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Pacific Asia Conference on Information Systems (PACIS)

Summer 6-27-2016

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Abstract

The ability to share EHR's (Electronic Health Record) underlying knowledge both internally and externally within healthcare organizations has been accepted as a method to improve the quality and delivery of care but has also raised important questions related to legal and privacy issues. This paper aims to explore the critical factors that impact knowledge sharing in the French healthcare sector. Our main research focus is to answer the question of how to improve Knowledge sharing in the healthcare sector? An exploratory qualitative study was handled to investigate EHR's underlying Knowledge sharing in French hospitals.

Three major issues were identified, namely the need for: a common healthcare terminology, the interoperability among healthcare information systems and the patient's informed consents before sharing his sensitive data. To fill this business gap, this paper proposes an ontological framework that extends the Systematized Nomenclature of Medicine Clinical Terms with privacy dimension, to secure access to sensitive patient's data.

Keywords: Knowledge Sharing, Healthcare Systems, Ontology, Electronic Health Record (EHR), Qualitative research.

1.   INTRODUCTION

Knowledge sharing plays a major role in improving organizational performance. Organizations are increasingly investing in knowledge sharing systems to effectively and efficiently capture, circulate, and reuse information resources (Nonaka and Takeuchi, 1995; Davenport and Prusak, 1998; Teigland, 2003). This key process is particularly sensitive in the healthcare sector where knowledge sharing is critical to patient care efficiency. This situation creates a challenge to make a balance between knowledge sharing, to ensure value creation and conservancy/protection of patient's data. Even though the impact of knowledge sharing on decision making and improvement has been discussed in previous research, there are some controversial factors that reduce the propensity to share within healthcare services and systems. Attitude, culture, and technologies have all been identified as barriers to the knowledge sharing process (Choi et al., 2008; Witherspoon et al., 2013).

Today, the use of the EHR's leads physicians to share sensitive information. To protect healthcare information and facilitate knowledge sharing processes in this sector, it is critical to define convenient classification principles. However, in France, medical data and information do not have different classifications; they are all confidential and protected by medical secrecy. The Touraine Act[1] (Article 47 of the Health Bill) would enable researchers, associations, and private companies access to billions of types of medical data. Although, classification rules create distinct classes of information based on their levels of sensitivity, as well providing access to qualified information demand a strategic value.This research focuses on understanding the factors that influence knowledge sharing between physicians in the French context and proposes an ontological framework that extends the Systematized Nomenclature of Medicine Clinical Terms with the privacy dimension, to secure access to sensitive patient's data. Our research questions are the following:
- What is the perception of the physicians with regard to the knowledge sharing practices?
- How can we explain in order to improve Knowledge sharing in the healthcare sector?

The paper begins by presenting the various researches about knowledge sharing, followed by a focus on the current context of the healthcare domain. Then, we describe the research methodology used to answer our questions followed by the presentation of the results. Later on, we discuss the main findings and propose a conceptual model and an ontological framework for healthcare knowledge sharing. We conclude by underlining the limits of our research, and we present the future research directions.

2.   BACKGROUND

Knowledge sharing (KS) is defined as "the act of making knowledge available to others within the organization. Knowledge sharing between individuals is the process by which knowledge held by an individual is converted into a form that can be understood, absorbed, and used by other individuals" (Ipe, 2003). It is a volitional action by which knowledge is made known to other

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[1] http://www.gouvernement.fr/action/la-loi-de-sante
  http://www.metronews.fr/info/loi-de-sante-definitivement-adoptee-decouvrez-ses-principales-mesures/mocE!etq9pORh5Nc/

people (Davenport and Prusak, 1998; Cramton, 2001). Knowledge sharing in the healthcare domain is commonway to improve performance by providing qualified services. Typically, different Healthcare Information Systems (HIS) have been planned to serve the knowledge sharing within a healthcare setting. One of these HIS is the implementation of Electronic Health Records. EHRs are considered to offer significant benefits to patients and health providers, as current paper-based records have serious deficiencies. The ISO Technical Report (ISO-TR20514)[2] defines basic generic EHRs as "a repository of information regarding the health status of a subject of care, in computer processable form". However, since the original idea of electronic health records was focused on data storage and not on data processing, a lot of current implementations do not take full advantage of the opportunities provided by computerization. In order to address the knowledge sharing issues, healthcare domain is gaining more focus in the field of Ontology and Semantic Research (Yuwen et al., 2010; Prathima et al., 2011). Ontology provides a common understanding of a domain that can be communicated between people and heterogeneous and distributed systems. Gruber (1995) defined Ontology as "explicit and formal specification of a shared conceptualization of a domain of interest". Ontology provides the unique representation of knowledge. It enables unambiguous recording of data in a knowledge base. Medical Ontologies such as Medical Language System (UMLS) and SNOMED-CT (Brut et al., 2011) would improve the access to the electronic patient records privacy. Ontology allows healthcare knowledge sharing through a semantic access to EHRs. i.e. by defining clinical terminologies for precise and shareable expressions in EHRs entries. Another advantage of ontology is that their hierarchical structure will result in better control over access and use of personalized medical information. In addition to the knowledge access problem, EHRs systems raise troubling issues regarding privacy and ethics (Ben-Assuli, 2015). Indeed, the rapid development of data collection and management technologies has led to previously unknown challenges in that medical information is now available on mobile devices, shared networks and even sensors attached to the human body (Malin et al., 2013). These changes in the way information is stored and retrieved have sensitized the public to issues of privacy (e.g. healthcare workers sharing health records of famous people, identity frauds or unintended disclosure of medical information through a stolen mobile device). Caine et al. (2012) showed that most patients wanted more control over the use of information stored in their EHR, and none agreed to a complete, comprehensive access to their EHR by practitioners affiliated with their healthcare provider. Powell et al. (2006) surveyed British citizens concerning the introduction of the NHS national health records system and inquired whether there were items send details which they preferred not to be shared with the national records system. They found that the items participants tended to wish to keep private were mostly related to pregnancy, contraception, sexual health and mental health, which are information considered sensitive, private and potentially stigmatizing.

3.   METHODOLOGY

A review of the literature examining knowledge sharing in healthcare revealed that the concept of Knowledge sharing and privacy were rarely studied jointly. As few studies addressed these two themes in an explicit way, an exploratory qualitative study is useful in this context. We conducted non-directive, face-to- face interviews with physicians working in different healthcare institutions. The guide of interview consists of four themes: (1) use of the Electronic Health Record, (2) Information sharing (Explicit knowledge), (3) knowledge sharing (Tacit/Implicit knowledge) and (4) Privacy and access. It was tested and refined with a physician, a department head of

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[2]http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=39525

resuscitation and intensive care, who participated in several projects involving the EHRs implementation. The data analysis was performed by using the qualitative content analysis method (Berelson, 1952) supported by NVivo 10 software. Our sample consisted of seven physicians who were requested to participate in our study from our personal networks. These physicians practice in 7 different healthcare institutions. Their experience varied between 20 and 30 years. Their profiles vary from general practitioner, anesthetist - resuscitator, specialist in vascular medicine, internal medicine specialist, two oncologists, and cardiac surgeon. These physicians have participated in implementing of EHRs in healthcare institutions in France.

The audio recordings were transcribed into a verbatim transcript. Interviews lasted about 75 minutes. They labeled transcripts, with a date and specialty of each physician, but no name. The senior researcher divided the seven transcripts into 630 text passages (i.e. text fragments, in other words, independent statements). Each text passage corresponded to a single topic or meaning. To familiarize themselves with interview content and the coding framework, three of the authors who were trained in the content analysis methodology, worked independently to determinate enablers (positive) or inhibitors (negative) factors of knowledge sharing. They used open coding to cluster practitioner statements into themes (nodes). Then, they compared and discussed their results with the senior researcher. Two other researchers, who were not involved in this research, started from scratch working independently to code the passages using NVivo10 software. The coders agreed on 90% of the passages, demonstrating inter-coder reliability. Coders discussed and resolved their disagreements. The senior researcher reviewed the results. The quotes of physicians were then translated into English and validated by a native English speaker.

4.   RESULTS

This section presents an analysis of the transcriptions in the light of studied objectives. According to the first physician, certain information must not be shared or distributed "it is not very easy to put up protection barriers for data security. How to implement them? According to the profile of each one? It is almost impossible to control medical staff, which comes for a long time or a temporary moment, and setting privacy rules is complicated". He explained the complexity of the sharing of sensitive information: "... people were affected by HIV; accessing their file was impossible. For these types of patients, stricter accessibility rules have to be defined for other physicians, moreover, which physicians can access the file should be based on the patient's agreement." For the second physician, the decision about classification of medical data returns to the patient, who is the proprietor of his data: "it is the patient who must choose what is available to the general public and what is not." He explained that "Even when you have security systems with access controls, generally the passwords are hung on the wall, like everywhere. If you want the hospital is the place of '3*8' (shifting work time), there is always a team which comes after the previous one; it is a place where there are temporary employees." The third physician defined the information which is not shareable and the people who can share them: "This information relates to personal patient life, psychic elements...sometimes we don't have time to ask a patient to choose which information is confidential and which one is private. Sometimes we are involved in a massive flood of information, and don't know how it should be shared." The choice of the information to share is difficult in consideration given the legal obligations. He explains that: "we are a little flooded by the sum of information that we have to give, and we always have a legal constraint." The fourth physician explained that medical staffs may have access to very private and highly confidential information, and should respect professional secrecy. Sometimes, he hides some elements: "I don't want to note the name of disease at all because it is so private. Some patients ask me not to note it on their file. I'll give you some examples, a voluntary interruption of pregnancy, or this can be

sexual assault...” He noted that the patient file sometimes contains information that is not useful or relevant to ensuring the consistency of care. The fifth physician considers that the patient has to know his record in its entirety and that it comes down to him to manage it and to empower. So, he notices: “for me it is the patient who has to manage these data and all information about his health...” He explained the complexity of sharing; “there are always questions about which knowledge and information should be shared and in which way it should be done? Daily, we are very confused... ” The sixth physician explains that some information must be kept discretely and/or anonymous. He notes that “For HIV, it is noted in blood results, but it is not re-reported roughly in red " PATIENT AFFECTED BY the HIV... Certain physicians who did not want to put it in EHRs, particular in the cases of AIDS”. The seventh physician interviewed acknowledges that remains vague concerning the information that can be shared “we share information if they are relevant to the care of the patient...Thus, everybody is entitled to the respect for its private life. It is things actually that can be psychiatric diseases, sexually transmitted disease.”

5. DISCUSSION AND CONTRIBUTIONS

The interviewed physicians found that the current EHR structure does not allow an effective and secure knowledge sharing. Although, this record has been built to solve sharing issues and to improve collaborative work, there is a business gap between theoretical expectations and its current use in Health Information Systems. More precisely our qualitative analysis has revealed that the knowledge sharing within EHR systems raises three main issues: (1) the need for a global standard terminology for semantic access to EHRs, (2) the need for semantic interoperability among healthcare information systems and (3) the need for managing privacy issues within EHR systems. Their issues are especially more challenging within the healthcare big data context. In order to move to an efficient and secure use of EHR, we propose a preliminary core ontological framework that covers the aforementioned main issues. This framework encompasses three main ontological facets: a domain facet, an informational facet and a privacy facet. (1)**The domain facet**: With the fast growing clinical terminologies and changing needs of the physicians in different hospitals, a common reference terminology needs to be adopted to ensure to ensure a high quality of information retrieval. The existing medical Ontologies such as Unified Medical Language System (UMLS), GuideLine Interchange Format (GLIF), Generalized Architecture for Languages (GALEN), International classification of Diseases (ICD) and Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT), could be used as a mean to standardize medical concepts within EHRs. SNOMED CT is proven to be the most efficient and robust classification. Our idea is to exploit these taxonomies in order to access in a standardized way to EHRs e.g. using the diseases classification, a certain concept such as “diabetes” will be the gateway for all the information classified based on it. Figure 1 depicts an excerpt of the SNOMED CT concept hierarchy.

Figure1. The SNOMED CT concept hierarchy."

Figure 2. “EHR information ontology”.
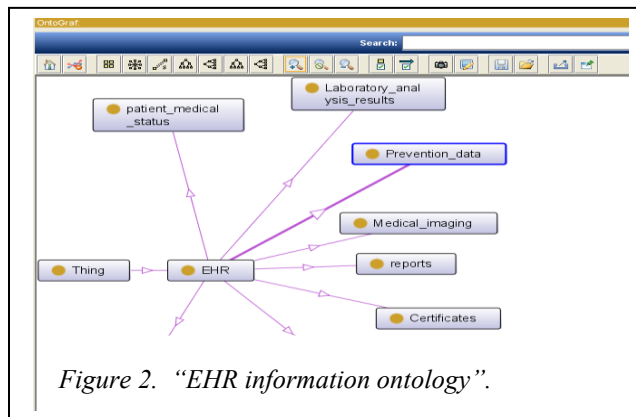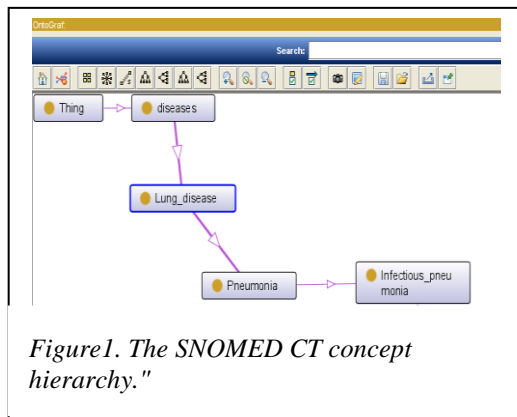
(2) **The informational facet:** in order to deal with interoperability issue multiple efforts for standardizing EHRs structure are proposed such as HL7 and openEHR, but no general solution was adopted for the moment. In France, an EHR is organized into eight areas that organize health data of a patient[3], namely: the synthesis of the patient medical status and general medical data; the treatments and healthcare associated documents (e.g. prescriptions); the reports (e.g. medical consultation or hospitalization reports); the medical imaging (e.g. latest magnetic resonance imaging results); the laboratory analysis results (e.g. blood analysis); the prevention data (e.g. vaccine reminders); the certificates or statements (e.g. certificate for a sport practicing); the personal space, which contains documents that the patient considers as important to inform his doctors (medical images or digital documents provided by a health professional).

(3)**The privacy facet:** Access control is a central problem in privacy management. The interviews revealed that the responsibilities in healthcare organizations are widely shared and that healthcare professionals may generally be non-compliant with privacy guidelines. A common practice in controlling access to sensitive data is Role-Based Access Control (RBAC). But RBAC is limited as it does take into account the patient consent for accessing to personal and sensitive data. According to the ISO 27002[4] standard, the privacy dimension needs to "ensure an appropriate level of protection to information. It is appropriate to classify the information to indicate the need, priorities and desired degree of protection when handling them. The information may have varying degrees of sensitivity and criticality. Some information may require a special level of protection or special handling. It should develop an information classification plan for prioritizing protection levels and inform stakeholders of the need for special handling". Legally, there is no typology for classifying privacy levels of medical data. However, it is possible to distinguish between Public, Private, and Confidential data. We propose to extend the RBAC model with the aforementioned data privacy levels. This enables preservation of the patient's privacy by exposing only the public personal data. The confidential and the private data will be only used for providing the patient with the best medical care, for example in the case of emergency situation. Figure 3 depicts the privacy ontology.
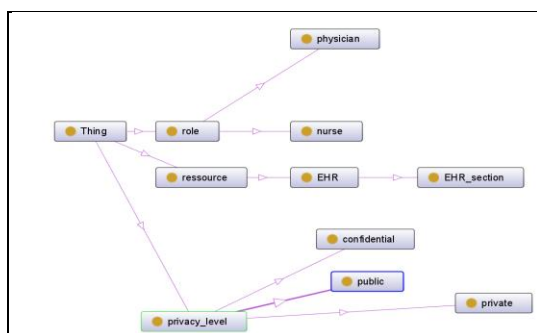

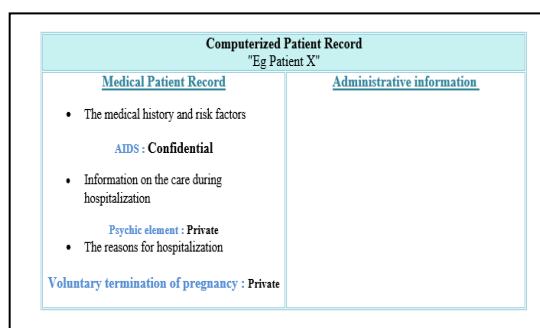*Figure 3.Class hierarchy of the privacy ontology*

Figure 4. Ontology-based electronic patient record annotation

With this core, ontological EHRs could be accessed through a semantic annotation based on SNOMED-IC ontology for representing patient diseases, on informational ontology for representing fine-grained standardized EHR sections and on privacy ontology for representing role access restriction as well as privacy dimension on patient's data. Figure 4 depicts a semantic annotation

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example.

## 6.	CONCLUSION

This paper has for objective to explore the mechanisms allowing the improvement of knowledge sharing in the healthcare sector. Our study underlines the role of knowledge classification for knowledge sharing. However, security concerns represent a predicament in determining what should be shared and what should be private. Decisions about shareable data are determined by the patients. Currently, there are no principles to classify information as confidential or sensitive, and this causes physicians to block access and consequently blocks sharing too. Furthermore, information technology does not propose qualified solutions for considering both privacy issues and shareability processes in the healthcare system, because in certain cases there is no clear rule to describe which knowledge is shareable and which is not. In order to move to an efficient and secure use of EHR, we propose a preliminary core ontological framework that covers the aforementioned main issues. Ontology can contribute to improving sharing knowledge, by making the medical knowledge understandable and accessible by the healthcare professionals. Experimental research focusing on our proposition would shed further light on its scientific utility. However, this study has limitations that could be addressed by future studies. First, the size of the sample is limited. Further explorations of knowledge sharing among other kinds of workers (e.g. nurse) and other countries would add richness to the phenomena and associations described here. Further this study used interviews and content analysis to examine the phenomena-of-interest. Additional research based on other methods, for example, field observations, survey instruments, and action research might yield new insights about the proposed framework. Actually, smartphones, social networks, sensors, smart meters, Internet of things (IoT), Cloud computing, etc., are all new technologies that make life much easier, by collecting a maximum of data about the patients, in order to conceive services fully adapted to their needs. Massive data is, therefore, being produced at exponential rate worldwide, all these elements motivate the use of comprehensive ontologies and semantic technologies to address these new challenges on data privacy.

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