Knowledge Management in Health care

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Abstract

While knowledge management (KM) is becoming an established discipline with many applications and techniques, its adoption in health care has been challenging. Though, the health care sector relies heavily on knowledge and evidence based medicine is expected to be implemented in daily health care activities; besides, delivery of care replies on cooperation of several partners that need to exchange their knowledge in order to provide quality of care. In public health decision is mainly based on data and a shift is needed towards evidence based decision making. It is obvious that health care can profit from many advantages that KM can provide. Nevertheless, several challenges are ahead, some are proper to KM and other particular to the health care field. This chapter will overview KM, its methods and techniques, and provide and insight into health care current challenges and needs, discuss applications of KM in health care and provide some future perspectives for KM in health care.

Introduction

In service base companies, knowledge is a central intangible asset; knowledge management deals with the creation, use, reuse, dissemination of Knowledge. Knowledge Management (KM) became a discipline during the 80's, and the growing role of information technologies enabled the development of efficient KM tools using databases and collaborative software.

As an interdisciplinary discipline, KM regroups concepts from Information Technology Management, Philosophy, Cognitive Sciences, and Organization Studies. The result is the existence of several schools and approaches in the practice of KM. In health care, KM is being developed mainly in the domain of electronic health record management and health organization management; in this context, previous researches in the business domain have been adapted and applied to the Healthcare Knowledge Management. But Health care KM raises different challenges and issues due to the own nature its Knowledge.

This chapter is organized in two parts; in the first part we will overview the knowledge management domain, beginning with several definitions of KM and a brief history. We will also discuss the different models and frameworks used in KM, introduce different techniques their advantages and drawbacks; and then discuss KM hardware requirements. In the second part we will look into health care knowledge management providing an overview of its applications, the advantages they provide and the challenges they face; then we will end with a discussion of health care knowledge management perspectives.

Knowledge Management

A brief history

Knowledge management had always been a central question in human societies. Indeed, its roots are to be found in the early history of human societies. Philosophers, Western as well as Eastern, have focused their attention on the question of knowledge; already in ancient Greece, 'scientific' discussions often lead to philosophical debates, especially on the concept of knowledge. The creation of epistemology has finally formalized the question of knowledge; indeed, epistemology addresses primarily the question of "what is knowledge?" and discusses its creation and adoption. In the current discipline of knowledge management, philosophical considerations from several schools are taken into account, especially in the ontological knowledge management field (Grenon, 2003).

On the other hand, practical knowledge management has always taken place in the society, and transmission of knowledge was much related to the technical progress. Beginning in the middle age, knowledge transmission occurred under what was called "Wandergesellen" in Germany and "Compagnonnage" in France, where craftsmen and artisan take a tour of the country for 6 months or one year to learn from several masters. This was one of the first structured methodologies for tacit knowledge transmission. Knowledge first spread orally, then in writing; but it was restricted to a low circle of educated people till the development of printing. If the first printing focused on religious and literature purpose, technical and specialized books began to spread after the wide adoption of the printing press.

In the 20th century, management as well as cognitive sciences and psychology led to today's Knowledge Management (KM) (Wiig, 1999). The current situation of KM started in the 1980s with the wide use of information technologies in companies; the focus was on the intangible asset that knowledge represents. The word KM itself appeared in the 80s and the academic discipline was created in 1995 (Stankosky, 2005).

Goals and challenges of KM are many; for companies, KM should increase their performance, help to develop partnerships, evaluate risks, organize management and enhance their economic value. Development of corporate memory and measurement tools also aims at assessing

intangible assets in the companies. Besides, knowledge transfer enhancement and companies' performance evaluations became issues of major importance.

After twenty productive years in KM, the first criticisms appeared in 2002. T.D. Wilson (Wilson, 2002) discussed the foundation of KM, mainly because of the difficulty to distinguish information from knowledge in most KM theories. He drew the conclusion that KM was a management fad and should disappear in the upcoming years. Actually KM survived well those criticisms, even if the precision of the vocabulary is not comparable to the one used in epistemology or in computer science based KM; probably the reason lies in the real need for companies as well as public organizations to use KM methods.

We can distinguish 2 main KM trends: people and information management centered and information technology centered. We should also recognize two other main orientations, the first is the need of evaluation in terms of performance measurement, and the second is the measurement of knowledge assets in order to evaluate the value of an organization (Wiig, 1999).

KM frameworks

Frameworks for KM support are based on considerations related to the structure of knowledge and to the structure of organizations where the frameworks are applied. In most of models, knowledge types are determined based on different criteria, such as having structured or unstructured knowledge, and having tacit or explicit knowledge.

First we have to make a distinction between high level frameworks and implementation oriented ones. The latter one focus on the "how to" implement KM in an organization, whereas the first one discuss the question of "what is KM" (Wong & Aspinwall, 2004). As our purpose is to focus more on the "how to" question, we will focus in the next paragraphs on the implementation oriented frameworks.

High level framework discuss how to fill the gap between theory and practice, that is the case of Knowledge Creation Frameworks for example (Siebert, 2005). Nonaka and Takeuchi (Nonaka & Takeuchi, 1995) depict steps to create knowledge in practice that go from perception to representation and from tacit knowledge to explicit one, they also show how those steps can enhance companies efficiency.

Concerning implementation frameworks, Sunassee and Sewry (Sunassee & Sewry, 2002) defined three categories of frameworks: prescriptive, descriptive and hybrids. *Prescriptive* frameworks give direction concerning the procedures that should be used, without describing precisely their content or implementations, for example step approach frameworks are mainly prescriptive frameworks (Wong & Aspinwall, 2004). *Descriptive* frameworks describe the key factors of KM that can drive KM initiatives to success or to failure, their forms of representations are mostly graphical (Wong & Aspinwall, 2004); examples of descriptive frameworks can be found in (Gore & Gore, 1999; Holsapple & Joshi, 2002). Finally Hybrid approaches combine both prescriptive and descriptive methods.

It is important to find a way to compare KM frameworks; though, frameworks are dedicated to specific applications which make their comparison complicated. Wong and Aspinwall (Wong & Aspinwall, 2004) proposed a comparison method of frameworks based on four elements, their structure, the knowledge types they represent, the KM processes and the KM influences or factors.

Methods and Techniques in KM

We can categorize the methods and techniques in KM in three groups: people and technology, requirements elicitation and value measurement.

People and Technology

Early approaches of KM frameworks in the early 1990s mainly focused on the structural organization and IT solutions to improve knowledge management (Wiig, 1999). Those methods were adapted for slow moving businesses were goals and technical solutions are perfectly identified and the market does not evolve quickly. But, these approaches were not adapted in a subsequent fast moving business environment where new challenges started arise as fast as they disappear.

Human centered KM has been early identified and became a new school of thought, in the early 1990s. Peters (Peters, 1994) wrote "the answer turns out to lie more with psychology and marketing of knowledge within the family than with bits and bytes". Nowadays frameworks take both *human* and *technical* perspectives into account. We will discuss both approaches separately and show how both are integrated in nowadays frameworks.

Human perspective: Motivation and adoption

The main issue for companies is to motivate employees to use KM systems. Not only that the technology matters, but people implication in KM initiatives is a key factor for its success. Without incentives, employees are not ready to share their knowledge; therefore, numerous solutions have been proposed to motivate employees to make use of KM systems. Some companies provide financial incentives (monetary rewards) or non financial incentives (air miles, days off) for the first users of the KM system. Incentives, financial or not, are particularly efficient in organization where detaining knowledge is often considered as a source of power. In addition to individual incentives, Zand (Zand, 1997) suggests a collaborative win-win reward system, in which a gain for an individual can be a gain for his peers, in opposition with classical win-lose rewards system.

It has also been recognized that higher management should use the system too; Liebowitz (Liebowitz, 1999) cites the success of the KM network of Buckman Labs, which was mostly a result of the high level implication of the senior management and especially the CEO.

The second motivation related issue is *knowledge adoption*; it has been a challenge that people were not ready to use or apply knowledge developed by others. Sussman and Siegal (Sussman & Siegal, 2003) built a theoretical model to understand the underlying issues of knowledge

adoption; their study discussed the role of informational influence in the process of knowledge adoption, and showed the importance of the source *credibility* to convince people of the usefulness of the acquired knowledge. Once again, the commitment of senior management, who are trusted in their organization, can have a huge influence on the success of a project.

Technical Perspective: data mining, inference engines and multi-agent systems

KM tools deals with explicit knowledge, meaning that Knowledge can be written on a support that is mainly an electronic one. Historically, collaborative tools, such as Lotus Notes, have been developed in the 1990s to enhance KM. Recent corporate tools widely adopted Web 2.0 technologies such as wiki platforms, semantic widgets, tagging and so on. Several concepts from the broad computer science research, such as *data mining*, *rules based reasoning*, and *multi-agent systems* have been integrated in KM solutions, the integration of those tools depends on the processes in action.

For instance, computer assisted Knowledge Discovery is mainly based on data mining techniques. A brief look on the papers of the Knowledge Discovery and Data mining (KDD) conference (Li, Liu, & Sarawagi, 2008) - the major conference on Knowledge Discovery - gives an overview of the overwhelming presence of data mining within Knowledge Discovery.

On the other hand, knowledge representation uses ontological models; due to the development of powerful inferences engines. Those representations can be used to infer knowledge from existing one, and shore up Knowledge Discovery processes. Several KM frameworks are based on ontologies (Fensel, 2002; Stojanovic, 2003; Sure, 2002; S.-Y. Yang, Lin, Lin, Cheng, & Soo, 2005), since high level representation of Knowledge using ontologies enables powerful queries and Knowledge manipulation, retrieval and discovery.

Finally, the multi-agents system (MAS) paradigm is rightly suited to model the distribution of knowledge on autonomous entities, thus, it is used in order to disseminate knowledge among employees in organizations. MASs also take in account reactivity (adaptation to changes in an environment) and proactivity (anticipation of user needs and consequently taking initiatives). These two factors are the keys for the success of a KM project; indeed, KM initiatives require adapting quickly and being able to handle user needs. In this context, Virtual Knowledge Communities (Maret, Subercaze, & Calmet, 2008) present an efficient way to model KM in organization since it integrates the MAS approach and the ontological representation of Knowledge. Virtual model Knowledge Communities' model has been used for business (Subercaze, Pawar, Maret, & Calmet, 2008) as well as for health care purposes (El Morr, Subercaze, Maret, & Rioux, 2008).

Requirements Elicitation

Requirements can be seen under two angles, a technological one and a human centered one.

From the technological stand point, *storage* of Electronic Knowledge Repository represented a challenge at the early stages of KM; indeed hardware investment can require significant amount

of money for a huge amount of data to process. Knowledge Discovery processes also require high computational power; nevertheless with the reduction of hardware costs, storage is no more a critical issue, but the latest research using ontological representation , inference engines, and data mining techniques still required powerful *computational power* (Guo, Pan, & Heflin, 2005). Regarding the software aspect of KM, several free and open-source solutions exists, such as KAON ("KAON," 2008) or Protégé (Gennari, et al., 2003) for ontology management and the creation of ontology based applications, and Pellet for inference engines ("pellet.owldl.com," 2008) . Open-source data mining libraries for Knowledge Discovery, and collaborative platforms, as well as numerous other tools such as semantic wikis and group blogging platforms, or some full platforms like “cyn.in” ("cinc.in," 2008), are also available.

From a human/user point of view, the analysis of the task is a critical and hard requirement to collect before setting up a Knowledge Management solution. Molani et al. (Molani, Perini, Yu, & Bresciani, 2003) proposed to use *intentional analysis* to analyze the requirements for KM, they argue that intentional analysis provides an acceptable solution in terms of model and methodology and is also suitable to generate a technical solution. Another technique called *Goal directed analysis* provides a method to acquire an accurate understanding of the requirements (Dardenne, van Lamsweerde, & and Fickas, 1993).

Davenport et al. (T. Davenport, H., De Long, & Beers, 1998) stressed on the importance of a knowledge-friendly *culture* for the success of KM projects. In their review of several KM initiatives, this factor was pointed out as one, if not the most important, key factor for the achievement of the project. Individuals should be encouraged to participate in knowledge sharing and not fear that sharing could cost them their jobs. Adapting the organization’s culture to KM becomes important if we want to avoid culture to deter KM initiatives.

Value Measurement

Assessing the value of KM is a primary concern for organizations. Like other intangibles assets, the reliability of Knowledge Management measurement in an organization is subject to debate. As underlined in a study for the European Union (Zambon, 2003), internal evaluations based on information provided by managers may be subject to bias and tend to overestimate the value of KM. On the other hand, evaluations conducted by third parties may be imprecise, as third parties may not have access to the internal knowledge assets. The absence of a market for intangible asset can also be a root of evaluation bias; indeed, knowledge as an intangible asset will be valuated and appear on the financial report but cannot be sold and has no proper market value. Therefore, there is no market structure that can regulate knowledge evaluation.

Several methods have been developed to estimate the value of knowledge in an organization, Skandia is the first company to have dealt with the *Intellectual Capital* (IC) measurement (N. Bontis, 1996). It defined Intellectual Capital as the sum of the human and structural Capital. Human capital combines abilities, knowledge, and innovation potential of the company’s employees; it includes the company’s philosophy and culture too. This kind of capital is not

property of the company, but the company drives benefits out of it. Structural capital is the patents, trademarks, hardware and “everything that gets left behind when employees go home” (Nick Bontis, 2001). IC reports developed by Skandia used 36 metrics to give a monetary value to an organization; metrics includes customer satisfaction, satisfied employees, number of patents, annual turnover. Second generation methods such as *IC-index*, was an extension of the Skandia IC metric, it tried to merge the different indicators of Skandia into a single index (Roos, Roos, Edvinsson, & Dragonetti, 1997). Other metrics were developed to evaluate Knowledge Management Systems (KMS), Kankanhalli et al. (Kankanhalli & Tan, 2004) present a thorough review of KMS metrics.

Knowledge Management Health care

Particularities of the health care domain

While knowledge management systems use Information Technologies (IT) to manage the creation, storage, sharing, and use/reuse of knowledge; health care presents a special challenges to the use of KM such as system complexity, impact of medical errors, substantial growth of knowledge in the medical field, and an increased health care cost. We will overview each of these factors in the following paragraphs; then we will look at the role that KM can play in health care, its advantages and challenges; finally we will point at perspectives of health care KM.

Health care System Complexity

The health care system is one of the most complex systems that we encounter in society (Anderson & McDaniel, 2000; Orr & Sankaran, 2007; Reinhardt, Hussey, & Anderson, 2004); it involves several partners working in *diverse* domains that need to collaborate in order to deliver care to a human being. Health care delivery involves health care professionals such as family physicians, specialists, nurses, radiologic technology technicians, lab technicians, social workers, psychologists, counsellors, etc. It also involves third parties such as hospital and clinic administrators, managers in finance, human resources, health care ministry, drug companies, health care insurance companies, activists groups, education organizations, research communities, etc. Besides; partners in health care delivery are *dispersed* around many geographical areas while they are acting on the same patient.

It is clear that the amount of knowledge, created by all of health care partners, is tremendous and that any knowledge created by one partner is of utmost importance to all others in order to deliver quality of care. The use of KM techniques in order to register and communicate and augment knowledge in health care sector is necessarily important. Nevertheless, the complexity of the health care sector presents a special challenge for the adoption of KM systems in health care, even though the impact of such adoption is expected to be tremendous (Bali & Dwivedi, 2007).

Health care Cost

The second characteristic of the health care sector resides in the cost escalation challenge. For instance, in the United States (U.S.) the total health spending will account for 18.4 percent of GDP by 2013 (Reinhardt, et al., 2004); in 2006, Canada has spent $148 billion on health services, which accounts for more than three times the expenditure on health services in 1975 after taking into account the inflation effect (Canadian Institute for Health Information, 2007). Worldwide, the rising cost of health care is pushing governments to find more efficient and less costly ways to deliver care. One of the factor contributing to the rise of health care cost is the surge in chronic diseases; indeed, global chronic diseases related deaths was estimated to be 35 million out of 58 million annual global deaths in 2005, and 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) (World Health Organization, 2005). Canada alone, will have by 2015, for the first time in its history, more people having an age of 65 and above, than people having an age under 15 (Institute of Aging-University of British Columbia, 2007) pushing the number of patients with chronic diseases to the rise.

The use of IT to decrease health care cost is behind many informatics project in health care: electronic health record (E.H.R.), e-home care, telemedicine, tele-radiology, tele-dermatology, e-public health care, etc. Nevertheless, there has not been a concerted effort to store and communicate the knowledge that is generated by all these different projects in e-health in order to use it in cost reduction strategies (e.g. more efficient and effective chronic disease management).

Medical errors and decision support

The patient is the center of all activity in health care and any medical error could have a detrimental effect on the patient's health or result in her/his death. Indeed, in the U.S. alone, it is estimated that medical errors cause million injuries and nearly hundred thousand deaths each year (T. H. Davenport & Glaser, 2002; Kohn, Corrigan, & Donaldson, 2000); besides, over 770,000 people are injured or die each year in hospitals from adverse drug events (ADEs) (Bates, et al., 1997; Cullen, et al., 1997). ADEs alone may incur an estimated cost of $3 million each year in a 650 bed hospital (Robert A. Raschke, et al., 1998), and this cost does not include malpractice and litigation costs, and other economic cost to patients. In the U.S. alone, hospital expenses to treat patients who suffer adverse drug events during hospitalization are estimated at between $1.56 and $5.6 billion annually (Kass, 2001).

Consequently, the use of knowledge management systems that support decision making in drug prescription and disease management protocols, would have a positive impact on health care delivery since it allows (1) the decrease, if not elimination, of adverse drug effects and medical errors caused by human oversight, and (2) the decrease of health care cost resulting from medical errors, giving a hand to health care financial resources management.

Knowledge growth

Research showed that clinical performance deteriorates over time (Choudhry, Fletcher, & Soumerai, 2005), besides, we, humans, are fallible; therefore, it is better to base a decision on solid and scientifically proven research findings, instead of basing it solely on recall and personal experience, or the experience of other colleagues. The term 'evidence based medicine' summarizes this approach.

Evidence based medicine practice is meant to integrate individual clinical expertise and the best external evidence found in research. Hence, medical knowledge should be made available to practitioners. Nevertheless, if availability of knowledge is a necessary condition for evidence based practice, it is not a sufficient one; indeed knowledge is "exploding" and therefore the need is for a tool that allows practitioners to find the right information at the right time. In 2000, it was estimated that a 34,000 references from over 4,000 journals were added monthly to the National Library of Medicine's MEDLINE database (Young, 2000). Currently, Medline contains over 16 million references to journal articles, the source of which are citations from approximately 5,200 worldwide journals in 37 languages (60 languages for older journals). Since 2005 the number of references added per day is between 2000 and 4000, while in 2007 alone over 670,000 total references were added (Medline, 2008) . Davenport and Glaser (T. H. Davenport & Glaser, 2002) argue that a doctor needs to be acquainted with about 10,000 different diseases and syndromes, 3000 medications, 1100 laboratory tests, and many of the 400,000 articles added each year to the biomedical literature. We are in front of information overload crisis, needless to say that this situation constitutes a real challenge to practice evidence medicine (Gray & De Lusignan, 1999; Heathfield & Louw, 1999; O'Brien & Cambouropoulos, 2000).

While evidence based medicine is a key aspect of today's medical practice (Druss, 2005; Glasziou, Burls, & Gilbert, 2008; Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996), the aforementioned abundance of information can keep a health professional from finding the right information (Eady, Glasziou, & Haynes, 2008). Indeed, the need is to deliver the right information, at the right time, to the right person, and in the right format. Failing to do so is an impediment to the implementation of evidence based medicine. In this context, Knowledge Management can play an important role by organizing knowledge and making it accessible.

Inefficiencies and wait time

The health care system is a system like any other, it has interrelated components, boundaries, a purpose, an environment with which it communicates, interfaces, input, output and constraints. As a system, health care system contains inefficiencies; once identified, inefficiencies should be eliminated since they constitute bottlenecks in the health care system that delay health care delivery for patients and increase health care cost. Long wait times has been already identified as one of the inefficiencies in some health care systems, in Canada for instance (Brian, 2006). In this context KM can play a vital role by studying and structuring organizational *processes* (Hayes, 2004) and sharing knowledge from successful experience.

Advantages and challenges of KM in Health care

Advantages

From the above it flows that KM can play important roles in health care. We will overview in the following the main advantages that KM can provide to health care delivery.

Medical error reduction

Knowledge management is able to assist in *medical errors reduction*, and consequently their cost, by providing a decision support for practitioners (Abidi, 2001). Case based reasoning and/or rule based reasoning can be used to attain this aim (Montani & Bellazzi, 2002). Already, knowledge management has been recognized as a tool used to cut the medication prescription errors; some cases report error reductions as high as 55% (Melymuka, 2002).

Cooperation and innovation

In a complex field such as the health care, *cooperation* between the different health care providers is vital in order to deliver quality of care (Elliott & O'Dell, 1999). Studies have shown that lack of cooperation in health care is a leading cause of many medical mistakes, hence the need for coordinated inter-professional care strategy (Interprofessional Care Steering Committee - HealthForceOntario, 2007). Thus, cooperative diagnosis can be achieved by the health care actors via the implementation of KM systems(Dieng-Kuntz, et al., 2006).

Besides, cooperation is a chance for *innovation*; this has been recognized by researchers and resulted in the creating of knowledge transfer networks (Ansell, 2007; Wickramasinghe & Davison, 2004). Furthermore, the health sector is a innovation driven field, hence management of clinical knowledge (Buchan & Hanka, 1997) using paradigms such as distributed knowledge management (Pedersen & Larsen, 2001) becomes paramount. In this perspective, innovation facilitation methodologies (Ansell, 2007; Canongia, Antunes, de Nazare, & Pereira, 2004; Fitzgerald, Ferlie, Wood, & Hawkins, 2002) as well as the analysis of knowledge flow barriers, in teams and organizations, should be tackled (Lin, Tan, & Chang, 2008). Finally, discovering knowledge sharing *mechanisms* and *organizational factors* that influence them is essential for cooperation and innovation (Currie & Suhomlinova, 2006; Donaldson, Lank, & Maher, 2005; Elliott & O'Dell, 1999).

Quality of care

Enhancing the quality of care is a major objective in all heath research; therefore, finding, sharing, collaborating, and developing clinicians' knowledge is necessary to discover and develop knowledge and hence *quality of care*. The adoption of knowledge management techniques is capable of enhancing the quality of care as suggested by Oranzo et al. (Orzano, McInerney, Scharf, Tallia, & Crabtree, 2008).

Besides, the *efficiency* of work can be enhanced by adopting knowledge management techniques in day to day practice (T. H. Davenport & Glaser, 2002); these techniques have already proven their effectiveness in different domains such as health insurance (Chae, Ho, Cho, Lee, & Ji, 2001). Increased efficiency in personal health care delivery (Batalden & Splaine, 2002; Stefanelli, 2002) as well as in public health decision making (Goddard, et al., 2004) is also a factor that promotes a better quality of care.

Cost reduction

While cooperation has an impact on quality of care which is seen the major aim of health care delivery, it has also an impact on cost since it allows sharing knowledge. Indeed, Lamont argues that regional health information organizations aim to "increase cost effective use of health resources by sharing information among a coalition of providers, payers, employers and other stakeholders" (Driver, 2001; Lamont, 2007; McElroy & Firestone, 2005). Besides, we've already discussed the financial impact of medical errors and adverse drug effects, KM based decision making can help reduce errors; in fact, KM adoption in health care was driven in some cases by the high cost of medical errors (McElroy & Firestone, 2005) and KM will continue to represent a definite advantage in this context not completely explored.

Knowledge organization and organizational learning

Knowledge is a major part of health organization's day to day activities; whether for practitioners or for managers. For management it involves financial management, human resources management, organizational dynamics and governance, strategic planning, information management, risk management, and quality management (Garman, Burkhart, & Strong, 2006). For practitioners it is their major source of evidence to practice correctly; nevertheless, practitioners knowledge is not stable it evolves in time; in their systematic review of relationship between clinical experience and quality of care, Choudhry et al. (Choudhry, et al., 2005) argued that "Physicians who have been in practice longer may be at risk for providing lower-quality care". Therefore, KM becomes vital to ensure evidence based practice for practitioners, and to ensure organizational learning for managers.

To use KM it is important to unveil (1) *knowledge creation and transfer, (2) Knowledge needs*, (3) health professional *roles*, (4) *information seeking* behaviour, (5) *Knowledge organization*, and (6) *Knowledge sharing* behaviour.

To make use of knowledge it is important to understand the way knowledge is *created* (C.-W. Yang, Fang, & Huang, 2007) and *transferred* (Ansell, 2007; Bate & Robert, 2002; Dawes & Sampson, 2003; Dwivedi, Bali, & Naguib, 2005; Lahaie, 2005; Tagliaventi & Mattarelli, 2006).

Nevertheless, knowledge that cannot be accessed is of no use; hence, to facilitate access to health knowledge, health professionals *knowledge needs* (Burnett, Williams, & Webster, 2005), the *roles* they play in KM, as well as their information *seeking* behaviour (Dawes & Sampson, 2003) should be detected.

Finally, an ultimate aim in KM is to transform a health organization into a *learning organization* able to generate new knowledge, create knowledge systems, and base organizational actions on knowledge (Driver, 2001; Fiol & Lyles, 1985; Miner & Mezias, 1996). To achieve organizational learning an understanding of knowledge is important (Driver, 2001; Engeström, 2007) as well as the implementation of different approaches such as organizational memory (Abidi, 2001; Lahaie, 2005) that supports concept organization and sharing, across community members, in order to maintain collaborative work; or the a knowledge environment such as the Healthcare Enterprise Memory environment proposed by Abidi (Abidi, 2001)..

Finally, in a multicultural, multilingual, or multinational collaborative health care teams, KM can play a role in *terminology translation* in order to overcome language and cultural barriers in the learning organization; this is of critical value to make sure that collaboration occurs in a unambiguous way (Kisilowska, 2006).

Challenges

Application of KM in health care is facing several major challenges, some of which are proper to the nature of the health care sector and others are common to other fields (Andreas, 2005).

The basic challenge remains the *awareness* of the importance and the potentials of KM in health care. Once KM is recognized as an organizational and practical asset, a *KM strategy* is needed (Sensky, 2002). Once the strategy is in place, *change management* should be planned for in order to establish a KM adoption *culture* in the workplace and find KM *champions* among practitioners to facilitate KM adoption (Caldwell, Chatman, O'Reilly, Ormiston, & Lapiz, 2008; Lukas, et al., 2007).

Any KM initiatives should take account to both people and technology. A powerful KM tool won't probably thrive if concerned individuals are not committed in its use. And reciprocally, employees highly motivated to adopt KM could loose their motivation if the tools supporting KM have low usability or do not provide relevant features. In highly competitive businesses, an efficient KM can make the difference between success and failure; nevertheless, KM is neither fad nor cure-all, rather it should be integrated in the organization culture. Consequently, usability is a major challenge that is facing KM in healthcare; especially that health care professionals are working in a stressful environment and are stretched in time. Any non-usable, non-human centered design is detrimental to KM endeavours.

Establishing *trust* in KM systems and providing adequate *confidentiality* and *security measures* are of special concern in health care and so are particularly challenging; indeed different researchers raised concerns regarding the formalization and traceability of conversations through KM systems (Guah & Currie, 2004; Nicolini, Powell, Conville, & Martinez-Solano, 2008). Besides, the well known time pressure in the health sector, due to a shortage in health professionals, is a particular barrier to the implementation of KM in health care; indeed, the use of IT and KM tools will be perceived as cumbersome unless adequate usability consideration and innovative interfaces are developed for KM systems.

Furthermore, the lack of integration between the different IT-based systems (telemedicine, PACS, electronic health record, decision support systems, etc.) is particularly challenging, in fact one do not to have at the end non integrated silos of information that does not allow taking full advantage of KM.

Finally, measuring the *performance* of health care KM systems requires adapted models and indicators. That have been said, experiences from the private and public sectors for measuring

intangible assets already exist and can provide basis to build health care KM systems performance indicators (Cinca, Molinero, & Queiroz, 2003).

Perspectives for the use of KM in health care

Beside the current knowledge management roles in the health care sector, few perspectives present an opportunity to develop new health care KM applications. These perspectives are *virtual communities*, *mobility*, *Electronic Health Record (E.H.R.)*, and *public health*.

Virtual communities

"Virtual" health care providers of different disciplines (e.g. medicine, nursing, social work, physical therapy, etc.) can create teams in which they combine their knowledge and expertise to provide a comprehensive plan of care. Though, it is essential to include patients in virtual health care teams; indeed, patients must be well informed about their conditions, treatment options and how to access them and be actively involved in their treatment (Davis, Wagner, & Groves, 2000). Health Virtual Communities, that include care givers and patients, in order to create manage and coordinate virtual medical teams (Pitsillides, et al., 2004).

Once a Health VC is in place, new knowledge emerges through social interactions (Ahmad, Kausar, & David, 2007). Patients have tacit knowledge about their medical condition and the way they experience their conditions, this tacit knowledge constitute a mine of information for clinical practice; indeed, it allows to get insight into the patient experience and hence assess her/his quality of life as well as the impact of a drug on a person's life. Virtual communities in this respect constitute an opportunity for a holistic approach to clinical practice.

Besides, Health VCs constitute an opportunity for e-continuing education. In health care, continuous education is essential; some professionals cannot continue practising unless they undergo a yearly continuous education course in order to update their knowledge. In this context, knowledge based Health VCs can play a major role by providing a platform for e-education and knowledge exchange between peers. The creation of virtual network of experts open the road to test new kind of cooperation paradigms and *peer-to-peer e-educational* paradigms (van Dijk, Hugenholtz, A-Tjak, & Schreinemakers, 2006).

Mobility

While managing knowledge will become an important daily practice, the future will be more mobile. We're witnessing already the explosion of mobile interactive devices, mobile health facilities, and the proliferation of e-homecare solutions (Hubert, 2006). Mobile knowledge management is the next step in mobile health care situations where patient is away from the point of care (O'Sullivan, McLoughlin, Bertolotto, & Wilson, 2007). The mobility approach is extremely valid in virtual communities (El Morr, 2007; Christo El Morr & Jalal Kawash, 2007; C. El Morr & J. Kawash, 2007); consequently, the creation of mobile Health VCs where knowledge is generated, disseminated and shared by both patients and caregivers is a next step that can provide advantage for both patients and caregivers (Hubert, 2006; Moreno & Isern, 2002; Siau & Shen, 2006).

Electronic Health Record (E.H.R.)

Worldwide, governments are striving to build national wide E.H.R. systems. There has been progress in this direction mainly in developed countries. Once health records are computerized the need will be to reach the right information about a patient at the right time, and to use the E.H.R. data for diagnosis purposes, for personal health decision support, for public health decision support, and for research purposes as well. Though, much of what has been done till now in E.H.R. involves data processing mainly (Van Vlymen, De Lusignan, Hague, Chan, & Dzregah, 2005); besides, health service managers are facing many difficulties when tying to access relevant data routinely for quality improvement (De Lusignan, Wells, Shaw, Rowlands, & Crilly, 2005). KM techniques can play here two roles one for managers and one for practitioners; indeed, KM techniques can help in searching for knowledge in the mass of data gathered helping practitioners to find more effective ways to treat patients by searching for similar patient case histories (O'Sullivan, et al., 2007), and helping managers to get relevant knowledge for total quality management (TQM) (McAdam & Leonard, 2001). Establishing, electronic health records, per se, constitute only a first step; using the mass of data gathered in order to support practitioners in generating knowledge and providing quality practise is the challenge ahead.

Evidence-based Public health

Networks for health care surveillance continue to evolve (Health Canada, 1999); nevertheless, studies show that information and communication technology are less used in public health than in other sectors of the society (Goddard, et al., 2004; Revere, et al., 2007). Public health is traditionally data processing and data analysis oriented, though there is more awareness that a shift is needed in public health from data driven decision making to knowledge driven decision making, or to put it in Goddart et al. words “provide direct guidance on the relative effectiveness of different interventions in a specific situation” (Goddard, et al., 2004). KM can play a vital role in organizing, structuring and supporting *evidence based public health* decision making (Andreas & Nicholas, 2006; Revere & Fuller, 2008). In this context, research needs to unveil how the public health community communicates and cooperate, particularly in terms of role and communication strategies, artefact used, etc. Different profiles of knowledge health care workers can then be sketched. Research methods from the Computer Supported Collaborative Work (CSCW) field can be used. Findings can well be integrated in the context of Community of Practice where knowledge tools can further knowledge creation, communication and transfer. The medical field is experiencing a move to evidence based medicine, a similar move to *evidence-based public health* is important and would be strategic for an advanced management of population health; KM can play a vital role to make this move.

Knowledge Transfer

Knowledge transfer is concerned with dissemination of knowledge connecting and adapting research findings to the society needs. Increasingly, the role of knowledge broker is recognized as vital in knowledge transfer (Lind & Persborn, 2000); knowledge brokering “links decision makers with researchers, facilitating their interaction”(Canadian Health Services Research Foundation, 2003; Lomas, 2007). In this context, there is a crucial need to understand how

knowledge is transferred, and transformed while it is transferred (Syed, 1999); cognitive theory can be of much help in this domain. This understanding will help providing a feedback to knowledge generators (i.e. researchers) and widen their knowledge (i.e. help generating more knowledge) (figure 1).

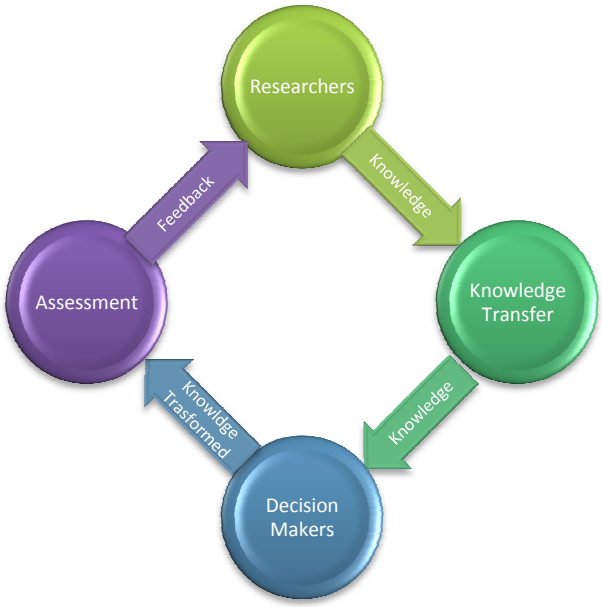

Figure1: Knowledge Transfer Cycle

Conclusion

Knowledge management in health care is progressing; the complexity and challenges facing the health care sector can be addressed by adopting of KM strategies. The use of KM in health care is promising to enhance the quality of care for patients by providing them with a continuity of care. The implementation of Health care KM system will allow health care partners (e.g. practitioners, administrators, etc.) to conduct evidence based practice and to collaborate relying on the best knowledge available. This is a challenge that opens the way to more innovations in both KM and health.

Key Terms and Their Definitions

Knowledge Management

The management (strategies, processes) used to capture, value, identify, and enhance the intellectual assets of an organization.

Rules Engine

A system that support rule based inferences. A set of rules is used to infer knowledge based on prior knowledge.

Decision Support Systems (DSS)

Computer based systems that support decision making processes based on a knowledge base. Different types of DSS exist, such as: model-driven, communication-driven, data-driven, etc.

Evidence Based Medicine

Evidence based medicine aims to apply knowledge/evidence generated by research following the scientific method to medical practice.

E-health

E-health is a term that encompasses diverse applications in medicine and health including Picture Archiving and Communication Systems, Electronic Health Records, Telemedicine, etc. E-health involves the use of a technology to enable health care delivery using electronic means.

Public Health

Public health is a discipline that is concerned with the health of the population in a country. Traditionally, it uses data analysis tools in order to assess population health, track threats to it (e.g. epidemics), and design measures to protect it. Disease prevention, smoking cessation programs, flu management, are all part of public health strategies.

Knowledge Transfer

Knowledge Transfer is a field of research concerned with finding practical ways to transfer knowledge between the knowledge producers and knowledge consumers/users; for example, transferring knowledge generated in academia to society (e.g. decision makers, companies, non governmental organizations).

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