers so that it cannot be avoided. Since healthcare organizations need to be effective in screening and organizing data into information useful to the decision making process; *clinical decision support systems* (CDSS) and KM software like *problem knowledge couplers* (PKCs) are very helpful in this regard. CDSS are active knowledge systems that use two or more items of patient data to generate case-specific advice, and PKCs are clinical decision support software used to obtain comprehensive information from the patient and practitioner [73] and store it for future consultation.

KM strategies like job shadowing and mentorship have also proved to be supportive in transferring the knowledge, skills, and expertise of aging workforce to their junior

colleagues. Extraction of this tacit knowledge held by experts should take place in multiple stages. The work of [74] describes these two stages in detail. In the first stage, discussion and dialogue should take place to validate the raw tacit knowledge, and in the second stage the validated knowledge is made explicit through capturing it in electronic documents such as reports. It can then be stored in databases and other knowledge repositories.

Finally, if KM is aligned with the goals of the organizations, it can potentially transform healthcare into learning organization and enable it to compete more sustainably across many strategic fronts.

2.10. Summary of Literature Review and Gaps in Literature

A review of the KM literature shows the changing view of the focus of KM, resulting in different definitions and different levels of technology support. In its early stage, KM research focused on empowering the knowledge worker and providing support for organizations starting to adopt its methodology. The support was mainly technological; in the form of information systems, decision support systems (DSS), and expert systems. In late 1990s to early 2000s the focus shifted into a practical approach, which is, finding better ways to manage organizational knowledge. Thus, many published definitions of KM emphasized on specific activities of KM that could be captured, managed, or facilitated by technology. Consequently, KM studies during the 2000s included lists of specific manageable activities, such as knowledge creation, identification, codification, sharing, reuse, and application (e. g., [75]) and technologies that support four basic KM

activities, namely, knowledge creation, codification, transfer, and application [76]. Early KM studies often focused more on codification, i.e., capturing and representing organizational knowledge using ICT (e.g. [77][78]). After this, organizations diverted their focus from mere codification to representation and dissemination of knowledge. Examples of specific tools included intelligent systems, DSS, various types of knowledge repositories and directories, and collaboration (e.g. [79]).

A quite different approach to KM research and practice during this period was the discussion of tacit and explicit knowledge, suggested by Nonaka [80], building on the work of Polanyi [81]. The tacit/explicit distinction was perceived as especially relevant in the development of KM resulting in a basic requirement that a KM system be able to manage both tacit and explicit knowledge [82][83]. In recent years there has been a shift towards the knowledge-based view of the organization [84]. This view put knowledge at the centre of the firm and argued that intellectual capital is the firm's key asset. Acquiring, integrating, and leveraging firm members' knowledge becomes an important KM activity. Thus the current focus of KM research is on enabling competitive advantage and managing knowledge as an organizational resource, strongly integrated with other resources [85].

In healthcare literature, the notion of KM is not well established. Many articles are based on theoretical aspects of understanding professional knowledge such as nursing, or on technical representation of expert knowledge in medicine (e.g., [86][87]). The 2002 conference namely "Knowledge Roundtable in Health", held at Queen's University in Canada, reported successful examples of KM practices in health settings that include critical care pathways, care planning, evidence-based decision making, and virtual health

networks. [88]. The conference also identified unresolved challenges such as the need for user participation, ICT investment, and organizational structures and cultures that support KM.

These findings led us to believe that an opportunity exists to apply KM concepts to create a healthcare delivery system that is strategic, proactive, and knowledge intensive. Companies are more and more integrating KM into their standard business process and a real change in attitude is a shift from the original, highly IT-centric KM approach to a state where human aspects rank higher on the stakeholder's agenda than ever before. Keeping this in mind, as a first step and a contribution to healthcare KM literature, we tried to explore the effect of physicians' personal and practice characteristic on KM adoption in primary care. To get a different view, in our second study, we observed the impediments in coordination of health services and the potential role of KM to streamline those impediments.

CHAPTER 3.

STUDY 1: KM SURVEY

3.1. General Methodology for the Research

This section outlines the general approach taken by us in designing and conducting this research. Research is usually undertaken to [89]:

- Explore an idea,
- Probe an issue, or
- Solve a problem.

Broadly, research is categorized as primary or secondary in nature. Primary research is the study of a subject through first hand observation and investigation, i.e., to analyze a workflow or conduct a survey or interview. Source of information for this kind of research include statistical data, historical data etc. Secondary research involves the examination of studies of other researchers. Source of information include book articles, journal papers, or literary works. In extension to these research types, there exist two research paradigms; quantitative and qualitative [90]. Quantitative research paradigm, also known as traditional or experimental paradigm, usually results in the collection of numeric data on which statistical tests can be performed and results can be drawn. Qualitative or constructivist research paradigm involves collection of words from the respondents through observations or interviews. Later on themes or patterns are drawn from the words to draw conclusions. Research can follow one of two paths based on either a deductive or an inductive reasoning approach is taken. The deductive research

approach calls upon proven principles or theories to develop a hypothesis, which is a proposed relationship between two or more variables. A relevant data set is tested to either support or reject the particular relationship being examined, and can lead to the formulation of generalized conclusions. Alternatively, the inductive research approach starts off with the data already residing in a particular subject of interest, and a theory is developed via its analysis.

The research approach followed towards this thesis is, therefore, primary and deductive in nature. It involves both quantitative and qualitative analysis in study 1 and study 2 respectively. Survey, observation, and interviews; methodologies used for both our studies will be discussed in the later sections. We employed these methodologies to collect the data set that would be further analyzed and validated to produce reliable results. Figure 6 depicts the general research methodology adopted for this research.

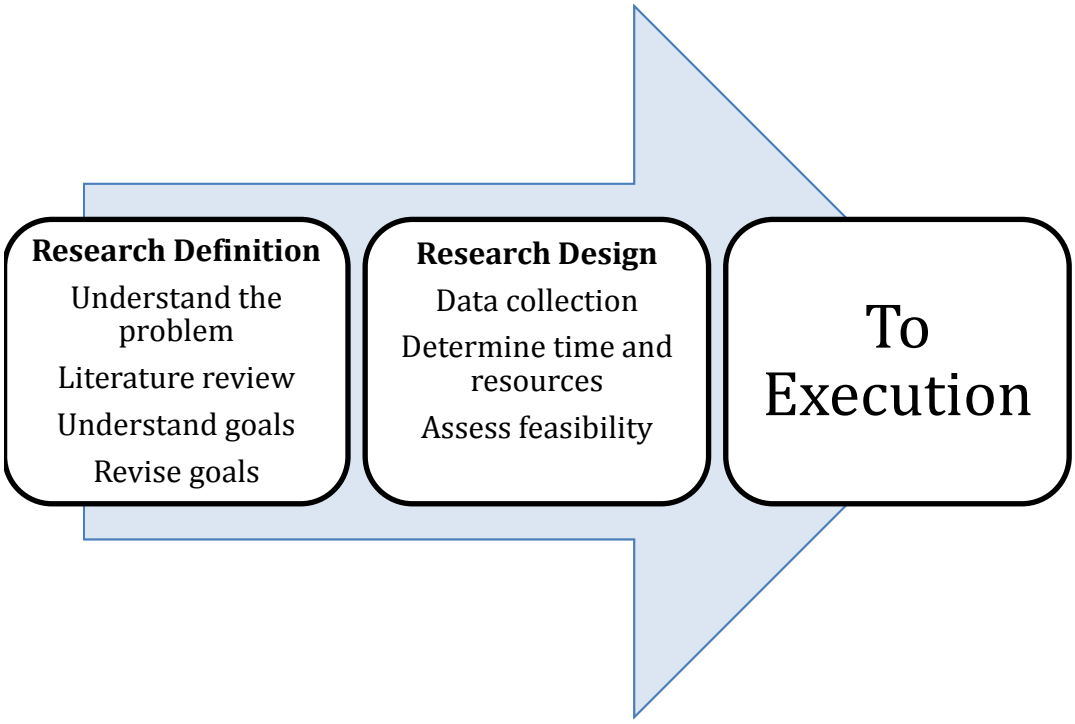

Figure 6: General Research Methodology for the Study

3.2. Introduction

Our first study is built upon a theoretical framework developed by [91] to assess the attitudes of healthcare providers towards adoption of Electronic Heath Record (EHR) in a clinical setting. This framework is based on the TAM [92] to evaluate the behavioural, social, and organizational factors that exist in a complex system such as healthcare. It was used to assess the attitude of Ontario's primary care physicians towards the adoption of the Diagnostic Assessment Program-Electronic Pathway Solution (DAP-EPS); a web-based tool that assists physicians to track cancer patients in their diagnostic journey [93]. TAM component of the model explains why a new technology may or may not be acceptable to users. Factors like perceived ease-of-use and perceived usefulness of

technology influence the decision of the user to use or not use the technology. In this capacity, we tend to analyze individual and practice factors that surround the diffusion of KM to investigate whether they are influential to KM adoption.

Our adapted model for KM adoption is depicted in Figure 7. It illustrates the individual characteristics, social, and technological factors proposed by [94] and adapted for our research.

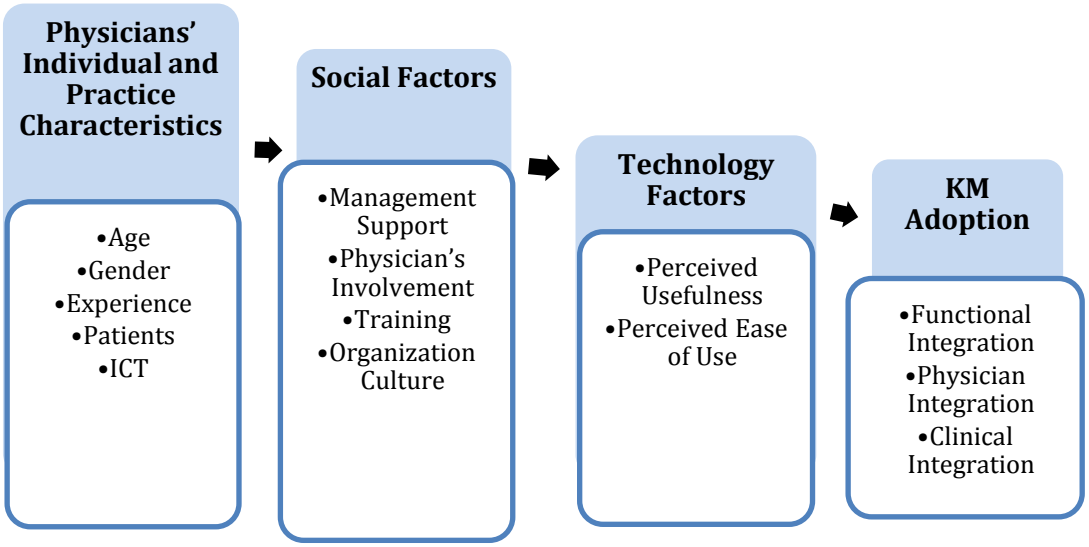

Figure 7: Model for KM Adoption (Adapted from [94])

3.3. Study Objective

Objective of a study can come from a defined need or from reviews of literature that can tell what is currently known about a topic. Using the available data, gaps can be figured out that need to be filled through research. For our study, as previously described in CHAPTER 2, a thorough literature search has been performed to shape the goal and formulate the hypothesis.

The general purpose of the study is to examine **the individual and practice factors of primary care physicians that have the potential to influence their KM adoption**. The specific objective can be stated as **to describe and compare physicians of differing age, sex, years of experience, number of patient seen/day, and ICT usage in their adoption of KM system.**

We further break down our specific survey objective into individual questions as follows:

Q1. How do younger and older physicians compare in their practice of KM techniques?

Q2. How do male and female physicians compare in their practice of KM techniques?

Q3. How do physicians with varying years of experience compare in their practice of KM?

Q4. Does a relationship exist between practice of KM techniques by physicians and the number of patients they see daily?

Q5. Is KM adoption of physicians and their ICT usage associated with each other?

We formulate the related hypotheses as follows:

H1. A difference exists in the age of physicians and their practice of KM techniques.

H2. A difference exists in the gender of physicians and their practice of KM techniques.

H3. A difference exists between years of experience of physicians and their practice of KM techniques.

H4. The more number of patients a physician sees in a day, the more KM techniques he or she uses.

H5. There is a correlation between KM adoption and ICT usage of physicians.

Here, by "practice/use of KM techniques" we mean **practicing observable individual activities related to management of knowledge.**

3.4. Survey Instrument: A Self-Administered Questionnaire

A cross-sectional survey was conducted to investigate the state of KM adoption among primary care physicians of Edmonton.

A survey is a system for collecting information to describe, compare, or explain knowledge, attitudes, and behaviour [95]. Survey research involves soliciting self-reported verbal information from people about themselves. The ultimate goal of sample survey research is to allow researchers to generalize about a large population by studying only a small portion of that population. Accurate generalization derives from applying the set of orderly procedures that comprise scientific sample survey research. According to [96] the best surveys have the following features:

- Specific, measurable survey objectives,
- Straightforward, purposeful questions,
- Sound survey design,

- Sound choice of population and sample,
- Reliable and valid survey instruments,
- Appropriate analysis,
- Accurate reporting of survey results, and
- Reasonable resources

A survey's objectives are measurable if two or more people can easily agree on all the words and terms that are used to describe its purpose. Purposeful questions are those that are logically related to the survey's objective. They are straightforward when they are precise and unambiguous. Survey design is a way of arranging the environment in which the survey takes place. The environment consists of individuals or groups of people, places, activities, or objects that are to be surveyed. A sample is a subset of population about which researchers are interested in gathering information. The ideal sample has the same distribution of characteristics as population. A representative sample requires an unbiased method to choose survey participants, obtaining adequate number of participants, and collecting high-quality data by relying on valid and reliable survey instruments. A reliable survey instrument is consistent whereas a valid one is accurate. Analysis of survey data use conventional statistical or other scholarly methods to analyze findings. The choice of appropriate method depends on whether the survey aims for description, comparison, correlation, or prediction. It also depends on the size of the sample and on the type of data collected. Fair and accurate reporting means staying within the boundaries set by the survey's design, sampling methods, data collection quality, and choice of analysis.

To ensure that our study was performed in a valid and appropriate manner, elements of the survey process described above were taken into consideration in the design and implementation of the survey.

There are five general methods of implementation by means of which survey information can be collected:

- Mail-out,
- Web-based,
- Telephone,
- In-person interviews, and
- Intercept

There are advantages and disadvantages associated with all of the above methods. For the purpose of our study we chose the mail-out format for collecting data. Mail-out format involves the dissemination of printed questionnaire through mail (postal service) to a sample of pre-designated potential respondents. These are self-administered questionnaire because the respondents are asked to complete the questionnaire on their own and return it by mail to the researcher. Since the researcher is not present at the time when respondents fill the survey, they are often called *unsupervised survey*. Like other methods, there are pros and cons of using a self-administered, mail-out questionnaire as described by [97]:

- It has lower cost as compare to other methods e.g., in-person or telephone interviews,
- It allows for wider geographic coverage,

- The lower unit cost combined with its ability to cover a wider geographic area allows surveyors to study a larger sample of persons or groups,
- Respondents are much more willing to complete a self-administered questionnaire when it can be done at their own convenience,
- Almost all of the questionnaires are received by the respondents within the same two or three days period so the potential influence of events outside the study that might influence the potential respondent's experience is reduced, and
- Respondents are more likely to provide truthful information on sensitive topics if a self-administered survey rather than face-to-face interview is used.

However, this method has also some disadvantages that limit its use in many research projects [97]:

- If the surveyor wants to collect data from samples that can be considered representative of the population, a complete and accurate list of the population should be available,
- With a single mailing that incorporates no incentives, the surveyor can probably expect no better than 20% response rate. One of the reasons for low response rate, particularly in studies targeted at general community samples is the low literacy rate and the inability to read and write, and
- Once the questionnaire leaves the surveyor's office, he or she has no control over who fills it out and whether that person consulted with others when completing it.

Taking into consideration the above-mentioned pros and cons, it is pondered upon **whether a self-administered, mail-out questionnaire is the best method to adopt for the study?**

We took into consideration two things as pointed in his work by [98]:

- **The literacy level of the target population**. As our test population is comprised of physicians, we believe that each and every member of population is literate and can read and write. We also believe that no matter what language each individual speaks, since they work in Canadian healthcare, they understand and can respond in English language.
- **The motivation level of the target population**. Though this is more difficult to assess than literacy level, it can be estimated by if the group decides its need to find out about itself or the amount of loyalty that individuals have to the group being studied. This type of questionnaire can be successfully administered to identifiable groups as compare to general population (in our case, physicians belonging to primary care). The strength of appeal conveyed in the cover letter can serve to increase the motivation level of the respondents.

3.5. Survey Instrument Development

At the heart of survey research is the questionnaire development process and learning how to ask questions that are straightforward and unambiguous. Key considerations in this process are the placement of questions within survey instrument and their format in terms of the method of implementation. As surveyor, we were aware of the fact that no questionnaire can be regarded as ideal for soliciting all the information necessary for a study, however, the following general guidelines about creating the questionnaire presented by [99] were kept in mind at the time of the development of the instrument:

- **Questionnaire clarity**. (Will respondents understand the questions)? Questions should be free of ambiguities that can confuse respondents,
- **Questionnaire comprehensiveness**. (Are the questions and response choices sufficiently comprehensive to cover a reasonably complete range of alternatives)? Questions should generate all the important information required for the study, and
- **Questionnaire acceptability**. (Are the questions too complicated or invade the privacy of the respondents)? Questions should not abridge ethical or moral standards.

Keeping these guidelines forward, survey questions were developed. The assembled questionnaire, with all questions and opening and closing remarks, constituted five pages having 19 questions. The first four questions were descriptive in nature and collected demographic information. Questions fifth, sixth, seventh, ninth, and eighteenth gathered data about the construct of KM practices of the physicians in their daily routine. Question eighth and tenth inquired about the most common method used by the physicians to seek knowledge and the most common obstacle in accessing that knowledge. Question 11, 12, 14, and 17 gathered data about the construct of usage of ICT at physicians' workplace. Questions13 and 16 investigated about the types of health records used by physicians and what do they generally use their Electronic Medical Record (EMR) for.

The respondents at any point can change his/her mind not to respond and can simply discard the survey. The final survey instrument that was prepared and launched to gather the opinions of the test population can be found in Appendix A. However, the snapshot of type of questions asked and information collected through it that is used in statistical analysis are given in Table 2.

Table 2: Information Collected Through Survey Questionnaire

Topic	Question No.	Information Collected
Gender of physicians	1	Male / female
Age of` physicians	2	Age range
Work experience of physicians	3	Years of experience range
Number of patients seen by the physicians per day	4	Average number of patients seen in a day
Practicing KM techniques during work	5,6,7,9,18	Awareness of information resources, usefulness of research, pursue answers to questions during patient interaction, time spent in seeking knowledge, willingness to share knowledge
Using ICT	11,12,14,15,17	Access to information portal, access to discussion board, ownership of EMR, interoperability of EMR with EHR, level of comfort in using ICT
Miscellaneous	8,10,13,16,19	Common source to seek knowledge, common obstacle in seeking knowledge, types of health records in use, purpose of EMR, attitude towards KM

Some questions of our survey capitalize on existing questionnaires for their data collection approaches. They are either adopted or adapted from published questionnaires. As each referenced instrument is already developed and statistically valid, they can be used to operationalize concepts important to our research. Each question with its referenced instrument is briefly discussed in this section. Demographic questions and few questions for KM practice and ICT usage are adopted from [100]. This is a modified pre-existing survey on adoption of EHR among physicians. The survey tool was originally developed and validated by [101]. Other KM practice and ICT usage questions were adapted from [102]. Minor adjustments were made to the text to make sure that the questions are relevant for the research context and the language is understandable by the proposed test population. We developed the rest of the questions keeping in mind the KM and ICT literature and survey guidelines. We made sure that the questions developed for this research study endeavoured to meet the following criteria, i.e., they should be:

- **Purposeful**. There should be an identifiable relationship between questions and the research objectives,
- **Concrete**. Questions should be precise and unambiguous,
- **Closed ended.** The response choice is known in advance which makes it easier to be analyzed statistically, and
- **Jargon-free.** Questions should not include any technical expression that is not understood by the respondents.

The response choice for questions 1, 2, 3, 4, 8, 10, 15 and 18 was categorical or nominal. These types of responses put respondents into categories. Categorical responses should be mutually exclusive and exhaustive. “KM practice” response choice was set up ordinal so

that a higher score on any given question would reflect a physician practicing more KM techniques at his or her workplace. Lower score would indicate a response associated with a physician not much indulge in KM activities. A mean (average) score is calculated from the individual responses to the five questions that were posed. A higher mean score is reflective of a perception of a workplace in which KM techniques are practiced frequently. The advantage of this method is that mean scores scales can be compared between different individuals and/or groups of individuals. The response choice for "ICT usage" was set as dichotomous or binary (yes/no). This binary response has numeric value depending on the response choice. Each question and its make-up are briefly discussed in Table 3.

Table 3: Survey Questions Makeup

Questions	Adopt	Adapt	Developed
1,2,3,4,9,10,16	[101]		
8,17		[102]	
11,12,19		[103]	
13,14,16,18	[103]		
5,6,7,15			✓

An example of KM and individual/practice characteristic questions found within the final survey, complete with the categorical and ordinal response choices can be seen in Figure 8.

Personal and Practice Data

Could you please indicate your gender?
Male
Female

Current State of Knowledge Management Practices

Do you pursue answers to the questions that arise during patient interaction?

Never
Some of the time
Most of the time
Always

Current State of Knowledge Management Technology

Do you have an information portal in your access at your clinic?

Yes
No

Figure 8: Snapshot of Survey Questions

3.6. Survey Instrument Assessment

Before performing any statistical analysis, it is important to assess the survey instrument so that accurate and reliable data can be collected. *Measurement error* refers to how well or poorly a particular instrument performs in a given population. No instrument is perfect, so one can expect some error to occur during measurement process. Psychometric is a branch of survey research that helps to determine the accuracy of the measurement tool. This assessment primarily consists of looking at the *reliability* and *validity* of the survey instrument.

Reliability is a statistical measure of how reproducible the survey instrument's data are. It determines the extent to which a developed set of questions can collectively measure the

variable being studied on a repeated basis. In other words, a reliable set of questions gives consistent answers to repeated questions. Reliability is commonly assessed in two forms, test-retest and internal consistency.

3.6.1. Test-Retest Reliability

Test-retest reliability is the most common used indicator of survey instrument reliability. It is measured by having the same set of respondents complete the survey at two different times. Correlation coefficients are then calculated to compare the two set of responses. In performing this test, the researcher should be careful not to select items or variables likely to change over short period of time. This does not indicate that the survey instrument is performing poorly but simply that the attribute itself is changed. Due to an average response rate of 54% and time constraints, test-retest reliability is not performed for our study.

3.6.2. Internal Consistency

Internal consistency is another commonly used psychometric measure in assessing survey instruments and scale. It is applied to a group of items that are thought to measure different aspects of the same concept. Internal consistency is an indicator how well different items measure the same issue. This is important because a group of items that purports to measure one variable should indeed be clearly focus on that variable. Internal consistency is measured by calculating *Cronbach's coefficient alpha (*α) named after 20th century psychometrician in 1951. Cronbach's alpha of 0.70 or greater is generally considered acceptable from an instrument reliability perspective [103]. The

calculated Cronbach's alpha for two instruments used in our survey instrument "KM practice" and "ICT usage" are summarized in Table 4.

Table 4: Cronbach's Alpha (Reliabilities)

Variable of Interest	No. of Items	Cronbach's Alpha
KM	5	0.72
ICT	5	0.83

Reliabilities for both constructs prove that items have good internal consistencies.

Validity of an instrument tests how well it measures what it sets to measure. Several types of validity are typically measured when assessing the performance of a survey instrument, such as, face, content, and construct.

3.6.3. Face Validity

Face validity is based on a superficial review of items by untrained judges. Assessing face validity might involve simply showing the survey to few colleagues to see whether they think the items look OK to them. It is the least scientific measure of all validity measures. However, in order not to leave any of the instrument assessment steps, face validity was performed by colleagues.

3.6.4. Content Validity

Content validity is a subjective measure of how appropriate the items seem to a set of reviewers who have some knowledge of the subject matter. It is also called pre-testing of

the survey instrument. The assessment of content validity typically involves an organized review of the survey's content to ensure that it includes everything it should and does not include anything it should not. Content validity is not quantified with statistic. Rather, it is presented as an overall opinion of a group of trained judges. It is not a scientific measure of a survey instrument's accuracy rather it provides a good foundation to build a methodology for rigorous assessment of the instrument. In our case, the survey questions were reviewed by a group of physicians who provided valuable insights into dimensions that might otherwise be overlooked by us.

3.6.5. Construct Validity

Construct validity is the most valuable of all validities. It refers to the degree to which inferences can legitimately be made from the operationalization in the study to the theoretical constructs on which the operationalization was based. Construct validity is often thought to compromise two forms of validity, convergent and divergent [104]. Convergent validity implies that several different methods for obtaining the same information about a given trait or construct produce similar results. Divergent or discriminant validity is another measure that implies that constructs that should not be related to each other theoretically, are, in fact, observed not to be related to each other. That is, one should be able to discriminate between dissimilar constructs.

3.6.6. Convergent Validity

To demonstrate convergent validity, we need to show that items that formed the KM construct are in fact related to each other. There are five questions (each item on the

scale) that all purport to reflect the construct of KM. We found the item-to-total correlations of the five scale items based on answers of the survey respondents. It is done by evaluating the Pearson correlation between the scores for a particular item and the average of the scores of the remaining items for that construct. In a reliable measure, all items should correlate well with the average of the others. It was observed that the item-to-total correlations for all items are higher than the cut off value of 0.4 (we assume 0.4 to 0.7 as mild positive association). This shows reasonable convergent validity proving that all five items are related to the same construct. This is illustrated in Table 5.

Table 5: Item-Total Correlation

Item Number	Item-Total Correlation
Item 1	0.44
Item 2	0.53
Item 3	0.54
Item 4	0.62
Item 5	0.40

Discriminant validity is not demonstrated in our case because there is no construct that can be used to measure divergence of the items with respect to that construct.

3.7. Test Population

The test or working population is an operational definition of the general population that is the representative of the general population, and from which the researcher is reasonably able to identify as complete a list as possible of the members of the general

population. The research hypotheses for this study were statistically tested against a sample from the test population of physicians working in primary healthcare in Edmonton. Primary health care focuses on basic health care services, including health promotion, illness and injury prevention, and the diagnosis and treatment of illness and injury [105]. Since primary care is huge, the researcher limits the scope of this study to the non-specialist GPs practicing family medicine in Edmonton. A non-specialist listing of Edmonton's GPs was accessed from "College of Physicians and Surgeons of Alberta" website [106]. This website is updated frequently so we can be sure that the information provided in this list is accurate and hence coverage/frame error is minimized. Only non-specialist physicians practicing family medicine full-time in Edmonton clinics were included. Specialists and part-time physicians were excluded from our test population. We also assumed that all of the physicians are older than 18 years of age and can read and write English as a language. Table 6 shows our inclusion and exclusion criteria for test population.

Table 6: Inclusion and Exclusion Criteria for Test Population

Included in Test Population	Excluded from Test Population
Full-time	Part-time
Non-specialists GPs	Specialists GPs
Working in Edmonton family clinics	Working outside Edmonton

3.8. Sample Size and Sampling Technique

A sample is a portion or subset of population. Results from statistical analysis performed on a particular sample can be generalized to the population if the sample is a good representative of its respective population. A crucial question at the outset of survey research is how many observations are needed in a sample so that generalizations can be made about the entire population. Generally, if a greater the level of accuracy required, researcher must address with specificity two things before selecting the size of the sample. They are:

- **Level of confidence**. It is the risk of error the researcher is willing to accept in the study, and
- **Confidence interval**. It is the level of sampling accuracy that the researcher obtains

Keeping in consideration the time, cost, and resource constraints of this study, we set the level of confidence to be 95% and the margin of error to be ± 10%. Calculation for our sample size is done using Eq. 1:

$$n_0 = \left[\frac{z \times \sqrt{p(1-p)}}{SE}\right]^2 \qquad \text{(Eq.1)}$$

The standardised "z" score is 1.96 for a 95% confidence interval, "p", that is the standard deviation for proportion is kept 0.5. This will give us the maximum sample size. "SE",

the standard error or the margin of error is 10% or 0.1. Our required sample size is calculated to be 96.04 ≈ 97. This means that we require at least 97 observations in order to generalize the findings of our survey research to the entire population of full-time GPs in Edmonton. Since we are dealing with a finite population (N=490 full time GPs in Edmonton [106]), we will apply the finite population correction factor using (Eq.2).

$$n = \frac{(n_0 \times N)}{(n_0 + (N-1))} \qquad \text{(Eq.2)}$$

Our required sample size now becomes 81.1 ≈ 82.

As for the sampling technique needed to collect the required number of observations, we chose the method of *simple random sampling*. This is a type of probability sampling where every unit of the test population has an equal chance of being selected. Members of the target population are selected one at a time and independently. Once they have been selected, they are not eligible for a second chance. This phenomenon is also called *sampling without replacement*. Random sampling is considered to reduce selection bias to a great extent. Since an updated list of all eligible physicians were available for our study, which corresponds that the sample would be representative of the population from which it was selected, the researcher concluded that simple random sampling technique was most suitable for this study. To conduct the random sampling, the researcher used a table of random numbers to look between 1 and 490 for 100 observations.

3.9. Ethics Approval

Since our research involved human participants, an ethics approval was required to ensure that all steps of the study were conducted with utmost ethical standards. For this reason a formal review and approval process was initiated within the Health Research Ethics Board (HREB) Panel B, at the University of Alberta.

The ethics approval process required that a standard proposal be completed and submitted to the HREB for review and assessment prior to the beginning of actual study. The thirty questions associated with the proposal pursued to understand the scope and execution methodology of the research. It also took into consideration how the study would manage all aspects linked to participant privacy, confidentiality, anonymity, and participant engagement during the survey process. The study number is "Pro00021714" with a title "Evaluation of Knowledge and Information Management System for Healthcare Providers". There were two modifications made in the proposal as required by the board. Firstly, it was asked whether the survey would be associated by informed consent form. We did the modification by replying that a study information sheet will be provided with the survey form. The participants are free to fill the survey or not. The completion of the survey will imply participants' consent. The second concern was the storage of the data after its collection and after the end of the study. A modification was made that the data will be kept in a locked cabinet in the supervisor's office at the Mechanical Engineering department at the University of Alberta. The supervisor of this study is also considered as the principal investigator of the study by the HREB. Only the supervisor has a key to the cabinet. Data will finally be destroyed after five years of study completion and not before that. The survey forms will be shredded at that time.

3.10. Survey Distribution, Follow-up and Collection

After the study approval from HREB, actual survey pre-distribution and distribution process started in August 2012. Final survey questions were reviewed, and study information sheets and recruitment letters were prepared. These are shown in Appendices A, B, and C respectively and were sent as a package to the potential respondents. The study information sheet provided general background information on the academic research and introduced the researcher to the sample of general physicians population of Edmonton. It explained the commitments taken by the researcher towards the confidentiality of responses and thus privacy of participants. The information sheet also stated that the study is a requirement towards the fulfillment of the researcher's Masters program and will be a part of her dissertation. The recruitment letter affirmed that participation was completely voluntary and that participants could depart from the survey at any time along the way. All they need to do, if they change their mind, is to discard the survey. It was also requested on the questionnaire itself to complete all the questions in an attempt to minimize items' nonresponses. Follow up letter were also prepared which were sent after ten days of the actual launch of the survey. The letter reminded the respondents that they had been sent a questionnaire to fill out and return, restated the importance of their participation, and encouraged them to take a few minutes to fill it now, if they have already not done so. In the letter it was also mentioned the researcher is aware of the possibility that the respondent has already mailed the responses, and in that case, the researcher apologize for any nuisance that this follow-up mail might have caused. The cut-off date for receiving the responses was set December 31, 2012 by the researcher as six weeks were considered enough time for the respondents to fill and mail

back the surveys. The logistics associated with the survey research process along with the timeline observed is summarized in Table 7.

Table 7: Critical Survey Activities and Timelines

Pre-Survey and Survey Activities	Timelines
Finalize Survey Questions	August 17, 2012
Assessment of Instrument Performed	August 30, 2012
Study Cost Estimation Done	September 5, 2012
Study Information Sheet Prepared	September 12, 2012
Recruitment Letter Prepared	September 20, 2012
Ethics Approval Received	October 10, 2012
Questionnaires, Information Sheets, and Recruitment Letter Printed	October 12-16, 2012
Addresses of Physicians' Clinics Collected	October 18-20, 2012
Envelops Addressed and Stamped	October 25-30, 2012
Surveys Mailed to Physicians	November 2-3, 2012
Follow up Letters Printed	November 10, 2012
Follow up Letters Mailed	November 13, 2012
Surveys Received by Researcher	November 20-December 31, 2012
Post-Survey Activities	Timelines
Conduct Descriptive Analysis of Collected Data	January 10-25, 2013
Conduct Inferential Analysis and Hypothesis Testing	February 8-March 2, 2013
Record Results and Findings	March 4-6, 2013

3.11. Data Analysis

3.11.1. Descriptive Statistics

The objective of descriptive statistic is to characterize or summarize sets of data in useful and manageable form. This section summarizes the descriptive statistics associated with the study. Firstly, the response rate of our survey was calculated. Later on, breakdown of every demographic variable (both individual and practice related) with their subgroups and response type is shown in Table 8. Later on, frequency distribution table for each categorical (demographic) variable collected from our sample are showcased. Some of the non-demographic variables were also used to describe certain practice characteristic of physicians. For instance, in the "KM practice" section, physicians were asked about the most common source they use for seeking knowledge and the greatest obstacle that come across when accessing that knowledge. In the "ICT usage" section, physicians were asked about the type of health records used in their clinics and for what purpose they use EMR. The information collected through these questions, though not used for inferential analysis, provide insights about physicians' knowledge-seeking behaviour and the state of ICT usage in their practice. Although only the demographic variables were called upon for hypothesis testing, all variables were summarized in detail to provide a clear image of the make-up of our study sample.

3.11.2. Response Rate

The response rate of our study is calculated by the number of physicians who responded divided by the number of eligible respondents to whom surveys were being mailed out.

100 surveys were sent out to the physicians of our random sample. 54 responses were received in total till our cut off date of Dec 31st, 2012. This makes our response rate to be 54%. In surveying, no single response rate is considered as standard. A 20% response rate for first mailing is not uncommon in unsupervised surveys [107]. Response rate can be elevated to up to 70% by follow up mailing. In our case, we received 16 surveys back before the follow up letter had been sent, which constitutes 16% of our total surveys. The response rate increased by38% after our follow up mail.

Table 8: Breakdown of Independent Variables

Demographic Variable	Characteristic	Subgroup	Hypothesis	Response Type
Age	Individual	(Years) 21-30 31-40 41-50 51-60 61-70 70+	H1	Categorical
Gender	Individual	Male Female	H2	Categorical
Experience	Individual	(Years) 0-5 6-10 11-15 16-20 21-25 25-30 30+	H3	Categorical
Number of Patients/day	Practice	-	H4	Numerical
ICT Usage	Practice	Information portal Discussion board EMR ownership Access to EHR Training to use ICT	H5	Numerical (score)

3.11.3. Demographic Variable: Age

Age of the physicians was collected under "individual characteristic" of physicians to test our first hypothesis H1. The researcher wanted to test whether physicians belonging to different age groups practice KM differently? Or there is no effect of age on a physician's KM practice. The response for the variable "Age" was categorized into six groups. There

were no physicians of more than 70 years of age. The frequency distribution table for the "Age" variable is shown in Table 9.

Table 9: Frequency Distribution of Physicians' Age

Physicians' Age (years)	Frequency	Percentage	Cumulative Percentage
21-30	11	20.37	20.37
31-40	18	33.33	53.70
41-50	16	29.63	83.33
51-60	9	16.67	100.00
Total	54	100.00	

3.11.4. Demographic variable: Gender

Gender of the physicians was collected under "individual characteristic" of physicians to test our second hypothesis H2. The researcher wanted to test whether male and female physicians practice KM differently? The response for "Gender" was categorized into two groups. The number of male and female physicians in our sample is almost equal. The frequency distribution table for the "Gender" variable is shown in Table 10.

Table 10: Frequency Distribution of Physicians' Gender

Gender of Physicians	Frequency	Percentage	Cumulative Percentage
Male	30	55.56	55.56
Female	24	44.44	100.00
Total	54	100.00	

3.11.5. Demographic Variable: Experience

Number of years of experience of the physicians was also collected under "individual characteristic" of physicians to test our third hypothesis H3. The researcher wanted to test whether physicians who have more experience are engaged in practicing KM techniques more than the newer physicians, or vice versa? The response for "Experience" was categorized into seven groups. The frequency distribution table for the "Experience" variable is shown in Table 11. As it is apparent from the table, the largest group of physicians falls under 0 to 5 years of experience.

Table 11: Frequency Distribution of Physicians' Experience

Years of Experience	Frequency	Percentage	Cumulative Percentage
0-5	20	37.04	37.04
6-10	8	14.81	51.85
11-15	9	16.67	68.52
16-20	5	9.26	77.78
21-25	7	12.96	90.74
26-30	2	3.70	94.44
30+	3	5.56	100.00
Total	54	100.00	

3.11.6. Demographic Variable: Patients

Number of patients seen by the physicians per day was collected under "practice characteristic" to test our fourth hypothesis H4. The researcher wanted to test whether

physicians who see large of patients per day are engaged in practicing more KM techniques than physicians who see less number of patients? The response for "Patients" was numeric and was collected by asking physicians what is the average number of patients they see in a day. The "Patients" variable is summarized in Table 12. The average number of patients seen by physicians came out to be 16.59 with a standard deviation of 9.01.

Table 12: Number of Patients Seen By Physicians/Day

Percentiles	3 (1%)
	6 (5%)
	10% (10)
	50% (15)
	75% (20)
	90% (30)
	95% (35)
	99% (40)
Observations	54
Mean	16.59
Standard Deviation	9.01
Variance	81.22
Skewness	0.905
Kurtosis	2.93

3.11.7. Demographic Variable: ICT

ICT usage of physicians was collected under "practice characteristic" to test our last hypothesis H5. The researcher wanted to test whether there is an association between ICT usage and KM practices of physicians? The response category for the "ICT" variable was binary i.e., the physicians could respond to a set of five questions in a "Yes" or "No". Each respondent was asked to elect a rating that best reflected his current ICT usage and perception about requirement of training to use ICT. Each response of "Yes" was assigned a value of "2" and "No", a value of "1". The ICT usage score of a respondent was out of ten. A higher mean score refers to a higher the use of ICT at the physicians' work place. Conversely, lower scores indicated a low use of ICT. The mean of 6.76 and standard deviation of 1.64 is shown in Table 13.

Table 13: ICT Usage by Physicians

Percentiles	4 (1%)
	4 (5%)
	5 (10%)
	6 (25%)
	6 (75%)
	8 (90%)
	9 (95%)
	10 (99%)
Observations	54
Mean	6.76
Standard Deviation	1.64
Variance	2.69
Skewness	0.10
Kurtosis	1.91

3.11.8. Variable of Interest: KM

The "practice of KM techniques" by each participant was measured using the questionnaire consisting of a set of five questions. These five questions were formed by extensively going through KM literature. Five items each investigating a different dimension of KM, were produced. They are related to awareness of physicians of various information resources, usefulness of research in their day to day practice, whether they pursue answers to questions that arise during patient interaction, whether they spend time in accessing knowledge, and are they willing to share their knowledge with their

colleagues. Three of these questions were adapted and adopted from literature as mentioned earlier. This constitutes more than 50% of the set of questions. The researcher developed the remaining two questions by taking into consideration the literature on KM and healthcare. Each respondent were given three ordinal choices with assigned values "3", "2", and "1" (3 point Likert-type scale). The final score on KM adoption was calculated by adding all the scores of individual item. A higher number of points allotted to a statement indicating a higher adoption of KM techniques. The total number of score that a respondent can score was 15. A graph box is plotted to see any outliers in the dataset as shown in Figure 9 and 10. We found two outliers in the data set, one of which was an extreme outlier. Survey responses were reviewed and it was found out that these outliers were due to missing values in survey response (item-non response). More than 50% of the responses were missing from these two questionnaires. Due to their extreme values, those two observations were excluded from the data set and the statistical analysis was performed on 52 observations rather than 54.

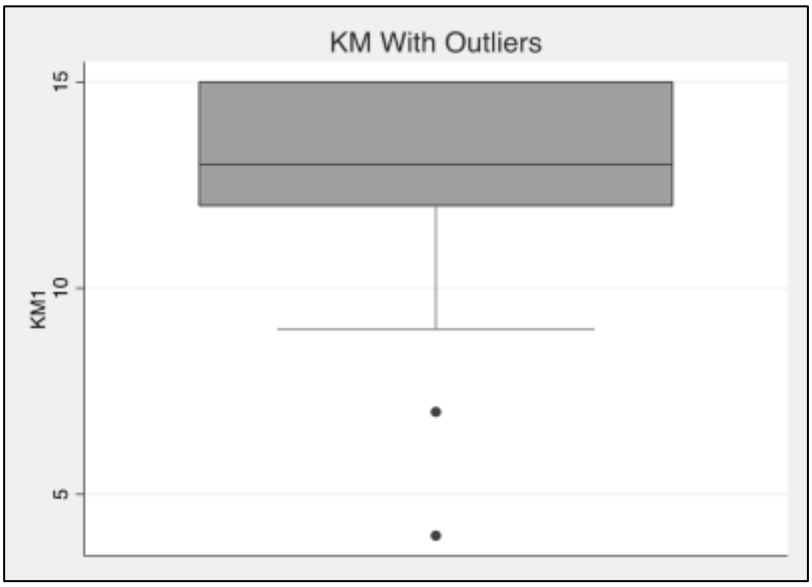

Figure 9: KM with Outliers

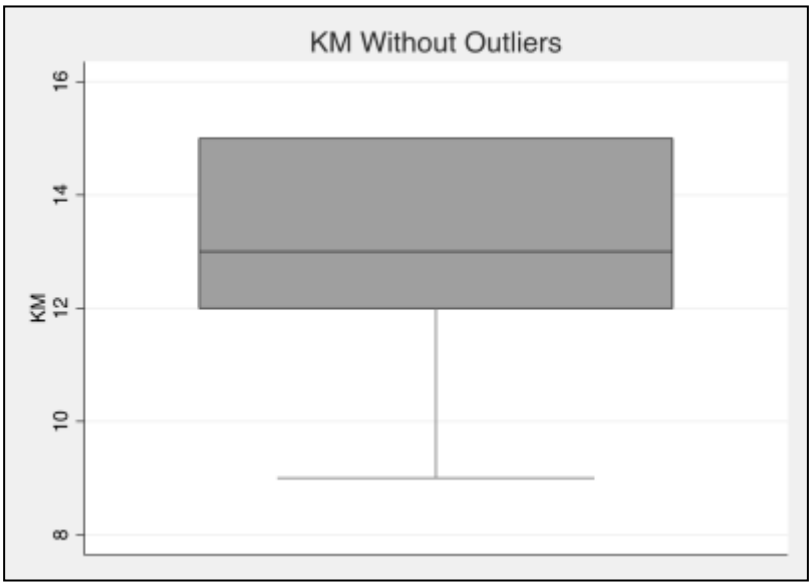

Figure 10: KM without Outliers

A histogram was then plotted to see the distribution of KM score (Figure 11). It cannot be said that it is perfectly normal but somewhat close to normal. The KM variable is summarized in Table 14 with a mean of 13.17 and standard deviation of 1.79.

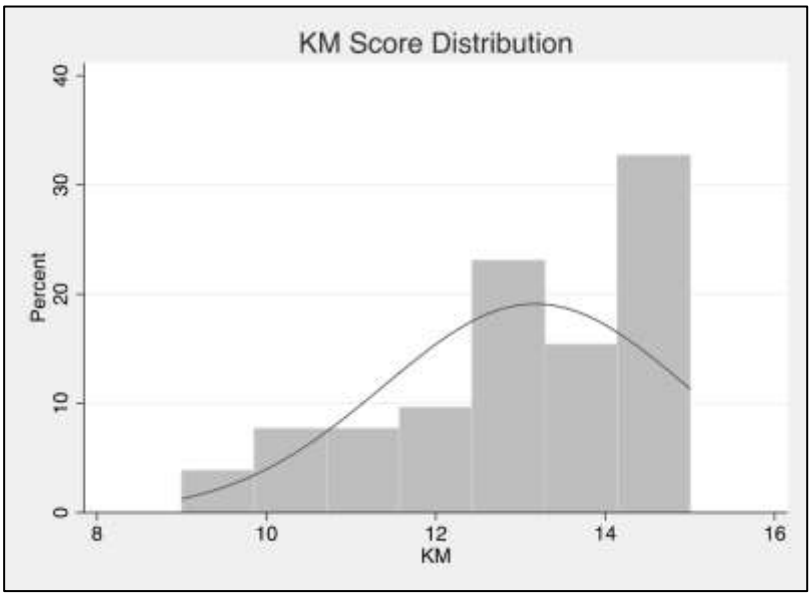

Figure 11: KM Score Distribution

Table 14: KM Score Summary

Percentiles	9 (1%)
	10 (5%)
	10 (10%)
	12 (25%)
	13 (75%)
	15 (90%)
	15 (95%)
	15(99%)
Observations	54
Mean	13.17
Standard Deviation	1.79
Variance	3.20
Skewness	-.73
Kurtosis	2.53

Some questions in the questionnaire (8, 10, 13, 16 and 19) were not asked to test any hypothesis but to gain insight of various dimensions that surround the concept of managing knowledge. We wanted to know what sources of knowledge do usually physicians refer to when they require information about anything that comes across during diagnosis and treatment of disease and also during patient interaction. We were also interested in knowing about the greatest obstacle they come across when accessing those resources. It was revealed through their responses that physicians mostly turn to websites as a common source to get information, followed by consulting their colleague called *curb consultation*. The most common obstacle in pursuing these knowledge

sources is lack of personal time. This is obvious in a busy patient care environment. According to [108], this notion is compounded by the fee-for-service remuneration model for primary care physicians which encourages patient throughput and hence do not encourage physicians to take part in KM activities.

Frequency distributions of both notions are shown in Figures 12and 13.

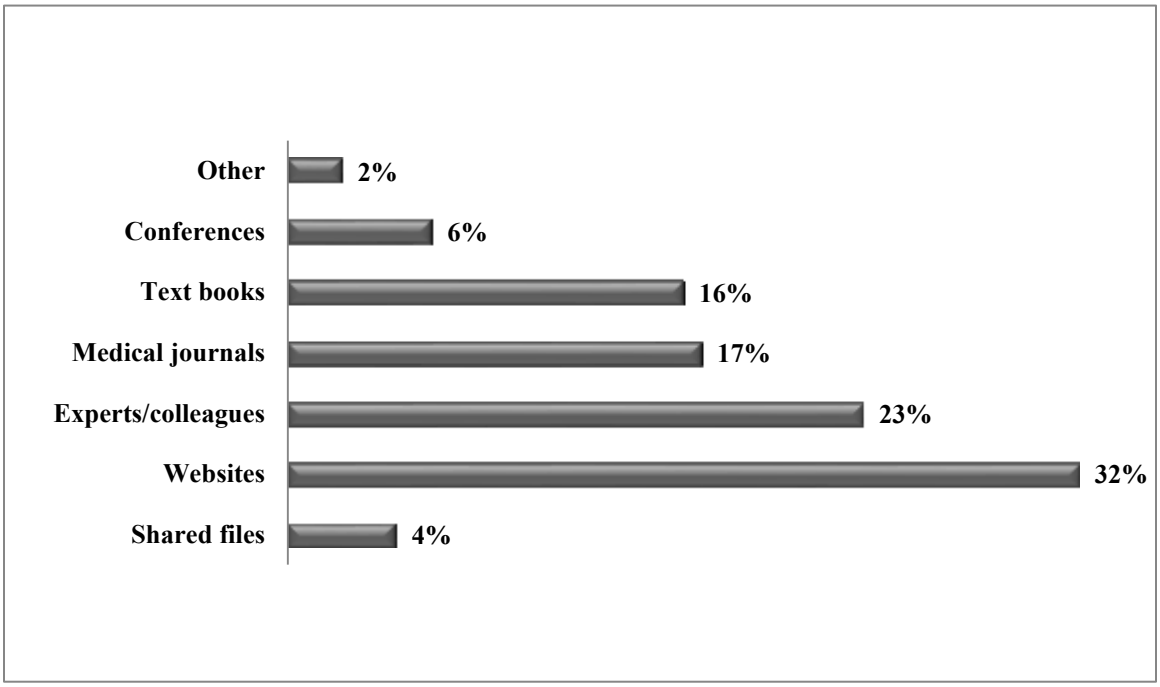

Figure 12: Frequency Distribution of Knowledge Sources Used

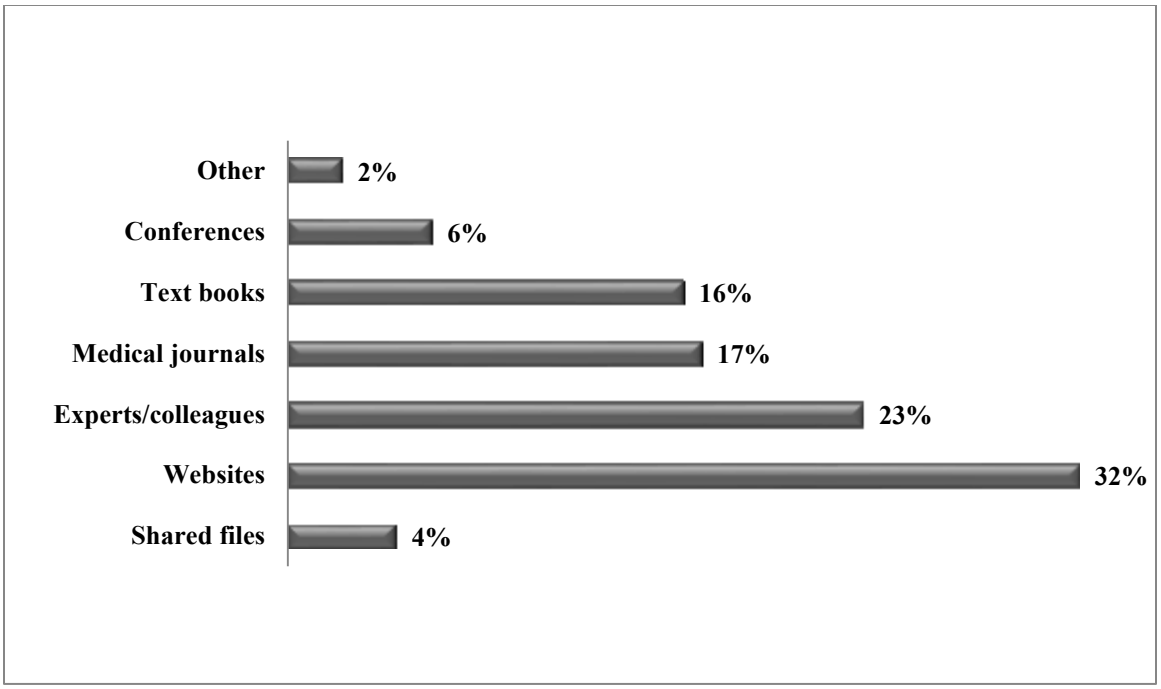

Figure 13: Frequency Distribution of Knowledge Obstacles

3.12. Inferential Statistic and Hypothesis Testing

3.12.1. Hypothesis 1 (H1)

We wanted to find out whether physicians belonging to different age groups (older and younger) differ in KM adoption, and hence we hypothesized that **a difference exists in the age of physicians and their practice of KM techniques.**

Significance level "α" is set to 0.05 for this research. A 0.05 α denotes the likelihood of obtaining the result due to chance is less than 5%. If a significance test yields a p-value lower than the significance level ($p < \alpha$), then the null hypothesis (which states that there is no relationship between two measured factors) is rejected. Conversely, a p-value more

than the significance level ($p > \alpha$) is considered non-significant and suggests that there is no relationship among the variables of interest and a difference does not exist.

A one-way analysis of variance (ANOVA), with $\alpha = 0.05$, was performed to determine whether the KM adoption was significantly different amongst the sub-groups of age of physicians. ANOVA was chosen as there were more than two subgroups were involved in testing. ANOVA tests whether the means of different groups are same and determines how observed variance in a variable can be attributed to other variables. There are three assumptions with the analysis of variance approach: the samples are normally distributed (normality), individual observations are independent of one another (independence) and the variance of each sample (i.e. group) is the same (homogeneity of variance). Normality and independence tests were not performed on any of the test data. Homogeneity of variance of dataset was confirmed using Bartlett's test for equal variance. If we find our p-value to be significant, a post-hoc analysis (pair-wise comparison test) was to be performed on the findings using Bonferroni correction to determine between which sub-groups the difference actually exists. Table 15 summarizes the findings of this test.

Table 15: ANOVA Results for H1

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F Statistic	p-value
Between groups	9.02	k-1= 3	3.00	0.82	0.49
Within group	177.20	n-k= 48	3.69		
Total	186.23				

We got a non-significant p-value ($p > 0.05$) for this test, **which implies us to reject our hypothesis 1. This means that there is no difference in old or young physicians in**

practicing KM techniques. This finding is consistent with the finding of Morton (see [91]) where individual physicians' characteristic had no effect on EMR adoption.

3.12.2. Hypothesis 2 (H2)

We wanted to find out whether male and female physicians differ in KM adoption, and hence we hypothesized that **a difference exists in gender of physicians and their practice of KM techniques.** Cross-tabulation of "Gender" and "KM" variables is illustrated in Table 16. However, statistical validity of any difference is determined through two-sample t test.

Table 16: Cross-Tabulation Between KM and Gender

Gender of Physicians	KM							Total
	9	10	11	12	13	14	15	
Male	1	1	4	3	4	5	10	28
Female	1	3	0	2	8	3	7	24
Total	2	4	4	5	12	8	17	52

A two-sample t test was performed to test our hypothesis. The t test's distribution is similar to the standard normal distribution or z distribution. To use the t distribution, the survey data or observations must be normally distributed and that the variances of the observations are equal. If the sample sizes are equal, unequal variances will not have a major effect on the significance level of the test. If they are not, a downward adjustment of the degrees of freedom is made and separate variances estimates are used instead of the combined or pooled variance. As one of our samples is less than 30 (female = 24), we

assume it as a small sample size so we need to pool the variances. Table 17 summarizes the findings of this test.

Table 17: t Test Results for H2

Group	Observation	Mean	Std. Error	Std. Deviation	95% C.I.
Male	28	13.28	0.34	1.84	12.57-14.00
Female	24	13.25	0.41	2.02	12.39-14.10
Combined	52	13.26	.26	1.91	12.73-13.80
Difference		.035	.536		-1.04-1.11

For H2, we got a non-significant p-value ($p > 0.05$), **which implies us to reject our hypothesis 2. This means that there is no difference between male and female physicians in practicing KM techniques.**

3.12.3. Hypothesis 3 (H3)

For our third analysis, we wanted to find out how do physicians with varying years of experience compare in their practice of KM? In this case we hypothesized that **a difference exists in years of experience of physicians and their practice of KM techniques.**

Since we are dealing with more than two categorical variables (sub-group of years of experience), ANOVA again was called upon to do the hypothesis testing. Bartlett's test for equal variance is used to test the homogeneity of the variance. Results are summarized in Table 18.

Table 18: ANOVA Results for H3

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F Statistic	p-value
Between groups	34.87	k-1= 6	5.81	1.73	0.13
Within group	151.35	n-k= 45	3.36		
Total	186.23	51			

The F test statistic is found by dividing the "Between groups" variance by the "Within group" variance. The degrees of freedom for the numerator are the degrees of freedom for the between group (k-1) and the degrees of freedom for the denominator are the degrees of freedom for the within group (N-k). For H3, we again got a non-significant p-value ($p > 0.05$), **which implies us to reject our hypothesis 3. This means that there is no difference between physicians having different years of experience in practicing KM techniques.**

3.12.4. Hypothesis 4 (H4)

For our analysis of hypothesis 4, we were interested in finding a relationship between the number of patients seen by a physician in a day and their KM adoption. We speculated that physicians who see more number of patients often come across situations where knowledge from other sources is required and therefore may practice KM techniques more efficiently than physicians who see less number of patients per day. This can also be viewed as physicians that are engaged in more KM activities might have more patient throughput. In this case we formed the hypothesis as **the more number of patients a physician sees per day, the more KM techniques he or she uses.**

Since we were interested in predicting a relationship between two numeric variables, namely "Patients" and "KM", simple linear regression was used to test the hypothesis. Firstly a scatter plot was plotted to see if there appear to be a relationship and can a line be fitted (Figure 14).

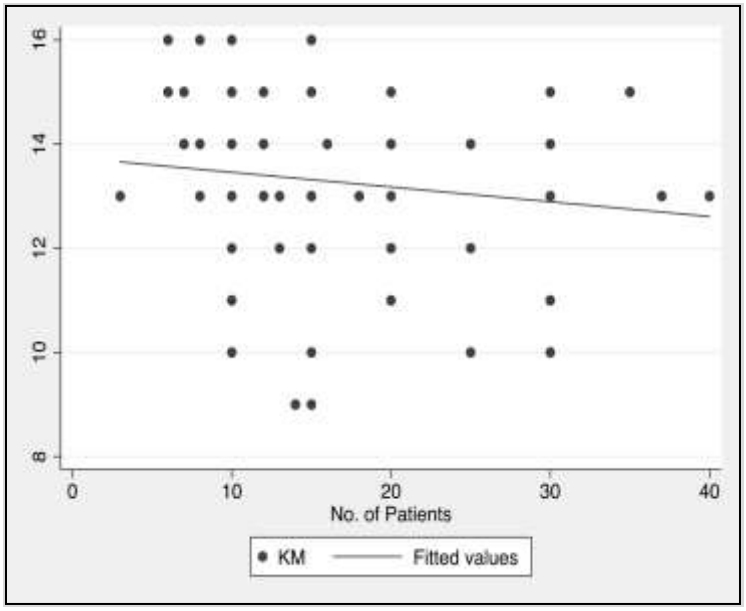

Figure 14: Scatter Plot Between KM and Patients/Day

Since a pattern was not found, we performed regression analysis to test whether a relationship exists. The results are summarized in Table 19.

Table 19: Regression Results for H4

Source	SS	Difference	MS
Model	3.39	1	3.39
Residual	182.23	50	3.65
Total	186.23	51	3.65

"SS" is the sum of square for variances and "MS" is the mean sum of square. For H4, we again got a non-significant p-value ($p > 0.05$), **which implies us to reject our hypothesis 4. This means that there is no effect of patients' throughput on the adoption of KM.**

3.12.5. Hypothesis 5 (H5)

For our final analysis, we were interested in finding if there is a correlation between the ICT usage of physicians and their KM adoption. We did not speculate if one variable is dependent on another neither we are interested in predicting value of one variable with the help of other. Here we are interested in finding out if there is an association between the two variables, "KM" and "ICT". In other words, physicians who are engaged in practicing KM techniques are the one who use more ICTs as well. In this case we formed the hypothesis as, **ICT usage of physicians is associated with KM adoption.** We used Pearson correlation for our analysis. The results are shown in Table 20.

Table 20: Correlation Between KM and ICT

	KM	ICT
KM	1.00	
ICT	0.65	1.00

The result does not allow us to reject our hypothesis and shows that **there exists a mild-to-strong correlation between KM practices and ICT usage of the physicians.**

3.13. Discussion of Results

Three key objectives were identified for assessment in our study using a statistical survey. The first objective, "KM and individual characteristics" investigated whether a relationship existed between an individual's characteristics (age, gender, and years of experience) and the KM adoption of primary care physicians. We then investigated our second objective "KM and clinical practice" to find out if the physicians who see more patients adopt more KM α tools and techniques. The last objective "KM and ICT usage" were investigated to see whether there is an association between KM adoption of physicians and their use of ICT at their workplace. From these overarching aims, a set of hypotheses was developed and tested to statistically gauge whether our perception towards KM adoption is true.

The variable "KM" was a set of questions each investigating different KM activities. An inter-item correlation was performed to see all items constituting the KM construct actually are correlated to each other. Since the five items that constitute KM construct are related to human behaviour, for instance, awareness of knowledge resources and the willingness of physicians towards sharing knowledge, the researcher was interested to see if certain human and practice characteristic have an impact on KM adoption. One more motivation for this investigation, especially to find out the relationship between age and years of experience of the physicians and their KM practices, was the abundance in KM literature about capturing the tacit knowledge of the aging workforce before they retire. This notion of KM emphasizes that older employees of organization must take part in knowledge transfer activities and should encourage KM techniques like job shadowing,

mentoring, and formation of lessons learned databases, in order to transfer their knowledge to others.

We were also interested in finding out the relationship between number of patients seen by the physicians everyday and their KM adoption because it was speculated that seeing more patients might arise situations where the physician has to be involved in more KM activities. This notion can also be viewed from another direction. It can also be speculated that more number of patients discourages the physicians to take part in KM activities, in this case a negative correlation should be expected. This view is supported by e-health literature that points that scarcity of time due to patient throughput is the greatest barrier in EMR adoption among physicians. Nonetheless, we failed to detect any relationship between the two variables.

One possible explanation of these results can be that physicians' attitude towards KM might be more nurtured, shaped, and influenced by forces outside of the individual or practice setting (e.g., training, organizational culture, physician's involvement in the implementation of KM system, management support, and leadership) thus limiting the impact of the four variables of our study towards KM adoption.

The last objective of our study was to find if KM adoption and their ICT usage of physicians are correlated. A mild-to-strong positive correlation between the two variables proves that technology is an essential part of KM system and most people perform KM activities using ICTs. This result is in line and support various KM literature where most of KM activities are conducted through technology.

CHAPTER 4.

STUDY 2: ROLE OF KM IN CARE COORDINATION

4.1. Introduction

The study was conducted in a mental health clinic (MHC) that is a part of a PCN located at Sherwood Park, Edmonton. A PCN is a joint venture between AHS local zone and a group of local primary care physicians who agree to provide diverse healthcare services tailored to their community needs. Most of the Alberta's PCNs leverage an interdisciplinary team of healthcare workers to complement the work of local physicians [109]. There were one patient- coordinator (PC), four clinicians, and the general manager of PCN at the MHC. The study duration was three weeks.

4.2. Study Background and Focus

Coordinated care is a key strategy in reforming health systems around the world. If health system in Canada is going to tackle the challenges it is facing in the 21st century, for example, growing and aging populations and an increasing burden of chronic disease; new ways of connecting services and service providers need to be found [110]. Despite its importance, the concept's lack of specificity and clarity significantly hamper its systematic understanding and successful application. The term "coordinated care" is vague and has different meaning in different context. According to [111], [112], and [113] there are six types of coordination in healthcare:

- **Functional coordination.** It is the degree to which back-office and support functions are coordinated across all units,
- **Organizational coordination**. It is the relationship among healthcare organizations,
- **Professional coordination**. It is the relationship among providers within and between organizations,
- **Service or clinical coordination.** It is the coordination of healthcare services in a single process across
- **Normative coordination.** It is related to shared-mission, work values, and organizational/professional culture, and
- **Systemic coordination.** It is the alignment of policies and incentives at the organizational level.

The focus of our research is *service or clinical coordination* (no.4 in the list above). Clinical coordination is the type of coordination by which patients experience the cohesiveness and connectedness of the health system [114]. Clinical coordination appears to be associated with a number of positive outcomes, including improved system performance, better clinical results, enhanced service quality, and patient satisfaction.

Prior to the development of PCNs in Alberta, the primary care system was isolated and functioned independently from other components of the healthcare system. Primary care consisted of disparate components and the care provided by family physicians was disconnected from other primary care services and the system as a whole. The redesign of Alberta's primary care system has been a key response to these issues. In 2003, PCNs were initiated through a trilateral agreement between the Alberta Medical Association (AMA), Alberta Health and Wellness, and regional health authorities. PCNs establish a

formal relationship between physicians and the health region to collaboratively plan and deliver health services for a geographic area based on population needs. PCNs were developed to better integrate healthcare delivery across the continuum of care (e.g., specialty services, acute, and long-term care). Objectives for PCNs include [115]: improving coordination of primary health services with other healthcare services (like hospitals, long-term care, and specialty care services), fostering a team approach to providing primary healthcare, and encouraging family physicians to work in cooperation with AHS to plan, coordinate, and deliver care for patients.

Our study is based on the definition of clinical coordination given by [116], which is:

- Maintaining patient continuity with the primary care physicians/team,
- Documenting and compiling patient information generated within and outside the primary care office,
- Using information to coordinate care for individual patients and for tracking different patient populations within the primary care office,
- Initiating, communicating, and tracking of referrals and consultations,
- Sharing care with clinicians across practices and settings, and
- Providing care and/or exchanging information for transitions and emergency care.

4.3. Study Objective

The study intended to explore whether the coordination objectives of the Primary Care Initiative (PCI) are met by putting the definition of [116] about coordinated care as our benchmark.

The objective of the study was to discover social and technical factors that affect the coordination of health services among PCN's clinics. The study sought to find the reasons behind coordination gaps, and recommend KM tools and techniques that can potentially bridge those gaps and improve coordination.

This is a case study with the aim to understand the internal dynamics of the case unlike our previous study whose aim was the generalization of results.

4.4. Study Methodology

Two qualitative research methodologies were used in this study, namely, *direct observations* and *semi-structured interviews*. Qualitative data collection methods play an important role in impact evaluation by providing information useful to understand the processes behind the collected results. Qualitative data collection methods are characterized by the following attributes [117]:

- They tend to be open-ended and have less structured protocols (researchers may change the data collection strategy by adding, refining, or dropping techniques),
- They rely more heavily on interactive interviews (respondents may be interviewed several times to follow up on a particular issue, clarify concepts, or check the reliability of data),
- They use triangulation to increase the credibility of their findings (researchers rely on multiple data collection methods to check the authenticity of their results), and
- Generally their findings are not generalizable to any specific population (rather each case study produces a single piece of evidence that can be used to seek general patterns among different studies of the same issue).

Direct observations were used to observe the processes for information retrieval and transfer between the PC and the EMR of the patients, and between the PC and other clinics (diabetic clinic, social and community services, physicians' offices). After the observations, semi-structured interviews were conducted with the PC, clinicians, and the PCN's general manager.

4.5. Ethics Approval

Since this study also involved observation of human participants, an ethics approval was required so that all the steps of the study were conducted with standardized procedure of the board. A formal review and approval process was initiated within the HREB Panel B, at the University of Alberta. The standard proposal was completed and submitted to the HREB for review and assessment, prior to the beginning of actual study. The proposal pursued to understand the scope and execution methodology associated with the research and also how the study would manage all aspects linked to participant privacy, confidentiality, anonymity, and participant engagement during the observation and interview processes. The study number is "Pro000342" with a title "Adoption of Knowledge Management Activities in PCN". There was one modification made in the proposal as required by the board. Firstly, it was asked whether the researcher would be in direct contact with the patients. We did the modification by replying that only the workflow of the PCN is observed and there would be no direct contact of the patients with the researcher. The supervisor of this study is also considered as the principal investigator of the study by the HREB.

4.6. Observation

Observation is used as a research method in two distinct ways, more structured (or systematic) and less structured (sometimes called un-structured)[118]. These two approaches originate in different academic traditions, and have different aims, purposes, and procedures.

More structured observation is a discrete activity whose purpose is to record physical and verbal behaviour. The roots of more structured observations are in positivist tradition in social science. The emphasis here is on the accurate and objective measurement of observable human behaviour, on precise definition and operationalization of concepts, on the production of quantitative data, and on the examination of relationships between variables using experimental and statistical techniques. The aim of more structured observation, therefore, is to produce accurate quantitative data on particular pre-specified behaviour or patterns of interaction. Observation schedules are pre-determined and the categories of behaviour to be observed are clearly defined before the data collection begins. The role of observer is to follow carefully the instructions laid down in the observation schedule, thereby minimizing observer subjectivity.

In contrast, the origins of less structured or unstructured observation lie in anthropology. Unstructured observation is used to understand and interpret cultural behaviour. Research in this tradition has rejected the positivist approach to social science. It emphasizes that to understand human behaviour one needs to explore the social meanings that underpin it. It includes studying the perspectives of attitudes, motives and intentions, as well as observation of behaviour in natural situations and cultural context. These data are combined with information from conversations, interviews and, where appropriate,

documentary sources to produce an in-depth picture of the culture of the group. Unstructured observation is characterized by flexibility and a minimum of pre-structuring but this does not mean that the observer begins data collection with no aims and no idea of what to observe, but there is a commitment to approach observation with a relatively open mind and in a more natural context.

The author adopted the method of less structured observation to observe the workflow of the PCN. The motivation behind adopting this method was to look closely at the whole picture, i.e., the organizational features, what the environment looks like, working habits of employees, and how they behave and interact. The author particularly focused on how patient-specific information is managed, how referrals are handled within the PCN, and what are the technical, social and behavioural impediments in the smooth transfer of these records.

4.7. Role of the Researcher as Observer

The role taken by the researcher in the group or setting under study varies according to the purposes of the research, the nature of the setting, the means of gaining access, and the observational method employed. His or her role is more of a detached, non-participant observer when the purpose of the research is to collect data on specific observable behaviours using more-structured techniques, and it is more likely to be that of an involved participant when the purpose is the collection of ethnographic data using less structured techniques. According to [119], typically researchers have referred to a standard topology of research roles. Such as:

Complete observer. The researcher has no interaction with the subjects during data collection and the role is somewhat concealed. The benefit of the complete observer role is that it eliminates the reactivity that stems from the immediate physical presence of the observer.

Observer as participant. The observer interacts with subjects, but does not take on an established role in the group. His or her role is that of a researcher conducting research. He or she may develop more participant roles with some subjects, but the key role is that of a researcher.

Participant as observer. This involves the researcher taking an established or a more participant role in the group for the bulk of the research. The researcher is better able to see the social world from the point of view of his or her subjects.

Complete participant. The researcher plays an established role in the group and is fully immersed in the participant role, but uses his or her position to conduct research. The advantage of the complete participant role is that it facilitates access. But sometimes playing the participant role means that the time and opportunities for data collection are limited.

The role taken by the researcher in this study was that of "observer as participant". The reason behind the adoption of this role is that we wanted to observe closely the workflow of the PCN and also wanted to clarify processes that were unclear. The intent was to maintain a passive presence, being as unobtrusive as possible, and not interacting with participants during this time, except in a limited sense, in order to gain clarification of actions and events as they occur. This provided data for the research and especially

helped the observer in gaining insight of the workflow. In this way we were able to collect supporting data by asking questions from the subjects. The motivation behind this approach was that we wanted to appreciate the perspectives of the subjects and understand the social meanings that underpin their interactions.

4.8. Workflow of PCN

The workflow of the PCN is illustrated in Figure 15. It shows the complete process of the continuum of care from the time the PCN receives a referral from the physician's office till the end of the patient's treatment at the PCN. In addition to other symptoms and diseases, patients also see physicians for anxiety, grief, stress, divorce and depression. GPs assess them and send a referral form to the MHC. There are variations in the way physicians write the referral form. Some forms just have few check boxes while others carry patient's medical history of five pages along with the list of medications being used by the patient. When the referral arrives in the MHC, PC checks if the clinician has treated any other family member of the patient previously. If yes, then the patient is sent to another clinician due to confidentiality issues. The PC pulls the patient record and the medical history sent by the GP. Every day at 1'0 clock the four clinicians meet for triage and see the referrals from the last 24 hrs. Two clinicians are from nursing background and two from social work background with eight to ten years of counselling experience. They go through the information given to them by PC. If they want more they can pull it through EMR. In the triage it is decided which clinician is best suitable for the patient. Then the referral is sent back to PC who calls and book patients for initial assessment. The initial assessment normally takes one to one and half hours. Sometimes due to

mobility issue, the initial assessment has to be done on phone. After the initial assessment, a comprehensive report is sent to the GP who is always kept in the loop. After this, one of the following steps is taken depending upon what is required.

- Sent patient back to GP with complete report and a list of prescription,
- See one of the clinicians on site,
- Sent to Family and Community Services,
- Sent to Regional Mental Health,
- Sent to private psychologist,
- Sent to employee assistant program (where counselling is arranged by the employers),
- Sent to addiction counselling,
- Sent to narcotic counselling, or
- Sent to sleep counselling.

Sometimes the patient contacts them himself as recommended by the clinicians. In other times the MHC makes the contact and sets up appointment for the patient. The patient history is only sent to them with written patient's consent. The clinicians then follow up after few weeks/months to see if the patient gets better. In the whole care episode, the clinicians see the patients, one or two times. It takes about four to five months for the episodic care to come to closure. The patient tells that he or she is feeling better and does not have any symptoms left. The workflow of care episode is shown in Figure 15.

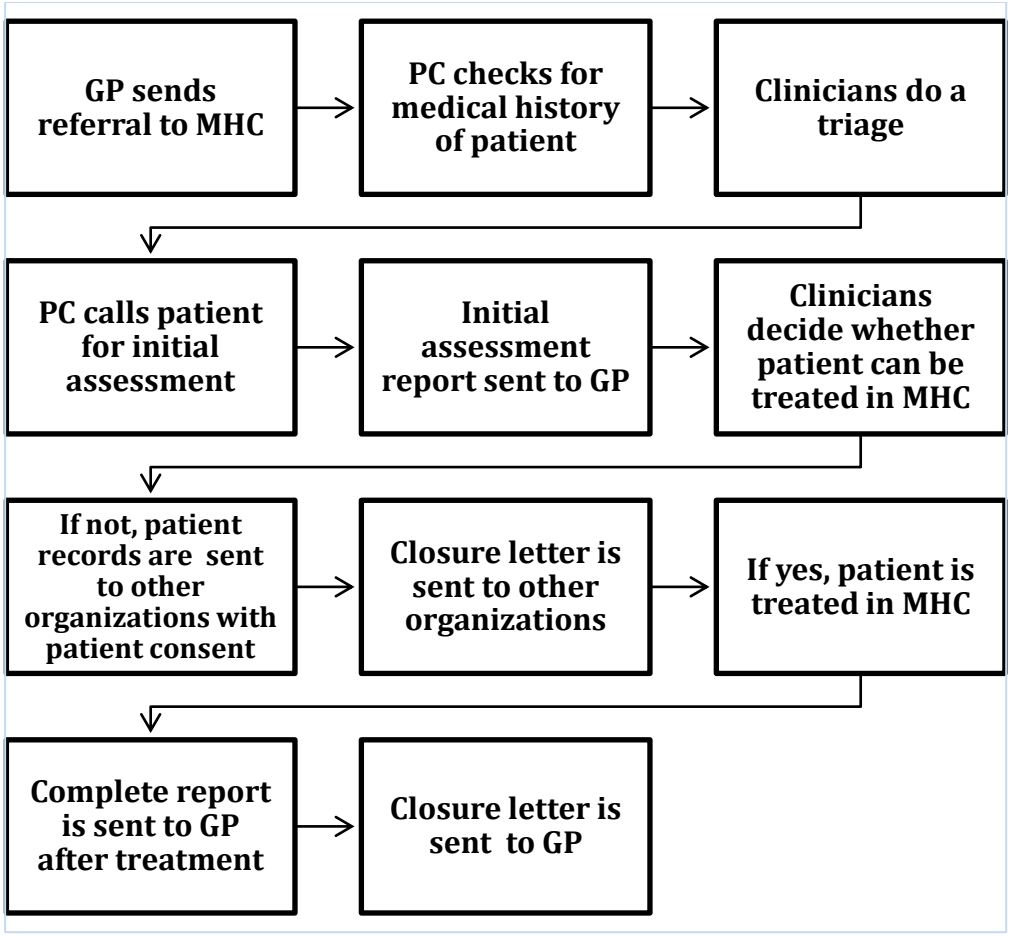

Figure 15: Workflow of PCN

4.9. Information Flow of PCN

There are four sources from where the MHC accesses information about patient's demographics, medical history, and current medical situation:

1. An EMR at the MHC,
2. Alberta Netcare that is an *electronic health record* (EHR),
3. Referral forms sent from the GP's office, and
4. Patient him/herself.

An EMR is a computerized health information system where providers record detailed information about patient's encounter. An EHR is a patient-oriented, aggregated, longitudinal system that assembles health information about a patient over a wide area network. The PC is the starting point of the information flow. PC gets patient demographics and his medical information from GPs in the form of referrals. If the PC needs additional information about the patient, she can get it from Alberta Netcare. She collects and assembles this patient-specific information, put it in patient's EMR, and also forwards it to the clinicians for triage. If the clinicians want more information, they can get it from patient' EMR. Some of the clinicians also have access to Alberta Netcare. The rest of the information is retrieved from the patient him/herself in the initial assessment. The initial assessment report is sent to the GP and the treatment gets started. After the treatment is finished, closure report is sent to the referring GP. If the patient cannot be treated in the MHC, his/her referral is sent to the required clinic along with the initial assessment report, medical history, and closure letter. Complete flow of information within and outside PCN is shown in Figure 16.

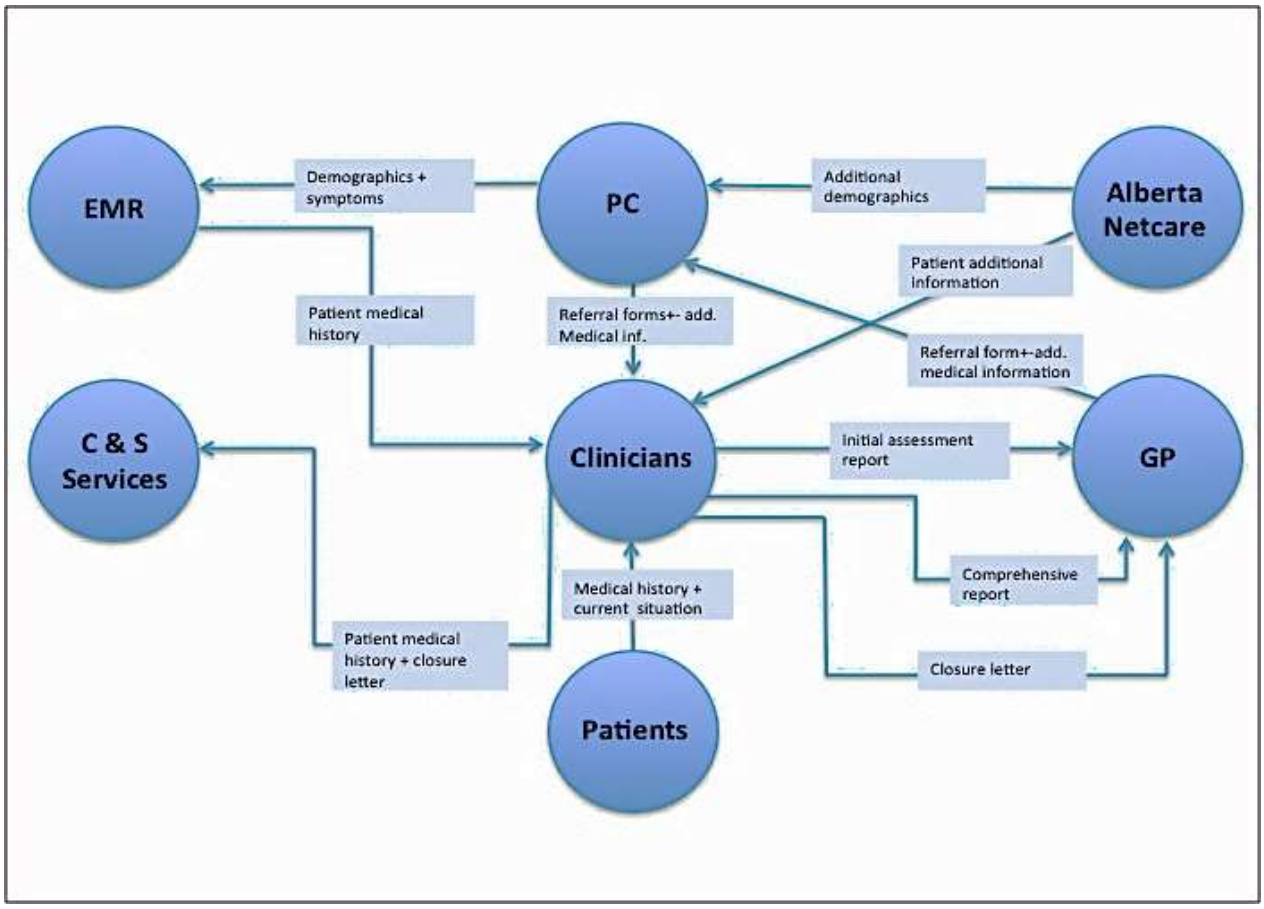

Figure 16: Information Flow of PCN

4.10. Semi-Structured Interviews

Use of multiple data collection methods provides a more convincing and accurate case study. Therefore, data was collected by both non-participant observations and semi-structured interviews conducted with the PC, the clinicians, and the PCNs general manager.

Semi-structured interview is a method of data collection that includes the naturalistic or unstructured question and answer session between the interviewer and the respondent.

Here, the questions are not asked in an invariant order (although some agenda of questions or topics is determined by the interviewer). The phrasing of each question can be varied according to what has gone before, what the interviewer has already found out, and according to the respondent's understanding. The interview appears less artificial more natural than a structured interview, and resembles more like a conversation between equal participants. Supplementary questions can be put according to the replies received, in a way that they do not interfere with the natural flow of conversation. This is in contrast with highly structured method of asking questions in which the procedures of data collection are carefully laid down so that individual interviewers are not departed from them in any way. For example, the questions are worded in the same way and asked in the same order as written in interview schedules and questionnaires. The responses are also categorized according to the categories that the research designer has provided.

In order to have a better understanding of the environment in which the PCN employees handle patient-specific information and the enablers and impediments in doing so, we opted a less or semi- structured method of interview. However, semi-structured interviews do not have same structure as that of natural conversations. An interview conducted in a semi-structured style still contains a degree of control of the interview process by the interviewer. The fact that the interview is more naturalistic should not disguise the issue that the interviewer has a focus.

4.11. Role of the Researcher as Interviewer

As an interviewer, we attempted to set aside hers own definitions, meanings, and perceptions during interviews in any effort to obtain accurate information without bias or

presupposition in responses. It is essential for good qualitative research to separate the interviewer's own perceptions, experiences and biases from the interview and analytical process as much as possible [120].

Methods to minimize the influence of our own personal biases during data collection and analysis included making notes on as we completed one interview and planned the next. As we proceeded to analyze data i.e., grouping data in several different iterations, we literally proceeded page by page with thoughts and scribbles to study the material. Making personal side notes helped to reflect as we read responses and to monitor our own biases. This process helps track and separate our own responses against those of the participants [121].

4.12. Validation of Collected Data

Qualitative research is being valued for its differences to quantitative research, rather than being perceived as having methodological shortcomings in comparison. Through recognizing these differences, it is understood that the quality of qualitative research cannot be judged comparatively with quantitative research which emphasis validity and reliability [122] as discussed in our previous study. Although there is a general consensus among researchers with respect to the validation principles and processes in quantitative studies, researchers do not have any such agreement when it comes to applying validation principles in qualitative studies. The issue of validation in qualitative research is rather ambiguous and contentious [123]. Some researchers have even suggested that the notion of validation, such as reliability and validity, should not even be considered a criterion for evaluating qualitative research [124]. Others have suggested that although validation is

important for qualitative research, it should be called something else than reliability and validity to distinguish it from what is done in quantitative research [125]. They argued that since reliability is a necessary condition for validity, demonstrating validity in qualitative research is sufficient to establish reliability.

Regardless of the different views of validation in qualitative research, there is some agreement that validation (or similar concepts) is essential in qualitative research to reduce misunderstanding and to develop a common scientific body of knowledge [126]. The question brought forward by these arguments is that how do observational data (as in our case) can be validated? One method is to check elements that can be potential threats to data validity in an observational research.

We categorize these threats in the context of our study. Since this study is *overt* where the role of the observer is not concealed, the threat of reactivity arises. Reactivity occurs when subjects behave differently because of the personal characteristics, or behaviour of the observer, or because they know they are being studied or observed. They change their behaviour in response to the procedures involved in the process of observation itself. This is also called *hawthorn effect*.

A second possible threat to validity comes from the inadequacies of the measuring instruments used in the observation. For instance, observation schedule may be unsuitable or inadequate for describing the actual nature of the behaviour that occurs. Some aspects of behaviour are ignored which may be important given the aims of the research. Selectivity in notes taking, and the distortion that can occur when the researcher relies upon memory to write field notes, can also be significant sources of error.

A third potential threat to validity comes from observer bias. All observers have particular cultural knowledge, and they approach observation from particular theoretical and sometimes political standpoints. These subjectivities can affect what behaviour is selected for observation and how this behaviour is interpreted and recorded.

Given that there are no generally accepted guidelines, expectations, or norms, to discuss validity in qualitative research, we refer to the four criteria proposed by [127] to form the framework for determining the validity of our research data that can mitigate most of the potential threats indicated above. They are:

- **Credibility.** It refers to the value and believability of the findings and involves two processes: conducting the research in a believable manner and being able to demonstrate credibility. The goal is to ensure that the participant was accurately described in the data and interpretations. (This can be seen at par with the concept of internal validity in quantitative research),
- **Dependability.** It refers to how stable the data is. (It is often compared to the concept of reliability in quantitative research),
- **Confirm ability.** It refers to the neutrality and accuracy of the data and is closely linked to the concept of dependability. (It can be seen as statistical conclusion validity in quantitative research), and
- **Transferability.** It refers to whether or not particular findings can be transferred to another similar context or situation, while still preserving the meanings and inferences from the completed study. (This is same as the concept of external validity of quantitative analysis).

Specific strategies for ensuring validity in this framework were needed. Table 21 illustrates four processes for determining trustworthiness in qualitative research and outlines the main strategies for addressing them as proposed by several authors.

Table 21: Validation of Observation Data

Criteria	Strategy	Author
Credibility	Prolonged engagement, Triangulation, Respondent's validation	(Johnson et al. 1994) [128], (Polit et al. 2001) [129]
Dependability	Reflexivity	(Jasper 2005) [130]
Confirm ability	Reflexivity	(Jasper 2005)[130]
Transferability	Thick description	(Lincoln and Guba 1985)[131]

4.12.1. Prolonged Engagement and Persistent Observations

Prolonged engagement and persistent observation can enhance the credibility of research. These skills require researchers to spend sufficient time in the field to gain full understanding of the phenomena being investigated. The lack of any new emerging data is the evidence that saturation has been achieved.

In our study, observations were conducted over an 8-hour shift for three weeks. We spent sufficient time in the field to gain a full understanding of workflow of the PCN and the technical and behavioural impediments in the flow of patient-specific information.

During the final observations no new concepts were emerging, which confirmed in the analysis, indicating that saturation had been achieved.

4.12.2. Triangulation

Credibility can also be achieved through triangulation. Triangulation is a method to replicate the observation and checking the similarities between results. Sometimes the whole study is repeated using the same procedures, with different observers. At other times, parts of a study may be repeated. Replication is more feasible in experiments and studies involving more structured observations, where procedures are clearly specified and therefore can be fairly easily repeated. One form of replication involves examining the extent of agreement between two observers observing the same behaviour. The technique here is comparing the two observers to see to what extent they agree. This is also called *inter-rater reliability*. In our case, as the author is the only observer of the process, inter-rater reliability has not been tested.

Another way to perform triangulation is comparing the data produced by different methods. This approach is taken for our study. The data collected through observation was compared to data collected through interviews. Input from the PCN's general manager was very helpful in this regard. He reviewed our study at various stages, reading material, questioning our interpretations, at times checking meaning, and bringing up points of validity concerns. Reviews by the dissertation committee may also be seen as an external audit checking for validity and ensuring an acceptable level of rigor in our study.

4.12.3. Respondents' Validation

Comparing data from the researcher's observations with data from various subjects involved is one form of respondent validation. Here our aim was to check the validity of the observations by reference to the subjects' perceptions. We discussed the observations with the PC, all four clinicians, and the general manager to see whether they feel the observations are accurate, and what their perceptions of a particular incident are. It also involved allowing them to read the transcription of their interviews to ensure that those have been accurately recorded and, therefore, are credible. The objective behind this technique was to access important additional knowledge about the technical and behavioural factors impeding the smooth access and transfer of information within and outside PCN that cannot be available through observations. Some examples are the thoughts and motives of subjects, their perceptions of the behaviour of others, and about the social context in which the behaviour occurred.

4.12.4. Reflexivity

In most qualitative research, the researcher is considered part of the research instrument; therefore the credibility of a study rests on the procedures implemented and self-awareness of the researcher throughout the research process [132]. Maintaining a reflective diary can be an important expression of reflexivity [133]. A reflective diary should provide the rationale for the decisions made by the researcher at various points during the study, and the instincts and personal challenges experienced by the researcher during the study.

In our study, a reflective diary illustrated the transparency of decisions made throughout the research process. Recording thoughts about decisions made about a specific problem and it's potential KM solution, enhanced dependability and highlighted the transparency of the process. The thoughts and ideas documented during data collection helped in the development of final solutions.

4.12.5. Thick Description

A thick description can aid the transferability of findings. Rich, thick description is writing that allows the reader to enter the research context [134]. In this manner the voices, feelings, actions, and meanings of interacting individuals are heard. In order to provide rich, detailed writing, we dedicated ourselves to the transcription of every interview making sure we alone held judgment between what was important and what was not. In this way we were able to catch inflection in voice, emotion, excitement, or phrases and comments that may have been made humorously or otherwise not seriously intended, and should not be taken at face value. Hearing recorded responses repeatedly and personally in the transcription of all interviews helped us to study and reflect. It took us closer to the data, and allowed much detail in our writing. The thick description in the discussion of results (section 4.13) permits the reader to make his or her own interpretations making possible applications in their own settings.

4.13. Results

The researcher observed several gaps in the management of information that creates challenges for the employees and hence results in an uncoordinated care. It was found out

that these gaps exist because of two reasons; work behaviour of the employees and technical factors (Table 22 and 23 respectively). Workarounds are created as a result of these challenges. We described the role of KM in bridging these gaps. KM goals, potential KM solutions, and KM processes involved in each of the coordination task are described. The researcher categorized the impediments to the flow of information as *behavioural* and *technical.*

Table 22: Behavioural Impediments to Information Flow

Coordination Task	Patients being referred to MHC		GPs sending referral forms to MHC
Challenges	Patients do not know about it	Referral forms for MHC being sent to the diabetic or MCC clinic	High variation in patient-specific information, Missing patient medical history, Missing list of medications
Workarounds	Time consuming and extra effort from the PC to convince them to come to MHC	Somebody has to deliver the referrals manually to the MCC	Time consuming for the PC and the clinicians to gather missing information
KM Goals	Error reduction	Error reduction, improved communication	Improved communication
Potential KM Solutions	E-mail, reminders	Business process management	Education and training for physicians
KM Processes Involved	Knowledge transfer	Knowledge transfer	Knowledge creation, capture and storage

Table 23:Technical Impediments to Information Flow

Coordination Task	MHC referring to social and communi	Initial assessment and comprehensive report	PC seeking more record out of Alberta Netcare	PC identifying if family members of the patient			GPs sending referral forms to MHC
Challenges	EMRs of clinics not compatible with	EMRs of both clinics not compatible with each	When PC goes into Alberta Netcare thru EMR, it	Check manually by address and then last name	EMRs of both clinics are not compatible with each	Forms are faxed instead of using EMR	Use hand written referral forms that creates
Workaround	Referral forms are faxed, Time	Report is faxed it to the referring physician. Time	PC has to login separately into Alberta Netcare, cut	Time consuming task	PC has to create new profile for patients, Struggle in	More work as staff label, scan, and fax the forms	PC has to struggle reading through it
KM Goals	Rework reduction , cost reduction	Rework reduction, cost reduction.	Easiness of use	Easiness of use	Availability of existing information	Rework reduction	Error reduction
Potential KM Solutions	Improved interoperability, Commun	Improved interoperability, Communities of practice	Technical improvement between EMR and Alberta	Alert system, Improved interoperability	Improved interoperability, Vendor management	Education and training for physicians using the	Improved interoperability for different types of
KM Processes Involved	Knowledge transfer and sharing	Knowledge transfer and sharing	Knowledge access	Knowledge access	Knowledge access	Knowledge transfer	Knowledge storage and access

4.14. Discussion of Results

To find out the rationale behind the impediments, short semi-structured interviews and informal discussion were conducted with the PCN's general manager and other employees. During these interviews, several findings were discussed. About the variation in the patient-specific information sent by the physicians, though it is sensible to think that more information from physicians would help clinicians to provide a better quality care; physicians seldom practice it. The main reason behind this could be ignorance of physician towards the importance of information. When physicians do not want to take the time to put enough information on the forms, it is either because they forget or they do not value the information that is there to be provided. Though it is possible to find a lot of patient information through Alberta Netcare, the physician has the primary relationship with the patients. For this reason, Alberta Netcare is not able to describe some of the finer points of the patient's healthcare. Another reason being stated was lack of knowledge of the physicians about how much information to provide. Most of the physicians do not know what happens after they send the form, so they are not in a position to value or determine why the information is needed. Mostly younger doctors send more complete information because they have a better sense of what is needed. More education and training sessions (KM social tools) are recommended through this research for the physicians to make them aware of the importance of information.

As shown in the results, there is a very high no-show rate because there is mismanagement of information, as patients often do not know about the referrals. There are several factors behind the no-shows. There is negligence on behalf of the physicians' clinics. Since MHC is a tough area and people do not accept that they are referred to the

MHC, several follow-up reminders in the form of e-mail and telephone calls are required for many patients to make them come to MHC.

Incompatibility between EMRs is the single most important hindering factor in the coordination. The reason behind is different version of EMRs being used by the MHC and physicians' offices. Physicians use EMRs that gets funding through Physician Office System Program (POSP) of the Alberta government. There are three EMRs that gets funding so each physician thinks there EMR is the best because that's the one they have. Convincing them to move to a single version is a near-impossible task that the PCN management had already tried in previous years. Switching to a different EMR requires relearning and has hidden cost associated with it [135]. It is expensive and frustrating. The MHC uses a non-POSP EMR called "HealthQuest" because it is less expensive and compatible to some extent to all of the POSP's EMRs though it is not fully compatible with any one of them. Our research of KM literature suggests that *Communities of Practice* (COPs), which could be a group of physicians interested in using and sending data through the same of kind of EMR would help facilitate coordination. Proper vendor management (physicians knowing their technical requirements, available EMR features, and which vendor to go to) is also helpful in this case.

Alberta Netcare and EMR interface with each other through Parameter Lounge Browsing (PLB). When a button is pressed in EMR it passes some arguments to Netcare Programming Interface (API) and handshaking between the two applications takes place. Alberta Netcare is called in the context of the EMR and brings the users right to that patient. Since there are problems in the interoperability between the two health records, things are to be done manually. If the clinicians have access to physician's EMR, they

could get information from there and that could save time and effort. Again, we recommend proper technological solution and vendor management for sharing of patient-related information between the MHC and physicians' offices.

CHAPTER 5.

CONCLUDING DISCUSSION

Managing knowledge in an organization can help in achieving better business results. This is because proper management of knowledge results in non-repetition of the same procedures, standardization of documentation allowing its easier management, and use of knowledge that individuals already have, hence, saving valuable resources like time and money, Moreover, KM may be seen as core competence in healthcare organizations as it can potentially enable them to face the many challenges of the 21st century. However, in order to achieve expected results, KM system should be set in a proper way, with enabling factors in organization that provide at least basic conditions for successful implementation and finally effective processes leading to desired goals. Even though there is extensive literature on KM in general, few researches have been conducted focusing on the effect of individual and practice characteristics of physicians on KM adoption. This study therefore focuses on uptake of KM by physicians and clinics. It was particularly challenging for the researchers of this study to step into almost untapped area and research with the assistance of the literature that does not completely match with the focal point of the research.

The purpose of the research is twofold. Firstly, to investigate the effect of individual and practice characteristics of physicians on practicing KM techniques, and secondly, to find the factors that impact the coordination of health services and the role of KM to improve it. In order to do that, two studies were conducted. A KM survey was launched among

primary care physicians in Edmonton that served as a step to achieve our first objective. It was aimed to understand the characteristics of physicians affecting their KM adoption. However our result showed that physician's individual and practice characteristics do not affect their KM adoption and it is speculated that one's attitude towards KM is more influenced by factors outside the individual or practice setting. (e.g., training, organizational culture, physician's involvement in the implementation of KM system, management support, and leadership). However, we found a positive correlation between KM adoption and ICT usage of the physicians proving that technology is a vital component of a KM system.

In our second study, a case study was conducted and the workflow of a PCN was observed and analyzed. It was aimed to understand how information is managed within and outside PCN. The intent was to explore the factors behind the mismanagement of information that result in an un-coordinated care. Semi-structured interviews were also conducted of the PCN staff to validate the results obtained through observation. Several technical and behavioural factors were identified that were responsible for the gaps in care coordination. Finally, the study was aimed to bridge those gaps through the recommendations of KM tools and techniques.

At the initiation of the research process, extensive literature was reviewed and papers written by many relevant authors in the field were analyzed. This resulted in the development of the authors' own KM practice model, comprising different categories.

Finally, it is important to mention that the author of this research has partially stepped into this area, since only two studies were conducted. Nevertheless, these results do

produce some valuable insights of KM adoption and its potential role in the coordination of care.

5.1. Contribution of Study

As stated in previous sections of the thesis, KM processes are mainly used in manufacturing or consulting companies and are neglected in the healthcare sector, especially in Canadian healthcare. It might be due to several reasons. Firstly, due to the assumption that KM is just another management fad and cannot provide benefits to the organizations, secondly, the FFS remuneration model for primary care physicians discourages any activity that hinders patient's throughput. Therefore no significant research has been conducted to investigate individual or practice factors that can potentially enable or disable KM initiatives in healthcare organizations including primary care clinics. However, after this research is conducted, we can claim that there is an effort to investigate the enablers and disablers of KM, at least at the individual and practice level in primary care. Therefore, the fact that this study has entered into almost new field (KM enablers and disablers at individual and practice level in Canadian primary care) is the biggest contribution of this research. The study findings and discussion presented in this thesis offer some general insights for consideration within the healthcare setting. The study sought to extend current knowledge related to KM by investigating a set of individual and practice variables that had the potential to impact KM in primary care clinics. More specifically, it examined whether age, gender, number of years of experience, and number of patients seen per day had the potential to influence KM practices by physicians. It also examined the association between the ICT usage of

physicians and their practice of KM techniques. These notions were investigated among the primary care physicians across Edmonton. The foundation of the research was built upon the understanding that KM system implementation is affected by both individual and practice characteristics of the physicians.

The second study can contribute to the organization in focus, namely PCN. The study explored whether there are gaps in coordination of health services among PCN's clinics and physician offices. The motive behind this element of the study was to discover the social and technical factors that affect the coordination of care, the reason responsible for gaps in coordination, and identification of the KM tools and techniques that can potentially bridge those gaps and to improve the overall process. The benchmark was highly recognized academic literature and best practices. Additionally, the study can also be helpful for other organizations similar to PCN, like family care clinics (FCCs) whose main objective is also to provide coordinated care. Therefore, we believe that it can contribute to wider practitioner audience.

The author of these studies played the leading role in developing the research questions, study designs, research methodology as well as in the study execution, data gathering, analysis and report writing processes. There were also two talks presented by the author at two different occasions. They are:

1. "Knowledge and Information Management in Healthcare Operations" at INFORMS HEALTHCARE 2011, Montreal, Quebec, in June-2011 and

2. "Role of Knowledge Management in Healthcare Coordination" at 4th Annual Graduate Research Symposium, Faculty of Engineering, University of Alberta, in June 2013.

5.2. Limitation of Study

It is significant to define the limitations of the study and thus contribute to its validity. This study has several limitations that need consideration. Our first study explored and reported only the individual and practice related characteristic of physicians and did not touch upon numerous organizational factors that can potentially affect KM activities of physicians, as illustrated in the theoretical model on which the study is based upon.

For the second study, generalizations of the results should be avoided, since the study was performed on one PCN only. The objective of this study was not to generalize the results but to have a closer look at the coordination gaps and the reasons behind them. Therefore, the results obtained in this study may or may not be applicable to other PCNs and this should be dealt with care. Regarding face-to-face interviews, even if the researcher had an interview guide, some questions were sometimes missed or forgotten and thus some information might lack. Subjectivity of a qualitative research should also be mentioned as a possible limitation. The bias is always present in this kind of research and thus this study is not free of that either.

5.3. Future Directions

Despite the limitations, this exploratory investigation contributes to the understanding of KM adoption by primary care physicians in Edmonton. The investigation took place in an

area where there is a paucity of research, i.e., the unique KM-individual/practice related experiences of physicians. The knowledge created through this study could potentially benefit future researchers by providing information on physicians' perceptions of KM adoption. As discussed in previous parts of the study, KM processes and tools were not researched sufficiently in healthcare environment. We have only partially stepped into this area, since only two studies were conducted. More cases should have been done in this area in order to provide more reliable data. The area for further research could therefore be investigating organizational factors that can potentially impact KM adoption in primary care. Exploring KM adoption in other domain of care can do further investigations as well. However, bigger samples are desired. From the point of view of the performed research, it would be beneficial if other qualitative studies were conducted in order to compare and hopefully confirm the findings. It would be valuable if it could be done through ethnographic research methods such as shadowing that take into account interactions among people that may be not grasped through other formalized methods. Studies can also be performed on other PCNs as well to find out if similar gaps in coordination exist.

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APPENDIX A: SELF-ADMINISTERED QUESTIONNAIRE

Knowledge Management in Primary Care: Physicians' Survey.

Please take a few minutes to fill out this short survey. Your agreement to participate in the study is completely anonymous and will have no bearing on the care you provide to the patients. We will not ask for your name in the survey. When our study is reported, the data will be collected and only aggregate results will be reported.

Personal and Practice Data

Could you please indicate your gender?
Male
Female

Could you please indicate your age range?

0 – 20 years old
21 to 30 years old
31 to 40 years old
41 to 50 years old
51 to 60 years old
61 to 70 years old
70 years and older

Could you please indicate your years of experience in clinical practice?

0 – 5 years
6 to 10 years
11 to 15 years
16 to 20 years
21 to 25 years
25 to 30 years
More than 30 years

Could you please indicate an average number of patients you see every day?

Current State of Knowledge Management Practices

Are you aware of these medical knowledge resources? BMJ Evidence Centre, Medline (PubMed), Cochrane Library, National Guideline Clearinghouse.

I am aware of all of them
I am aware of some of them
I am not aware of any of them

How useful is research finding in your day-to-day management of patients?
Extremely useful
Useful
Not useful

Do you pursue answers to the questions that arise during patient interaction?

Never
Some of the time
All the time

What is the most common source/method you use in seeking this knowledge? (Check all that apply)

Shared files
Websites
Other experts/colleagues
Medical journals
Textbooks
Conferences and presentations
Other

How much time on average you spend in a day seeking knowledge from resource?

I do not spend time on this at all
I do spend time on this sometime
I do spend time all the time. Please describe how much (minute/hrs.)

What is the most common obstacle in accessing the required knowledge? (Check all that apply)

Lack of personal time
Unavailability of the resource
Locating the expert
Too much information
See no financial gain
Other

Current State of Knowledge Management Technology

Do you have an information portal in your access at your clinic?

No I do not have
Yes I have
Other

Do you have an online discussion board at your access to consult with geographically dispersed experts?

No I do not have
Yes I have

Other

What sort of health records system do you currently use?

Paper
Electronic, but paper used to record notes first followed by transcription
Electronic, desktop in exam room
Electronic, laptop carried into exam room

How long have you owned your EMR? (Months/years

I do not own EMR (skip the next two questions)
I own EMR for

Is your Physician Office System (EMR) is connected to EHR of patients?

No, It is not connected
Yes, It is connected _____
Other

What do you use your EMR system for?

Billing
Scheduling
Encounter note taking
Lab results
Order entry
Contraindication management
None of the above
Other

Do you feel skilled and confident to use any of the above-mentioned technology?

No I think I require more training
Yes, I am trained enough
Other _____

Attitude towards Knowledge Management

How willing you are to share your knowledge with others? (colleagues and staff)

None of the time
All the time
Sometimes
Other _____

How would you describe your attitude towards Knowledge Management?

Welcoming
Not welcoming
Somewhat welcoming

Thank you for your participation in this survey.

APPENDIX B: STUDY INFORMATION SHEET

Study Title: Knowledge management in primary care

Physicians' experience regarding knowledge management system in clinical practice.

Researchers:

Aasia Anwar[1] M.Sc. student

John Doucette[1,2] P. Eng., PhD

1. Department of Mechanical Engineering, University of Alberta, Edmonton, AB, Canada, T6G 2G8

2. T. R Labs, 7th Floor, 9107 - 116 Street, Edmonton, AB T6G 2V4

Purpose:

This study is approved by Health Research Ethics Board. The application number is Pro00021714.

The purpose of this study is to gather physicians' feedback regarding their experience of incorporating knowledge management tools and techniques in their clinical practice. This study forms part of a research project towards Masters studies for Aasia Anwar.

Benefits:

This project will help researchers understand how knowledge management practices and technologies implemented in health care can help improve the patient care experience while making the right knowledge available at the point of care. We expect many benefits to physicians, nurses and patients to come from this study in the future. We hope to understand your experience so that we can make better use of these practices and technologies in the future. There is no direct benefit or remuneration provided for participating in this study although information collected may be used to improve the way health services are carried out in the future.

Study Period:

The estimated study period is from August 2012 to December 2012.

Project Risks:

There are no known risks to participating in this study.

Providers Participation:

Your participation in the study is voluntary. Declining to participate or early withdrawal from this study will not impact your current or future medical practice. Your participation consists of a short survey, which asks questions about your awareness and behaviour regarding knowledge management system in your family practice. No further involvement is required from you. You may decline to participate in this study. Should you wish to withdraw from the study, simply ignore our invitation and discard the survey. You also have the right to ask questions and ask for more information by contacting the researchers at aasia@ualberta.ca. Return of the survey to the researcher, implies your consent to participate.

Provider Record Privacy:

The information that you provide will be kept confidential. By completing this survey, you give permission to the researchers to use the information provided, in their research. Code numbers will be used on surveys, transcripts and notes. All information from the study will be used only in an aggregate form; your name will not be known. Only principal and co-investigators, and research team members will review information from the surveys. All data collected will be stored in a locked cabinet at the University of Alberta for a period of five years and then destroyed.

Information from surveys will be used for interim and final reports, publications and presentations of research information, but at no time will you be known by your name or in any other way. Anonymity and privacy will be assured as much as possible. You may request a copy of interim and final reports, which we will be mailed to you if you wish.

Providers' Concerns:

If you have concerns about this study, please contact the University of Alberta Research Ethics Office at 492-2615

APPENDIX C: RECRUITMENT LETTER

Re: A survey of your experience with knowledge management system

Dear Madam or Sir:

I am contacting you with regard to your experience of using knowledge management tools and techniques in your day-to-day clinical practice. We are conducting a research project to understand more about healthcare provider's awareness, behaviour and perspective towards knowledge sharing and using knowledge technology. This research project is being conducted by Dr. John Doucette of the University of Alberta, and Aasia Anwar, an M.Sc. student also at the University of Alberta. In addition to providing valuable feedback, this research project will also be used as part of Aasia's M.Sc. thesis research at the University of Alberta, and results may also be used as the basis for one or more academic publications or presentations.

We would like to invite you to participate in a short survey to understand your experience with knowledge management system. The survey should take about 5 minutes to complete. Your agreement to participate in the study is completely anonymous and will have no bearing on the care you provide to your patients. We will not ask for your name in the survey, nor will we be aware of who did or did not complete this survey. When our study is reported, the data will be compiled in aggregate form and only those aggregate findings results will be disseminated.

If you wish to participate, please return it to the University of Alberta in the self-addressed and stamped envelope provided. If you wish to decline participation, please discard the survey.

For more information, please refer to the **Study Information Sheet for Healthcare Providers** prefacing the survey. We would greatly appreciate your feedback.

Thank you

Aasia Anwar

John Doucette